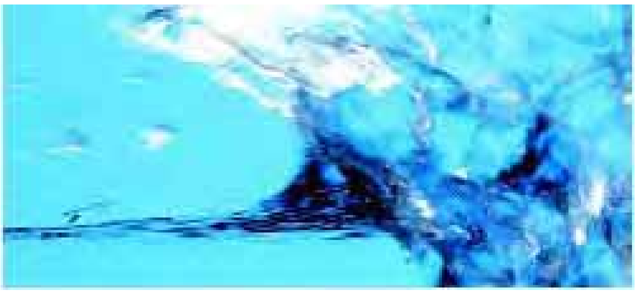
The Department of Water, Land and Biodiversity Conservation



Aquifer Storage Capacities of the Adelaide Region

TODD HODGKIN

Report DWLBC 2004/47

Government of South Australia

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Foreword

South Australia's natural resources are fundamental to the economic and social well-being of the State. One of the State's most precious natural resources, water is a basic requirement of all living organisms and is one of the essential elements ensuring biological diversity of life at all levels. In pristine or undeveloped situations, the condition of water resources reflects the equilibrium between, rainfall, vegetation and other physical parameters. Development of these resources changes the natural balance and may cause degradation. If degradation is small, and the resource retains its utility, the community may assess these changes as being acceptable. However, significant stress will impact on the ability of the resource to continue to meet the needs of users and the environment. Understanding the cause and effect relationship between the various stresses imposed on the natural resources is paramount to developing effective management strategies. Reports of investigations into the availability and quality of water supplies throughout the State aim to build upon the existing knowledge base enabling the community to make informed decisions concerning the future management of the natural resources thus ensuring conservation of biological diversity.

Bryan Harris
Director, Knowledge and Information Division
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CONTENTS

LIST OF TABLES

GLOSSARY

artesian	A condition of confined aquifers where the potentiometric surface exceeds the natural ground surface, such that a well intersecting the aquifer at this point produces free flowing groundwater.
available storage head	The term used in this report to describe the calculated water level rise above the aquifer groundwater levels of autumn 2003 associated with either the sub-artesian or artesian storage scenarios.
confined aquifer	An aquifer bounded above and below by impervious layers or layers of distinctly lower hydraulic conductivity. In confined aquifers, the groundwater pressure is usually higher than atmospheric and the water level in wells are above the elevation of the top of the aquifer.
elastic storage	That proportion of water stored in a confined aquifer by pressure but not that volume of water which would freely drain under the influence of gravity if the aquifer was unconfined.
fracture pressure	The term used in this report to describe the level of pore water pressure that, when applied to a confined aquifer, would be greater than the effective stress present at the top of the aquifer, thus causing the rupturing or failure of the overlying confining bed and strata.
hydraulic conductivity (K)	A measure of the ability of an aquifer to transmit fluid. A high K value indicates high groundwater flow conditions. Units are typically in m/day. K is the constant of proportionality in Darcy's law , and is a function of both the porous medium and the fluid.
karstic	Term applied to carbonate aquifers having irregular and large pore spaces and vughs caused by the dissolution of aquifer material, typically of very high hydraulic conductivity.
potentiometric surface	An imaginary surface representing the static head of groundwater and defined by the water level in wells tapping into the aquifer. In an unconfined aquifer the potentiometric surface is the water table which is in equilibria with atmospheric pressure. In confined aquifers the potentiometric surface is the hypothetical surface the water would equilibrate to if not confined. Also known as the piezometric or pressure surface.
storage coefficient (S)	The storage coefficient is the volume of groundwater stored or released from a column of aquifer with unit cross section under a unit change of head. Storage coefficient is dimensionless and also known as storativity.
specific storage (S_s)	The storage coefficient for a unit volume of aquifer, representing the amount of water stored or expelled from storage owing to compressibiltiy of the mineral skeleton and the pore water per unit change in head. Also known as the elastic storage coefficient.
specific yield (S_y)	The storage coefficient of unconfined aquifers, representing the amount water that can readily drain or fill the pore spaces of the aquifer as the water table falls or rises.
sub-artesian	Confined but non-overflowing groundwater conditions.
transmissivity (T)	A measure of the amount of water that can be transmited horizontally by the full saturated thickness of the aquifer under a hydraulic gradient of 1. Transmissivity is the product of hydraulic conductivity (K) and the saturated aquifer thickness (b).
unconfined aquifer	Aquifers which have no upper confining layer so the standing water level represents the water table determined by atmospheric pressure.
water table	The groundwater levels of an unconfined aquifer. Also known as the phreatic or free surface.

SI UNITS COMMONLY USED WITHIN TEXT

Name of unit	Symbol	Definition in terms of other metric units	
Millimetre	mm	10^{-3} m	length
Metre	m		length
Kilometre	km	10^{3} m	length
Hectare	ha	10^{4} m^{2}	area
Microlitre	µL	10^{-9} m^{3}	volume
Millilitre	mL	10^{-6} m^{3}	volume
Litre	L	10^{-3} m^{3}	volume
Kilolitre	kL	1 m^{3}	volume
Megalitre	ML	10^{3} m^{3}	volume
Gigalitres	GL	10^{6} m^{3}	volume
Microgram	µg	10^{-6} g	mass
Milligram	mg	10^{-3} g	mass
Gram	g		mass
Kilogram	kg	10^{3} g	Mass

Abbreviations Commonly Used Within Text

Abbreviation		Name	Units of measure
TDS	=	Total Dissolved Solids *(milligrams per litre)*	mg/L
EC	=	Electrical Conductivity *(micro Siemens per centimetre)*	µS/cm
PH	=	Acidity	
δD	=	Hydrogen isotope composition	°/oo
CFC	=	Chlorofluorocarbon *(parts per trillion volume)*	pptv
δ^{18}O	=	Oxygen isotope composition	°/oo
^{14}C	=	Carbon-14 isotope *(percent modern Carbon)*	pmC
Ppm	=	Parts per million	
Ppb	=	Parts per billion	
ASR	=	Aquifer Storage and Recovery	
ASTR	=	Aquifer Storage Transfer and Recovery	
DWLBC	=	Department of Water, Land and Biodiversity Conservation	
EPA	=	Environment Protection Authority	
EP(WQ)P	=	Environment Protection (Water Quality) Policy	
EWR	=	Environmental Water Requirement	
EWP	=	Environmental Water Provision	
GDE	=	Groundwater Dependent Ecosystem	
K	=	hydraulic conductivity	
km^{2}	=	square kilometres	
L/sec	=	Litres per second	
mAHD	=	metres in Australian Height datum	
mbgl	=	metres below ground level	
mg/L	=	milligrams per Litre	
NABCWMB	=	Northern Adelaide and Barossa Catchment Water Management Board	
NAP	=	Northern Adelaide Plains	
OCWMB	=	Onkaparinga Catchment Water Management Board	
PWA	=	Prescribed Well Area	
PCWMB	=	Patawalonga Catchment Water Management Board	
Q4	=	4th Quaternary sedimentary aquifer intersected below ground	
T1	=	1st Tertiary sedimentary aquifer intersected below ground	
T2	=	2st Tertiary sedimentary aquifer intersected below ground	
TCWMB	=	Torrens Catchment Water Management Board	
USI	=	Urban Stormwater Initiative	
WAP	=	Water Allocation Plan	
WPAS	=	Waterproofing Adelaide Strategy	
WWTP	=	wastewater treatment plant	

EXECUTIVE SUMMARY

Background and Methodology

Modelling of long-term historical surface water flows by Clark (2003) indicates that an average of about 174 000 ML/year may be available for capture, storage and subsequent re-use. The challenge is to identify appropriate storage, treatment and delivery to demand centres for this stormwater runoff. The deep Tertiary aquifers beneath metropolitan Adelaide provide an ideal storage mechanism through the use of Aquifer Storage and Recovery (ASR) technology to inject, and later recover the water to meet potential demand. There are currently 22 operational projects injecting about 2000 ML/year of treated stormwater into various aquifers. Another five schemes are planned for imminent development, which will increase the maximum injection volumes to about 3900 ML/year.

There are a number of constraints to the viability of ASR and the unit cost per kilolitre of water is likely to be a significant factor contributing to the uptake of this technology as a means to augment available water supplies, particularly across the urban landscape. However, one advantage of ASR is that low cost options such as incorporating wetlands to capture and treat the water prior to injection can be developed first. More costly options that may incorporate greater infrastructure such as water towers or large concrete box drains beneath median strips with associated mechanical filtration can be developed in stages as cost benfits per unit of water become more favourable. These options present opportunities to locate ASR schemes close to demand centres, limiting any associated costs of additional piping infrastructure if the water is not going to be treated to the same level as potable supplies.

Key questions regarding the future of ASR in Adelaide are "what is the capacity of the aquifers to store significantly more water?'' and "what are the environmental issues and risks faced by ASR proponents?" Driven by the objectives and resources of the Water Proofing Adelaide Strategy and the Urban Stormwater Initiative, this study provides the answers to these questions.

Only the storage capacities of the major sedimentary aquifers (Q4, T1, T2, Port Willunga Formation and Maslin Sands aquifers) have been evaluated as the highly variable nature of fractured rock aquifers prevent their reliable quantification at a regional scale. The **additional** storage capacities **above** the 2003 groundwater levels have been evaluated and analysed for two key scenarios; **i).** a **sub-artesian** scenario, in which groundwater level rises are limited to within 2 m below ground to avoid the creation of artesian flows in surrounding wells, and **ii).** an artesian scenario, in which groundwater levels (potentiometric surfaces) above ground level were used. The City of Salisbury has already demonstrated that multiple ASR schemes utilising artesian storage conditions are achievable. Volumes of groundwater already held within the confined sedimentary aquifers under pressure (elastic storage) **below** the 2003 levels were also evaluated.

Environmental Issues

The key environmental issues and potential risks associated with further ASR development in the Adelaide region are:

- Reduced stream flows arising from excessive harvesting of runoff in drainage systems where the environmental water requirements of any dependent surface or groundwater ecosystems has not been quantified;
- Excessive water table rises in unconfined or semi-confined aquifer domains;
- Groundwater discharge to land from shallow or fractured rock aquifer areas in areas of moderate to steep relief; and
- Conformance of ASR projects with the Environment Protection (Water Quality) Policy.

Results

The aquifer storage capacity datasets generated by this study are applicable to regional or district-scale areas. For smaller project-scale areas (less than about 50 km^2), storage capacity estimates should be refined by individual proponents using local conceptual hydrogeological models and/or groundwater flow modelling.

For **all evaluated sedimentary aquifer areas**, the total additional storage capacity is about 19 000 ML for the sub-artesian scenario and 79 000 ML for the base case artesian scenario. These volumes are considered to be accurate to about +/- 30% and rely upon a uniform specific storage value of 9.0E-6 for all aquifers. Importantly, the additional aquifer storage capacities within the Onkaparinga and Northern Adelaide and Barossa catchment water management board areas are likely to exceed the potential supply from stormwater runoff. Extensive development of ASR in these areas may thus be reliant upon the future use of reclaimed water.

The volume of groundwater already held as elastic storage within the confined sedimentary aquifers is estimated to be about 96 000 ML. Abstraction of such native groundwater prior to the first ASR injection cycle to increase the storage capacity may be a favourable ASR option in brackish or saline aquifer areas, as there are few, if any, existing groundwater users in such areas. However, it is unlikely that large proportions of this capacity is likely to be ever realised for ASR due to the potential for adverse impacts on adjacent groundwater users that the required additional abstraction would generate. For fractured rock aquifer domains within and immediately adjacent to the evaluated sedimentary basins, the conceptual additional ASR storage capacity is considered to be of the order of 1 000 to 1 500 ML

The additional storage capacities of the major sedimentary aquifers were refined to exclude those areas where the aquifer is potentially unconfined or has unfavourably low combinations of available storage heads and transmissivity. The resultant reduction for the sub-artesian scenario is only minor, the total capacity being lowered from about 19 000 to 17 000 ML. A refined artesian scenario volume is not as readily quantified, but may be at least 53 000 ML (two-thirds of the total area capacity).

Maps showing an aquifer ASR ranking system for the sub-artesian and artesian storage scenarios have been prepared to highlight the various areas where favourable aquifer domains coincide with potential source water and ASR demand centres. A conceptual limit to the magnitude of achievable ASR storage across the Adelaide region within the major sedimentary aquifers under a mix of sub-artesian and artesian storage, inclusive of the potential from existing elastic storage and fractured rock aquifer domains, is about 25 000 to 50 000 ML. Given Adelaide's current water demand of about 300 000 ML/year, ASR schemes within the evaluated aquifers have the potential to meet about 17% of total demand.

Recommendations and Further Work

1. Integration of the results of this study with existing economic evaluations of the potential for stormwater harvesting to identify suitable **individual** ASR sites that coincide with preferred aquifer domains.
2. Improve the understanding of current levels of groundwater use (and hence ASR demand potential or artesian-ASR limitations) within the unprescribed parts of the metropolitan area.
3. Development of a groundwater flow model incorporating all existing and planned ASR projects in the Adelaide Plains Sub-Basin to;
   I. better identify the limits of artesian conditions and hence predict more accurately the buffer zones needed around existing users of the T1 and T2 aquifers to prevent adverse impacts; and
   II. to reconcile the storage capacity estimates of this study.
4. Accelerate consultation between the EPA, DWBLC, catchment boards and existing ASR operators to resolve the ASR issues affected by the Environment Protection (Water Quality) Policy.
5. From an ASR perspective, prioritise the evaluation and quantification of environmental water requirements and provisions of the Willunga Basin creeks south of (and including) Pedler Creek, the Little Para River, Dry Creek, Smith Creek and Cobbler Creek systems ahead of other drainage systems.
6. Owners of any new wells drilled in the future proposing large-scale abstraction (ASR or not), should be encouraged to install a monitoring well and perform a constant-rate aquifer test that permits the evaluation of aquifer storativity.

1 INTRODUCTION

Aquifer Storage and Recovery (ASR) has become a significant tool of alternative water resource management in the Adelaide region during the past decade. At present, there are about 22 operational ASR projects injecting between 1100 to 2300 ML/year of rural and urban stormwater runoff.

In addition to stormwater runoff as a source water for ASR, the use of treated effluent is currently being trialled at the Bolivar wastewater treatment plant.

Most end uses of ASR water to date have been for irrigation and industrial purposes. However, an ASR trial at the Greenfields Railway Station site has recently commenced to examine the potential for recovering pre-treated stormwater injectant to produce supplies of high quality drinking water.

The continuing adoption of proven ASR technology, and recent investigations into alternative source water supplies and beneficial end uses, have the potential to increase the contribution of ASR as an alternative water supply measure by at least an order of magnitude above current levels of injection. Under this growth scenario, the storage capacities of targetted aquifers in the Adelaide region may become a constraint to ASR development. The capacity of the aquifer systems to store ASR water is not well known, especially in the main urbanised areas of Adelaide where abstraction of groundwater is unprescribed.

The opportunity to review available hydrogeological data and evaluate aquifer storage capacities for ASR has arisen through the resources and objectives of the Waterproofing Adelaide Strategy (WPAS) and the Urban Stormwater Initiative (USI). These programmes seek to better understand the contribution water re-use may have to Adelaide's future water resource management. The main water management boundaries of the study area are shown on Figure 1.

Evaluation of aquifer storage capacities commenced in late February 2004 and concluded in October 2004. Only the storage capacities of the major sedimentary aquifers have been quantified. This has been achieved by:

1. Evaluation of the **additional** aquifer storage capacities **above** the groundwater levels present in autumn 2003 for two main scenarios:
    I. a **sub-artesian** scenario, in which groundwater level rises are limited to within two metres of the natural ground surface; and
    II. an **artesian** scenario, in which groundwater level rises **above** ground were determined base on percentages of safe fracture pressure levels.
2. Quantification of the volumes of groundwater held under pressure (elastic storage) within the confined aquifer systems as of autumn 2003.

Additionally, an important aspect of the study is to consider the environmental risks associated with existing and potential ASR projects, especially in relation to the recently released Environment Protection Policy (Water Quality). This policy came into effect on 1st October 2003 and aims to manage the quality of all surface, ground and marine waters across the state and protect these resources from potential pollution.

2 OBJECTIVES

The evaluation of aquifer storage capacities and assessment of ASR-related environmental issues will resolve key uncertainties regarding the future role of ASR in the Adelaide region. Resolution of these factors should provide greater assurance to proponents of ASR.

In summary, the study objectives comprise:

- Evaluation, and quantification where possible, of the maximum additional storage capacity of favourable aquifers for ASR.
- Provision of an updated status of existing and proposed ASR projects and current ASR licensing issues.
- Broad-scale identification of preferred aquifer domains for ASR, likely source water volumes and potential medium to large-scale ASR users.
- Assessment of environmental issues associated with ASR and delineation of any areas considered potentially unsuitable for ASR from an environmental perspective.
- Consideration of preferred aquifer areas, environmental and source water restrictions to refine the likely ASR storage volumes.
- Identification of key issues regarding ASR licensing and conformance with the EP(WQ)P that require further consideration by the Department of Water, Land and Biodiversity Conservation (DWLBC) and the Environmental Protection Authority (EPA).
- Identification of key knowledge gaps and provision of recommendations for any future work.

The focus of the study has been on those aquifer systems considered suitable for medium to large-scale ASR projects. The aquifer potential for small-scale (about 2 – 20 ML/year) projects, or even smaller domestic-scale projects, has not been expressly evaluated. Such projects may be preferentially realised in the shallower Quaternary aquifers present throughout most of the study area.

3 BACKGROUND

This section provides a brief background to the development of ASR in the Adelaide region and presents summary information regarding the current suite of ASR projects and status of current ASR licensing arrangements. Much of the section has been sourced from Martin, R. and Dillon, P (2002) – Aquifer Storage and Recovery – Future Directions for South Australia.

3.1 ASR Development in the Adelaide Region

ASR has been defined by Pyne (1995) as "the storage of water in a suitable aquifer through a well during times when the water is available, and recovery of the water when it is needed." The concept of ASR for a confined aquifer system is displayed schematically on Figure 2.

ASR is one form of groundwater recharge enhancement, used to provide additional water supplies and improve water resource management. Other forms include:

- infiltration basins, in which water is directed into relatively large but shallow holding ponds to promote the infiltration of water beneath the base of the ponds to a shallow watertable aquifer; and
- bank filtration, whereby pumping wells adjacent to a watercourse induce recharge from the stream into the shallow aquifer.

A comparison of the various groundwater recharge enhancement methods is given in Martin and Dillon (2002).

In the Adelaide region, ASR by recharge wells has developed as the main form of groundwater recharge enhancement due to the combination of several factors, notably the presence of suitable deep confined aquifers, restricted availability of open space and a lack of suitable water table aquifers.

Development of ASR in the Adelaide region effectively commenced in the early 1990's when Dillon and Pavelic (1996) established guidelines for the quality of stormwater for aquifer injection. This work included trial injections at Andrews Farm, an urban development in the Northern Adelaide Plains (NAP) region, using an artificial wetland as the key component of stormwater capture, storage and pre-treatment.

Following the success of Andrews Farm, CSIRO and DWLBC (previously as the Department of Water Resources and DENR) undertook numerous investigations and trials in the mid-to-late 1990s. Many of these investigations included the co-operative involvement of local governments, particularly the City of Salisbury, with trials at The Paddocks, Greenfields, and Kaurna Park. Other sites investigated during this period include Regent Gardens in the metropolitan area and about eight sites in the Willunga Basin.

In the late 1990s, as successful ASR trials became operational sites, the research and trial focus of ASR switched to ASR with treated effluent from wastewater treatment plants (WWTP's). In 1997, a consortium comprising United Water, SA Water, CSIRO, DWLBC and the Department for Administrative and Information Services (DAIS), commenced a major research project into the feasibility of injecting reclaimed water from the Bolivar WWTP for subsequent recovery as irrigation water for the surrounding horticultural industry. This project is well advanced and is at the leading international edge of ASR research.

An ASR trial injecting reclaimed water from the Christies Beach WWTP into limestone aquifers of the nearby Willunga Basin also commenced in 2001. Further developments are pending the results of the Bolivar project.

The advent of ASR resulted in the preparation of a Code of Practice for Aquifer Storage and Recovery by the Environment Protection Agency (EPA). The code was prepared with the assistance of DWLBC and issued as a final document in January 2004. It is intended to assist proponents of ASR develop projects that are technically sound and compliant with the needs of environmental protection. A schematic depiction of an ASR project with multiple barriers to pollution is shown on Figure 3.

The most recent developments in ASR research in the study area are:

- The commencement of an Aquifer Storage Transfer and Recovery (ASTR) trial at the Greenfields Railway Station site to investigate the feasibility of using aquifer attenuation to enable development of drinking water supplies from pre-treated stormwater injectant. CSIRO are leading the trial in partnership with SA Water, United Water and the City of Salisbury. The distinction in the definition of ASTR versus ASR is that a separate recovery well is used for ASTR as opposed to the same well for injection and recovery for ASR (Rinck-Pfeiffer et al, 2004).
- Proposed injection trials within an unconsolidated sand aquifer (Carisbrooke Sand) at the Urrbrae wetland site. Project participants include CSIRO and the Patawalonga Catchment Management Board.

3.2 Current ASR projects

In the period around 2001, Martin and Dillon (2002) estimated there were eight operational ASR sites in the Adelaide region, injecting about 680 ML/year.

As part of this study, a review of operational and investigation sites was undertaken utilising published reports, current licensing records and discussions with various operators and consultants. The locations of the updated sites are shown on Figure 4, which highlights the current status of investigation sites. Investigation sites are considered to be definitive projects that have undertaken desktop pre-feasibility assessments, conducted field investigations or performed injection trials.

Table 1 presents summary information for the 22 ASR sites currently operational in the Adelaide region, whilst Table 2 presents details for ASR investigation sites that are likely to become operational in the near future. Other key details for these operations and investigation sites are included as Appendix A.

Table 1. Operational ASR Projects – Summary Details

Project	Average or Design Injection Volumes (ML/year)	Year Operation Commenced	Aquifer
Aldinga Scrub	5	2000	Port Willunga Formation
Andrews Farm (Stebonheath Park)	100	1993	T2 (Port Willunga Formation limestone)
Bruschi	60	1999	Port Willunga Formation
Buttery	9	1998	Port Willunga Formation (sand)
Kaurna	150	1999	T2 (Port Willunga Formation limestone)
Mildara Blass	4	2001	Port Willunga Formation (sand)
Morphetville Racecourse	*640*	2003	T1 (Port Willunga Formation limestone)
New Brompton Estate	0.75	1996	Quaternary (sand)
Northgate	75	2001	Fractured Rock
Osborne FR	12	1998	Fractured Rock
Paddocks Wetland	75	1998	T1 (Port Willunga Formation limestone)
Parafield Airport	*550*	2003	T2 (Port Willunga Formation limestone)
Parfitt Square	1.5	1997	Quaternary (sand)
Pine Lakes	*45*	2004	T2 (Port Willunga Formation limestone)
Pooraka Triangle	*100*	2004	T2 (Port Willunga Formation limestone)
Priest	20	1994	Fractured Rock
Regent Gardens	60	1998	Fractured Rock
Scotch College, Brownhill Creek	40	1989	Fractured Rock
St Elizabeths Anglican Church	1	1997	Quaternary (sand)
Tea Tree Gully Golf Course	*50*	2000	Fractured Rock
Thorpe	1	2001	Port Willunga Formation
Torrens Valley Sportsfield	*40*	2003	Fractured Rock
Vines Golf Course	5	2002	Fractured Rock
Total	**2 044**		

Note – figures in italics represent design injection volumes for those projects that have only recently commenced

Table 2. Imminent ASR Projects – Summary Details

Project	Design Yield (ML/year)	Aquifer
Osborne MS	23	Maslin Sands
Flagstaff Hill Golf Club	35	Fractured Rock
Barker Inlet Wetlands	350	T2 (Port Willunga Formation limestone)
Greenfields Wetland	500	T1 (Port Willunga Formation limestone)
Civic Park	20	Fractured Rock
Edinburgh Park	750	T2 (Port Willunga Formation limestone)
Total	**1 678**	

Table 1 shows that about 2 000 ML/year is currently being injected across the study area, notably in the NAP region at projects under the management of the City of Salisbury. Based on historical data from sites that have been operational for several years, the maximum injected total volume is of the order of 2 300 ML/year.

Table 2 shows that there are six ASR investigation sites that are likely to become operational in the next 18 months, which should increase the amount of stormwater injected by about 1 700 ML/year. The two largest sites (Greenfields Wetland and Edinburgh Parks) are managed by the City of Salisbury, who consider that up 26 000 ML/year of stormwater re-use (not necessarily all injected into aquifers) may be ultimately feasible within the NAP region (C. Pitman, pers. comm.).

3.3 Current Licensing Arrangements

As described by Martin and Dillon (2002), the licensing arrangements of an ASR project can be complex as a result of the influence of three separate pieces of legislation:

1. The *Environment Protection Act 1993*, administered by the EPA, which is concerned with the quality of water stored and recovered.
2. The *Water Resources Act 1997*, administered by the DWLBC, which controls the construction of wells, drainage of water into wells and the extraction of water from wells within prescribed areas.
3. The *Development Act 1993*, administered by local governments, which may require approvals for some components of an ASR project. For example, a storage dam with a wall height in excess of three metres, requires planning approvals under this Act.

Within the Adelaide metropolitan area, the EPA will licence an ASR project as a ‘prescribed activity of environmental significance’ if discharge of stormwater to the aquifer occurs from a catchment area of more than one hectare or if the stormwater has been chemically treated. The metropolitan area for this purpose is defined as the metropolitan planning area from the *Development Act 1993*, which is shown on Figure 4.

There are potential exceptions to the EPA criteria outlined above for ASR licensing according to existing arrangements between the DWLBC and EPA. The arrangement is based on a distinction that the EPA will licence those projects where the stormwater comes from stormwater drains and other infrastructure and DWLBC will be responsible for all licensing in rural areas where the stormwater originates from natural watercourses.

Regardless of whether a project is licensed by the EPA, all ASR projects must secure two permits and possibly one licence from the DWLBC:

1. A Well Permit to enable drilling and construction of each water well.
2. A Drainage Permit to allow drainage of water into a well.
3. If within a Prescribed Well Area (PWA), an extraction licence must also be secured to allow recovery of stored water. Extraction of groundwater in such areas is controlled by Water Allocation Plans (WAP), which are administered by the Catchment Water Management Boards in partnership with the DWLBC. ASR projects within a PWA are issued with credits to reflect the fact that they are not abstracting entirely from the native groundwater resource.

Within a PWA, an ASR project may be subject to other regulatory criteria, such as upper limits on the quantity of recovered water in relation to the volume injected (currently 75% within the McLaren Vale PWA and 80% within the Northern Adelaide Plains PWA) and prescribed groundwater monitoring as outlined in the WAP.

A key current issue in the licensing and compliance requirements of ASR projects has been the development of the Environment Protection (Water Quality) Policy 2003 [EP(WQ)P] by the EPA. Authorised on the 10 April 2003, the EP(WQ)P is designed to provide a consistent state-wide approach to the protection of water quality for all inland surface, groundwater and marine water bodies. The policy covers a range of issues, including:

- Water quality objectives;
- Management and control of point and diffuse sources of pollution;
- Obligations relating to particular activities; and
- Water quality criteria, discharge limits and listed pollutants.

The protection of native groundwater quality should be a key aspect of all ASR design considerations. Barriers to pollution of native and recovered groundwater used by ASR projects to date are shown schematically on Figure 5.

The EP(WQ)P is discussed in more detail in section 7.1.3.

4 REGIONAL HYDROGEOLOGY

4.1 Geology and hydrostratigraphy

The study area occurs mainly within the St Vincent Basin, an intracratonic sedimentary basin formed by rejuvenated Palaeozoic faults during the continental separation of Australia and Antarctica in the Eocene (Cooper, 1979). Basin strata are up to 700 m thick and were laid down in a shallow graben bounded by folded and block-faulted Proterozoic and Palaeozoic rocks (Drexel and Priess, 1995).

St Vincent Basin has been subdivided into several sub-basins, the largest being the Adelaide Plains Sub-basin (Fig. 6). The Golden Grove, Noarlunga and Willunga Embayments are asymmetric tectonic valleys in which the wedge of sediments dip gently southwards and thickens towards their faulted southeastern margins (Drexel and Priess, 1995).

The major stratigraphic and equivalent hydrostratigraphic units of the St Vincent Basin are presented in Table 3.

Throughout each embayment of the St Vincent Basin, the Tertiary sedimentary aquifers constitute the largest and most important groundwater resource in terms of general use and also for ASR projects developed to date.

The Quaternary aquifers are relatively thin and of limited extent. They have typically been developed for abstraction by small-scale users for stock and domestic purposes in favourable areas. In terms of ASR potential, these aquifers may be better suited to localised small-scale or domestic-scale projects that are outside the focus of this study.

Fractured rock aquifers are often limited in extent and typically exhibit high transmissivities and low storage capacities, reducing their overall ASR potential.

As a consequence of the reduced potential of the Quaternary and fractured rock aquifers, this study limits the estimation of aquifer storage capacities to the main Tertiary sedimentary aquifers, which comprise:

- Willunga Embayment
  - Port Willunga Formation Aquifer
  - Maslin Sands Aquifer

Both these aquifers predominantly occur as confined systems but also as semi-confined or unconfined systems in the northern areas where Quaternary sediments are absent and the Tertiary sediments outcrop.

- Golden Grove Embayment
  - T1 Aquifer
  - T2 Aquifer

The hydrostratigraphy of the Golden Grove Embayment is complicated by the degree of faulting and lateral facies changes present in the embayment. Several geological units

Table 3. Stratigraphy and Hydrostratigraphy of St Vincent Basin

AGE		WILLUNGA & NOARLUNGA EMBAYMENT			GOLDEN GROVE EMBAYMENT			ADELAIDE PLAINS SUB-BASIN		
		Stratigraphy	Hydrostratigraphy	Description	Stratigraphy	Hydrostratigraphy	Description	Stratigraphy	Hydrostratigraphy	Description
Quaternary	Holocene	Sempaphore Sand, modern alluvium and beach gravels	Quaternary Aquifer	Thin shallow sandy unconfined and semi-confined aquifers. Confining bed over much of the embayment.	Sempaphore Sand, modern alluvium and beach gravels	Unconfined Aquifer	thin sand aquifers rstriced mainly to coastal areas	Sempaphore Sand, modern alluvium and beach gravels	Unconfined Aquifer	thin sand aquifers near coast
		Ngankipari Sand						Saint Kilda Formation	Unconfined Aquifer	thin sand, shell aquifers near coast
	Pleistocene	Christies Beach Formation			Pooraka Formation	Aquitard		Pooraka Formation	Aquitard	
		Kurrajong Formation			Keswick Clay	Aquitard		Glanville Formation	Aquitard	
		Ngaltinga Formation			Hindmarsh Clay	Aquitard, Q1 - Q5 Aquifers	predominantly clay aquitard with interbedded thin sandy confined aquifers	Hindmarsh Clay	Aquitard, Q1 - Q6 Aquifers	predominantly clay aquitard with interbedded thin sandy confined aquifers
		Ochre Cove Formation								
		Seaford Formation								
	Pleistocene / Pliocene?	Burnham Limestone			Carisbrooke Sand	T1 or T1A Aquifer	thin sandy mainly confined aquifer with resticted extent	Carisbrooke Sand	Q4 Aquifer	significant in eastern side of NAP PWA
Tertiary	Pliocene	Hallet Cove Sandstone	?	?	Hallet Cove Sandstone and Dry Creek Sand		thin sand y confined aquifer restrcted to western areas	Hallet Cove Sandstone and Dry Creek Sand	T1 Aquifer: T1A Aquifer	confined sandy aquifer, thickening to the south-west
					Croydon Facies		semi-confining bed	Croydon Facies		semi-confining bed
	Miocene to Oligocene	Port Willunga Formation; Pirramimma Sand Member	Port Willunga Formation Aquifer	Confined aquifer in southern area, unconfined elsewhere	Port Willunga Formation: upper limestone	T1 or T1B Aquifer	to arae between Para Fault splinters	Port Willunga Formation: upper limestone	T1 Aquifer: T1B Aquifer	confined aquifer, thickening to south ansn south-west
					Munno Para Clay Member	Aquitard	confining bed limited to western areas	Munno Para Clay Member	Aquitard	confining bed, absent in north of NAB PWA
					lower limestone (Pirramimma Sand Member)	T1 or T2 Aquifer	confined aquifer , extent limited to south-west areas	lower limestone (Pirramimma Sand Member)	T2 Aquifer	thick confined aquifer, sandy and thinning in north and north-east of NAB PWA
		Ruwarung Member			Ruwarung Member (Pirramimma Sand Member)	Aquitard	mainly confining bed, restricted extent	Ruwarung Member (Pirramimma Sand Member)		
		Aldinga Member			Aldinga Member	T1, T2 or T3 Aquifer, Aquitard	variable sand and clay unit	Aldinga Member		
	Eocene	Chinaman Gully Formation	Aquitard	Confining bed	Chinaman Gully Formation	T1, T2 or T3 Aquifer, Aquitard	variable sand and clay unit	Chinaman Gully Formation	Aquitard, T3 Aquifer	occurrence as a thin sandy aquifer
		Blanche Point Formation: Tuit Member	Aquitard	Confiing bed over southern half of embayment, aquifer to aquitard elsewhere	Blanche Point Formation	Aquitard	mainly confining bed	Blanche Point Formation	Aquitard	mainly confining bed
		Perkana Member								
		Gull Rock Member								
		Tuketja Member								
		Tortachilla Limestone	Aquitard		Tortachilla Limestone	T1 - T4 Aquifer	thin confined aquifer	Tortachilla Limestone	T4 Aquifer	thin confined aquifer
		South Maslin Sand	Maslin Sands Aquifer	Confined aquifer over most of extent, unconfined along northern extent	South Maslin Sand		thin confined aquifer, thickest in north east areas	South Maslin Sand		
		North Maslin Sand			Clinton Formation	Aquitard	confining bed , restricted extent	Clinton Formation	Aquitard	confining bed , restricted extent
					North Maslin Sands	T1 or T4 Aquifer	thin confined sandy aquifer	North Maslin Sands	T4 Aquifer	confined sandy aquifer
Permian		Cape Jervis Formation	Aquitard		-			-		
Cambrian		undifferentiated	Fractured Rock Aquifer	mostly localised confined or semi-confined aquifers	-			-		
Proterzoic		Undifferentiated Adelaidean			Undifferentiated Adelaidean	Fractured Rock Aquifer	mostly localised confined or semi-confined aquifers	Undifferentiated Adelaidean	Fractured Rock Aquifer	mostly localised confined or semi-confined aquifers

thus often form a single aquifer system. A significant portion of the T1 aquifer occurs as semi-confined or unconfined sandy aquifers in the northern and northeastern areas of the embayment.

- Adelaide Plains Sub-basin
  - Q4 Aquifer
  - T1 Aquifer
  - T2 Aquifer

The hydrostratigraphy of the Adelaide Plains Sub-basin uses the same nomenclature as the Golden Grove Embayment but is less complex because of the greater aquifer continuity and uniformity. The Q4 aquifer consists entirely of the sandy Carisbrooke Sand formation, which may be of late Tertiary age, and is often in direct hydraulic connection with the underlying T1 Aquifer.

The T1 Aquifer can be subdivided into two sub-aquifers, which, whilst often in direct hydraulic connection, have different lithological properties. The T1B sub-aquifer is a sandy unit and requires well screening, whilst the T1B sub-aquifer occurs as semi-consolidated or consolidated limestones. The T1B sub-aquifer is preferred by many groundwater users as a result of typically higher well yields and the ability to complete the well with an open-hole production interval.

4.2 Hydrogeology

4.2.1 WILLUNGA EMBAYMENT

The Willunga Embayment is a wedge-shaped basin containing Quaternary and Tertiary sediments that reach a maximum thickness of about 350 m in the southern and southeastern areas. The sediments pinch out against basement rocks along the northern boundary of the McLaren Vale PWA and the Willunga Fault to the east (OCWMB, 2000).

Bowering (1979) undertook a review of the hydrogeology of the Willunga Embayment at about the same time as the Tertiary stratigraphy was investigated by Cooper (1979). The hydrostratigraphy shown in Table 2 is effectively that of Bowering, whilst the stratigraphy is a combination of the work of Cooper (1979) and May (1992).

A schematic cross-section showing the extent of the four main aquifer systems along the main axis of the Willunga Embayment (northeast – southwest) is shown on Figure 7.

Quaternary Aquifer

The Quaternary Aquifer system comprises relatively thin unconfined, semi-confined and perched aquifers within a dominantly clayey assemblage throughout the southern half of the Willunga Embayment. The thickness of Quaternary sediments is variable but commonly reaches about 20–30 m in the southern areas of the embayment, where they form confining beds above the Port Willunga Formation Aquifer.

Port Willunga Formation Aquifer

The Port Willunga Formation Aquifer comprises sand and limestone of the Port Willunga Formation and is generally high yielding. It is unconfined in a relatively narrow strip about two to three kilometres wide near McLaren Vale and McLaren Flat (Martin, 1998). South of here, the aquifer is confined and increases in thickness to about 160 m at the southern and southeastern margins.

In the southwest of the embayment the aquifer lithology is dominated by limestones of the Aldinga Member, which Cooper (1979) defined as variable shelly and bryozoal clays, silts and sands, and limestones which are fawn, yellow-brown and grey in colour. In areas further inland, the aquifer is predominantly sandy, and occurs mainly as the Pirramimma Sand; a lateral facies equivalent of the Aldinga Member. Considered to be of marginal marine origin, the Pirramimma Sand consists mainly of weakly cemented, fine-grained quartz sand. Localised calcareous and ferruginous cementation occurs, particularly in the upper beds (Cooper, 1979).

Maslin Sands Aquifer

The Maslin Sands Aquifer is confined beneath the Port Willunga Formation Aquifer by the Blanche Point Formation and Tortachilla Limestone over much of the Willunga Embayment. It also occurs as an unconfined or semi-confined aquifer over a relatively large area to the north and northeast of McLaren Vale. It is bounded underneath and laterally by basement rocks of Cambrian and Proterozoic age.

The Maslin Sands Aquifer comprises the North Maslin Sand and South Maslin Sand, which are in direct hydraulic connection with each other. The North Maslin Sand typically has a greater extent and thickness than the South Maslin Sand. It is of fluvial origin and of variable thickness, consisting of cross-bedded quartz sand (Cooper, 1979). Sorting is poor near the base of the unit but is improved elsewhere. Minor carbonaceous material, pyrite and lignite occur in the upper parts of the North Maslin Sand.

The South Maslin Sand has a marine origin and typically consists of fine and coarse-grained quartz sands with good to moderate sorting and round to sub-rounded constituent grains (Cooper, 1979). In general terms, the South Maslin Sand is thus likely to form a higher yielding aquifer than the North Maslin Sand.

Fractured Rock Aquifer

The Fractured Rock Aquifer in the Willunga Embayment outcrops to the east of the Willunga Fault and along the northern extent of the McLaren Vale PWA near the Onkaparinga Gorge (DWLBC, 2002). The aquifer is highly variable and occurs as multiple localised aquifer systems formed in areas where structural features such as faults and joint sets, lithological contacts and weathering effects enhance the secondary porosity of the rock unit. The aquifers occur predominantly within the Stonyfell Quartzite, Saddleworth Formation, Tapley Hill Formation and equivalent of the ABC Range Quartzite.

In the southwest of the embayment the basement rocks can comprise Permian tillites or Cambrian shales and limestones. These formations act largely as aquitards.

Noarlunga Embayment

The Noarlunga Embayment occurs adjacent to the Willunga Embayment (Fig. 6) and is bounded to the southeast by the Clarendon Fault and to the north and northwest by basement outcrop. As a groundwater resource, the Noarlunga Embayment is significantly smaller than the Willunga Embayment and is dominated by sandy aquifers containing brackish or saline groundwater.

The embayment is not part of the McLaren Vale PWA, consequently groundwater usage is not regulated or understood very well. A hydrogeological investigation of the Noarlunga Embayment was undertaken by Rescignano in 1985. Key points from this investigation include:

- Sediments reach a maximum thickness of about 170 m in the southwest portion of the embayment.
- Shallow Quaternary sands and gravels form thin unconfined and confined aquifers with characteristically low well yields (less than 0.5 L/sec).
- Tertiary sands, largely undifferentiated but including the Maslin Sands and Blanche Point Formation, form mainly confined aquifers beneath the Quaternary sediments.
- The Tertiary aquifers have the lowest salinity, being less than 2000 mg/L Total Dissolved Solids (TDS) in a narrow strip about 1 km wide next to the Clarendon Fault. Elsewhere, the salinities within the aquifers are typically in excess of 3000 mg/L TDS, possibly higher in the southwest of the embayment where there is little or no data.

4.2.2 GOLDEN GROVE EMBAYMENT

The Golden Grove Embayment is defined as that portion of the St Vincent Basin bounded by the Eden-Burnside and Para faults (Fig. 6). The most recent detailed hydrogeological studies of the embayment have been by Gerges (1996 and 1999).

Tertiary and Quaternary sediments within the Golden Grove Embayment thicken to the southwest and reach over 400 m near the coast. However, they are typically only 10–100 m thick north and east of the Central Business District (CBD) and between 100–250 m thick south of the CBD.

Gerges (1996) subdivided the metropolitan area into several zones based on geological setting and the major groundwater abstraction domains. These zones are shown on Figure 8 and have been simplified to show only a zonation based on geological settings.

As identified earlier, the hydrostratigraphy of the Golden Grove Embayment is complicated as a result of erosional and depositional boundaries, lateral facies changes and faulting. Consequently, multiple geological formations can be juxtaposed together and form effectively single aquifer systems, or result in aquifers laterally abutting against aquitards. Examples of the hydrostratigraphic complexity can be seen on the three hydrogeological sections presented on Figures 9 to 11.

The major fault systems are considered to be transmissive in many areas, permitting significant lateral groundwater throughflow from fractured rock aquifers in the Adelaide Hills westwards into the adjoining Tertiary aquifers (Gerges, 1996).

Quaternary Aquifer

Within the Golden Grove Embayment, Quaternary aquifers generally occur as thin confined or semi-confined aquifers within sandy interbeds of the Pooraka Formation or Hindmarsh Clay. These formations are of a Pleistocene age and comprise largely mottled clay and silt of fluvial and alluvial origin. The aquifers have considerable variation in thickness (1–18 m) and extent. Thickness rarely exceeds two to three metres.

Gerges (1996) indicates there are up to three Quaternary aquifers present in Zone 4 and up to five aquifers in Zone 4A and Zone 2. Wells intersecting these aquifers are generally low yielding (<3 L/sec) and variable, reflecting the low aquifer transmissivity and inhomogenity. The most transmissive sections of these aquifers are usually located adjacent to major bedrock structures or surface drainage (for the shallowest aquifers).

The salinity of the Quaternary aquifers is also variable, ranging from less than 500 to about 3500 mg/L TDS. The lower salinity areas usually correlate to the higher transmissivity areas described above.

T1 Aquifer

Within the Golden Grove Embayment, as within the Adelaide Plains Sub-basin, the T1 Aquifer is defined as the shallowest Tertiary aquifer system present. Within the embayment, the T1 Aquifer can consist of any one or several formations of the entire Tertiary sequence (Table 3).

Summary descriptions of the Tertiary strata are presented in Table 4 (after Gerges, 1996).

Within Zone 4, the T1 Aquifer is typically about 25 m thick and dominated by the sandy lithologies of the Carisbrooke Sand, Aldinga Member, Chinaman Gully Formation or undifferentiated sands. The aquifer is predominantly confined but can be semi-confined or unconfined near the River Torrens and in proximity to the Eden-Burnside Fault.

Within Zone 4A, the aquifer is dominated by the same lithological units as in Zone 4 but can also include the South Maslin Sands or undifferentiated sands. Importantly, the aquifer is significantly thicker, reaching a maximum thickness of about 140 m in localised areas close to the Eden-Burnside Fault.

Within Zone 2 east of the inferred Brighton Fault (Fig. 10), the T1 Aquifer can consist of the sandy facies of the Hallet Cove Sandstone, Dry Creek Sand or Ruwarung Member and limestone facies of the Port Willunga Formation. The sandy facies are present throughout the zone, whereas the limestone facies are present only in the western areas.

Within Zone 2A and areas west of the Brighton Fault in Zone2, the T1 aquifer has the same hydrostratigraphy as throughout the Adelaide Plains Sub-basin, which is described in the following section. The aquifer thickness in this region ranges from about 10 – 55 m.

Table 4. Summary Descriptions of St Vincent Basin Tertiary Strata (after Gerges, 1996)

Unit Name and Age	Average Thickness (m)	Lithology and Occurrence	Environment of Deposition
Burnham Limestone	2	Limestone - white and clayey. Occurs in association with Hallett Cove Sandstone.	Marine
Hallett Cove Sandstone and Dry Creek Sand	50	Shelly dark grey to brownish-grey sand, silt and clay. Highly fossiliferous sandstone. Occurs over whole area west of Para Fault in a restricted area between Brown Hill Creek and the coast.	Marine, warm shallow environment
Croydon facies'	10–45	Fossiliferous sand and silt, glauconitic. Thin shelly and sandstone interbeds occur over whole area west of para Fault.	Shallow marine
Port Willunga Formation - upper unit	35	Yellow fossiliferous sand, limestone grading to white hard limestone. Occurs over area west of para Fault and west of Sturt River as a thin strip along the coast.	Shallow warm marine shelves
Munno Para Clay Member (Port Willunga Formation)	12	Dark grey, stiff, calcareous clay. Comprises beds of clay separated by two bands of white to grey limestone.	Warm marine
Janjukian unit (Port Willunga Formation)	20	Sand, pale grey to yellow, silty, occasional limestone-environmental bands. Glauconitic. Occurs west of para Fault and in Golden Grove-Adelaide Embayment possibly south of River Torrens.	Warm marine
Ruwarung Member (Port Willunga Formation)	78	Pale grey interbedded chert-limestone and siltstone. Glauconitic, pyritic. Occurs over the whole area except north of River Torrens in Golden Grove-Adelaide Embayment.	Marine
Aldinga Member (Port Willunga Formation)	36	Clay, stiff, grey to dark grey, carbonaceous. Glauconitic, pyritic. Shell remains grading to sand and silt. Occurrence similar to overlying member. Change to sandy silty facies in an area near Eden-Burnside fault zone.	Marginal marine
Chinaman Gully Formation	12	Grey to black carbonaceous silt and clay. Highly pyritic, lignitic. Sand at the base.	Marginal marine

Unit Name and Age	Average Thickness (m)	Lithology and Occurrence	Environment of Deposition
Blanche Point Formation	50–70	Grey, friable shelly siltstone grading to alternating hard and soft siltstone bands (cherty). Glauconitic, large Turritella shells. Moderately cemented greenish to pale grey, highly glauconitic limestone at the base.	Deep marine
Tortachilla Limestone	3–5	Brown and green, weakly cemented glauconitic limestone.	Marine
South Maslin Sand	20	Dark grey carbonaceous sand and silt. Pyritic and glauconitic.	Marginal marine
Clinton Formation	16	Pale grey, white clay, sandy. Pyritic. Highly carbonaceous, lignite layers.	Marine to non-marine
North Maslin Sand	15	Pale grey, yellow and brown, clayey, silty and gravelly pyritic sand.	Fluviatile, estuarine

Depending on the nature of the bounding faults, the T1 aquifer in the Golden Grove Embayment can be hydraulically connected to fractured rock aquifers along the hills face zone and to Quaternary or Tertiary aquifers west of the Para Fault.

T2 Aquifer

The T2 Aquifer is defined as the second Tertiary aquifer intersected, confined beneath the T1 Aquifer by an aquitard. Like the T1 Aquifer, it is well distributed throughout the Golden Grove Embayment and can consist of various geological units (Table 3). It is generally thinner than the T1 Aquifer.

Within Zone 4, the T2 Aquifer occurs mainly as a confined aquifer comprising sandy beds of the Chinaman Gully Formation and/or South Maslin Sands. The aquifer is relatively thin, ranging from about 3–15 m. Within Zone 4A, there is effectively no T2 Aquifer present.

In Zone 2, the T2 Aquifer mostly comprises the sandy facies of the Aldinga Member and to a lesser degree the Chinaman Gully Formation. Within Zone 2A and in Zone 2 west of the Brighton Fault, the T2 Aquifer consists of the lower limestones of the Port Willunga Formation.

T3 and T4 Aquifers

Within Zone 2, the T3 Aquifer mainly consists of South Maslin Sand. It occurs at depths in excess of 190 m, is generally thin (< 10 m) and contains brackish to saline groundwater (salinities of the order of 2000 – 16 000 mg/L TDS).

In the small area west of the inferred Brighton Fault, the T3 Aquifer comprises sandy beds of the Aldinga Member and Chinaman Gully Formation, whilst the T4 Aquifer occurs within South Maslin Sand. The aquifers are separated by fine-grained sediments of the Chinaman Gully Formation.

Within Zone 4 or 4A there are effectively no T3 or T4 aquifers.

4.2.3 ADELAIDE PLAINS SUB-BASIN

The Adelaide Plains Sub-basin is the most extensive portion of the St Vincent Basin within the study area, extending from the Para Fault in the south and east to beyond the northern limit of the Northern Adelaide Plains Prescribed Well Area (NAP PWA). Schematic hydrogeological cross-sections of the NAP region are shown on Figures 12 and 13.

Quaternary and Tertiary sediments thicken to the south, reaching a maximum thickness of about 120 and 500 m in the metropolitan area between the River Torrens and the Para Fault. The hydrostratigraphy of the sub-basin is much simpler than the Golden Grove Embayment because of the greater uniformity and extent of the key geological units.

The most recent broad scale investigations of the area include those by Evans (1990), Gerges (1996, 1999, 2001) and Zulfic (2002). The following brief aquifer descriptions are sourced from these reports.

Quaternary Aquifers

In coastal margins, thin unconfined aquifers or perched watertable aquifers can occur within quartz-sand sediments of the Sempahore Sands or shelly sands of the St Kilda Formation. These aquifers have been predominantly accessed by small-scale stock and domestic users in areas of low salinity. The aquifers can be in direct connection with the sea and consequently at risk of seawater intrusion.

In the western metropolitan area, up to six thin confined aquifers occur within the Hindmarsh Clay. These are designated Q1 to Q6 in order of increasing depth (Gerges, 1996). The Hindmarsh Clay consists of mottled clays and silts of fluviatile and estuarine origin. Within this sequence, the aquifers occur as interbeds of sand and gravel that range in thickness from 1–18 m, but are rarely much thicker than two metres. The continuity and extent of individual aquifers is uncertain and may be less than that shown on Figure 10 and 11.

In the NAP region, a shallow perched Quaternary aquifer is present in the area between Virginia and Gawler River. Elsewhere, three Quaternary aquifers (Q1 to Q3) are generally recognised in the NAP region with thicknesses ranging from about 3 to 15 m. They can be quite discontinuous, as indicated by Evans (1990), with lateral extents less than 2000 m. Overall, the thickness of the enclosing Hindmarsh Clay diminishes northwards and can be as little as 20–30 m near the northern limit of the NAP PWA. Clay generally underlies the Q3 aquifer and forms a confining bed above the Q4 Aquifer, however, there are localised occurrences of the Q3 Aquifer directly overlying the Q4 Aquifer.

Q4 (Carisbrooke Sand) Aquifer

The Q4 aquifer in the NAP area is comprised solely of the Carisbrooke Sand. It is a sandy confined aquifer that extends throughout most of the region, but is absent within two to five kilometres of the coastline north of St Kilda and in the western and northwestern metropolitan suburbs.

The Q4 Aquifer averages about 20 m thickness, except near the Little Para River, where it is 40 to 60 m (Gerges, 2001). The aquifer consists of multi-coloured, poorly sorted, fine to medium grained quartz sand and silt, with some clay and thin gravel beds (Zulfic, 2002). Wells within the aquifer are typically low yielding and require screening and extensive development to minimise the production of fine sands.

Over much of it's extent, the aquifer is in direct hydraulic connection with the underlying T1 Aquifer. However, in the northern and northeastern parts of the study area, the Q4 Aquifer directly overlies the T2 Aquifer.

T1 Aquifer

The hydrostratigraphy of the T1 Aquifer in the Adelaide Plains Sub-basin is relatively simple and comprises the Hallet Cove Sandstone, Dry Creek Sand, Croyden Facies and upper limestone units of the Port Willunga Formation above the Munno Para Clay Member. It has also been considered to include the Carisbrooke Sands where the units are in direct hydraulic connection. For the evaluation of aquifer storage capacities, the Carisbrooke Sand is deemed to constitute a 'separate' aquifer.

The T1 Aquifer is absent in the northern and northeastern areas of the NAP PWA and thickens to the south and southeast to attain a maximum thickness of about 100 to 110 m beneath the western suburbs of Adelaide.

The Hallet Cove Sandstone and Dry Creek Sand are of a shallow marine origin and comprise shelly, dark grey to brown sand, silt and clay, often highly fossiliferous (Gerges, 1996). In the Adelaide Plains Sub-basin, the shelly Dry Creek Sand underlies and intertongues with the Hallet Cove Sandstone. In the Dry Creek area, drilling beneath the Dry Creek Sand indicates the sequence becomes finer grained and silty (Drexel and Priess, 1995). This sequence is known as the Croyden Facies and is recognised elsewhere as typically fossiliferous and glauconitic silts and sands (Gerges, 1996).

The Hallet Cove Sandstone and Dry Creek Sand are generally considered as the T1A sub-aquifer, as the Croyden Facies has the potential to act in places as a weak semi-confining bed. However, detailed information on the extent of the Croyden Facies and its hydrogeological nature is very limited (Zulfic, 2002).

The T1B sub-aquifer consists of yellow fossiliferous sands and limestones of the Port Willunga Formation above the Munno Para Clay Member. It often enables high-yielding bores with open-hole production intervals, making it a preferred aquifer for industrial and horticultural users and ASR projects.

T2 Aquifer

The T2 Aquifer in the Adelaide Plains Sub-basin is usually separated from the overlying T1 aquifer by the Munno Para Clay Member; a highly effective confining bed of about 5 to 10 m thickness. The clay member consists of stiff blue-grey calcareous clay, often separated by two thin interbeds of white to grey limestone.

Throughout most of the study area, the aquifer consists of well-cemented limestones of the lower Port Willunga Formation. Gerges (2001) recognises three sub-divisions of the T2 Aquifer in the NAP region based on lithological characteristics:

- Sub-aquifer T2a – mostly pale-grey to white well cemented limestone/sandstone;
- Sub-aquifer T2b – a pale yellow to orange brown limestone/sandstone, friable to moderately cemented and occasionally interbedded with highly calcareous fossiliferous sand; and
- Sub-aquifer T2c – mainly interbedded sand and very friable limestone with occasional silt and clay.

In the northeastern areas of the NAP PWA and within the Kangaroo Flat area, the T2 aquifer consists mainly of quartz sand and minor clay (James-Smith and Gerges, 2001). These sands may represent the Pirramimma Sand shown on Table 3.

The T2 Aquifer thins to the north and northeast of Gawler River, where it ranges from about 20 to 70 m thickness. In this area, the Munno Para Clay Member is absent and the aquifer is directly overlain by Quaternary sediments.

In the metropolitan area, very few wells intersect the T2 Aquifer, whereas in the NAP PWA, the upper section of the T2 Aquifer forms the main groundwater supply.

T3 and T4 Aquifers

Within the Adelaide Plains Sub-basin, the T2 Aquifer is underlain by the Ruwarung and Aldinga members of the Port Willunga Formation. Although limited intersections exist, these units are predominantly fine-grained marine sediments that act as confining beds with a combined thickness that ranges from about 50–150 m.

The T3 Aquifer is formed by sandy sections of the Aldinga Member or underlying Chinaman Gully Formation. It is relatively thin, being of the order of 5 m in the NAP region and up to 20 m in the metropolitan area adjacent to the Para Fault.

The T4 Aquifer consists mainly of South Maslin Sands and occasionally North Maslin Sands (Gerges, 1996) and is separated from the overlying T3 Aquifer by thick confining beds of the Blanche Point Formation. The aquifer is well distributed in the study area but of uncertain thickness. South of the Little Para River, Gerges (1996, 2001) indicates thicknesses ranging from about 20–60 m.

Both the T3 and T4 aquifers are saline; levels up to 80 000 mg/L TDS have been recorded in the deeper T4 aquifer.

Fractured Rock Aquifers

Fractured rock aquifers are generally not accessed in the study area portion of the Adelaide Plains Sub-basin due to the great thickness of overlying sediments, even immediately adjacent to the Para Fault.

However, in the northeastern parts of the study area, it is likely that Proterozoic basement rock occur at depths of less than 100 m.

4.3 Groundwater abstraction

This section briefly presents recent groundwater abstraction from the main aquifer systems within the study area to:

- provide context for the ensuing section on groundwater levels and subsequent influence on aquifer storage capacities; and
- highlight the locations of existing groundwater users as indicators of potential ASR development.

4.3.1 MCLAREN VALE PWA

Total groundwater abstraction from the McLaren Vale PWA in recent years has been in the range from 4500–5500 ML (DWLBC, 2003). The predominant water use is for viticulture and horticulture, hence groundwater abstraction is strongly influenced by the amounts and seasonal patterns of rainfall.

A summary of groundwater abstraction from individual aquifers is presented in Table 5, whilst the locations of production wells in the Port Willunga Formation and Maslin Sands aquifer used in the 2002/03 period are shown on Figure 14a and b.

Table 5. McLaren Vale PWA 2002/03 Groundwater Abstraction

Aquifer	**Abstraction** (ML)
Quaternary	18.4
Port Willunga Formation	2 818.0[1]
Maslin Sands	826.2
Fractured Rock	866.9
Unassigned	234.5
Total	4 764.0

Note 1. 39.3 ML of this amount is assigned to the Blanche Point Formation

Table 5 shows that the Port Willunga Formation Aquifer is the main source of groundwater, with lesser but similar amounts from the Maslin Sands Aquifer and Fractured Rock Aquifer.

4.3.2 METROPOLITAN AREA

The groundwater resources of the Golden Grove Embayment and much of the urban area within the Adelaide Plains Sub-basin are not prescribed. Hence, an accurate database of recent groundwater abstraction is unavailable. The most recent studies of groundwater abstraction in these areas has been by Edwards et al (1987) and Gerges (1996, 1999).

The largest groundwater users in the metropolitan region in the past few decades have been industrial users, local government and schools for irrigation of reserves and sporting grounds and by golf clubs in the western suburbs. Industrial users include:

- Penrice Soda Products (Penrice), Osborne;
- Coopers Brewery, Regency Park;
- Samcor, Gepps Cross;
- Coca-Cola Amatil, Thebarton;
- Cadbury Schweppes, Payneham; and
- Hallet Bricks, Golden Grove.

The location of major groundwater users in the mid-1980s as identified by Edwards et al (1987) are shown on Figure 14c, whilst summary details of these historical abstractions are included as Appendix B.

Excluding sites that occur within the NAP PWA (notably Penrice – Dry Creek operations), the Edwards survey revealed that annual abstraction from the Tertiary aquifers in the mid-1980s was about 4750 ML and 600 ML from fractured rock aquifers. All but 8 ML of the Tertiary aquifer abstraction was considered to be from the T1 Aquifer.

In more recent years, abstraction from the T1 Aquifer by several western-suburb golf clubs and by Penrice at their Osborne operation has increased significantly. Currently, an estimated 1250 to 1500 ML/year is abstracted by the Riverside, Glenelg, Kooyonga, Grange and Royal Adelaide golf clubs.

Current abstraction from the T2 aquifer in the metropolitan area is considered to be very limited. In the Regency Park area, Coopers Brewery abstract 300 – 400 ML/yr and lesser amounts are pumped by the Regency Park Golf Course.

4.3.3 NORTHERN ADELAIDE PLAINS PWA

Within the NAP PWA, groundwater abstraction is dominantly from the T1 and T2 aquifers by several large industrial users and by numerous horticultural users.

The largest industrial groundwater user in the PWA is Penrice Soda Products at their Dry Creek salt harvesting operations. In 2002/03, abstraction from four T1 Aquifer wells at this site totalled about 1000 ML.

The locations of groundwater abstraction wells for the Q4, T1 and T2 aquifers during the 2002/03 period are shown on Figure 16 d–f, whilst Table 6 presents summary abstraction totals for the main aquifers.

Table 6. NAP PWA 2002/03 Groundwater Abstraction

Aquifer	Abstraction (ML)
Q1, Q2, Q3	396.4
Q4	97.6
T1	3 309.8
T2	12 574.6
Fractured Rock	135.1
Unassigned	33.5
Total	16 547.0

Groundwater abstraction in recent years is considered to have reduced significantly following the establishment of the Virginia Pipeline Scheme in 1999, which currently provides about 10 000 ML/year of high-quality reclaimed water to irrigators in the NAP region.

4.4 Groundwater levels

Groundwater levels for the major sedimentary aquifers from the autumn 2003 period are presented on Figure 15a-g and discussed briefly below to provide the basis for evaluation of available heads for aquifer storage calculations in Section 5.

The groundwater levels shown on Figure 15 are absolute levels (mAHD). These levels are also represented as depths below ground later in the report.

4.4.1 MCLAREN VALE PWA

Groundwater levels for the Port Willunga Formation and Maslin Sands aquifers during April 2003 are shown on Figures 15a and b. The contours show that regional groundwater flow in both aquifers is towards the southwest. Levels are highest in the north and northeast of the PWA, where the aquifers outcrop or subcrop and receive most of their recharge from direct rainfall infiltration and throughflow from fractured rock aquifers.

Groundwater levels are generally higher in the Port Willunga Formation Aquifer than the underlying Maslin Sands Aquifer. Downwards leakage of groundwater is restricted by confining beds within the Blanche Point Formation.

Although not shown on the figures, the spring (maximum) groundwater levels are typically a few metres higher than the April levels but can vary by up to 10 m. The variation between seasonal highs and lows is related to the density of production wells, abstraction volumes and natural aquifer recharge variability.

A review of groundwater levels by Clarke (2002) for the 1999 to 2002 period concluded that groundwater level trends for the main aquifers were relatively stable.

4.4.2 METROPOLITAN AREA

T1 Aquifer

Groundwater level contours for the T1 Aquifer for March 2003 are shown on Figure 15c. The contours are considered to be only approximate due to the limited data available. However, they are reasonably consistent with regional groundwater flow patterns determined by Gerges (1999) for earlier periods

Groundwater flow direction in the Golden Grove Embayment is predominantly westerly and not affected by any significant abstraction. In northeastern areas of this embayment, where the T1 Aquifer is unconfined or semi-confined, groundwater levels and flow paths would be strongly controlled by the undulating topography present.

In the western and northern suburbs there is a marked drawdown cone developed as a result of the combined effects of:

- summer abstraction by several golf clubs in the western suburbs;
- large-scale perennial abstraction by Penrice at their Osborne and Dry Creek operations; and
- abstraction from the Thebarton industrial area.

Groundwater levels surrounding the golf course abstraction centre recover by around 10 – 15 m during winter and spring but remain depressed around the industrial abstraction centres.

Groundwater levels are not necessarily continuous across the Para Fault due to the juxtaposition of different aquifer and aquitard units. In some areas, the T1 Aquifer in the Golden Grove Embayment is considered hydraulically connected to Quaternary aquifers in the Adelaide Plains Sub-basin (Fig. 10).

T2 Aquifer

Groundwater levels for the T2 Aquifer as at March 2003 in the metropolitan area are shown on Figure 15d. There are few T2 monitoring wells in the Golden Grove Embayment, consequently the contours are considered interpretive only in this area and are based partly on previous work by Gerges (1999).

Within the Adelaide Plains Sub-basin part of the metropolitan area, groundwater levels indicate northerly flows resulting from the regional impacts of abstraction in the NAP PWA.

A minor drawdown cone is thought to occur near Regency Park in response to abstraction by Coopers Brewery in recent years.

Winter-spring groundwater levels in the metropolitan area are similar to the summer-autumn levels.

4.4.3 NAP PWA

Q4 Aquifer

Groundwater level contours for the Q4 Aquifer are shown on Figure 15e. Flow direction throughout most of the study area is westerly and largely unaffected by abstraction. Some localised flow direction variation occurs in the Waterloo Corner and Virginia areas where concentrated abstraction from the Tertiary aquifers is thought to induce minor vertical leakage from the Q4 Aquifer.

T1 Aquifer

Groundwater levels for March 2003 (Fig. 15f) show a widespread cone of depression at the southern end of the NAP PWA where abstraction from the Dry Creek and Waterloo Corner areas reduces groundwater levels to about –8 to –14 mAHD. Groundwater levels in the Waterloo Corner largely recover during the winter-spring period but remain depressed in the Dry Creek area due to perennial abstraction by Penrice.

Where long-term records exist in the main irrigation areas, groundwater levels have been shown to be declining at an average rate of 0.6 m/year (Gerges, 2001). However, in recent years (1999 – 2002) there are some widespread recovery trends occurring at rates of up to 1 m/year (Zulfic, 2002). This recovery may be, at least partly, due to gradually reduced abstractions following the commissioning of the Virginia Pipeline Scheme in 1999.

T2 Aquifer

Groundwater levels for the T2 Aquifer for March 2003 are shown on Figure 15g, which show the large drawdown cone associated with irrigation abstraction centred around Virginia. At the end of the winter-spring period the drawdown cone remains intact but reduced by about 30 m on the centre of the cone.

In recent years, another small cone of depression has been recognised in the Kangaroo Flat area during the summer irrigation season (Zulfic, 2002).

Long-term records indicate a rate of groundwater level decline of 0.35–0.7 m/year (Gerges, 2001), but as with the T1 Aquifer, Zulfic (2002) has analysed recovery trends in the 1999 to 2002 period (up to 2 m/year).

4.5 Groundwater Salinity

4.5.1 MCLAREN VALE PWA

Groundwater salinity contours for the Port Willunga Formation and Maslin Sands aquifers are shown on Figures 16a and b.

Within the Port Willunga Formation Aquifer, salinity is generally less than 1500 mg/L TDS, being freshest in areas closest to recharge zones adjacent to areas of aquifer outcrop and the Willunga Fault. Salinity increases to the southwest along the direction of groundwater flow and is above 3000 mg/L TDS adjacent to the coast between Port Willunga and Sellicks Beach.

The salinity of the Maslin Sands Aquifer is generally slightly higher than the Port Willunga Formation Aquifer but shows a similar distribution pattern. Salinities are lowest in the northeast near outcrop areas and the Willunga Fault and increase to the west and southwest, reaching above 3000 mg/L TDS in a coastal zone about 1.5–2.5 km wide between Maslin Beach and Sellicks Beach.

Analysis of salinity trends by Clarke (2002) for the 1999 to 2002 period indicated that salinities were stable or lowered slightly at most observation sites for both aquifers.

4.5.2 METROPOLITAN AREA

T1 Aquifer

Groundwater salinity contours for the T1 Aquifer in the metropolitan area are shown on Figure 16 c and f. These contours are considered only as approximate because of the lack of data (both spatial and temporal). Data prior to 1990 were used and the past work of Gerges (1996) was also considered.

Within the Golden Grove Embayment, groundwater salinities are generally less than 2000 mg/L TDS but can be elevated in some areas near Rostrevor and in the northwestern margin near the Para Fault. In the Adelaide Plains Sub-basin, salinities are typically less than 1000 mg/L TDS in areas to the southwest of Port Road. North and northwest of here, groundwater salinities increase to 4000–5000 mg/L TDS.

T2 Aquifer

Salinity contours for recent years are shown on Figure 16d, however, there are insufficient records to produce accurate contours.

In the Adelaide Plains Sub-basin area, groundwater salinities less than 2000 mg/L TDS are restricted to western and southwestern suburbs. The salinity distribution pattern is similar to the T1 Aquifer; a high salinity (3000–5000 mg/L TDS) corridor zone occurs beneath the northwestern and inner northern metropolitan suburbs.

4.5.3 NAP PWA

Q4 Aquifer

Salinity contours, using spatially limited data for the period since 2001, are shown on Figure 16e. They show that salinities are lowest in eastern areas and near the Little Para River.

Salinity increases to above 3000 mg/L TDS over a large area in the northwest of the PWA, as well as within a smaller area just beyond the southern limit of the PWA.

T1 Aquifer

Salinity contours for the T1 Aquifer are shown on Figure 16f. They were generated using recent data but remain similar to previously published contours (Gerges, 2001).

Fresh groundwater (< 1000 mg/L TDS) occurs in two major areas – a southern area near Waterloo Corner and the Little Para River and a northern area trending east-west through the Virginia area. Salinities in excess of 3 000 mg/L TDS occur in the northwest of the PWA, an area near Elizabeth and near the southern limit of the PWA.

Long-term records indicate that the average groundwater salinity of the T1 Aquifer has typically increased by 200–800 mg/L TDS (Gerges, 2001). Reasons cited for these increases include:

- leakage from overlyng saline Quaternary aquifers due to corroded well casing;
- lateral flow from highly saline areas;
- vertical leakage from overlying Quaternary aquifers where confining beds are thin or ineffective; and
- leakage from the T2 Aquifer in dual completion wells.

T2 Aquifer

Salinity contours for the T2 Aquifer have been updated using 2003 data and are shown on Figure 16g. Whilst these contours are similar to those produced by Gerges (2001), the extent of low salinity groundwater in the area between Bolivar and Salisbury may be greater than previously indicated.

Fresh groundwater occurs in two main areas, one along the Gawler River and a smaller area near Bolivar and Salisbury. Like the T1 Aquifer, salinities above 3000 mg/L TDS are restricted to the northwest parts of the PWA, an area between Elizabeth and Virginia and in the southwest corner of the PWA.

Gerges (2001) notes that the salinity of the T2 Aquifer has increased by about 200 mg/LTDS during the past 30 years of pumping along some areas of the Gawler River for similar reasons to the T1 aquifer increases.

5 AQUIFER STORAGE CAPACITIES

5.1 *Methodogies and assumptions*

5.1.1 AQUIFERS EVALUATED

The quantification of aquifer storage capacities has been limited to the major sedimentary aquifers of the study area, namely the:

- Port Willunga Formation and Maslin Sands aquifers in the Willunga Embayment;
- T1 and T2 aquifers in the Golden Grove Embayment; and
- Q4, T1 and T2 aquifers in the Adelaide Plains Sub-basin.

The focus of the aquifer storage capacity estimation is upon the **additional** volumes that may be realised **above** the groundwater levels present within the aquifers as at autumn 2003. These represent the volumes that are likely when an ASR project starts by injecting first (in the winter season) before commencing the first abstraction (recovery) cycle in the ensuing summer period. However, in section 5.6, consideration is also given to the existing volumes of native groundwater held under pressure (elastic storage) within each major sedimentary aquifer as at autumn 2003. It may be possible for ASR projects to commence by initially abstracting native groundwater, thus creating extra storage capacity before commencing the first injection cycle.

The localised nature and variability of fractured rock aquifers prevents the quantification of storage potential on a regional scale. The ASR potential of fractured rock aquifers can only be reliably assessed by localised studies that should include field investigations. Conceptual storage capacities of fractured rock aquifer systems are discussed briefly in section 5.7

The shallow Quaternary aquifers of the study area have been precluded from storage capacity estimations as they are typically thin and of limited extent, which restricts the magnitude of the potential ASR projects. This study has a focus to examine potentially medium to large-scale projects (>20 ML/year). For an ASR project to achieve 20 ML of injection from a single well within a 100 day winter season, the aquifer must support injection rates in excess of about 3 L/sec. As outlined in section 4, the Quaternary aquifers would not support such rates in most areas.

The aquifer storage capacity potential of the shallowest Quaternary aquifer systems in the Adelaide Plains Sub-basin has previously been investigated by Pavelic, et al (1992). This study estimated that, for an average aquifer thickness of 2 m, semi-confined conditions resulting in a storativity value of 1.0E-3 and a maximum groundwater level of two metres below ground level (mbgl), the additional aquifer storage potential was about 2000 ML over the entire study area (530 km^2). It should be noted that the storativity value implies a leaky aquifer and that much of the resultant volume would be stored in adjacent aquitard and aquifer units. If truly confined conditions were applicable, the storage potential would be much less, possibly up to two orders of magnitude less.

The deepest aquifers (T3 and T4 aquifers) in the Golden Grove Embayment and Adelaide Plains Sub-basin were precluded from evaluation because of their generally high salinity and great depth below ground. These factors increase the establishment costs of an ASR project and can significantly lower the recovery efficiency of the project, unless a significant volume of better quality water can be "built up" around the well before recovery commences.

5.1.2 ESTIMATION TECHNIQUE

The capacity of an aquifer to store additional water is a function of the aquifer storativity and increased potentiometric head (available head). The additional volume is defined as:

Confined aquifer - $\Delta V = A . h . S$

$= A . h . b . S_s$

Unconfind aquifer - $\Delta V = A . h . S_y$

where

- A = area
- h = available head
- S = storativity (storage coefficient)
- b = aquifer thickness
- S_s = specific storage
- S_y = specific yield

The available head is better known in comparison to the storativity or specific yield and has been calculated by contouring several parameters using Surfer (version 8) software before importing into Arcmap GIS software for spatial analysis.

As most of the aquifers evaluated are confined, aquifer storage capacities have been estimated for two main scenarios:

- Sub-artesian scenario – the available head has been calculated such that the increased groundwater levels rise to within 2 m of the natural ground surface, i.e., no flowing wells occur.
- Artesian scenario – a scenario that "allows" the potentiometric surface (heads) of the confined aquifer to rise to some level above ground, thus increasing the storage capacity but potentially creating artesian flow in surrounding wells that intersect the same aquifer. The maximum available heads have been calculated as 85% of the fracture pressure level of the overlying confining bed above each aquifer. However, consistent with existing practice at "artesian" ASR sites in the Adelaide region, the storage capacity at approximately 50% of the fracture pressure has been used to dtermine the main storage volumes under the artesian scenario.

The determination of fracture pressure levels relies on the use of the principles of Effective Stress and assumed overburden and hydrostatic pressures of 20 and 10 kPa/m. Aquifer fracture pressure (at ground level) consists of the depth to the top of the aquifer and any available potentiometric head below ground level to the pre-existing aquifer potentiometric surface. In terms of the risk to physical integrity of confining beds, the 50% level is considered conservatively low, especially for the semi-consolidated and consolidated aquifers within the Port Willunga Formation, which make up the majority of the available aquifers for ASR. However, for shallow unconsolidated aquifers, pressure-injection can contribute to technical difficulties in practice. Driscoll (1986) states that for most recharge wells in unconsolidated sediments, the injection pressure above ground level should not exceed 20% of the depth to the top of the screens. Matrix redistribution and stability may be adversely affected by excessive injection pressures, possibly leading to clogging problems for ASR projects with screened wells.

For those aquifers where potentially unconfined conditions occur, the “sub-artesian” scenario comprised limiting the storage capacity to comprise only the elastic storage component of the aquifer. This represents a conservative or likely minimum estimate of aquifer storage capacity. To estimate the likely maximum aquifer storage capacities in areas where potentially unconfined conditions occur, the calculations used a gravity storage component (ie, specific yield) estimate and a maximum watertable rise to a limit of 5 mbgl. The 5 mbgl level was chosen to optimise storage whilst minimising the potential for adverse effects from increased groundwater levels, such as:

- waterlogging;
- soil salinisation;
- building or other infrastructure stability; and
- increased saline groundwater seepage to sewers.

As storativity data is scarce, minimum and maximum specific storage values were applied to the above scenarios, resulting in the generation of four sets of aquifer storage capacities. From these datasets, a base case scenario was selected to use in further spatial analysis of aquifer storage capacities as discussed in sections 5.5, 5.6 and 8.

The base case scenario adopts the following parameters and assumptions:

- Available storage heads calculated as approximately 50% of the fracture pressure level.
- Uniform specific storage value of 9.0E-6.
- For unconfined aquifer domains, only the elastic storage (confined) component was considered for groundwater level rises to 2 mbgl.

Contouring (or gridding) was done for three different domains that provided unique coverage of the main aquifer sedimentary basins:

- Willunga Embayment – 6 083 000 to 6 113 000 N, 265 000 to 290 000 E
- Golden Grove Embayment – 6 119 000 to 6 152 000 N, 270 000 to 295 000 E
- Adelaide Plains Sub-basin – 6 126 000 to 6 180 000 N, 255 000 to 295 000 E

All contouring and resultant figures were produced in the GDA94 datum (Zone 54 Transverse Mercator projection). Contouring was done for 50 by 50 m cell sizes using a simple linear kriging interpolator. Surfer grid files that stored z values as the product of available head and aquifer thickness were exported as point files into Arcmap. Within Arcmap, the aquifer storage capacities were calculated by clipping the contour files with aquifer area polygons. The sum of the grid-file z values was then multiplied by the unit cell area (2500 m^2) and the specific storage to determine the additional aquifer storage capacity (m^3).

Evaluation of the existing volumes of groundwater held in elastic storage in the major sedimentary aquifers was done by subtracting contours of the top of each aquifer from the autumn 2003 groundwater level contours. The resultant pressure head files were multiplied by aquifer thickness contours and imported into Arcmap for spatial analysis as described above.

The various data sources used to generate the surfer contour files are discussed in sections 5.2 and 5.3, whilst the available storage heads for additional aquifer storage are detailed in section 5.4. The resultant additional aquifer storage capacities are presented and discussed in section 5.5 and the existing volumes of groundwater held in elastic storage are presented in section 5.6.

5.2 Contouring domains and depths to groundwater

The groundwater levels used to determine available heads are those from the autumn period of 2003 as presented on Figure 14a-g.

Ground level contours were regenerated in Surfer after exporting the Arcmap-based 5 m topography contour dataset as point data files. Some minor interpretive adjustments were made to this dataset where quarry outlines were previously assigned levels of 0 mAHD and in flat-lying areas where the distance between 5 m contours was significant.

Depths to groundwater contours were subsequently calculated in Surfer using the grid maths function and are shown on Figure 17a-g. These figures also show the main aquifer domain extents used in the estimation of storage capacities. The limits of some aquifers and the divides between areas of confined and unconfined semi-confined conditions are considered only approximate. They have been largely derived from past hydrogeological studies by Evans (1990), Gerges (1996, 1999) and Martin (1998).

5.2.1 WILLUNGA EMBAYMENT

Throughout much of the Willunga Embayment, groundwater levels in the Port Willunga Formation Aquifer are typically less than 20 m and increase to about 80 m in a narrow band adjacent to the Willunga Fault (Fig. 17a).

For the confined sections of the Maslin Sands Aquifer, depths to groundwater are similar to the Port Willunga Formation Aquifer, being mainly less than 30 m but increasing to 70 – 90 m near the Willunga Fault (Fig. 17b). In the northern and northeastern areas where the Maslin Sands Aquifer is unconfined or semi-confined, the depth to groundwater is quite variable and strongly controlled by topography.

5.2.2 GOLDEN GROVE EMBAYMENT

Depths to groundwater for the T1 Aquifer are similar in magnitude and pattern to the Tertiary aquifers of the Willunga Embayment.

Regional groundwater levels are largely unaffected by any significant abstraction. In the southern half of the embayment, depths to groundwater are typically less than 20 – 25 m, being shallowest (about 5 m) in the northwest corner of the embayment adjacent to the coat (Fig. 18c). Adjacent to the Eden-Burnside Fault, depths increase to up to about 70 – 90 m. In the northeastern half of the embayment, depths to groundwater are variable, being shallowest along the Torrens River valley and deepest adjacent to the northern and southeastern margins of the embayment.

Adelaide Plains Sub-basin

In the Adelaide Plains Sub-basin, depths to groundwater are strongly influenced by abstraction. The autumn 2003 levels represent the greatest depths to groundwater, which subsequently diminish during the winter period when irrigation abstraction ceases temporarily.

The use of autumn levels for estimation of aquifer storage capacities results in a bias towards maximum available storage volumes. The effect of lower (spring) groundwater levels for the T1 and T2 aquifers is discussed in section 5.5.

For the T1 Aquifer in the metropolitan region of the Adelaide Plains Sub-basin the maximum depths to groundwater are about 20 – 30 m in the abstraction centre formed by western suburb golf clubs. Elsewhere in the metropolitan area, depths to groundwater are typically 10 – 15 m (Fig. 17c).

In western and central parts of the NAP region, depths to groundwater within the T1 Aquifer are shallow, typically less than 10 m. In the Waterloo Corner area, where abstraction is concentrated, depths to groundwater peak at about 15 – 20 m. In a narrow band adjacent to the Para Fault, depths to groundwater increase to about 70 –80 m (Fig. 17f).

In much of the metropolitan region, depths to groundwater in the T2 Aquifer are typically very shallow (less than 5 m), partly as a result of limited abstraction. Throughout the NAP region, depths to groundwater are dominated by the major drawdown cone associated with the concentration of abstraction in the Virginia area. At the centre of the cone, depths reach 60 m and only become shallow (less than 10 m) near the coast or northwestern parts of the PWA (Fig. 17g). In eastern and northeastern areas of the NAP PWA, depths increase to about 60 m near the Para Fault escarpment and in elevated areas near Gawler.

For the Q4 Aquifer, from which abstraction is limited, the depths to groundwater are similar in autumn and spring. Adjacent to the Para Fault and northwest of Gawler, depths range from about 25 – 50 m but become very shallow (less than 5 m) within 2 – 4 km of the coast.

5.3 *Sedimentary aquifer parameters*

Aquifer parameters for the major sedimentary aquifers have been reviewed, principally by using the results of:

- 90 aquifer test analyses;
- SA Geodata records for wells with known aquifer intervals; and
- previous contouring of aquifer depth and thickness.

The locations of the tested wells are shown on Figure 18, whilst summary details of the aquifer tests are included as Appendix C.

5.3.1 TRANSMISSIVITY AND WELL YIELDS

Transmissivity values determined from aquifer test analyses are displayed on Figures 19 a – h. The values plotted are “effective” values; they include well losses and can incorporate the effects of any leakage from adjoining aquifer or aquitard units.

Whilst the available data set highlights broad trends and variations in transmissivity, there are insufficient data points to reliably or accurately contour transmissivity for any aquifer. Consequently, well yields have also been used to assist subdivision of the study area into broad transmissivity domains. The yield values plotted are only for those wells with an assigned aquifer within SA Geodata and the dataset was filtered to remove records for windmills and narrow wells (those with casing less than 100 mm diameter). Additionally, for wells with multiple yield values, any depth-based yields were removed in preference to time-based records associated with airlifting or pumping.

Transmissivity domains have been interpreted mainly using the aquifer tests and an understanding of the known aquifer thickness and lithology in preference to well yields. The transmissivity categories listed below in Table 7 are not considered exclusive for the domains shown on Figure 19, as there is likely to be localised variations in both aquifer thickness and hydraulic conductivity.

Table 7. Transmissivity Domain Categories

Transmissivity Category	Transmissivity (m^2/day)
Very Low	< 25
Low	25 - 50
Moderate	50 - 100
High	100 - 200
Very High	> 200

Willunga Embayment

Within the Port Willunga Formation Aquifer, transmissivity can be readily correlated with aquifer lithology as well as thickness. The highest transmissivities occur where limestone or calcareous and fossiliferous sandstones form the dominant lithology in the southwestern parts of the embayment (Fig. 19a). In the northwest area, transmissivity is lower due to the aquifer being thinner and also because it comprises a higher percentage of lower permeability marly sediments. In the northeastern area, the Port Willunga Formation consists dominantly of quartz sands and sandstones that, overall, have a lower permeability than their limestone equivalents to the southwest. The transmissivity of these sands is still interpreted to be high in a relatively narrow corridor adjacent to the Willunga Fault where the aquifer is thickest.

For the Maslin Sands Aquifer, the interpreted transmissivity domains are mainly influenced by aquifer thickness, but also to a lesser degree by the abundance of the South Maslin Sand in comparison to the North Maslin Sand formation. The South Maslin Sand is of a marine origin and is expected to have a higher hydraulic conductivity than the fluvial North Maslin Sand because of the greater degree of sorting and rounding of constituent grains. The two “moderate” transmissivity domains shown on Figure 19b correspond to areas of relatively thick (> 20 m) South Maslin Sand. However, there are insufficient wells in these interpreted domains to validate the importance of the facies influence upon transmissivity.

Golden Grove Embayment

Within the Golden Grove Embayment, much of the variation in transmissivity is attributable to the number of different geological formations that constitute a “single” aquifer. In the area south and southwest of the CBD, transmissivity values are highest where the T1 aquifer occurs as Dry Creek Sand, Hallet Cove Sandstone and lower limestones of the Port Willunga Formation. Some sites within these areas intersect limestones with very high transmissivities, such as the Morphetville Racecourse ASR project (842 m^2/day).

In much of the embayment, the T1 Aquifer consists of undifferentiated quartz sands or sands of the Carisbrooke Sand, Aldinga Member or Chinaman Gully Formation. These areas are typically assigned as very low or low transmissivity domains (Fig. 19c) as a result of limited aquifer thickness and relatively low hydraulic conductivity. Overall, these transmissivity domains are consistent with aquifer parameters assigned by Gerges (1999) for groundwater flow modelling.

The T2 Aquifer included in this study is limited to the southern and southwestern areas of the embayment. West of the inferred Brighton Fault and north of the southern splinter of the Para Fault, the T2 Aquifer is assigned a moderate to high transmissivity due to the relative abundance of limestones of the Port Willunga Formation. East and south of these faults, the T2 Aquifer consists mainly of sandy facies of the Aldinga Member of generally limited thickness. Consequently, the assigned transmissivity is lower.

Adelaide Plains Sub-basin

The Q4 (Carsibrooke Sand) Aquifer typically has a very low to low transmissivity throughout the study area as a consequence of limited thickness and low hydraulic conductivity. Whilst there were no aquifer test results available, the low hydraulic conductivity is inferred from the fine-grained and poorly sorted nature of the sand units that dominate the formation. The transmissivity domains shown are based entirely on aquifer thickness, which has been previously shown by Gerges (1999) to be greatest (up to 60 m) near the Little Para River.

The transmissivity domains for the T1 Aquifer are shown as separate plans for the T1A and T1B sub-aquifers, even though the sub-aquifers are probably effectively connected in most of the study area. The overall transmissivity of the T1 Aquifer can thus be considered as the combined transmissivities of the two sub-aquifers.

Within the metropolitan area, the T1 Aquifer is relatively thick and uniform and has a correspondingly uniform moderate to high transmissivity. Twenty aquifer tests have been analysed for this region; transmissivity ranges from 39 –189 m^2/day at an average value of 83 m^2/day. In the NAP region the T1 transmissivity is interpreted to decline northwards in association with diminishing aquifer thickness (Figs 19g, h).

Gerges (1999) indicates higher transmissivities for the T1 Aquifer in the Little Para River area, where assigned hydraulic conductivity values of between 2–8 m/day infer transmissivity levels of at least 200 m^2/day.

The T2 Aquifer is relatively thick and permeable throughout much of the Adelaide Plains Sub-basin study area, resulting in typically high transmissivities above 100 m^2/day. Several aquifer tests indicate transmissivities of about 200 m^2/day (Figs 19 e, i).

From near the Gawler River, the aquifer thins northwards and transmissivity is expected to diminish. Additionally, in the northeastern parts of the NAP PWA, limestones are absent and the aquifer comprises mainly quartz sands. Consequently, the T2 transmissivity is inferred to be low to moderate in these marginal areas. However, recent testing by DWLBC (James-Smith and Osei-Bonsu, 2001) proves that the limestone sections of the T2 Aquifer, even in the Kangaroo Flat area, can still be quite transmissive (142 m^2/day).

5.3.2 AQUIFER THICKNESS AND STORATIVITY

Contours of aquifer thickness for the studied aquifers are displayed on Figures 20a-i. These contours are based on gridding of data points generated from hardcopy plans of aquifer thickness produced by previous workers, namely:

- Willunga Embayment – Bowering (1979);
- Golden Grove Embayment – Gerges (1999); and
- Adelaide Plains Sub-basin – Evans (1990) and Gerges (1999).

The aquifer thickness contours were used for the delineation of aquifer transmissivity domains and for the calculation of available artesian storage heads for confined aquifer domains.

Storativity (storage coefficient) values from aquifer test analyses are also plotted on Figure 20 where available. Unfortunately, most of the aquifer tests reviewed only monitored groundwater levels in the production well, which precludes the assessment of storativity. Only 26 of the 90 aquifer tests reviewed have storativity assessments, which are presented in Table 8.

The storativity values derived from all assessments range from 2.84E-5 to 1.80E-3, with an average of 4.48E-4. The actual storativity of an aquifer can be difficult to reliably obtain from aquifer tests because the assessed value can be an “effective” value, which includes the effects of leakage from adjacent aquitards and aquifers and the effects of partial well penetration.

For this study, the specific storage, which equates to the storativity for a unit aquifer volume, is the **key** required input to aquifer storage capacity estimation, as the aquifer thickness has been separately determined. Values of specific storage for the wells listed in Table 8 were calculated separately for the maximum aquifer interval and for the production interval. Due to the abundance of wells that only partially penetrate the aquifer, the “maximum aquifer thickness” specific storage values may be considerably lower than the true values. Conversely, the “production interval” specific storage values may be higher than actual for many of the tests reviewed.

The scarcity of storativity values over the large study area and the lack of a surrogate parameter, like well yield for transmissivity, prohibits reliable domaining (let alone contouring) of specific storage values. A range of values was subsequently adopted over uniform areas for aquifer storage capacity calculations, as explained in section 5.4.

Willunga Embayment

The Port Willunga Formation Aquifer forms a wedge-shaped aquifer elongated along the main axis of the embayment, with the zero (saturated) thickness inferred to occur along a northeast trending line from near Port Willunga, through McLaren Vale to an area east of Blewitt Springs (Fig. 20a). The aquifer steadily thickens to the southeast and reaches a maximum of about 150 m adjacent to the Willunga Fault near Willunga.

There are six storativity assessments for the Port Willunga Formation Aquifer. For each of these tests, the well only penetrates a minor percentage of the full aquifer thickness. The results indicate that the likely minimum specific storage is about 6.5E-6.

The Maslin Sands Aquifer also forms a wedge-shaped aquifer, thickening to the south and southeast, reaching a maximum thickness of about 70 m near Sellicks Beach (Fig. 20b). At the northeastern end of the embayment, where the aquifer is largely unconfined, thickness is diminished (generally less than 30 m) and influenced by topography. Only two storativity assessments are available, which indicate likely specific storage values of between 3.0E-6 to 9.0E-6.

Table 8. Storativity Values

Well Unit No.	Project	Aquifer	Storativity	Maximum Aquifer Thickness (m)	Production Interval (m)	Specific Storage for Maximum Aquifer Thickness	Specific Storage for Production Interval
Willunga Embayment							
662706647	Willunga Basin SADME Investigations	Port Willunga Formation	5.20E-05	85	14.0	6.12E-07	3.71E-06
662707364	WLG70	Port Willunga Formation	2.70E-04	85	8.0	3.18E-06	3.38E-05
662706505	Willunga Basin SADME Investigations	Port Willunga Formation	3.00E-04	130	9.0	2.31E-06	3.33E-05
652700998	Willunga Basin SADME Investigations	Port Willunga Formation	7.70E-04	150	5.5	5.13E-06	1.40E-04
662706875	Willunga Basin SADME Investigations	Port Willunga Formation	1.30E-03	130	23.0	1.00E-05	5.65E-05
662707037	Willunga Basin SADME Investigations	Port Willunga Formation	1.70E-03	140	17.0	1.21E-05	1.00E-04
662707949	Willunga Basin SADME Investigations	Maslin Sands	5.55E-05	35	7.6	1.59E-06	7.30E-06
662708013	Willunga Basin SADME Investigations	Maslin Sands	7.00E-05	45	6.0	1.56E-06	1.17E-05
Golden Grove Embayment							
662818567	Morphetville	T1	8.80E-05	45	45.0	1.96E-06	1.96E-06
662807945	Oaklands Park	T1	1.30E-04	50	14.2	2.60E-06	9.19E-06
662701875	Marion Golf Course	T2	2.80E-04	10	13.1	2.80E-05	2.15E-05
Adelaide Plains Sub-basin							
662812979	Torrens College	T1A	5.56E-04	77	34.0	7.22E-06	1.64E-05
662818881	De Ruvo	T1B	7.30E-05	27	19.0	2.70E-06	3.84E-06
662816624	Greenfields	T1B	1.55E-04	49	46.0	3.16E-06	3.37E-06
662812516	Coca Cola	T1B	3.00E-04	43	36.0	6.98E-06	8.33E-06
662806920	Samcor 1974	T1B	3.30E-04	40	7.0	8.25E-06	4.71E-05
652800893	Grange Golf Club	T1B	3.40E-04	30	24.0	1.13E-05	1.42E-05
662813378	Kidman Park Test 1	T1B	3.60E-04	35	32.0	1.03E-05	1.13E-05
652800436	Grange Golf Club	T1B	5.30E-04	30	22.0	1.77E-05	2.41E-05
662812979	Torrens College	T1B	5.35E-04	34	34.0	1.57E-05	1.57E-05
652800315	Fort Largs	T1B	1.80E-03	22	14.5	8.18E-05	1.24E-04
662820250	Coopers	T2	2.84E-05	100	20.0	2.84E-07	1.42E-06

Well Unit No.	Project	Aquifer	Storativity	Maximum Aquifer Thickness (m)	Production Interval (m)	Specific Storage for Maximum Aquifer Thickness	Specific Storage for Production Interval
662813634	Regency Park Golf Course	T2	1.26E-04	105	12.0	1.20E-06	1.05E-05
662817760	Mawson Lakes ASR (MFP)	T2	1.60E-04	95	48.0	1.68E-06	3.33E-06
662816257	Virginia	T2	2.00E-04	70	61.5	2.86E-06	3.25E-06
662819388	Kangaroo Flat Investigation	T2	1.13E-03	42	13.0	2.69E-05	8.68E-05

Golden Grove Embayment

West of the inferred Brighton Fault and north of the southern splinter of the Para Fault, the T1 Aquifer occurs as the T1A and T1B sub-aquifers. Figures 20c, d show that these sub-aquifers thicken to the west and attain thicknesses of about 15 and 35 m near the coast. In the region near and south of Brown Hill Creek, the T1 Aquifer occurs as Dry Creek Sand and Hallet Cove Sandstone directly overlying lower limestones of the Port Willunga Formation. Each of these formations thicken to the southwest, resulting in a wedge-shaped aquifer that ranges from less than 10 m in the northeast to about 100 m in the southwest.

In the region northeast of Brown Hill Creek but east and south of Torrens River, the T1 Aquifer occurs mainly as sandy parts of the Aldinga Member or undifferentiated quartz sands. Based on isopachs determined by Gerges (1999) for individual stratigraphic units, the T1 Aquifer in this area is typically 20 - 50 m thick (Fig. 20c). Thickness increases to the southwest and reaches a maximum of about 90 m adjacent to the Eden-Burnside Fault.

Within northeastern areas of the embayment, where the T1 aquifer can be unconfined, thickness is highly variable and partly influenced by topography. It ranges from a few metres to about 50 m and is typically 10 – 20 m.

The T2 Aquifer in the area between the two Para Fault splinters is considered to have a reasonably uniform thickness of about 100 m, although there are limited wells that intersect the full extent of the aquifer. West of the Brighton Fault, the aquifer thickens to the southwest from about 65 m to nearly 100 m at the coast. In the domain immediately northeast of the Brighton Fault, the T2 Aquifer is considered to consist solely of the sandy section of the Aldinga Member (for the purpose of this study). Based on existing isopachs (Gerges, 1999) for this unit, the aquifer has a thickness that varies from a few metres in the north, 12 m at the western side and up to 30 – 40 m to the south and northeast (Fig. 20e).

Adelaide Plains Sub-basin

Thickness contours have been derived using the isopachs of Evans (1990) and Gerges (1999). These isopachs have some spatial overlap, in which significant variation can occur. In such areas, the aquifer thickness contours were simplified to merge with those from adjoining areas.

The Q4 Aquifer thickness generally diminishes in a westerly direction from the Para Fault to a depositional or fault limit within a few kilometres of the coast (Fig. 20f). The aquifer is thickest (40 - 60 m) in a zone near and parallel to the Little Para River.

There were no available storativity assessments of the Q4 Aquifer.

The T1A sub-aquifer thickens in a relatively uniform pattern to the southwest. In the metropolitan area, the sub-aquifer increases from about 40 m in the north to 80 m along the coast near West Beach (Fig. 20g). Within the NAP region, the sub-aquifer gradually thins to the northeast, reaching an irregular depositional limit in a corridor trending northwest from Elizabeth to Middle Beach. The contours shown for the T1A sub-aquifer include the Croyden Facies.

The T1B sub-aquifer has a more variable thickness than the overlying T1A sub-aquifer (Fig. 20h). In the metropolitan area it is thickest (about 40 m) near the Para Fault and diminishes to the west to about 15 – 20 m near the coast. In the NAP region the aquifer thins from about 15 – 25 m at the southern end to a depositional limit near Gawler River in the north.

Nine wells, all with production intervals in the T1B sub-aquifer, have storativity assessments from the reviewed aquifer tests. These wells typically have production intervals over the full thickness of the limestone sequence of the upper Port Willunga Formation and have relatively uniform specific storage values from 3.4E-6 to 4.7E-5 with an average of 2.3E-5. These values are probably higher than actual, as the overlying T1A sub-aquifer would have contributed to the effective storativity determined. If the full thickness of the T1A sub-aquifer above these nine wells is included, the minimum T1 Aquifer specific storage is considered to be of the order of 5E-6. Gerges (1999) adopted specific storage values for the T1 Aquifer within the Adelaide Plains Sub-basin that ranged from 7.0E-6 to 1.0E-5.

Within the NAP region the T2 Aquifer thickens to the south, from about 20 m in the northeast to about 90 m at the southern limit of the NAP PWA (Fig. 20i). In the metropolitan area the aquifer thickness is relatively constant at about 100 m (Fig. 20d).

Five storativity assessments were available for the T2 Aquifer, which indicate specific storage values for the production intervals of 3.2E-6 to 8.6E-5. However, most of these wells only partially penetrate the aquifer, indicating the actual specific storage values may be of the order of 5.0E-6 to 1.0E-5.

5.4 Available storage heads

For the confined aquifers under an artesian storage scenario, depth to the top of the aquifer is an important factor in determining the maximum injection pressure head available. Using the same data sources and methodologies employed for aquifer thickness, structure contours of the top of the main aquifer units were generated. The depths to the top of the aquifer were then calculated in Surfer 8 and are displayed on Figures 21a –i.

The available storage head for confined aquifers was calculated as the sum of available injection pressure above ground and the available head below ground (ie, the depth to groundwater). Thus the greatest available storage heads occur where the aquifer is relatively deep and the existing groundwater level is well below ground.

For the sub-artesian storage scenario, the available storage head was limited to groundwater level rises to 2 mbgl, to prevent the creation of any artesian flows in wells neighbouring a potential ASR project (that are screened in the same aquifer interval). An indication of the available storage heads for this scenario can be observed on Figures 18a – g, which show the depth to groundwater contours.

For the maximum artesian scenario, available storage heads were limited to 85% of the determined aquitard fracture pressures. These 85% available storage heads are shown on Figures 22a - i, whilst the 50% base case available storage heads are shown on Figure 23a –i. The 50% value of aquitard fracture pressure is considered reasonably consistent with injection pressures recommended at several existing or potential ASR projects in the Adelaide region. Maximum injection heads above ground level of about 60 - 70 m have been used at sites such as Andrews Farm and Cheltenham Racecourse, where the depths to the top of the aquifer are about 100 -120 m and depths to groundwater are about 20 m (Sibenaler, 2000 and S Howles, pers.comm.).

For the estimation of aquifer storage capacity in unconfined aquifers, the available storage head is simply the rise of the watertable level that can occur without significantly increasing the potential for adverse effects such as waterlogging, soil salinisation and infrastructure stability. The additional storage capacity of unconfined aquifers typically exceeds the capacity of confined aquifers by several orders of magnitude but the adverse risk factors are also greatly increased. Within the project area, potentially unconfined conditions occur in some areas of the evaluated aquifers (Fig. 17a,b,c). However, to provide conservative (minimum) estimates in these areas, only the elastic storage component has been used in calculating the aquifer storage capacity for the main scenarios.

A brief discussion of the available storage heads for the sub-artesian and 50% base case artesian storage scenario is provided below.

Willunga Embayment – Sub-artesian Scenario

For the Port Willunga Formation Aquifer, the available storage heads are greatest in a narrow band parallel to the Willunga Fault. Within approximately two kilometres of the fault, available storage heads range from about 20 - 70 m (Fig. 17a). In remaining areas of the embayment, available storage heads are typically about 10 - 20 m, becoming less near creeks and in some northern areas.

Available storage heads for the Maslin Sands Aquifer are similar to the Port Willunga Formation Aquifer in most areas of the embayment.

Willunga Embayment – Base Case Artesian Scenario

The available storage heads show a similar pattern to the sub-artesian scenario but are of greater absolute values. Adjacent to the Willunga Fault, available storage heads for the Port Willunga Formation Aquifer range from about 40 – 110 m (Fig. 23a) and 20 - 40 m in most remaining areas of the embayment, being least near creeks and other areas of low relief.

Available storage heads for the Maslin Sands Aquifer are typically higher in most areas because of the greater depth to the aquifer. The greatest available storage heads are about 50 – 80 m near the Willunga Fault and about 40 - 60 m in areas of high relief near the northern limits of the aquifer.

Golden Grove Embayment – Sub-artesian Scenario

Available storage heads in all aquifer domains are generally limited as a result of the generally shallow depths to groundwater. A lack of abstraction highlights the significance of deepened groundwater levels, caused by abstraction, in creating elastic storage "opportunities" in confined aquifers within the study area.

In the domain west of the inferred Brighton Fault and north of the southern splinter of the Para Fault, the available storage heads are very limited (typically only 2 – 10 m) for both the T1 and T2 aquifers (Fig. 18c).

Within the confined aquifer domains southwest and east of the CBD area (Fig. 18c, e) the available storage heads for the T1 and T2 aquifers are similar. They increase from minima of about 5 – 10 m in the northwestern parts in a southeasterly direction to maxima of about 50 – 100 m adjacent to the Eden-Burnside Fault.

Golden Grove Embayment – Base Case Artesian Scenario

For the confined aquifer domains the distribution of available storage head is strongly controlled by proximity to the bounding Eden-Burnside Fault. West of the inferred Brighton Fault and north of the southern splinter of the Para Fault, the available storage heads are dominated by the positive head component and are relatively uniform at about 50 – 60 m. (Fig. 23c)

For the remaining confined aquifer domains, the available storage heads range from about 30 m on the northwest side to about 60 – 140 m within about one kilometre of the Eden-Burnside Fault, being greatest in the area between Brown Hill Creek and Fourth Creek.

In the potentially unconfined domain available storage heads generally increase away from the Torrens Valley to maxima of about 30 – 70 m adjacent to the Eden-Burnside Fault and relatively elevated areas near Dry Creek.

In the area west of the inferred Brighton Fault and north of the southern splinter of the Para Fault, the T2 Aquifer available storage heads are slightly higher than the T1 Aquifer as a result of greater aquifer depths and range from about 40 – 70 m (Fig. 23e).

Adelaide Plains Sub-basin – Sub-artesian Scenario

Available storage heads for the Q4 aquifer are generally limited over much of the study area to less than 15 m. In northeast parts of the NAP PWA and in a narrow band adjacent to the Para Fault, heads can increase to about 70 m but are typically in the range from 20 to 50 m (Fig. 17e).

For the T1 Aquifer, available storage heads in the metropolitan area are commonly of the order of 5–15 m but can reach 20–25 m near western suburb golf courses at the end of the summer irrigation season. Heads can also reach 20–30 m near the Thebarton abstraction centre and immediately adjacent to the Para Fault escarpment (Fig. 17c). In the NAP region, available storage heads can be as high as 15–20 m near the Waterloo Corner abstraction centre but are typically less than 10 m throughout much of the NAP region (Fig. 17f).

Available storage heads for the T2 Aquifer in the metropolitan area are very limited year-round, being typically less than 5 m, apart from inner northeastern areas, where the available heads can increase to about 10–15 m. In the NAP region, available storage heads are strongly influenced by the drawdown cone caused by cumulative irrigation abstraction. In the Virginia area, available storage heads can be as high as 60 m at the end of the irrigation season but reduce to about 30 m (Fig. 17g) at the end of the winter-spring period, just prior to recommencement of irrigation abstraction. In northern and western areas of the NAP region, available storage heads are typically less than 10 m, whilst in northeastern areas and adjacent to the Para Fault, heads can increases to 30 – 70 m.

Adelaide Plains Sub-basin – Base Case Artesian Scenario

Available storage heads for the Q4 Aquifer are limited to between 30 – 50 m as a result of the limited aquifer thickness and shallow depths to groundwater (Fig. 23f). Much of the available head can be attributed to the depth of the aquifer (20 to 105 m) beneath shallower Quaternary sediments. The maximum available storage heads of 60 – 120 m occur in a localised area adjacent to the Little Para River and Para Fault where aquifer thickness and depth are significantly enhanced.

The available storage heads for the T1B sub-aquifer are the same as the overlying T1A sub-aquifer because of their direct hydraulic connection. In a small corridor north of the depositional limit of the Dry Creek Sand in the NAP region, the available storage heads of the T1B sub-aquifer were determined from structure contours of the upper limestones of the Port Willunga Formation (Fig. 23h).

In much of the NAP region, the T1 Aquifer has available storage heads of about 40 – 60 m (Fig. 23g) with a general increasing trend to the east. Close to where the little Para River transects the Para Fault, available storage heads increase to about 130 m. In the metropolitan area, the available storage heads are typically 60 – 80 m, being reasonably uniform as a result of the relative consistency in depth to the top of the aquifer and depths to groundwater.

For the T2 Aquifer, available storage heads are typically higher than the T1 Aquifer because of it's greater depth and deeper groundwater levels associated with large-scale abstraction from the NAP PWA. In the metropolitan area available storage heads range from about 90 – 120 m with an increasing southerly trend predominantly due to the increasing depth of the aquifer (Fig. 23e).

In the NAP region the distribution of available storage heads is quite variable, due to interaction of the variability in depth to the top of the aquifer and depths to groundwater. Available storage heads vary from about 30 m near Two Wells, to 90 m near Virginia at the centre of the regional drawdown cone and to 120 -160 m as a narrow band parallel to the Para Fault between Gawler and Salisbury (Fig. 23i). If September 2001 groundwater levels are used, the available storage head in the Virginia area diminishes to a maximum of about 60 m.

5.5 Additional aquifer storage capacities

The additional storage capacities of the sedimentary aquifers for the five different scenarios outlined earlier are presented in Table 9. Totals for each aquifer within individual catchment water management boards are also shown on Figures 25a – i.

The additional storage capacities shown in Table 9 represent upper-bound ASR injection volumes in the sense of areal extent, as these volumes are for 100% of each aquifer domain. The actual likely maximum ASR injection volumes will be less when limiting criteria such as native groundwater salinity, availability of source water and economic factors are applied. The effects of limiting storage to areas of salinity less than 3000 mg/L TDS and/or to preferred aquifer areas are presented in sections 5.7 and 8.

Before discussing the results of the additional aquifer storage capacity calculations, the following points are restated here from earlier sections regarding the different parameters and assumptions used for each of the five separate scenarios:

- **Sub-artesian, minimum specific storage scenario**
    - Available storage heads are limited to 2 mbgl for confined aquifers.
    - Specific storage value of 6.0E-6 applied to all aquifer domains.
    - For unconfined aquifer domains the calculated additional storage capacity is limited to the elastic (confined) storage component for storage heads to 2 mbgl.
- **Sub-artesian, maximum specific storage scenario**
    - As above except that a specific storage value of 1.2E-5 applied.
- **Maximum Artesian, minimum specific storage scenario**
    - Maximum available storage heads for confined aquifers applied at 85% of the determined aquitard fracture pressure.
    - Specific storage value of 6.0E-6 applied to all confined aquifer domains.
    - For unconfined aquifer domains the storage capacities were calculated using effective specific yield values of 0.025 – 0.05 for groundwater level rises restricted to 5 mbgl.

- **Maximum Artesian, maximum specific storage scenario**
  - Maximum available storage heads for confined aquifers applied at 85% of the determined aquitard fracture pressure.
  - Specific storage value of 1.2E-5 applied to all confined aquifer domains.
  - For unconfined aquifer domains the storage capacities were calculated using effective specific yield values of 0.05 – 0.10 for groundwater level rises restricted to 5 mbgl.
- **Base Case scenario**
  - Maximum available storage heads for confined aquifers applied at approximately 50% of the determined aquitard fracture pressure.
  - Specific storage value of 9.0E-6 applied to all confined aquifer domains.
  - For unconfined aquifer domains the calculated additional storage capacity is limited to the elastic (confined) storage component for storage heads to 2 mbgl.

The base case aquifer storage capacities listed in Table 9 are also presented graphically on Figure 26 to highlight the relative capacities between aquifers and catchment board areas.

5.5.1 DISCUSSION OF RESULTS

Sub-artesian Scenario

The results show that the additional capacity to store water in confined aquifers without creating artesian conditions in the study area is relatively limited. Assuming an average specific storage value of 9.0E-6, the total additional aquifer storage capacity of the entire study area amounts to about 19 000 ML.

Assuming a uniform specific storage value, the distribution of additional aquifer storage capacity is controlled by aquifer thickness and available storage head (which is simply the depth to groundwater less 2 m). Within the Adelaide Plains Sub-basin, groundwater levels are much more significant than aquifer thickness, especially for the T2 Aquifer. In the Torrens and Patawalonga catchment board areas, this aquifer is quite thick (typically in excess of 90 m) but the available storage head is mostly less than five metres, resulting in a storage capacity of only 666 ML. In contrast, within the NABCWMB area, the available head is typically 20 – 50 m whilst the aquifer thickness is mostly 50 – 90 m. The total T2 Aquifer storage capacity in the NABCWMB area is 10 717 ML, which is about 16 times higher than the T & P CWMB area. Part of this difference is also related to the difference in surface area extent of the two areas (the NAP area is 3.5 times greater).

The limiting effects imposed by retaining sub-artesian conditions for confined aquifers is best exemplified by the T2 Aquifer additional storage capacity within the T & P CWMB area. The storage capacity of this aquifer in the Adelaide Plains Sub-basin area increases from 666 ML to 15 356 ML when the base case artesian scenario conditions are applied.

Table 9. Additional Aquifer Storage Capacities

Aquifer - Domain	Basin	Storage Capacity (ML)				
		Sub-artesian Scenario		Maximum Artesian Scenario		Artesian Base Case
		Minimum Ss	Maximum Specific storage	Minimum Ss	Maximum Ss	
Onkaparinga Catchment Water Management Board						
Port Willunga Formation - confined	Willunga Embayment	1 739	3 478	4 015	8 029	4 683
Port Willunga Formation - unconfined	Willunga Embayment	23	46	6 738	13 475	35
Maslin Sands - confined	Willunga Embayment	1 292	2 584	6 249	12 497	6 353
Maslin Sands - unconfined	Willunga Embayment	299	597	90 571	181 141	448
Confined sub-total		*3 031*	*6 063*	*10 263*	*20 527*	*11 036*
Unconfined sub-total		*322*	*644*	*97 308*	*194 616*	*483*
Torrens and Patawalonga Catchment Water Management Boards						
Q4 - confined	Adelaide Plains Sub-basin	10	20	185	370	172
T1A - confined	Adelaide Plains Sub-basin	811	1 622	5 697	11 393	5 597
T1A - confined	Golden Grove Embayment	11	21	102	203	98
T1B - confined	Adelaide Plains Sub-basin	425	850	2 969	5 938	2 918
T1B - confined	Golden Grove Embayment	10	21	141	281	133
T1 mainly as Dry Creek Sand and lower Port Willunga Formation - confined	Golden Grove Embayment	255	511	790	1 580	869
T1 mainly as sandy Aldinga Member - confined	Golden Grove Embayment	451	901	959	1 918	1 136
T1 mainly as sandy Aldinga Member and undifferentiated sands - unconfined	Golden Grove Embayment	124	249	29 021	58 043	187
T2 - confined	Adelaide Plains Sub-basin	333	666	17 060	34 120	15 356
T2 - confined	Golden Grove Embayment	41	82	1 187	2 374	1 085
T2 mainly as sandy Aldinga Member and undifferentiated sands - confined	Golden Grove Embayment	121	242	844	1 688	828
Confined sub-total		*2 468*	*4 936*	*29 933*	*59 865*	*28 193*
Unconfined sub-total		*124*	*249*	*29 021*	*58 043*	*187*

Aquifer - Domain	Basin	Storage Capacity (ML)				
		Sub-artesian Scenario		Maximum Artesian Scenario		Artesian Base Case
		Minimum Ss	Maximum Specific storage	Minimum Ss	Maximum Ss	
Northern Adelaide and Barossa Catchment Water Management Boards						
Q4 - confined	Adelaide Plains Sub-basin	986	1 973	4 197	8 393	4 387
T1A - confined	Adelaide Plains Sub-basin	240	481	2 118	4 235	2 049
T1B - confined	Adelaide Plains Sub-basin	409	818	2 815	5 630	2 775
T1 mainly as undifferentiated sands - unconfined	Golden Grove Embayment	16	32	4 697	7 023	24
T2 - confined	Adelaide Plains Sub-basin	5 358	10 717	29 606	59 213	29 757
Confined sub-total		*6 994*	*13 988*	*38 736*	*77 472*	*38 968*
Unconfined sub-total		*16*	*32*	*4 697*	*7 023*	*24*
Confined Total		**12 493**	**24 987**	**78 932**	**157 863**	**78 196**
Unconfined Total		**462**	**924**	**131 027**	**259 682**	**693**

The effect of increasing groundwater levels over a wide area, but without creating artesian flow in adjacent wells, as a result of significant implementation of ASR projects could have several positive effects on the groundwater resource and existing users. Increased groundwater levels may slightly reduce drawdown within existing wells or reverse the vertical head gradient direction between the deeper Tertiary aquifers and the shallower Quaternary wells, which are often more saline, thus providing some amelioration of the negative effects of aquifer salinisation from corroded leaky wells.

Maximum Artesian Scenario

The maximum artesian scenario shows that the total additional storage capacity can be much greater than the sub-artesian scenario, with total estimates ranging from 210 000 – 417 000 ML. These volumes can be considered as technically feasible but practically unlikely.

The storage capacity of confined aquifers in this scenario ranges from 79 000 to 158 000 ML. However, these volumes are unlikely to be fully realised because of the artesian flows that would be induced in surrounding wells. Virtually none of the potentially affected wells have headworks capable of managing artesian flows and many of the wells are irrigation wells that are inactive during the winter period when the artesian conditions would occur.

The reality of maximising aquifer storage capacities under artesian conditions would have to involve the creation of buffer zones around individual ASR projects. The ASR proponent should undertake a detailed well census to identify any surrounding wells at risk of artesian conditions. For those wells at risk, the proponent would have to make suitable arrangements with these affected groundwater users or alternatively reduce the magnitude of proposed injection.

Within the study area there are some broad areas where a particular aquifer is not commonly used, such as the Maslin Sands Aquifer in the Willunga Embayment or the T2 Aquifer in the southern end of the Adelaide Plains Sub-basin. These areas may be best suited for maximising storage under artesian conditions. The paradox of ASR storage in the study area is that many of these under-utilised areas have shallow depths to groundwater and the available storage amount is virtually entirely composed of the positive (artesian) storage head above ground level.

For the maximum storage scenario, aquifer storage capacities are significantly influenced by the gravity storage component of the three unconfined aquifer domains (the Port Willunga Formation and Maslin Sands aquifers in the Willunga Embayment and the T1 Aquifer in the Golden Grove Embayment). These range from 131 000 to 260 000 ML (62% of the total). These volumes may be conservatively low, as they are based on relatively low specific yields of 0.025 – 0.10. The yield values used were derived simply by assuming that only 50% of the unconfined aquifer domains consisted of sandy sediments possessing Sy values of 0.05 – 0.20. The gravity storage capacities are not considered likely to become major components of ASR potential storage as a result of two key reasons:

- Within the assigned unconfined aquifer domains, the hydrogeology is relatively complex and confining beds of various effectiveness are likely to occur internally within the aquifer or above the aquifer, within shallower Quaternary sediments over large parts of the aquifer domains, making the aquifer response semi-confined or confined.
- The risk of adverse effects from shallow watertable levels resulting from ASR injection are probably too great in many parts of the areas assigned as unconfined because the areas are either extensively urbanised and/or comprise undulating topography.

For these reasons, only the elastic storage component of the unconfined aquifer domains was considered as practical for inclusion in the base case scenario.

Base Case Scenario

The base case scenario applies a uniform and average specific storage value of 9.0E-6 to all aquifer domains, which results in a total aquifer storage capacity of 79 000 ML. The following key points are made:

- The confined aquifer domains dominate the total aquifer storage capacity (99%) as the three unconfined domains only use the elastic storage component and are of relatively limited areal extent.
- 49% of total capacity occurs within the NABCWMB, 36% within T & P CWMB's and the remainder (15%) within the OCWMB. These ratios are reasonably consistent with the total surface areas of available sedimentary aquifers within the catchment boards.
- For the OCWMB, the storage capacity of the two main aquifers is similar (4683 ML for the Port Willunga Formation Aquifer and 6353 ML for the Maslin Sands Aquifer).
- In the T & P CWMB's, the majority of additional aquifer storage capacity occurs within the Adelaide Plains Sub-basin (24 043 ML) compared to the Golden Grove Embayment (4336 ML).

- The T2 Aquifer dominates the available storage capacity in the Adelaide Plains Sub-basin as a result of the combined effects of thickness, depth and lowered groundwater levels. In the T & P CWMB area, T2 aquifer storage capacity totals 17 269 ML compared with the T1 Aquifer total of 10,938 ML. In the NABCWMB area, the dominance of the T2 Aquifer is most pronounced; 29 757 ML compared with 4 848 ML for the T1 Aquifer.
- The Q4 Aquifer represents only a minor resource in comparison to the Tertiary aquifers.

The 50% fracture pressure level adopted for the base case scenario still invokes artesian conditions across the entire extent of each confined aquifer domain, creating the same management issues raised above. A detailed assessment of 'allowable' artesian areas using groundwater flow modelling to predict the conical pattern of groundwater level mounding around ASR sites would be required to refine the likely artesian aquifer storage capacities presented above.

Accuracy of Results

The key variable affecting the accuracy of the additional storage capacity estimates is specific storage. The uniform base case value of 9.0E-6 is considered to be accurate to about +/- 30%.

Other factors that are recognised as having potential influence on the magnitude and accuracy of estimates are:

- Additional minor storage capacity could be available in a narrow band seaward of the coastline if ASR projects were installed close to the coast. These volumes are probably minor and some inclusion of coastal areas has already been incorporated in the Torrens Island area.
- Some additional minor storage capacity is likely to be present in the Golden Grove Embayment as the aquifer geometries were simplified and minor potential aquifer zones were omitted from calculations.
- Additional minor storage capacity would be available within the Noarlunga Embayment in coastal areas where the Port Willunga Formation and Maslin Sands have significant thickness. Capacities were not calculated due to the lack of data and the likely elevated salinities and groundwater levels. In the coastal area between Port Noarlunga and Moana, an indicative estimate of additional aquifer storage capacity is of the order of 300 ML for both aquifers.
- Accuracy of groundwater levels – whilst considered suitably accurate over most of the aquifer domains, groundwater levels near the basin margins and bounding faults are probably less accurate. The reduced accuracy is a function of the variation in topography and some uncertainty in the degree of hydraulic connection between sedimentary aquifers and the adjoining fractured rock domains across the major fault zones.

- Aquitard storage – the estimation approach used only calculated storage capacity values for the aquifer zones but not for any intervening aquitards. In practice, storage (or release) of water within the aquitard units may be significant as the finer grained sediment of aquitards are typically more compressible than aquifer materials. However, the specific storage values applied in this study are considered “effective” in that they probably incorporate some amount of storage or release of water from internal or intervening aquitard units. Water “injected” into aquitard units adjacent to the ASR aquifer may not be readily recovered, hence potentially lowering the recovery efficiency.
- Variability of groundwater levels – aquifer storage capacity is related to groundwater levels, hence the capacities could increase or diminish over time in association with groundwater level changes. The seasonal variation of groundwater levels in areas where irrigation abstraction is significant has a large influence on aquifer storage capacities. This is discussed below in greater detail. Longer-term groundwater level trends may also affect aquifer storage capacities. Within the Willunga and Golden Grove embayments, such trends are fairly stable and consequently, aquifer storage capacities are not expected to vary much. In the Adelaide Plains Sub-basin, long-term historical declining trends have been overprinted by recent recovery trends since 1998-99. These recoveries may be related to decreased irrigation abstraction brought about by the introduction of alternative water supplies from the Virginia Pipeline Scheme. If the recent recoveries were to continue, the additional aquifer storage capacities will diminish slightly.

Effects of Irrigation Abstraction

The seasonal variation in groundwater levels of both the T1 and T2 aquifers in the Adelaide Plains Sub-basin has a significant effect on computed aquifer storage capacities.

The values listed in Table 9 are based on autumn data, when groundwater levels are deepest and additional aquifer storage capacities consequently greatest.

The minimum additional storage capacity occurs in spring when recharge effects are maximised just prior to the recommencement of irrigation abstraction. Estimation of storage capacities using September 2001 groundwater was completed for the T1 and T2 aquifers and the results presented in Table 10 to highlight the seasonal variation in storage capacity.

The results highlight the significant influence of seasonal groundwater levels on the sub-artesian scenario volumes. Using March 2003 levels, the combined additional aquifer storage capacity is 11 365 ML, which is reduced by 29% to 8 105 ML if the September 2001 levels are used. The variation is greatest for the T1 Aquifer in the metropolitan area, where the winter recovery from golf course abstraction is marked.

The variation for the base case artesian scenario is understandably less, as the depth to groundwater is not the sole variable in determination of available head. The combined T1 and T2 capacity using September 2001 levels (54 922 ML) is only slightly reduced from the March 2003 level of 58 452 ML (a 6% reduction).

Table 10. Additional Aquifer Storage Capacity Variation[1]

Aquifer and Catchment Board	Sub-artesian Scenario Storage Capacity (ML)			Artesian Scenario Storage Capacity (ML) [2]		
	Mar '03 groundwater levels	Sep '01 groundwater levels	% Reduction	Mar '03 groundwater levels	Sep '01 groundwater levels	% Reduction
T1 - T & PCWMB	1 854	1 114	39.9	8 515	7 772	8.7
T1 - NABCWMB	974	706	27.6	4 824	4 340	10.0
T1 - total	***2 828***	***1 820***	**35.7**	***13 339***	***12 112***	**9.2**
T2 - T & PCWMB	499	464	7.0	15 356	15 301	0.4
T2 - NABCWMB	8 037	5 820	27.6	29 757	27 509	7.6
T2 - total	***8 537***	***6 285***	**26.4**	***45 113***	***42 810***	**5.1**

Note 1. all volumes based on a specific storage value of 9.0E-6
2. Artesian Scenario volumes based on 50% fracture pressure level

In reality, the likely additional aquifer storage capacities that could be realised for the T1 and T2 aquifers in the Adelaide Plains Sub-basin would be within the range of values shown in Table 10 as the autumn values represent maxima and the spring levels minima.

5.6 Existing groundwater volumes in elastic storage

The aquifer storage capacities presented in section 5.5 represent the **additional** storage volumes that may be realised over and above the volumes of groundwater already stored within the major aquifers as at autumn 2003. Extra storage capacity for an ASR project could be potentially created by initially abstracting native groundwater prior to commencement of the first injection cycle. This may be a particularly favourable ASR project option in areas where the native groundwater salinity is in excess of about 2,000 mg/L. In such areas, there are typically few, if any, existing groundwater users and ASR projects may represent a key beneficial use of such brackish aquifers.

To quantify the groundwater volumes currently in aquifer storage, only the elastic component of each major confined sedimentary aquifer has been considered. The gravity storage volumes held within the confined aquifers are much higher than the elastic storage component, being of the order of many thousands of gigalitres. However, these volumes are not realistically accessible in the confined aquifer systems and thus have not been evaluated. The elastic storage component is based on the amount of difference in levels between the autumn 2003 potentiometric surface and the top of the aquifer, i.e., that groundwater held under confined conditions before the groundwater level declines beneath the top of the aquifer and unconfined conditions commence.

The elastic storage volumes held within the major sedimentary aquifers as at autumn 2003 are presented in Table 11 with the additional aquifer storage capacities for comparison.

The evaluation of existing groundwater in elastic storage shows that the total amount of 95 716 ML and the pattern of distribution between individual aquifers and catchment boards are similar to the additional aquifer storage capacities of the artesian scenario.

Unlike the additional aquifer storage capacities, only a minor proportion of the existing groundwater volumes may be realised as actual ASR storage potential because large-scale "sacrificial" or pre-ASR abstraction to create significant drawdown cones ahead of initial injection has the potential to cause adverse impacts. These include:

- **Potential for adverse drawdown interference affects on surrounding wells**. The creation of storage potential by pre-ASR abstraction would probably occur in the summer and autumn months immediately prior to the winter injection season. During this time, groundwater abstraction from existing wells is usually at it's peak and correspondingly, groundwater levels at their lowest. Further decline of groundwater levels from a new ASR project may have adverse impacts on the surrounding wells. In relation to ASR projects, the rights of existing groundwater users are typically protected by allocation criteria in Water Allocation Plans. For example, the NAP WAP stipulates that "*recharged water shall only be allocated where the proposed location and manner of use of the water is not likely to:………cause unacceptable interference with the water supply from existing wells".* Such criteria could limit the potential volumes of pre-ASR abstraction in areas of closely spaced groundwater use.
- **Ongoing or repetitive use of the "existing" groundwater storage capacity**. If a potential ASR project plans to utilise the additional storage capacity created by pre-ASR abstraction for multiple years, then the potentially negative affects from reducing groundwater levels on a permanent basis must be assessed.
- **Use or disposal of abstracted groundwater**. If the native groundwater is too saline for use, then there may be no economically or environmentally acceptable method of disposal for potential pre-ASR abstraction.
- **Potential for land subsidence from excessive groundwater level declines**. This potential may be limited or effectively non-existent for small-scale abstractions over short periods. However, the impacts of prolonged and large-scale abstraction on land subsidence should be noted. Belperio (1993) has shown that land subsidence in the Bolivar area caused by groundwater abstraction has been about 140 mm over about the past 50 years.
- **Potential for adverse impacts upon groundwater dependent ecosystems**. Reduced groundwater levels may have a negative affect upon the water budget of any dependent ecosystems, even if the period between pre-ASR abstraction and restoration of groundwater levels from ASR injection is brief.
- **Securing allocation transfers in prescribed well areas**. To date, ASR operations usually commence as an operation by injecting first prior to recovery later of a portion of that water injected. Within a PWA area, pre-ASR abstraction would require the securing of groundwater allocations from existing groundwater users.

Table 11. Groundwater Volumes Held in Elastic Storage as at Autumn 2003

Aquifer	Basin	Existing Elastic Storage (ML)	Additional Storage Capacity (ML)	
			Sub-artesian Scenario	Artesian Scenario
Onkaparinga Catchment Water Management Board				
Port Willunga Formation	Willunga Embayment	1 358	2 609	4 683
Maslin Sands	Willunga Embayment	7 597	1 938	6 353
	Sub-total	*8 955*	*4 547*	*11 036*
Torrens and Patawalonga Catchment Water Management Boards				
Q4	Adelaide Plains Sub-basin	280	15	172
T1A	Adelaide Plains Sub-basin	7 038	1 216	5 597
T1A	Golden Grove Embayment	136	16	98
T1B	Adelaide Plains Sub-basin	3 664	638	2 918
T1B	Golden Grove Embayment	202	16	133
T1 mainly as Dry Creek Sand and lower Port Willunga Formation	Golden Grove Embayment	483	383	869
T1 mainly as sandy Aldinga Member	Golden Grove Embayment	513	676	1 136
T2	Adelaide Plains Sub-basin	28 504	500	15 356
T2	Golden Grove Embayment	1 883	62	1 085
T2 mainly as sandy Aldinga Member and undifferentiated sands - confined	Golden Grove Embayment	1 041	182	828
	Sub-total	*43 744*	*3 702*	*28 192*
Northern Adelaide and Barossa Catchment Water Management Boards				
Q4	Adelaide Plains Sub-basin	3 793	1 480	4 387
T1A	Adelaide Plains Sub-basin	2 779	361	2 049
T1B	Adelaide Plains Sub-basin	3 427	614	2 775
T2 - confined	Adelaide Plains Sub-basin	33 018	8 038	29 757
	Sub-total	*43 017*	*10 491*	*38 968*
	Total	**95 716**	**18 739**	**78 196**

Resolution of how much of the existing groundwater storage in the confined sedimentary aquifers could be used for ASR cannot be done readily. It would be best investigated at a project scale by studies that utilise groundwater flow modelling to consider the environmental and social impacts of increased abstraction and diminished groundwater levels.

It is difficult to foresee considerable 'access' to the total volumes currently held in storage given that it would represent significant additional abstractions from groundwater resources which are largely under stress and not capable of additional sustainable withdrawals. Conceptually, the potentially accessible capacity is likely to be less than 10 000 ML.

5.7 Aquifer storage capacities for areas less than 3000 mg/l TDS

Most end uses for ASR water are quality dependant. To date, the majority of ASR projects in the study area use recovered water for turf irrigation or horticulture, which typically apply an upper bound salinity of 1000 mg/L TDS.

To refine the estimates of additional aquifer storage capacities for those areas where the recovered water would remain less than 1000 mg/L TDS, the following assumptions were adopted:

- injected water is required within the same irrigation season, i.e., no significant building up of a freshwater plume to act as a buffer zone in subsequent recovery periods;
- injected water salinity of 300 mg/L TDS; and
- recovery efficiency of 75%.

By applying the above assumptions, recovered water remains below the 1000 mg/L limit in areas where the native groundwater salinity is less than about 3000 mg/L TDS.

Using the salinity contours shown on Figure 16a-g, the base case scenario volumes were recalculated. These revised storage capacities are presented in Table 12 and also shown on Figure 27a – i.

The reduced total aquifer storage capacity is 68 045 ML, which is 9944 ML (12.6%) less than the base case total of 78 889 ML. Table 12 shows that the greatest reduction occurs within the T & P CWMB boundaries of the Adelaide Plains Sub-basin for the T2 Aquifer (38.1 % reduction).

Reduced aquifer storage capacity based on salinity constraints may not be necessarily realised, as there are potential benefits from ASR development in saline groundwater areas, which include:

- In coastal areas where the aquifer discharges to the sea, ASR injection without significant recovery can create a hydraulic barrier, preventing potential seawater intrusion.
- Areas of elevated native groundwater salinity often have few or no existing groundwater users, which presents an opportunity to maximise storage volumes under artesian conditions, albeit at potentially lower recovery efficiencies.

5.8 Fractured rock aquifers

Aquifer storage capacities for fractured rock aquifers have not been evaluated because their highly variable and discontinuous nature prevents reliable quantification on a regional scale.

Fractured rock aquifers often have a lower ASR potential than sedimentary aquifers as a result of:

Table 12. Base Case Additional Aquifer Storage Capacities for Areas Less than 3000 mg/L TDS

Aquifer - Domain	Basin	Storage Capacity (ML)	% Reduction from Entire Area Base Case
Onkaparinga Catchment Water Management Board			
Port Willunga Formation - confined	Willunga Embayment	4 573	2.3
Port Willunga Formation - unconfined	Willunga Embayment	35	–
Maslin Sands - confined	Willunga Embayment	5 745	9.6
Maslin Sands - unconfined	Willunga Embayment	425	5.1
Confined sub-total		*10 318*	*6.5*
Unconfined sub-total		*460*	*4.7*
Torrens and Patawalonga Catchment Water Management Boards			
Q4 - confined	Adelaide Plains Sub-basin	112	34.9
T1A - confined	Adelaide Plains Sub-basin	4 983	11.0
T1A - confined	Golden Grove Embayment	98	–
T1B - confined	Adelaide Plains Sub-basin	2 480	15.0
T1B - confined	Golden Grove Embayment	133	–
T1 mainly as Dry Creek Sand and lower Port Willunga Formation - confined	Golden Grove Embayment	869	–
T1 mainly as sandy Aldinga Member - confined	Golden Grove Embayment	1 118	1.6
T1 mainly as sandy Aldinga Member and undifferentiated sands - unconfined	Golden Grove Embayment	125	32.9
T2 - confined	Adelaide Plains Sub-basin	9 497	38.2
T2 - confined	Golden Grove Embayment	1 085	–
T2 mainly as sandy Aldinga Member and undifferentiated sands - confined	Golden Grove Embayment	828	–
Confined sub-total		*21 203*	*24.8*
Unconfined sub-total		*125*	*32.9*
Northern Adelaide and Barossa Catchment Water Management Boards			
Q4 - confined	Adelaide Plains Sub-basin	3, 907	10.9
T1a - confined	Adelaide Plains Sub-basin	1 973	3.7
T1b - confined	Adelaide Plains Sub-basin	2 583	6.9
T1 mainly as undifferentiated sands - unconfined	Golden Grove Embayment	18	25.0
T2 - confined	Adelaide Plains Sub-basin	28 357	4.7
Confined sub-total		*36 820*	*5.5*
Unconfined sub-total		*18*	*25.0*
Confined Total		**68 342**	**12.6**
Unconfined Total		**603**	**9.9**

- typically high transmissivity and low storativity, which increases the potential for migration of injected water away from the injection site and subsequently lower recovery efficiency; and
- in areas of moderate or steep relief with little or no sedimentary overburden, the potential for groundwater discharge to land via seeps and springs is increased.

However, in many parts of the study area, fractured rock aquifers form the only available groundwater resource. Consequently, there are no other alternatives for ASR projects in such areas.

Key fractured rock aquifer features are shown on Figures 24a-c. These include:

- the distribution of the main geological formations in areas of basement outcrop;
- approximate depths to the top of Cambrian or Proterozoic basement rocks within the main sedimentary basins; and
- well yields from SA Geodata for production intervals assigned to fractured rock aquifers.

To investigate the conceptual volumes of additional water that fractured rock aquifers in the study area may be capable of storing, only those areas within or immediately adjacent to the major basins where sediments overlay basement rocks have been considered. These criteria have been adopted to focus only on those areas where the fractured rock aquifers are most likely to be confined and the potential for groundwater discharge to land is reduced.

The depth to basement rocks has been determined for three categories; 0 – 30, 30 – 80 and 80 – 100 m. The distinction between these categories is somewhat arbitrary but was chosen to highlight:

- Areas of shallow sedimentary cover (0–30 m) where the potential for unwanted groundwater discharge to land is still possible in areas of moderate to high relief;
- An ‘ideal’ depth of cover (30–80 m), which effectively reduces the groundwater discharge potential and limits well depths to cost-effective levels; and
- The area where depths to basement (80–100 m) start to significantly influence well drilling and construction costs. In such areas, there is likely to be a shallower sedimentary aquifer more suitable for ASR anyway.

To highlight the varying amounts of areas potentially suited for fractured rock ASR between Tertiary basins, the depth to basement domain areas are listed in Table 13.

In terms of ASR potential, fractured rock domains may be of more significance to the OCWMB than the other catchment boards as a result of the relatively limited sedimentary aquifer storage capacity and the large extent of buried fractured rock areas (188 km^2).

Within the Golden Grove Embayment, the fractured rock domain is of most importance in the northeastern suburbs where suitable sedimentary aquifer alternatives are often absent. Indeed, all of the ASR investigations or operations undertaken to date in this area involve fractured rock aquifers.

Table 13. Areas of Sedimentary Cover Above Basement

Basin	Basement Depth Category (mbgl)[1]	Area (km^2)
Willunga Embayment	0–30	43.1
	30–80	44.3
	80–100	10.6
	sub-total	*98.0*
Noarlunga Embayment	0–30	46.4
	30–80	30.5
	80–100	12.6
	sub-total	*89.5*
Golden Grove Embayment	0–30	67.2
	30–80	39.5
	80–100	15.8
	sub-total	*122.5*
Adelaide Plains Sub-basin	0–30	69
	30–80	83.1
	80–100	55.5
	sub-total	*207.6*

Note 1. mbgl = metres below ground level

Whilst significant areas of relatively shallow sedimentary cover above basement rocks have been identified in the Adelaide Plains Sub-basin, these are mainly north of the Gawler and Kangaroo Flat areas, where water demand is likely to be much lower.

Conceptually, it is estimated that the ASR storage potential of the outlined fractured rock areas in the Willunga, Noarlunga and Golden Grove embayments is of the order of 1000 to 1500 ML, based on the following assumptions:

- Aquifer storage comprises only the elastic (confined) component using a specific storage value of 6.0E-6.
- The aquifer area is only 20% of the total areas listed in Table 13 to represent the localised and discontinuous nature of fractured rock aquifers.
- Average aquifer thickness of 50 m.
- Available head is uniform within each depth domain, being the addition of half the average depth to bedrock and an average depth to groundwater of 10 m.

In practice, the total storage volumes that could be realised by fractured rock ASR sites is likely to be higher as a result of some hydraulic connection between fractured rock zones and the overlying or adjacent sedimentary aquitard or aquifer sequence.

Currently there are seven operational ASR projects injecting about 230 ML of water into fractured rock aquifers within the study area. Using these statistics and the conceptual storage volume outlined above, it is feasible that at least another 30 similarly-sized ASR sites could be potentially established in the fractured rock aquifers of the study area.

6 SOURCE WATER

This section provides a brief presentation of the types and quantities of source water potentially available for ASR in the study area and the existing usage levels of such water.

The inherent variability in occurrence of stormwater runoff, access to source water, and available open space form major variables in assessing the injection potential of areas for ASR. Such variables are often constraints and the ASR volumes that could be practically achieved will be consequently lower than the totals presented in Section 5. The assessment of such factors is not usually quantified until a detailed project feasibility is undertaken. Recent and current studies are resolving these aspects of stormwater reuse in the Adelaide region. These include the Adelaide Coastal Waters Study, water supply modelling by Clark (2003) and evaluation of stormwater harvesting potential by KBR (2004).

The aquifer storage capacities presented in section 5 are refined in section 8 to incorporate only those areas that have the highest ASR storage potential and which have excluded any zones based on the potential for adverse environmental impacts. It these revised storage capacities that should be further analysed with regard to source water variables to define the potentially economic ASR sites or areas.

The various forms of source water for ASR in the study area are considered to be:

- stormwater runoff from open drains or creeks in largely non-urbanised catchments;
- stormwater runoff collected from closed or lined drains in urbanised areas;
- reclaimed water from WWTP's;
- local-scale roof runoff; and
- mains water supplies from the SA Water distribution network.

Only stormwater and reclaimed water are discussed below.

6.1 *Stormwater runoff*

6.1.1 CATCHMENT DISCHARGES TO SEA

The main catchment boundaries of the study area are shown on Figure 28a – c, which also show urbanised areas in contrast to largely open or rural areas to highlight the broad nature of stormwater runoff in each catchment.

The yields of the major catchments have been estimated previously for various purposes. For this study, the typical discharges to Gulf St Vincent from the main catchments have been used to quantify the magnitude of potential stormwater runoff supply for ASR.

Wilkinson (2004) indicates that stormwater runoff discharge to the Gulf in the metropolitan area for Gawler River to Sellicks Beach averaged about 100 000 ML between 1995 and 2003. Longer-term records indicate the typical discharge is about 160 000 ML/year (SA Government, 2004). Modelled discharges using available data for the 1900 – 1995 period by Clark (2003) are presented in Table 14.

Table 14. Stormwater runoff discharge to Gulf St Vincent (after Clark, 2003)

River/Drain System	Average Flows to Sea (ML/year)
Gawler River[1]	25 200
Smithfield Drain	2 100
Helps Rd Drain	3 600
Little Para River[2]	5 800
Dry Creek	13 100
West Lakes / Enfield	13 100
Torrens River[3]	38 100
Keswick Creek	11 200
Sturt River	12 500
Brighton Coast	3 700
Field River	9 500
Christies River	3 200
Onkaparinga River[4]	27 400
Willunga Basin	5 500
Total	**174 000**

Note 1. average discharge from Virginia Park gauging station 1973–1988
2. includes 300 ML spill from Little Para Dam
3. includes 13 400 ML spill from Kangaroo Creek Dam
4. includes 21 700 ML spill from Mt Bold Dam

Based on an average annual discharge of about 174 000 ML (Clark, 2003) and a general maxim that 70% of catchment yield can be feasibly harvested using technical and economic criteria (KBR, 2004), a volume of about 125 000 ML/year is considered to be the maximum available quantity of stormwater runoff for reuse in the study area. However, these volumes do not consider the quantities of water needed to sustain dependant ecosystems. This issue is discussed in more detail in section 7.

The urbanisation of Adelaide has significantly increased the volumes of water discharged to the Gulf and has also increased the discharged level of various pollutants into the marine environment. Excessive nutrient loads and some potentially toxic levels of metals have contributed to a loss of seagrass habitat and adversely impacted reliant marine ecosystem(s). The reduction of stormwater discharge and improvement of water quality brought about by the implementation of wetland capture and treatment systems often used in ASR development can thus produce positive environmental outcomes for the near-shore marine environment.

In terms of the total potential supply from stormwater harvesting for aquifer injection, the volumes captured by large-scale wetland systems do not necessarily require complete injection. Schemes such as Parafield export large quantities of treated stormwater directly to clients such as GH Michels without the need for aquifer storage.

6.1.2 STORMWATER DRAINAGE NETWORK AND EXISTING USERS

The stormwater drainage networks of the study area are shown on Figures 29a – c, which also show the location of existing operational ASR projects.

Apart from existing ASR projects, it is difficult to ascertain the locations and magnitude of other stormwater runoff users in the study area as the surface water resources are unprescribed. This may change in the future if prescription of the surface water resources of the Western Mt Lofty Region (WMLR) occurs.

Of the existing ASR projects, the Morphetville and Parafield schemes have the (planned) capacity to harvest 100% of the divertible stormwater yield from their sub-catchments. Consequently, these sub-catchment boundaries are also shown on Figure 29b and c to highlight areas where the potential for further ASR development is limited using stormwater runoff.

6.2 Reclaimed Water

As outlined earlier, treated effluent from WWTP's constitutes another significant source of water for ASR. Injection trials at the Bolivar project commenced in 1997 and have recorded encouraging results. It is possible that, with further satisfactory progress, operational ASR projects using reclaimed water for non-potable end uses may commence by 2008 (R Martin, pers. comm., 2004).

It is important to note that the volumes of reclaimed water that may be injected by future ASR projects are likely to be only minor in comparison to the volumes used by existing or future pipeline schemes. South Australia leads the nation in reclaimed water use as a result of existing pipeline schemes from the Bolivar, Glenelg and Christies Beach WWTP's. After treatment to suitable levels, the reclaimed water is pumped directly to numerous end-users, principally horticulturists, viticulturists and golf courses.

The locations of the various pipeline schemes are shown on Figure 29a – c. Recent levels of WWTP discharge and reclaimed water use are presented in Table 15.

Table 15. 2002/03 Metropolitan WWTP Discharge and Reclaimed Water Use (after SA Water, 2003)

WWTP	2002/03 Total Wastewater Produced (ML)	Effluent Salinity (mg/L TDS)	2002/03 Total Wastewater Discharged (ML)	2002/03 Reclaimed Water Reuse (ML)	% Reuse	Reuse Scheme / Operator
Aldinga	214	853		214	100.0%	Aldinga STEDS / Henry Walker Environmental
Christies Beach	10 478	920	8 179	2 299	21.9%	Willunga Basin Pipeline / Willunga Basin Water Company
Glenelg	19 452	1 126	18 072	1 380	7.1%	Glenelg Pipeline / SA Water
Port Adelaide	9 326	6 561	9 326	0	0.0%	n/a (plant due to close in 2004)
Bolivar	47 119	1 165	34 368	12 751	27.1%	Virginia Pipeline Scheme / Water Reticulation Services Virginia
Total	86 589	-	69 945	16 644	19.2%	

7 ASR ENVIRONMENTAL RISKS

This section highlights the main environmental issues and risks associated with harvesting stormwater runoff and injecting the captured water into aquifers. Specific environmental issues associated with injection of reclaimed water from wastewater treatment plants are not discussed here. Such issues are currently under investigation as part of the Bolivar ASR project.

The environmental risks discussd below are taken into account when considering the ASR potential of the various aquifer areas. The resultant exclusion of some aquifer areas and ranking of remaining areas is presented in section 8.

7.1 Background

This section provides a brief background for potential ASR proponents on the potential impacts injection of stormwater runoff into native groundwater systems may have on dependent ecosystems. Issues associated with the *Environment Protection (Water Quality) Policy 2003* (EPPWQ) are also discussed.

7.1.1 GROUNDWATER DEPENDENT ECOSYSTEMS

The definition of groundwater dependent ecosystems (GDE's) is difficult because a wide variety of relationships exist between ecosystems, individual species and groundwater (Lamontagne, 2002). As a precautionary rule, ecosystems that derive part of their water budget from groundwater must be considered as groundwater dependent (Hatton and Evans, 1998).

Clifton and Evans (2001) defined six types of groundwater dependent ecosystems based on distinctive fauna or flora:

- **Wetlands** – Defined in the *Water Resources Act 1997* as a swamp or marsh and includes any land that is seasonally inundated. Wetlands are probably the GDE's most impacted by land-use change, with up to 66% of wetland area lost since European settlement in SA (Government of South Australia, 2000). Wetlands typically have a water table level within a few metres of the ground surface.
- **Terrestrial Vegetation** – Terrestrial vegetation dependent upon groundwater (phreatophytes) are often similar to wetland plant communities but the distinctions are that the water table does not reach the ground surface and the depth to groundwater is often of the order of 5 to 10 m.
- **Cave and Aquifer Ecosystems** – Cave systems often provide habitat for numerous fauna and can be affected readily by groundwater level or quality changes. Aquifer ecosystems are based on the presence of **stygofauna** - groundwater-dwelling animals within the pore spaces and fractures of aquifers. Stygofauna are typically small invertebrates (crustaceans or protozoans) that can be classified according to their size and/or use of sub-surface habitat. The presence, nature and role that stygofauna may play in ecosystem function is poorly known in most aquifers, perhaps apart from some

well-studied karstic aquifer systems. Humphreys (2002) provides a background to the emerging understanding of stygofauna within Australia.

- **Baseflow Ecosystems** – Groundwater baseflow to streams and rivers provides for the maintenance of stream flow or pool levels over prolonged dry periods. Numerous streams in the Adelaide region receive some amount of groundwater baseflow.
- **Terrestrial Fauna** – Although not an ecosystem in itself, migratory fauna and some terrestrial animals can be highly dependent upon the availability of groundwater seasonally or during droughts (Hatton and Evans, 1998).
- **Estuarine and Near-shore Marine Habitats** – There is increasing evidence that some estuarine and near-shore marine ecosystems rely to some extent on submarine groundwater discharge (Lamontagne, 2002). Such habitats include coastal swamps, mangroves, lagoons and offshore freshwater springs.

7.1.2 ENVIRONMENTAL WATER REQUIREMENTS AND PROVISIONS

Environmental water requirements (EWR's) can be defined as 'the water regime needed to maintain water dependent ecosystems, including their processes and biological diversity, at a low level of risk" (Hydrological Society of SA, 2002). Water for the environment is now a key issue in water resource management in South Australia. The Water Resources Act 1997 requires assessments of, and provision for, water for the environment through it's planning processes.

EWR's can be difficult to ascertain and are generally not well understood in all parts of the study area. Major studies of the Gawler and Onkaparinga river systems have been completed and the EWR's quantified for various sections of the river systems (NABCWMB, 2002 and SKM, 2003). Several other EWR assessments are currently underway or planned to commence soon in other stream systems present in the study area. Imminent studies include the "Aquatic Ecosystem surveys for Angas, Cudlee, Millers and Mt Pleasant Sub-catchments" and "Assessment of the Capacity of Pedler and Ingleburn Creeks to Meet Environmental and Other Demands for Water.

Environmental Water Provisions (EWP's) are "*that part of the environmental water requirements that can be met any given time*" (Hydrological Society of SA, 2002). The allocation of EWP's is a complex issue given that water resource managers must also balance the environmental needs with social and economic needs. A detailed and lengthy consultative approach is required, and to date within the study area, these consultations are still largely incomplete, even for the most studied river systems (Gawler and Onkaparinga rivers).

The average annual discharges to sea from the surface drainages outlined in Table 14, whilst incorporating any historical abstractions by the few known surface water users such as the City of Adelaide Council, do not take into account any EWR's. Recent investigations into the stormwater harvesting and ASR potential of certain areas, such as the Northern Adelaide Regional Water Resources Plan (KBR, 2003) and the Pre-Feasibility Study for District Scale ASR in the McLaren Vale PWA (REM, 2002), also acknowledge that the EWR's of many drainage systems such as Dry Creek, Little Para River, Maslin Creek and Willunga Creek are unclear. Ultimately, the resolution of EWR's and EWP's for the catchments of the study area will provide upper bound limits for the amounts of stormwater runoff that can be harvested for direct reuse or injected into aquifers.

Existing and imminent ASR operations typically only harvest a small proportion of runoff, typically during high flow months only, which implies a relatively low current risk upon drainage systems with unknown EWR's. However, in the future, new ASR or wetland schemes located in catchments already harvesting significant volumes will need to consider the EWR's in more detail. In broad terms, the results of this study indicate that future resolution of EWR's may not overly restrict ASR development in the study area due to the overall disparity between additional aquifer storage capacities and runoff discharge. The average discharge to sea from drainages within the study area is about 174 000 ML, which is about two to ten times greater than the likely additional aquifer storage capacities of the major sedimentary aquifers presented in section 5 (19 000 – 78 000 ML).

7.1.3 ENVIRONMENTAL PROTECTION (WATER QUALITY) POLICY 2003

A further environmental issue faced by ASR proponents is conformance with the EP(WQ)P. Authorised by the EPA on 10 April 2003, the EP(WQ)P is designed to provide consistent and statewide protection of all marine, inland and underground waters from pollution. The policy aims to prevent potential point-source pollution from activities not previously licensed under the *Environmental Protection Act 1993* by establishing water quality criteria for receiving bodies of water and/or defining pollutant discharge limits. Non-conformance with these criteria is deemed an offence and the EPA may choose to:

- Issue an Environment Protection Order (EPO) to gain compliance;
- Issue an expiation notice ($300) for breach of a mandatory policy;
- Prosecute through the Court (maximum penalty of $30 000).

The EP(WQ)P also seeks to reduce and manage waste discharge from diffuse sources of pollution from the development and implementation of best practice environmental management. This will be done by the adoption of Codes of Practice or guidelines for a range of activities (EPA, 2003).

A key part of the policy is the setting of water quality limits for different water body types for various 'environmental values' or uses. The criteria levels have been largely sourced from recent and current national water quality guidelines and are included as Appendix D.

Importantly, the EP(WQ)P states that if a particular water body has more than one environmental value then the lowest (absolute) value for any water quality criteria will prevail.

The adoption of the default water quality criteria listed in Schedule 2 of the policy was intended to provide immediate and complete protection. The EPA recognise that the default environmental water values and quality criteria may vary for different locations and with time. Consequently, there are mechanisms and processes within the policy that allow for 'adjustments' of the policy environmental values and criteria. Such changes would require extensive consultation with relevant organisations, industries and the community likely to be affected by any change.

The EP(WQ)P also provides for some variation from the criteria listed in Schedule 2 by the possible recognition of mixing zones for surface water or attenuation zones for groundwater. Water quality criteria would only apply at the edge of the defined mixing or attenuation zone. For potential ASR projects the importance of groundwater attenuation zones is significant. However, the acceptance of an attenuation zone by the EPA is subject to several conditions as outlined in Clause 15 (2) of the policy:

a) *the zone must not be situated wholly or partly within a water protection area within the meaning of Part 8 of the Act (Environmental Protection Act 1993);*

b) *the zone must not extend beyond the boundaries of the land on which the waste is generated except with the consent of the landowners affected;*

c) *the aquifer must not have high permeability properties (eg Karst rock or fractured rock aquifers);*

d) *the zone's operation must-*

   I. *be sustainable; and*

   II. *not prejudice the water quality objectives for the waters outside the zone*

There are no defined water protection areas that coincide with the sedimentary aquifers evaluated by this study. The nearest boundary of a water protection area occurs in fractured rock areas about three kilometres east of Tea Tree Gully.

The policy also manages control over discharge of wastes by stipulation of pollutants that cannot be discharged into a well, quarry, shaft or infiltration basin. These pollutants are listed in Schedule 4 of the policy but do not include any substances that would be reasonably expected to occur within stormwater runoff.

DWLBC, local government and research organisations, in consultation with the EPA through several ASR workshops, have identified several key issues of the EPPWQ in relation to ASR that require resolution. These include:

- Injection of water with a salinity variation from the native groundwater greater than +/-10% is deemed to be pollution. Stormwater runoff, especially from urbanised catchments, is typically less saline than native groundwater salinity in most areas of the preferred ASR aquifers.
- The migration of any portions of an injected plume of water across any surface cadastral/property boundaries. Natural aquifer variations cause dispersion of the injectant within the aquifer and the regional hydraulic gradient imparts some control over the flow regime of the injectant. These processes can prevent the recovery of the entire injectant volume, leaving some residual injectant in the aquifer, which travels slowly down gradient. Other "non-aquifer" conditions can prevent the full recovery of injectant, such as the conditions within some Water Allocation Plans to limit recovery to no more than 75% (McLaren Vale PWA) or 80% (Northern Adelaide Plains PWA) of the injected volume. These conditions were formed in recognition of the natural aquifer dispersion and that additional groundwater allocations from the native groundwater resources of these areas are unsustainable or permissible.
- The interaction of the EP(WQ)P with criteria and guidelines already established for ASR projects within Water Allocation Plans.

- The levels of some default values of water quality, or the lack of stated water quality criteria for several environmental values.
- Definition and acceptance of the 'environmental values' of aquifers.
- Lack of understanding regarding the potential presence and importance of stygofauna within confined aquifer systems.

The EPA are currently seeking to address some of these issues. Funding has been recently secured for an evaluation and review of the accepted environmental values of the Adelaide region aquifers. The EPA is also considering investigation of any stygofauna within aquifers of the Adelaide region after recently completing similar studies in the South East (D. Duncan, pers. comm., 2004).

The above issues are not yet resolved and the workshop meetings are ongoing. The main avenues for resolution of the interaction and conformance of ASR projects with the EP(WQ)P are considered to comprise:

1. Stipulation of water quality protection conditions within the Operating Licence for ASR projects authorised by the EPA. It is possible that such conditions would legally take precedence over any related requirements or provisions of the EP(WQ)P (J Cugley, pers. comm., 2004) .
2. Definition and acceptance of aquifer attenuation zones for individual projects by the ASR proponent and the EPA.
3. Definition and reclassification of the environmental values and associated water quality criteria for individual aquifers for specific areas. This approach, as stipulated within the EP(WQ)P, requires extensive consultation and amendment of the policy document.

7.2 ASR environmental risks

The major issues and risks associated with development of ASR in the study area are presented in Table 16 and discussed in more detail for each catchment water management board area below. Importantly, the tabled issues are not considered comprehensive, and are only relevant to the actual aquifers evaluated for additional aquifer storage capacities. Aquifers not evaluated, such as the shallow Quaternary aquifers may have numerous and complex environmental risks because they are commonly of shallow depth, are unconfined or semi-confined and have intimate interconnections with surface water resources and their associated ecosystems. Such aquifers may also be adversely affected if the portion of harvested stormwater reduced the EWR of the aquifer.

7.2.1 ONKAPARINGA CATCHMENT WATER MANAGEMENT BOARD AREA

For the areas evaluated within the OCWMB area, the principal ASR-related environmental risks are considered to be:

Table 16. Key ASR Environmental Risks

ASR Project Stage	Environmental Issue	Potential Environmental Risk(s)	Comment
Water capture and pre-treatment	Reduced stream flows	Adverse impact on surface water EWR's	Adverse risk potential should be balanced against positive impacts stormwater harvesting is likely to have on near-shore marine environment, i.e., reduced nutrient, sediment and metal loads to the coastal marine habitat. Risks partly unknown due to lack of comprehensive knowledge of EWR's and establishment of EWP's. Risk is inherently related to proportion of run-off harvested and is expected to increase in areas of concentrated ASR development.
	Reduced stream flows	Adverse impact on groundwater EWR's	Similar issues to above for any reliant groundwater dependent ecosystem that receives some portion of its water budget from 'losing' streams. Usually involves shallow perched or unconfined aquifer systems.
	Catchment pollutants	Adverse impact on native groundwater quality.	Types and concentrations of potential pollutants influenced by the nature of the catchment. Open or rural catchments may produce higher salinity and turbidity levels than urbanised catchments, which in turn may produce unsatisfactory levels of trace metal pollutants. All catchments are likely to produce some levels of microbiological contaminants from animal faeces. The risks are ultimately determined by the degree of pre-treatment.
	Catchment pollutants	Adverse impact due to major land use change	Not necessarily a significant risk if pre-treatment system can, or is modified to, attenuate the 'new' pollutants.
Injection / Aquifer Storage	Increased water table levels in unconfined or perched aquifer systems	Water logging, soil salinisation, altered ecosystem water budgets	Risk would be a function of aquifer parameters, conditions (unconfined or semi-confined) and the amount of injected water.
	Groundwater discharge to overlying aquifers	As above	Similar to above but specifically related to the potentials for upwards vertical leakage from the injected aquifer through the adjoining aquitards and into any shallow unconfined aquifers. Significantly less risk than the above unconfined aquifer scenario. Risk would be influenced by the vertical permeability of the aquitard unit.
	Groundwater discharge to land	Water logging, increased stream baseflows and altered ecosystem water budgets	Adverse effects may be from water logging and activation of seeps and springs, which could alter the land use, affect infrastructure or be detrimental to the water budget of any groundwater dependent ecosystem. Risk potentially greater for fractured rock aquifers because of greater uncertainties regarding aquifer geometry and continuity, e.g., a fracture zone aquifer interval that may be 80 m below ground in the well concerned may extend a long way and daylight (or intersect) the ground surface where the relief is less. Potentially, any increased stream baseflow arising from ASR injection may be beneficial to a groundwater dependent ecosystem.
	Groundwater discharge to sea	Adverse impact on near-shore marine habitats due to potential water quality or flow regime change	Risk level unknown because of uncertainties regarding nature of any groundwater discharge and any marine ecosystem reliance in the study area. Potential for a beneficial impact from ASR by providing a hydraulic barrier to seawater intrusion as a result of increased groundwater levels.
	Aquifer or cave ecosystems	Adverse impact upon ecosystem function	The greatest known diversity of stygofauna typically occurs within shallow, often karstic, unconfined aquifers. Within deeper confined aquifers, the potential for stygofauna may be less, although such aquifers have been less studied. The potential ecosystem function of any meio- or micro-stygofauna is not clearly known.

ASR Project Stage	Environmental Issue	Potential Environmental Risk(s)	Comment
Recovery	Conformance with EP(WQ)P	Groundwater pollution	Risk related to the injected water quality in comparison with the native groundwater quality and accepted environmental values of the native groundwater resource. The risk is strongly influenced by the degree of pre-treatment by the ASR proponent and of any acceptable water quality attenuation within the aquifer.
	Migration of Residual Injectant	Groundwater pollution	Should pre-treatment and any (accepted) aquifer attenuation be insufficient to improve groundwater quality to the protected environmental values, then a proportion of the injected water is likely to migrate down-gradient and not be recoverable by the ASR well due to natural aquifer mixing processes and/or catchment board imposed limitations on the percentage of recoverable water.
	Lowered groundwater levels	Altered ecosystem water budget	Risk likely only minimal and localised around the ASR recovery well as ASR projects are effectively only licensed to recover volumes of water such that groundwater levels return to at least pre-ASR levels.

1. **Increased water table levels**. The potentially unconfined domains of both the Port Willunga Formation and Maslin Sands aquifers have been excluded from the delineation of suitable ASR areas in section 8. The domain boundaries are only approximate and it is possible that the unconfined extent of the Port Willunga Formation Aquifer extends further east of McLaren Vale as shown on Figure 17a. ASR investigations in or near these potentially unconfined domains should carefully assess the conditions governing the targetted aquifer (unconfined, semi-confined or confined) by performing suitable aquifer tests.
2. **Reduced stream flows**. Quantitative EWR's are only presently known for the Onkaparinga River system, which discharges an average amount of 27,400 ML/yr to the Gulf. However, additional aquifer storage capacities in areas close to the Onkaparinga River are limited. Most of the significant aquifer storage capacity occurs near and south of Pedler Creek. These creeks have a combined average discharge of about 5,500 ML/year to the Gulf. Given the presence of several groundwater dependent ecosystems and the likely capacity of the sedimentary aquifers to store more water than is available from runoff, the quantification of EWR's and EWP's of the Willunga Embayment creeks is important to future ASR development.
3. **Groundwater discharge to land**. Within the Willunga and Noarlunga embayments, there is a relatively high proportion of groundwater use from the Fractured Rock Aquifer compared to the sedimentary aquifers. Existing Fractured Rock Aquifer wells are often located in areas of moderate or steep relief. In such areas, the potential for adverse discharge of injected water to the ground surface via seeps or springs is elevated. ASR investigations considering the Fractured Rock Aquifer near the basin boundaries should carefully assess the potential for such discharge.

The potential exists for discharge of injected groundwater into the near-shore marine environment from ASR projects located near the coast south of Port Willunga in both the Port Willunga Formation Aquifer and the upper sections of the Maslin Sands Aquifer. However, such discharge is not considered to be a significant environmental risk. Such injected water would be of a better quality in terms of the suspended solid and nutrient loads compared to the surface water runoff that it effectively 'replaces' from discharging into the Gulf.

Elsewhere in the study area, the potential for groundwater discharge into the Gulf from the evaluated aquifers is very limited. The tops of the aquifers evaluated are at least 60 to 70 m below ground, significantly below the sea-floor in the near-shore margins of the Gulf in the metropolitan and NAP areas. Current studies investigating the potential input of nutrients from groundwater into the Gulf in the Adelaide region consider that only the uppermost Quaternary aquifer (Q1) discharges into the Gulf in the metropolitan and NAP areas (CSIRO Land and Water, 2004).

7.2.2 TORRENS AND PATAWALONGA CATCHMENT WATER MANAGEMENT BOARD AREAS

1. **Increased water table levels** within the potentially unconfined aquifer domain of the Golden Grove Embayment as shown on Figure 17c. ASR within this area has the potential for adverse impacts associated with increased water table levels reaching

near the ground surface if the aquifer behaves in an unconfined or semi-confined manner. The domain shown on Figure 17c is considered reasonably conservative in that the T1 Aquifer south of the Torrens River is probably reasonably well confined, and elsewhere the Quaternary sediments are typically fine-grained and likely to behave as a confining bed. ASR investigations to date in this area have focussed on fractured rock aquifers as the overlying sedimentary units have generally limited transmissivity. Any future ASR investigations of the relatively shallow sedimentary sequence should undertake aquifer testing to determine the aquifer conditions and the potential for adverse water table rise. The moderate relief associated with the Torrens River valley and steep relief of the hills face escarpment may also increase the risk of groundwater discharge to the land surface from any shallow sedimentary aquifers.

2. **Groundwater discharge to land.** Within the northeastern parts of the Golden Grove Embayment, the Fractured Rock Aquifer forms a significant proportion of the available groundwater resources. Fractured rock ASR projects in this area, especially where the fracture intervals are shallow and the surrounding relief is moderate or high, have increased potential for discharge of groundwater to the land via seeps and springs. Such sites should be carefully assessed by aquifer testing and consideration of the surrounding hydrogeological regime.
3. **Reduced stream flows.** The streams and creeks within the areas of evaluation have typically been significantly degraded or altered for flood control. However, the EWR's and EWP's are not quantitatively known for these drainages, so there is the potential for adverse risk from excessive harvesting of stream flow, particularly in the less disturbed upper reaches of the streams. In overall terms, the approximate discharge to the Gulf of all drainages in the metropolitan area between Seacliff and Gillman totals about 79 000 ML. This level of discharge is greater than the likely additional aquifer storage capacity of the area (limited to about 28 000 ML), thus making the determination of EWR's in the evaluated parts of the Torrens and Patawalonga catchment boards less important (from an ASR perspective) than the Onkaparinga and NAP areas.

7.2.3 NORTHERN ADELAIDE AND BAROSSA CATCHMENT WATER MANAGEMENT BOARD AREA

1. **Reduced stream flows.** Only the Gawler River system has had EWR's quantified to date. The EWR's and EWP's of the Little Para River, Dry Creek and other creeks in the study area should be quantified in order to rationalise the risks potential stormwater harvesting for ASR poses. Like the Onkaparinga area, the capacity of the aquifers evaluated in the NAP area (11 000 to 39 000 ML) is likely to exceed the average annual Gulf discharge (24 600 ML). Thus, source water supply from stormwater runoff could become a limiting factor in ASR development.
2. **Catchment Pollutants and Land Use Change.** Parts of the NAP region, particularly west of the established suburban areas of Salisbury and Elizabeth have significant potential for becoming more urbanised. Associated with such change is the likelihood of a change in the nature of catchment pollutants, which may affect the ability of existing or potential ASR projects to protect the groundwater resource from pollution. However, this risk is not considered to be high for those schemes that incorporate wetland pre-treatment and storage.

8 ASR POTENTIAL

This section serves to rationalise the additional aquifer storage capacities presented in section 5 by identifying areas considered preferable for ASR development based on the ranking of hydrogeological criteria and by exclusion of high environmental risk areas.

The ranking system is based on aquifer lithology, aquifer transmissivity and available storage head and has been applied separately for the alternative sub-artesian and artesian storage scenarios. The areas subsequently defined are still broad, as the rankings do no consider other important pre-requisites for ASR such as availability of source water, open space and other economic factors. Such further analysis is warranted and could now be achieved by coupling the results of this study with others such as the recent work on stormwater harvesting by KBR (2004).

In terms of the realisation of individual sites or discrete areas with high ASR potential, the ASR aquifer potential maps shown on Figures 30 and 31 visually highlight areas where preferred aquifer areas coincide with potential source water (drainage lines, major stormwater pipes and reclaimed water pipeline layouts) and potential demand centres based on significant (> 10 ML) use of groundwater or mains water.

8.1 Sub-artesian scenario

This scenario applies to the additional aquifer storage capacities determined by limiting the amount of available storage heads (or rises in groundwater levels) to within two metres of ground surface. This scenario translates to ASR projects that consider injection by gravity only, which may be the only ASR option available in many parts of the study area where there are many closely spaced groundwater users, such as the main irrigation areas within the McLaren Vale and NAP PWA's.

The aquifer criteria used for sub-artesian ASR ranking are listed in Table 17.

In broad terms, the aquifer rankings reflect the potential magnitude of an ASR project. Whilst it is not feasible to correlate quantitatively, the category 1 to 3 areas are probably the only areas capable of realising ASR projects in excess of 200 ML/year, whereas the category 5 or 6 areas may be limited to schemes less than about 50 ML/year.

Within sections 8.1 and 8.2, numerous references are made to the relative magnitude of ASR projects (small, medium and large). These categories themselves are arbitrary and are defined by the author as:

- Large-scale - > 200 ML/year;
- Medium-scale – 20 to 200 ML/year;
- Small-scale – 2 to 20 ML/year; and
- Domestic-scale - < 2 ML/year.

These scale categories, when ascribed to a particular area**, do not** infer anything about source water availability, rather they just serve to assist comparison of additional aquifer storage capacities between different areas. Additionally, the categories relate to a **single well** ASR project. Multiple wells for an individual project would obviously increase the ASR magnitude.

Table 17. ASR Aquifer Ranking Criteria – Sub-artesian Scenario

ASR Category	Main Aquifer Lithology	Transmissivity Category (m^2/day)	Available Storage Head (m)	Transmissivity Category (m^2/day)	Available Storage Head (m)	Transmissivity Category (m^2/day)	Available Storage Head (m)
1	limestone	>= High	> 20	–	–	–	–
2	sand	>= High	> 20	–	–	–	–
3	limestone	>= High	10–20	Moderate	> 20	–	–
4	sand	>= High	10–20	Moderate	> 20	–	–
5	limestone	>= High	5–10	Moderate	10–20	Low	> 20
6	sand	>= High	5–10	Moderate	10–20	Low	> 20

The lithology criteria are somewhat simple but are intended to denote where the aquifer mainly consists of consolidated or semi-consolidated calcarenites or limestones that have a high probability of open-hole completion in the production interval. Such completions have proven to be advantageous for ASR to date. The sand category is used to denote unconsolidated, predominantly quartzose sands that typically require screening of the production interval. Such injection wells have generally higher risks of clogging and well collapse. Experience to date suggests that such aquifer zones may be limited to small-scale ASR projects.

The ranking criteria have a bias towards the theoretical additional aquifer storage capacity, as even low transmissivitiy areas are included where they coincide with large available storage heads. Actual injection rates that may be realised in some of the low transmissivity (25–50 m^2/day) domains may be too low to achieve ASR projects in excess of 20 ML/year. In practice, ASR proponents using this study to identify suitable well sites should reconcile the ASR rankings shown on Figure 30a-i with the transmissivity domains and well yields shown on Figure 19a-i and the depth to groundwater contours shown on Figure 17a-g. As an additional qualifier, the transmissivity domains are only broad-based and are influenced more by the regional (but better known) contours of aquifer thickness than any detailed spatial understanding of hydraulic conductivity (K). An example of this would be the Morphetville Racecourse ASR project, where the surrounding area has been assigned a transmissivity of moderate to high, based mainly on aquifer thickness and average hydraulic conductivities of the order of 1–2 m/day. However, the project intersects locally high K limestones (15–20 m/day) that results in a very high transmissivity (842 m^2/day).

The results of applying the aquifer ranking criteria to the main sedimentary aquifers are shown spatially on Figure 30a-i. The resultant aquifer domains were subsequently intersected with the GIS-dataset of additional aquifer storage capacities to provide estimates of the potential ASR volumes. Table 18 presents these refined aquifer storage capacities for each aquifer category and catchment board. It also shows the total areal extent of each aquifer category to highlight the ratio of storage potential to area.

Table 18. Refined Additional Aquifer Storage Capacities - Sub-artesian Scenario

ASR Category	Aquifer								Totals	
	Area (km2)	Storage Capacity (ML)	Area (km2)	Storage Capacity (ML)	Area (km2)	Storage Capacity (ML)	Area (km2)	Storage Capacity (ML)	Area (km2)	Storage Capacity (ML)
Onkaparinga Catchment Water Management Board										
	Port Willunga Formation		**Maslin Sands Aquifer**							
1	27.2	1 542	–	–					27.2	1 542
2	6.1	287	–	–					6.1	287
3	19.4	258	–	–					19.4	258
4	10.5	253	56.6	1 422					67.1	1 675
5	14.6	109	–	–					14.6	109
6	2.4	24	45.0	478					47.4	502
Total	80.2	2 473	101.6	1 900					181.8	4 373
Torrens and Patawalonga Catchment Water Management Board										
	T1A		**T1B**		**T1**		**T2**			
1	–	–	16.8	109	10.1	167	–	–	26.9	276
2	0.8	12	–	–	–	–	–	–	0.8	12
3	–	–	123.3	478	21.6	165	10.3	143	155.2	786
4	23.5	269	–	–	18.6	519	12.0	111	54.1	899
5	–	–	30.2	51	13.3	39	29.9	204	73.3	294
6	137.1	930	–	–	14.9	129	10.3	39	162.3	1 098
Total	161.4	1 211	170.3	638	78.5	1 019	62.4	497	472.6	3 365
Northern Adelaide and Barossa Catchment Water Management Board										
	Q4		**T1A**		**T1B**		**T2**			
1	–	–	–	–	–	–	253.2	5 377	253.2	5 377
2	–	–	–	–	–	–	–	–	0.0	0
3	–	–	–	–	60.5	291	126.9	1 442	187.5	1 733
4	18.2	265	0.9	3	–	–	38.7	415	57.8	683
5	–	–	–	–	162.6	264	67.8	383	230.3	647
6	31.6	303	59.2	129	–	–	30.2	275	120.9	707
Total	49.8	568	60.1	132	223.1	555	516.7	7 892	850	9 147

Before discussing the results further, it is important to note that the aquifer storage capacities shown in Table 18 and discussed below:

1. are based on a uniform 'base case' specific storage value of 9.0E-6; and
2. represent only the **additional** storage capacity above the autumn 2003 groundwater levels (and not any potential capacity below the autumn 2003 levels that may be realised if significant pre-ASR abstraction was to occur).

By excluding aquifer areas with limited storage potential and/or significant adverse environmental risks, the revised total additional aquifer storage capacity across the study area for sedimentary aquifers is 16 885 ML. This is only a minor reduction (9.9%) from the total capacity across all areas (18 740 ML), which is not surprising given that the study has focussed mainly upon the deep confined sedimentary aquifers of the region.

8.1.1 ONKAPARINGA CATCHMENT WATER MANAGEMENT BOARD AREA

Port Willunga Formation Aquifer

Figure 30a shows that a high percentage of the total aquifer area is retained after applying the aquifer ranking criteria. Areas that have been excluded comprise:

- the potentially unconfined aquifer domain;
- some low-lying areas adjacent to major drainage lines where the depth to groundwater is less than seven metres; and
- areas of very limited aquifer thickness.

The potential exists for parts of the Port Willunga Formation Aquifer to be unconfined or semi-confined further east of the area shown on Figure 17a, specifically northeast of McLaren Flat. ASR investigations targetting the Port Willunga Formation Aquifer in this area should clearly establish the aquifer conditions present.

Table 18 shows that the total additional aquifer storage capacity for all categories is 2643 ML and that most of this capacity occurs within high-ranking category 1 and 3 areas (1800 ML). These categories constitute consolidated or semi-consolidated limestone aquifers with favourable transmissivities and available storage heads. North-east of Willunga, the aquifer is dominated by unconsolidated quartz sands, and, whilst also having favourable transmissivities and available storage heads, may require extensive pre-treatment to ensure very low level of suspended solids.

Figure 30a shows a reasonably large corridor area adjacent to the Willunga Fault southwest of Willunga where highly suitable aquifer domains, numerous water courses and potential ASR users all coincide. Additionally, the Willunga Basin Water Company owns and operates a reclaimed water pipeline scheme over some of this high-potential corridor, which may one day provide acceptable source water for ASR projects.

In terms of potential ASR users, only those groundwater users with recent allocations greater than 10 ML/year are shown on Figure 30a-i. Within the Willunga Embayment, most groundwater use is by horticulturists and viticulturists. These users and the economics of their industries are likely to control the bulk of future ASR development. Such development could be achieved by individual property owners but perhaps also by groups of irrigators on a larger scale. The Onkaparinga Catchment Water Management Board is already considering the merits of district-scale ASR development (REM, 2002).

Maslin Sands Aquifer

The refinement of additional aquifer storage capacities for the Maslin Sands Aquifer produces a similar pattern of results to the Port Willunga Formation Aquifer:

- a high percentage of suitable areas and capacity is ‘retained’, the refined total of 1900 ML is only a 20.1% reduction from the 2386 ML total for all areas;
- the potentially unconfined aquifer domain is excluded; and

- low-lying areas near some major drainage lines are excluded because of the shallow depths to groundwater.

A key factor potentially limiting ASR development within the Maslin Sands Aquifer, as with all unconsolidated sand aquifers, are the technical issues associated with well clogging and aquifer integrity, which can severely restrict injection rates and volumes. In relative terms however, the Maslin Sands Aquifer is probably more conducive to successful ASR than many sand aquifers of the Adelaide Plains Sub-basin or Golden Grove Embayment. This is because of the greater proportion of higher-permeability marine South Maslin Sands and the relatively high amount of gravity storage heads available. Reducing this 'advantage' however, is the rural nature of the surface water catchments, which is likely to cause higher levels of suspended solids than urban catchments, thus necessitating a high degree of filtration during the capture and pre-treatment phase.

8.1.2 TORRENS AND PATAWALONGA CATCHMENT WATER MANAGEMENT BOARD AREAS

Within the Golden Grove Embayment and that part of the Adelaide Plains Sub-basin within the Torrens and Patawalonga catchment board areas, the refined additional aquifer storage capacity for the T1 Aquifer is 2868 ML. This represents only an 8.4% reduction from the total capacity for all areas (3131 ML). For the T2 Aquifer, the reduction is more significant (33.1%), from about 743 ML to 497 ML.

Golden Grove Embayment (T1 Aquifer)

From an areal perspective, the potential of the T1 Aquifer is significantly diminished when the aquifer rankings are applied and environmental risks considered (Fig. 30c,d). The potentially unconfined domain is excluded because of the adverse environmental and socio-economic risks from increased groundwater levels. Even though the domain boundaries are considered conservative, the aquifers comprise largely unconsolidated sands with relatively low transmissivities that are not 'technically' attractive for ASR anyway.

Elsewhere within the Golden Grove Embayment, the relatively shallow depths to groundwater and the relatively low transmissivities preclude several areas, notably near the coast and immediately south of the CBD area, from ASR suitability.

In terms of potential source water and users for ASR development in the T1 Aquifer, there are several sites that occur as relatively large mains water consumers near the Sturt River. However, it must be noted that within the central metropolitan area, basic visual analysis of potential ASR sites and users may be misleading, as the groundwater abstraction data plotted on Figures 30c,d, e is nearly 20 years old and the mains water user dataset provided by SA Water is considered to be not comprehensive nor necessarily accurate.

Golden Grove Embayment (T2 Aquifer)

For the sub-artesian scenario, ASR potential in the preferable limestone lithologies west of the Brighton Fault is limited because of the very shallow depths to groundwater (usually less than 5 m). Elsewhere within the embayment, the ASR potential is limited to sand aquifers (mainly the Aldinga member or undifferentiated sands of the Port Willunga Formation) in a corridor near and parallel to the Eden-Burnside Fault.

Both the Sturt River and Brown Hill Creek transect category 4 and 6 aquifer areas and are obvious potential sources of water. The stormwater pipe network in these aquifer areas may not be high-yielding because of their relatively limited catchment extents.

Adelaide Plains Sub-basin (T1 Aquifer)

Figures 30c, d show that the T1 Aquifer provides large areas within the western and northwestern suburbs of high ASR suitability. Only a small area has been excluded near the southern limit of the sub-basin based on shallow groundwater depths. No aquifer areas have been excluded for environmental risk reasons as it is considered that the aquifer does not discharge any significant amounts of groundwater to overlying aquifers nor into near-shore marine environs.

The separate aquifer rankings provided for the T1A sub-aquifers may be somewhat misleading, as in most areas, the T1A and T1B sub-aquifers are probably adequately connected. The T1B rankings, although possibly conservatively low, could be considered as the best overall indicator,of T1 Aquifer suitability. The T1A sub-aquifer rankings would best apply to the instance where there are confining beds beneath the Dry Creek Sand and the ASR proponent only considers the upper sandy interval of the T1A sub-quifer.

The category 1 areas shown on Figure 30d are effectively a result of the drawdown cones caused by golf course and industrial users abstraction centres. The Thebarton industrial area straddles the Torrens River, which could be reasonably expected to provide a considerable amount of harvestable water from it’s annual average discharge of 38 000 ML. Elsewhere, enhanced source water opportunities may only be possible near the coast, where the stormwater drain and pipe networks have a greater catchment extent. At the southern limit of the sub-basin, the SA Water Glenelg reclaimed pipeline scheme and Brown Hill Creek drain are possible water sources.

Adelaide Plains Sub-basin (T2 Aquifer)

The potential for gravity injection ASR within the T2 Aquifer is limited in this part of the study area (Fig. 30e). Whilst the aquifer is favourable in terms of its limestone dominated lithology and high transmissivity, the shallow depths to groundwater are responsible for it’s limited additional aquifer storage capacity (497 ML). Category 3 and 5 areas occur in the inner northwestern suburbs. In these areas, the main potential source of water is the Torrens River, whilst the stormwater pipe network may provide limited yields.

The refined aquifer areas correspond with the only known T2 groundwater users (Regency Park Golf Course and Coopers Brewery) and also with numerous large-scale mains water users.

8.1.3 NORTHERN ADELAIDE AND BAROSSA CATCHMENT WATER MANAGEMENT BOARD AREA

Q4 Aquifer

The application of ranking criteria to the Q4 Aquifer results in the exclusion of large areas of the aquifer (Fig. 30f) due to the relatively poor aquifer parameters. As the aquifer is considered confined throughout the evaluated areas and there is minimal or no discharge to shallow aquifers or the marine or land environments, there was no exclusion based on adverse environmental risks factors. The refined additional aquifer storage capacity is 568 ML, a significant reduction (61.6%) from the 1480 ML capacity of all areas.

The refined domains are category 4 or 6 areas, predominantly located near the Little Para River where the transmissivity is inferred to be higher as a result of increased aquifer thickness and also increased available storage heads are present adjacent to Para Fault escarpment. The typically poorly sorted and fine grained nature of the sands that constitute this aquifer will probably limit the achievable rates of ASR injection and relegate the vast majority of this aquifer to domestic-scale ASR applications or at best, irrigation or industrial projects of less than 20 ML/year.

T1 Aquifer

The application of ranking criteria does not exclude much of the aquifer extent (Figs 30g, h), apart from some small areas near the coast where the depth to groundwater becomes shallow and in the northern areas where the aquifer thins considerably between the Little Para and Gawler rivers. There were no areas excluded for environmental risk reasons.

Volumetrically, the refined additional aquifer storage capacity is 687 ML, a reduction of 29.5% from the total of 974 ML for all areas. Much of the reduced capacity is classed as the T1A sub-aquifer capacity, which may not be realised if injection occurs into the T1B sub-aquifer and the hydraulic connection with the overlying T1A sub-aquifer is reasonable. Overall, the T1 aquifer ASR potential is moderate to high in the NAP area, being predominantly category 3 and 5 areas. Numerous potential stormwater runoff sources occur within the region; the major drainage lines comprise the Little Para River, Dry Creek and Helps Road Drain.

Compared to the other parts of the study area, the NAP region has the most favourable combinations of aquifer properties, water sources and potential demand. This is reflected by the number of medium to large-scale ASR projects already installed and planned for development by the Playford and Salisbury councils in this area. The City of Salisbury alone, have recently developed conceptual plans for the harvesting of up to 26 000 ML of stormwater runoff (C. Pitman, pers. comm., 2004). Not all water harvested would be necessarily injected into aquifers, as a significant proportion would be pumped directly to the end user after capture and treatment. This study shows that such volumes could not be practically achieved without the creation of artesian conditions over large areas.

Most of the existing T1 groundwater users occur in the Waterloo Corner irrigation area, where there appears to be limited scope for sourcing stormwater runoff. Adoption of ASR by these users will probably be dependent upon the viability of using reclaimed water from the Virginia Pipeline Scheme (Fig. 30g) or perhaps by collective groups of irrigators near the closest drainage line (Helps Road Darin).

T2 Aquifer

Figure 30i shows that only areas close to the coast where shallow depths to groundwater occur have been excluded. Like the T1 Aquifer, none of the T2 aquifer has been excluded for environmental risk reasons, as the aquifer is confined throughout the evaluated domain and has no significant discharge to land, sea or overlying aquifers.

The refined additional aquifer storage capacity is 7 892 ML, which is only 1.8% lower than the capacity for the full area (8 037 ML). The pattern of aquifer categories is dominated by the shape and extent of the regional drawdown cone developed by prolonged irrigation abstraction centred in the Virginia area and also to a lesser degree by the occurrence of the aquifer as unconsolidated quartzose sands in the northeastern parts of the NAP PWA. Within the category 1 area, irrigators form the main potential ASR demand. The Gawler River and the Smith Creek system form the only practical sources of stormwater runoff for this potential demand group. Whilst the Gawler River appears to have a reasonably high average coastal discharge of about 25 000 ML, it may not prove to be a reliable source of large water quantities as there is typically little runoff generated on the coastal plain and discharges are reliant upon overflows or releases from the Warren and South Para reservoirs. Alternatively, the Virginia Pipeline Scheme would provide ASR opportunities to hundreds of irrigators if injection with reclaimed water ever becomes possible.

Given the proximity of many irrigation wells to each other, ASR by gravity injection may be the only viable method of ASR in the main irrigation areas. Given the low relief of the irrigation areas, the risk of gravity injected ASR wells causing artificial flows at the wellheads of surrounding users is very minimal. Thus, gravity injection ASR provides an effective form of self-management, minimising the chances for causing adverse affects on neighbouring users.

8.2 Artesian scenario

Similar criteria to the sub-artesian scenario have been applied to delineate ASR aquifer rankings for the scenario where artesian storage is envisaged or required. The same aquifer parameters used in the sub-artesian scenario were applied, with the additional influence of the depth to the top of the aquifer, which influences the determination of fracture pressure and hence available storage heads.

The aquifer ranking criteria are presented in Table 19, which produce eight distinct aquifer categories. There are two more aquifer categories than for the sub-artesian scenario, based on a wider range of available storage heads. Similar qualifying comments can be made regarding the artesian aquifer ranking criteria as for the sub-artesian scenario, namely:

- The categories are biased towards the theoretical storage capacity and not necessarily achievable ASR injection rates, as combinations of low transmissivity and high available storage heads are included alongside high transmissivity areas with limited available storage heads.

- Potential ASR magnitude is broadly inversely proportional to the aquifer category number, with category 1 to 3 areas potentially capable of >= 500 ML/year projects, whereas category 7 and 8 areas may be limited to about 50 ML/year projects.
- Significant local variations to hydraulic conductivity are possible within individual aquifer domains, thus affecting the accuracy of the ASR category. More importantly, the variation will strongly influence the maximum rate of injection possible.

The spatial results of applying the artesian ranking criteria are displayed on Figure 31 a-i.

The GIS datasets of aquifer thickness multiplied by available storage heads were not re-analysed to refine the estimates of additional aquifer storage capacities. In reality, the key limitation to the amount of ASR storage that may be achieved under artesian conditions will be the extent of artesian groundwater levels emanating (approximately radially) outwards from an ASR well and the location of any neighbouring wells screened in the same aquifer. These zones cannot be readily defined using the methodologies and datasets of this study. The zones of artesian influence and definition of any required buffer zones could only be realistically accurately done at a project scale or at best, small district level, preferably with the use of groundwater flow modelling. The storage capacity dataset produced by this study is best suited to estimation of maximum ASR potentials and should only be applied on a regional level or over sub-areas that are still reasonably large (say greater than about 50 km^2), especially for the artesian storage scenario. If the study datasets were applied to small areas, the injected ‘mound’ of water would be incorrectly shaped like a city skyscraper, with tall vertical sides. The larger the area analysed, however, the less would be the error margin associated with the unrealistic vertical edges of the ‘injected’ mound.

To visually highlight the potential areas on Figure 31 a-i where artesian ASR storage may or may not be suitable, one and two kilometre buffer zones have been drawn around existing groundwater users. Unlike Figure 30, all recent groundwater allocations regardless of size have been plotted on Figure 31, as each existing well may represent a limitation to potential ASR development. Only those groundwater allocations that are in close proximity to each other have been used to create the buffer zones. Remote groundwater users or those users near the margin of major pumping centres have been ‘ignored’, as these users may represent potential artesian ASR proponents.

Notwithstanding the above, the following discussion is provided to qualify the ASR potential maps shown on Figures 31a-i.

8.2.1 ONKAPARINGA CATCHMENT WATER MANAGEMENT BOARD AREA

Port Willunga Formation Aquifer

Figure 31a shows that the widespread distribution of Port Willunga Formation Aquifer allocations may limit the implementation of large-scale ASR projects relying on artesian storage conditions. However, as aquifer conditions for ASR are excellent within the category 1 and 3 areas southwest of Willunga, large projects may be realised if groups of irrigators were to form singular district-scale projects.

A relatively narrow corridor of artesian ASR ‘opportunity’ occurs parallel to the coast south of Port Willunga because of the absence of users caused by the relatively high salinity levels. The drainage lines that transect this corridor have relatively small catchment areas and probably only form a small percentage of the average annual discharge of about 5500 ML from the entire Willunga Basin. Artesian ASR schemes in this corridor could also provide a hydraulic barrier to potential seawater intrusion

The potentially unconfined aquifer domain is not considered for the artesian scenario, as it is not feasible to consider such storage in a truly unconfined aquifer. Similarly, the unconfined domains of the Maslin Sands Aquifer in the Willunga Embayment and the T1 aquifer in the Golden Grove Embayment have been excluded. If the aquifers in these areas were actually only semi-confined, the probability of adverse affects would be much greater than for the sub-artesian scenario, as the artesian scenario is based on groundwater levels considerably above the natural ground surface.

Maslin Sands Aquifer

Aquifer rankings are only moderate (typically category 4 or 6) as result of the generally low to moderate transmissivity. This is despite the significantly increased available storage heads arising from the significant depth of cover above the aquifer along the south-east margin of the embayment (Fig. 31b).

The extent of potential exclusion zones based on the creation of artesian groundwater levels in surrounding wells is much less pronounced than for the Port Willunga Formation Aquifer. Most of the existing groundwater allocations in the Maslin Sands Aquifer are located in the northern unconfined or semi-confined portions of the aquifer.

It is possible that ASR proponents would only target the Maslin Sands Aquifer for artesian storage instead of the Port Willunga Formation Aquifer if there were too many neighbouring Port Willunga Formation Aquifer wells likely to be adversely affected by Port Willunga Formation injection.

8.2.2 TORRENS AND PATAWALONGA CATCHMENT WATER MANAGEMENT BOARD AREAS

Golden Grove Embayment (T1 Aquifer)

The potential for large-scale artesian ASR projects within the T1 Aquifer is spatially limited as there numerous existing groundwater users in the category 3 and 5 areas in the southern and southwestern suburbs (Fig. 31c,d). However, the Morphetville Racecourse ASR project highlights that in localised areas of high transmissivity and storativity (within the limestone’s of the Port Willunga Formation), large injection volumes can be achieved without significant development of an artesian zone of influence.

The category 3 and 5 aquifer areas coincide well with potential source water from the Sturt River and Brown Hill Creek. Elsewhere, the stormwater pipe network may provide source water for ASR projects, apart from the Bray Street stormwater catchment shown on Figure 29b, which is extensively harvested by the Morphetville Racecourse ASR project.

Lower-ranked artesian aquifer areas (category 6 and 8) occur in a broad band adjacent to the Eden-Burnside Fault between Brown Hill Creek and Fourth Creek. These aquifer domains are dominated by unconsolidated quartz sands of relatively low transmissivity and may only support small-scale ASR projects less than 20 ML/year. Such magnitudes may still be suitable for irrigation of sports grounds or public open spaces.

Golden Grove Embayment (T2 Aquifer)

For the T2 Aquifer in the Golden Grove Embayment, the potential for large-scale (> 200 ML/year) ASR projects is limited to the coastal area west of the inferred Brighton Fault, where the aquifer consists of the lower limestone’s of the Port Willunga Formation. There are limited numbers of large-scale mains water users, perhaps reducing the potential demand for ASR. Existing users of the shallower T1 Aquifer may consider ASR use of the T2 Aquifer, thus reducing the potential for adverse impacts on other users from development of widespread artesian groundwater levels.

The potential for moderate-sized ASR projects also occurs in a narrow band adjacent to the hills face zone between the Brighton Fault and about one kilometre northeast of Brown Hill Creek. The T2 Aquifer in this area is defined as the sandy Aldinga Member of the Port Willunga Formation, which may necessitate extensive filtration as part of the pre-treatment process and also limit injection rates.

Adelaide Plains Sub-basin (T1 Aquifer)

The aquifer potential for artesian ASR in the Adelaide Plains Sub-basin portion of the Torrens and Patawalonga catchment board areas is reasonably high. In much of the western suburb areas, the aquifer is ranked as category 3 (Fig. 31c,d). The artesian storage capacity diminishes gradually to the north largely as result of decreasing aquifer thickness and depth of cover. These decreasing trends are responsible for the somewhat arbitrary location of the boundary between the category 3 and 5 areas.

Potential exclusion zones to artesian ASR development are concentrated in the southern margins of the Adelaide Plains Sub-basin, where there is a relatively high concentration of both existing irrigation and industrial T1 users. These buffer zones are drawn around T1 users based on data that is nearly 20 years old, thus they may be inaccurate. In the northern part of the catchment board area there are typically fewer (but larger) industrial groundwater users, such as Penrice at their Dry Creek and Osborne operations. Such users may be potential artesian ASR proponents.

Overall, the potential for ASR development is probably highest at the southern end of the Adelaide Plains Sub-basin, where several potential water sources (Torrens River, Brown Hill Creek and the Glenelg WWTP reclaimed water pipeline) occur in relatively close proximity to mains and groundwater users. In terms of open space, the Adelaide airport occurs in this area and has already been flagged by others as a high potential ASR site, especially given the location of the Brown Hill Creek drain along it's southern boundary.

Adelaide Plains Sub-basin (T2 Aquifer)

The aquifer ranking for the T2 Aquifer is very high, comprising category 1 in most areas as result of the high transmissivity and large available storage heads (> 80m). Notably, the available storage heads are dominated by the artesian groundwater level component as a result of the considerable depth of cover and the very shallow depths to groundwater.

Complementing the high additional aquifer storage capacities under artesian conditions is the lack of existing T2 users in this part of the study area. Whilst not definite, it is considered that the Regency Park Golf Course and Coopers Brewery may be the only existing users. The T2 Aquifer in this region may thus be ideally suited to the development of numerous medium or large-scale ASR projects utilising artesian storage. Such projects may develop from the demand generated by existing T1 Aquifer or mains water users. The T2 Aquifer within this region may also be worth considering the merits of even larger-scale injection of mains water by SA Water for potable end uses.

8.2.3 NORTHERN ADELAIDE AND BAROSSA CATCHMENT WATER MANAGEMENT BOARD AREA

Q4 Aquifer

Figure 31f shows that, for artesian storage conditions, low to moderate aquifer rankings occur only near the Little Para River and adjacent to the Para Fault escarpment. Within these refined aquifer domains, there is limited potential for the need of buffer zones around existing Q4 users, as they are typically located further west of the preferred aquifer areas.

As for the sub-artesian scenario, the Q4 aquifer, with it's typically low permeability, is only likely to support small-scale or domestic-scale ASR projects, which would probably be more effectively achieved by gravity injection rather than pressure injection.

T1 Aquifer

The artesian aquifer rankings are shown on Figures 31g, h and generally diminish to the north largely as a result of the decreasing depth of cover

At the southern end of this region the rankings are generally moderate to high (category 3 and 5). As indicated earlier, these are the rankings for the T1B sub-aquifer, which may be slightly conservatively lower than actual where the overlying T1A sub-aquifer is reasonably hydraulically connected. In this southern region, where most of the large existing T1 and T2 ASR projects occur, there is a relatively high correlation with potential source water and open space.

In irrigation areas north of the little Para River, the T1 Aquifer could also host significantly sized ASR projects. However, the likelihood of large individual ASR projects using artesian storage is low due to the proximity of many irrigation wells to each other. Artesian

ASR projects in these areas may only be feasible if groups of adjacent irrigators were to form a collective ASR project. Even then, access to stormwater runoff is probably limited and ASR development may be reliant upon the future use of reclaimed water from the Virginia Pipeline Scheme.

T2 Aquifer

Favourable artesian aquifer rankings for the T2 Aquifer occur in many parts of the NAP PWA (Fig. 31i). There are three broad ranking zones:

- low aquifer rankings in the relatively thin and unconsolidated sandy aquifer areas near Gawler and Kangaroo Flat;
- the broad category 3 zone which coincides with the main irrigation abstraction centred on Virginia; and
- category 1 and 3 areas to the south of the above and parallel to the Para Fault south of Smith Creek.

The southern part of the NAP PWA, where there are few or potentially no irrigation wells that would be adversely affected by artesian ASR projects, represents one of the highest potential ASR areas in the entire Adelaide region. Not surprisingly, this is where most of the existing pressure-injection ASR operations have been established or planned (Parafield, Kaurna Park, Edinburgh).

The existing ASR operations in the Salisbury area south of the Little Para River provide a useful insight into the issues that several artesian ASR projects located within a relatively small area are likely to raise. The Parafield scheme is the largest, with the current ability to harvest 1 100 ML/year and the possibility of expansion to capture significantly more runoff. It is currently in its second injection season and is understood to be contributing to artesian groundwater levels at the nearby Greenfields Railway ASTR investigation site and Pine Lakes ASR operation. These sites are about 1 000 and 600 metres from the Parafield injection wells. Being managed by the same operator (City of Salisbury), the interaction of artesian conditions between these three sites is not expected to create any potential user conflicts. These three sites raise two key questions:

- what are the implications on viability of existing or planned individual ASR sites when nearby ASR sites can increase local groundwater levels and reduce storage potential;
- what are the possible or projected limits of increased groundwater levels from individual or grouped ASR projects that may cause adverse impacts upon non-ASR users of the same aquifer.

In the Parafield area, the ASR projects are far from the nearest cluster of T2 irrigators (8–10 km) and highly unlikely to adversely affect them. Further north, an ASR centre may develop around the existing Kaurna Park operation and Edinburgh and Burton West Wetlands investigation sites. This centre may be within 3–4 km of numerous T2 irrigation wells and would have increased potential for influencing groundwater levels within the irrigation wells. Proponents of such ASR schemes should carefully consider the potential for adverse impacts arising from the creation of artesian groundwater levels. This would be best achieved by undertaking groundwater flow modelling and a census of local groundwater use.

In the northern half of the NAP PWA, the aquifer rankings for artesian ASR storage remain high. The likelihood of individual landholders developing significantly sized artesian ASR operations is low due to the close spacing of the 560 current T2 Aquifer allocations in this region.

9 CONCLUSIONS AND RECOMMENDATIONS

The key findings and conclusions regarding the evaluation of aquifer storage capacities, assessment of environmental risks and potential for further ASR development within the study area comprise:

1. There are currently 22 operational ASR projects injecting about 2000 ML/year of stormwater runoff into sedimentary and fractured rock aquifers. Another six projects planned for imminent development will increase the total injection potential to about 3900 ML/year.
2. Only storage capacities of the major sedimentary aquifers currently abstracted from have been evaluated in detail. Quantification of the storage capacity of fractured rock aquifers on a regional scale would not be sufficiently accurate. A conceptual estimate of the ASR storage potential of fractured rock aquifers within or immediately adjacent to the Willunga, Noarlunga and Golden Grove embayments is of the order of 1000 to 1500 ML/year.
3. Evaluation of the **additional** (sedimentary) aquifer storage capacities **above** the ground levels of autumn 2003 indicates that:
   I. The total aquifer storage capacity for the scenario where groundwater level rises are limited to two metres below ground (the **sub-artesian scenario**) is about **19 000 ML** for **all** aquifer areas; and
   II. The total aquifer storage capacity for the scenario where groundwater is stored under artesian conditions to approximately 50% of the aquitard fracture pressure levels (the **base case artesian scenario**) is about **79 000 ML** for **all** aquifer areas.
4. The estimates of aquifer storage capacities are considered to be accurate to within 30%. The principal uncertainty is the values of storativity/specific storage, the spatial variation of which is poorly understood. A limited storativity dataset precludes accurate zonation across the project area, and as a result, a uniform specific storage value of 9.0E-6 applies to the volumes outlined above.
5. The evaluated storage capacity estimates are only considered applicable to regional or district-scale planning type studies. The use of the storage capacity data-set for estimation of smaller areas (say less than about 50 km^2) or individual projects is less valid, especially for the artesian scenario. Such areas should apply well theory by calculation or modelling to better predict the injected water mound build-up and consequent storage capacity.
6. The application of salinity criteria and other assumptions that would restrict the recovered water quality to below 1 000 mg/L TDS reduces the additional aquifer storage capacities by only a small margin. For the base case artesian scenario, total capacity is reduced by about **10 000 ML** to **69 000 ML**.
7. The Torrens and Patawalonga Catchment Water Management Board areas, compared with the Onkaparinga and Northern Adelaide and Barossa board areas, are the most sensitive to aquifer storage capacity changes based on salinity criteria or sub-artesian versus artesian storage conditions.

8. Groundwater currently held in elastic (confined) storage within the evaluated sedimentary aquifers totals about **96 000 ML**. Abstraction of native groundwater prior to the first ASR injection cycle to increase the storage capacity may be a favourable ASR option in brackish or saline aquifer areas, as there are few, if any, existing groundwater users in such areas. However, it is unlikely that large proportions of the **existing** storage capacity could be accessed by ASR projects given the potential for adverse impacts on surrounding wells and the need to secure allocation transfers in prescribed well areas.
9. Surface water flow modelling by Clark (2003) shows that approximately 174 000 ML of stormwater runoff is discharged annually into Gulf St Vincent. Within the Onkaparinga and Northern Adelaide and Barossa board areas, the likely aquifer storage capacities exceed the annual stormwater discharges, whereas in the Torrens and Patawalonga Catchment Water Management Board areas, stormwater discharges exceed the total aquifer storage capacity.
10. The key potential environmental risks and issues associated with further ASR development include:
    I. Reduced stream flows from excessive stormwater harvesting. The environmental water requirements of surface water or groundwater dependent ecosystems for most drainages within the study area are not well known. Only the Gawler and Onkaparinga River system EWR's have been quantified to date, but ironically, these drainages are not close to preferred aquifer areas. The quantification of environmental water requirements and provisions within the Willunga Basin and the Northern Adelaide Plains region is important given that aquifer storage capacity exceeds total coastal discharges in these areas.
    II. Water table rise in unconfined aquifer domains. The potential for soil salinisation, water logging, and altered baseflow conditions upon the natural environment and other adverse socio-economic impacts is significant in unconfined or semi-confined aquifers (fractured rock or sedimentary) where groundwater levels rise to within less than about 10 m of the natural ground surface. Such aquifer domains occur as relatively small portions within the Willunga and Golden Grove embayments.
    III. Groundwater discharge to land. For shallow sedimentary or fractured rock aquifers in areas of moderate to steep relief, the potential exists for reactivation of seeps and springs away from the injection well site, even under confined or semi-confined aquifer conditions
    IV. Conformance with the Environmental Protection (Water Quality) Policy. The policy was released with state-wide application of default criteria that conflict with certain aspects of ASR operations already licenced by the EPA. These aspects include problematic definition of acceptable salinity criteria (change limited to +/-10% variation for freshwater aquatic systems), interaction of the policy with established water quality criteria in Water Allocation Plans and uncertainty regarding the accepted environmental values of the major aquifers.

11. Resolution of the conformance issues current and future ASR projects have with the Environmental Protection (Water Quality) Policy could be pursued for individual projects by stipulation of water quality protection conditions within the Operating Licence issued by the EPA or by definition and acceptance of groundwater attenuation zones. An alternative solution mechanism for multiple ASR projects would be the reclassification of the environmental values and water quality criteria for aquifers over discrete areas.
12. The refinement of additional aquifer storage capacities to exclude areas having potentially high adverse environmental risks and those areas with unfavourable aquifer conditions (low available storage head and low transmissivities) does not diminish the total storage capacity significantly. For the sub-artesian scenario, the total additional aquifer storage capacity diminishes by only about 10% from 19 000 to 17 000 ML.
13. Of the refined additional aquifer storage capacity total, about 11 000 ML occurs as storage capacity within the semi-consolidated or consolidated limestone aquifers of the Port Willunga Formation, which enable open-hole well completions preferred by ASR operators to minimise potential clogging problems.
14. Only the relatively small potentially unconfined domains of the Port Willunga Formation and Maslin Sands aquifers in the Willunga Embayment and the T1 Aquifer in the Golden Grove Embayment have been excluded for environmental risk reasons.
15. Refinement of the artesian scenario additional aquifer storage capacities is not reliably quantifiable due to uncertainties regarding the magnitude and extent of an artesian water mound(s) that could be built-up without having adverse impacts on surrounding groundwater users. Conceptually, it is considered that at least two-thirds of the total area capacity would be ‘retained’, providing a minimum of about 53 000 ML of refined artesian storage.
16. Within areas of concentrated groundwater abstraction for irrigation, ASR development may be limited to projects using gravity injection only, thus reducing the potential for creation of unwanted artesian flows in neighbouring wells. Artesian storage in such areas would be reliant upon the formation of groups of users forming a single, shared project. The potential for ASR development using artesian storage is highest within the:
    - I. T1 and T2 aquifers in the northern metropolitan region south and east of the main NAP irrigation areas. Not surprisingly, this is where numerous existing and proposed ASR schemes by the City of Salisbury and City of Playford already occur.
    - II. T2 Aquifer within the western and northwestern suburbs, where there are very few existing T2 users.
    - III. Maslin Sands Aquifer throughout much of the Willunga Embayment.
17. In reality, a mixture of both gravity-injected and pressure-injected ASR projects will continue to develop across the study area. Conceptually, a likely additional aquifer storage capacity that includes sub-artesian and artesian areas is of the order of 20 000 to 40 000 ML. This amount excludes the additional, but probably minor amounts of ASR storage capacity available from fractured rock aquifers and from existing elastic groundwater storage within the major sedimentary aquifers. These additional amounts may be of the order of 5000 to 10 000 ML, making the total likely aquifer storage capacity of the region about 25 000 to 50 000 ML.

18. The likely storage capacity of 25 000 to 50 000 ML is somewhat lower than previous conceptual estimates. However, the development of this preferred portion of storage capacity could still constitute a significant contribution to the alternative water supplies that the Water Proofing Adelaide Strategy seeks to identify and encourage development of. Such a storage capacity represents about 8 to 17% of the forecast total water use of the Adelaide region (300 000 ML/year), or about 12 to 25% of Adelaide's current level of mains water use (200 000 ML/year).
19. The development of further ASR projects above the current injection level of about 2 000 ML/year will largely be driven by socio-economic factors. Recent estimates conclude that "*Adelaide could use in the order of 10 000 ML more stormwater than it currently uses for $0.10 - $1.50 per kilolitre supplied*" (Government of South Australia, 2004). Future increases in the value of water and advances in the use of reclaimed water for ASR or alternative end-uses of treated stormwater would incrementally increase the development of ASR.

In light of the findings and conclusions of this study, the following recommendations are made:

1. Integration of the results of this study with existing economic evaluations of the potential for stormwater harvesting to identify suitable **individual** ASR sites that coincide with preferred aquifer domains.
2. Improve the understanding of current levels of groundwater use (and hence ASR demand potential or artesian-ASR limitations) within the unprescribed parts of the metropolitan area.
3. Development of a groundwater flow model incorporating all existing and planned ASR projects in the Adelaide Plains Sub-Basin to;
    I. better identify the limits of artesian conditions and hence predict more accurately the buffer zones needed around existing users of the T1 and T2 aquifers to prevent adverse impacts; and
    II. to reconcile the storage capacity estimates of this study.
4. Accelerate consultation between the EPA, DWBLC, catchment boards and existing ASR operators to resolve the ASR issues affected by the Environment Protection (Water Quality) Policy.
5. From an ASR perspective, prioritise the evaluation and quantification of environmental water requirements and provisions of the Willunga Basin creeks south of (and including) Pedler Creek, the Little Para River, Dry Creek, Smith Creek and Cobbler Creek systems ahead of any other drainage systems.
6. Owners of any new wells drilled in the future proposing large-scale abstraction (ASR or not), should be encouraged to install a monitoring well and perform a constant-rate aquifer test that permits the evaluation of aquifer storativity.

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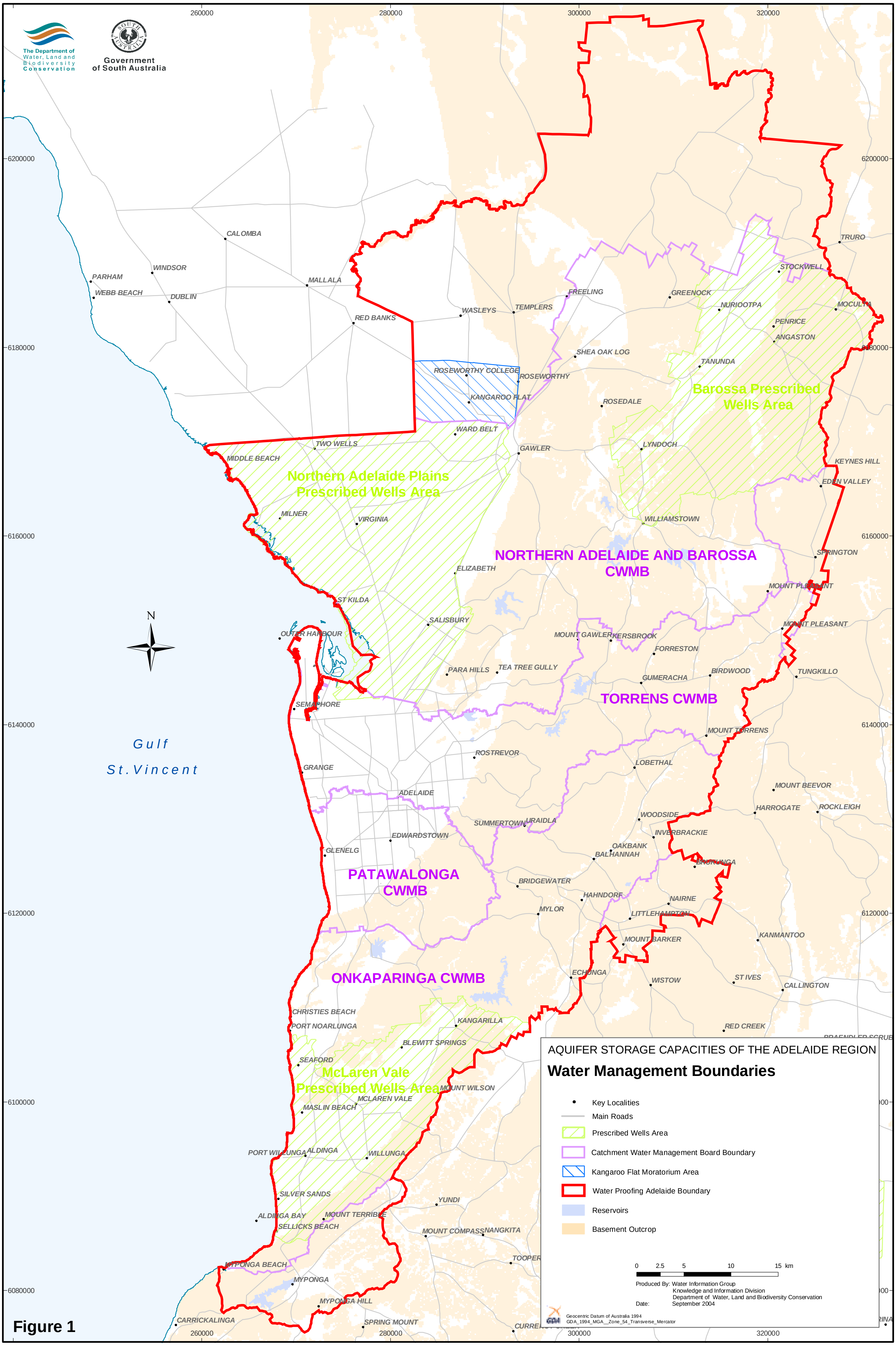
11 FIGURES



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Government of South Australia
Gulf St. Vincent
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NORTHERN ADELAIDE AND BAROSSA CWMB
TORRENS CWMB
PATAWALONGA CWMB
ONKAPARINGA CWMB
Northern Adelaide Plains Prescribed Wells Area
Barossa Prescribed Wells Area
McLaren Vale Prescribed Wells Area
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Water Management Boundaries
Key Localities
Main Roads
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Water Proofing Adelaide Boundary
Reservoirs
Basement Outcrop
0 2.5 5 10 15 km
Produced By: Water Information Group Knowledge and Information Division Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994 GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 1

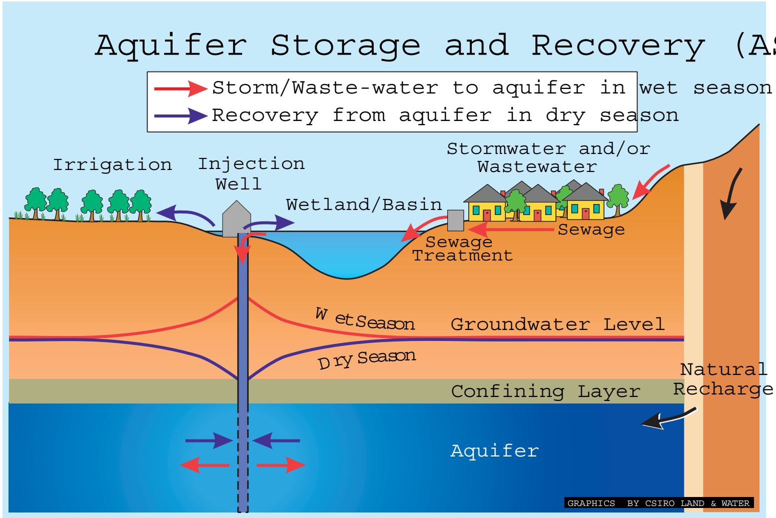


Figure 2 Schematic depiction of ASR (after Dillon et al 2000)

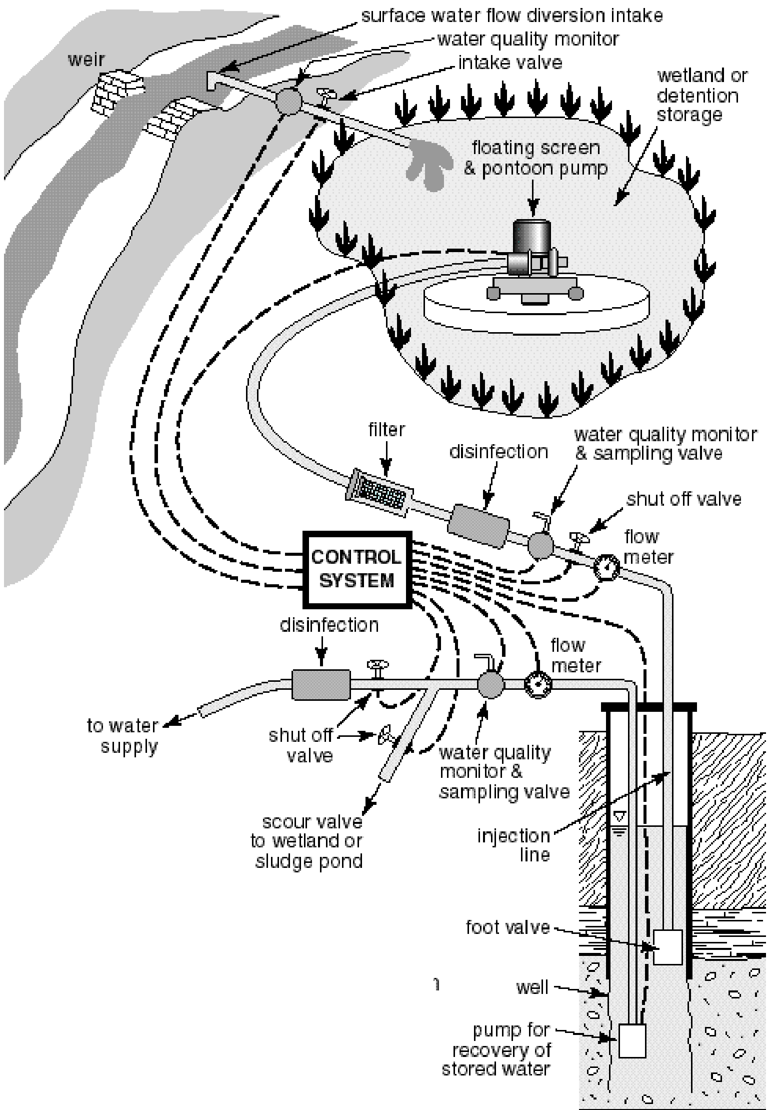
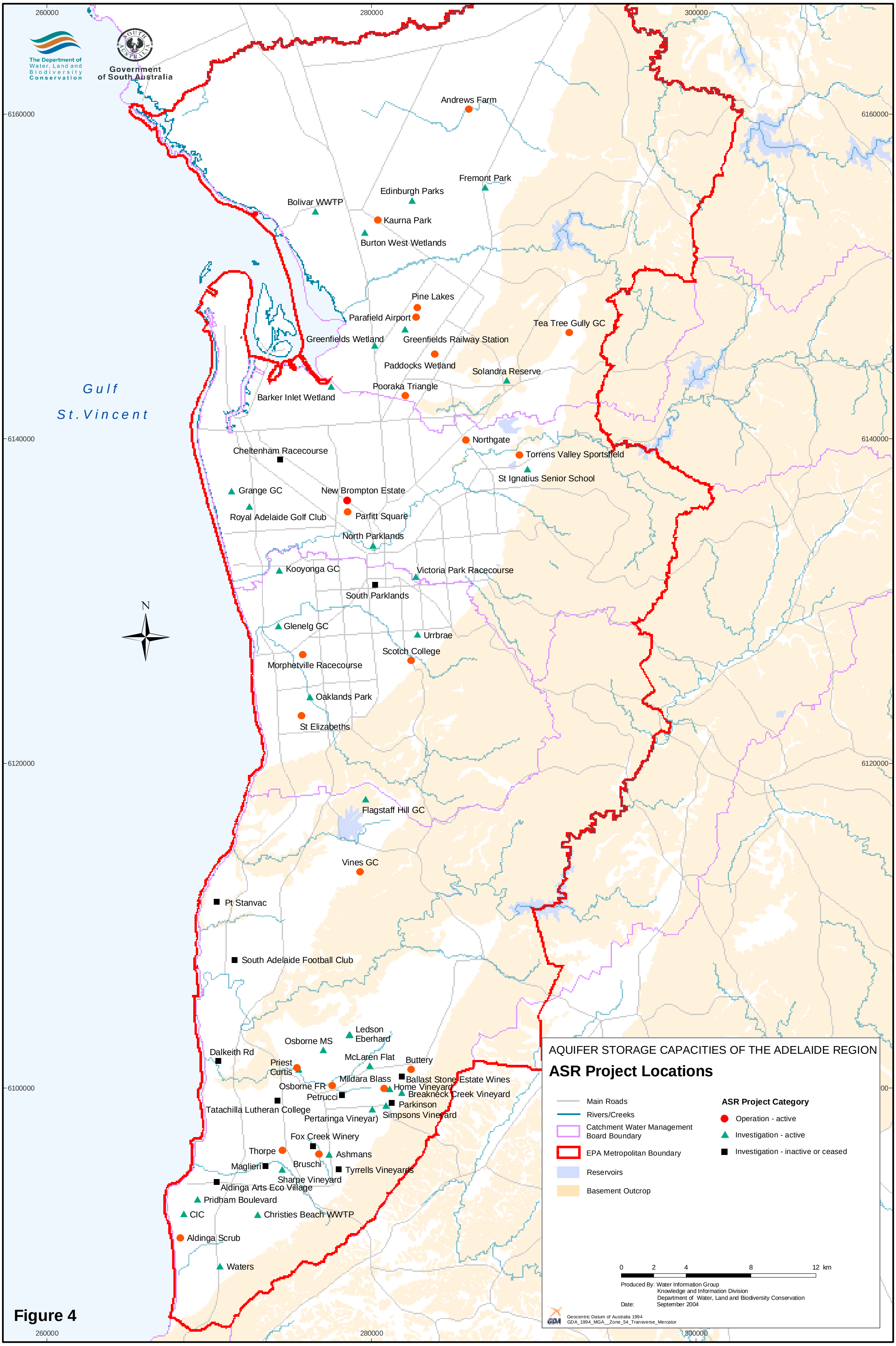


Figure 3 Components of a well-configured ASR system showing barriers to pollution (after Dillon et al 2000)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Government of South Australia
Gulf St.Vincent
N
Andrews Farm
Fremont Park
Edinburgh Parks
Bolivar WWTP
Kaurna Park
Burton West Wetlands
Pine Lakes
Parafield Airport
Greenfields Wetland
Greenfields Railway Station
Tea Tree Gully GC
Paddocks Wetland
Solandra Reserve
Pooraka Triangle
Barker Inlet Wetland
Northgate
Torrens Valley Sportsfield
St Ignatius Senior School
Cheltenham Racecourse
Grange GC
New Brompton Estate
Parfitt Square
Royal Adelaide Golf Club
North Parklands
Kooyonga GC
Victoria Park Racecourse
South Parklands
Glenelg GC
Urrbrae
Scotch College
Morphetville Racecourse
Oaklands Park
St Elizabeths
Flagstaff Hill GC
Vines GC
Pt Stanvac
South Adelaide Football Club
Ledson Eberhard
Osborne MS
Dalkeith Rd
McLaren Flat
Buttery
Priest
Curtis
Mildara Blass
Ballast Stone Estate Wines
Osborne FR
Home Vineyard
Petrucci
Breakneck Creek Vineyard
Parkinson
Tatachilla Lutheran College
Pertaringa Vineyar)
Simpsons Vineyard
Fox Creek Winery
Thorpe
Ashmans
Bruschi
Maglieri
Tyrrells Vineyards
Sharpe Vineyard
Aldinga Arts Eco Village
Pridham Boulevard
CIC
Christies Beach WWTP
Aldinga Scrub
Waters
260000
280000
300000
6160000
6140000
6120000
6100000
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Project Locations
Main Roads
Rivers/Creeks
Catchment Water Management Board Boundary
EPA Metropolitan Boundary
Reservoirs
Basement Outcrop
ASR Project Category
Operation - active
Investigation - active
Investigation - inactive or ceased
0 2 4 8 12 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 4

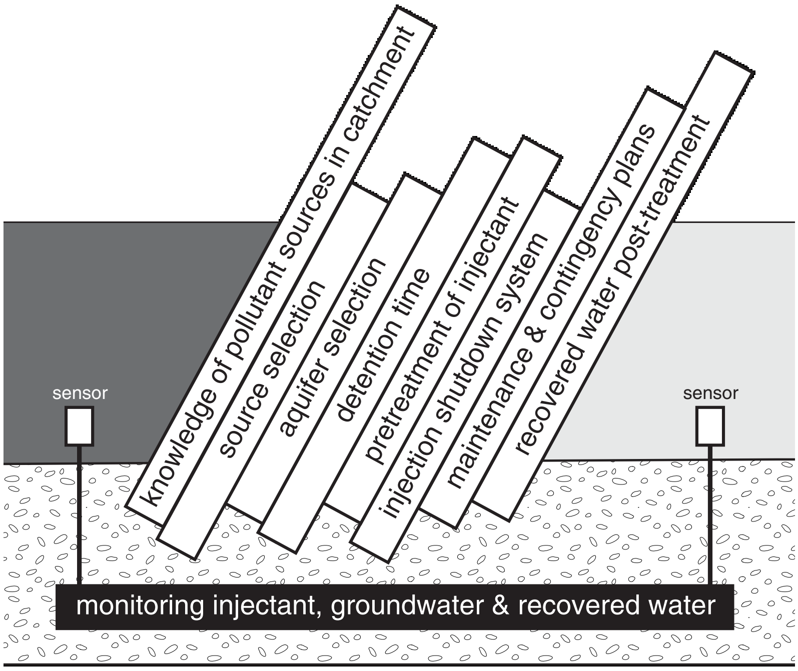


Figure 5 Barriers for protection of native and recovered groundwater (after Dillon et al 2000)

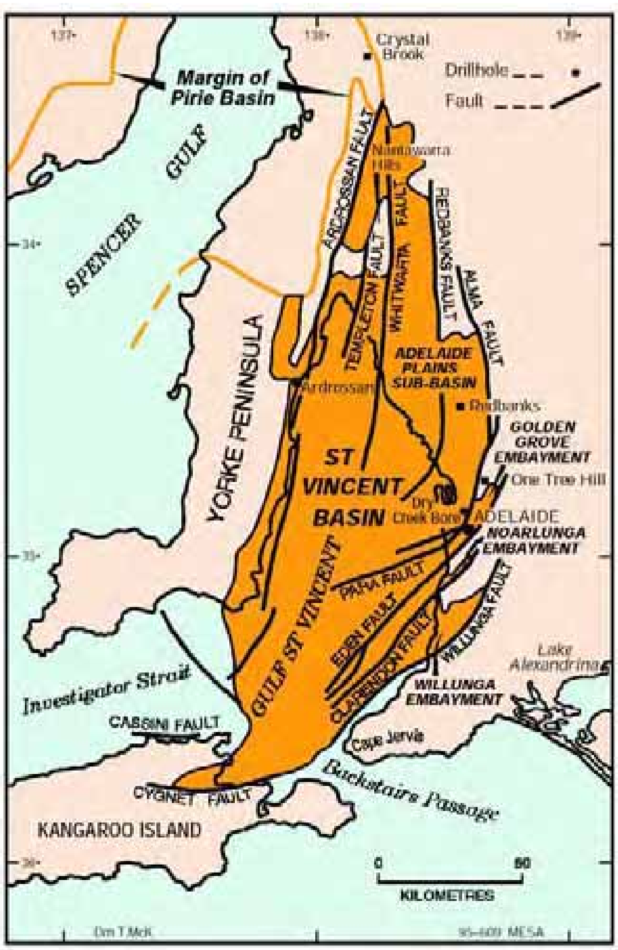
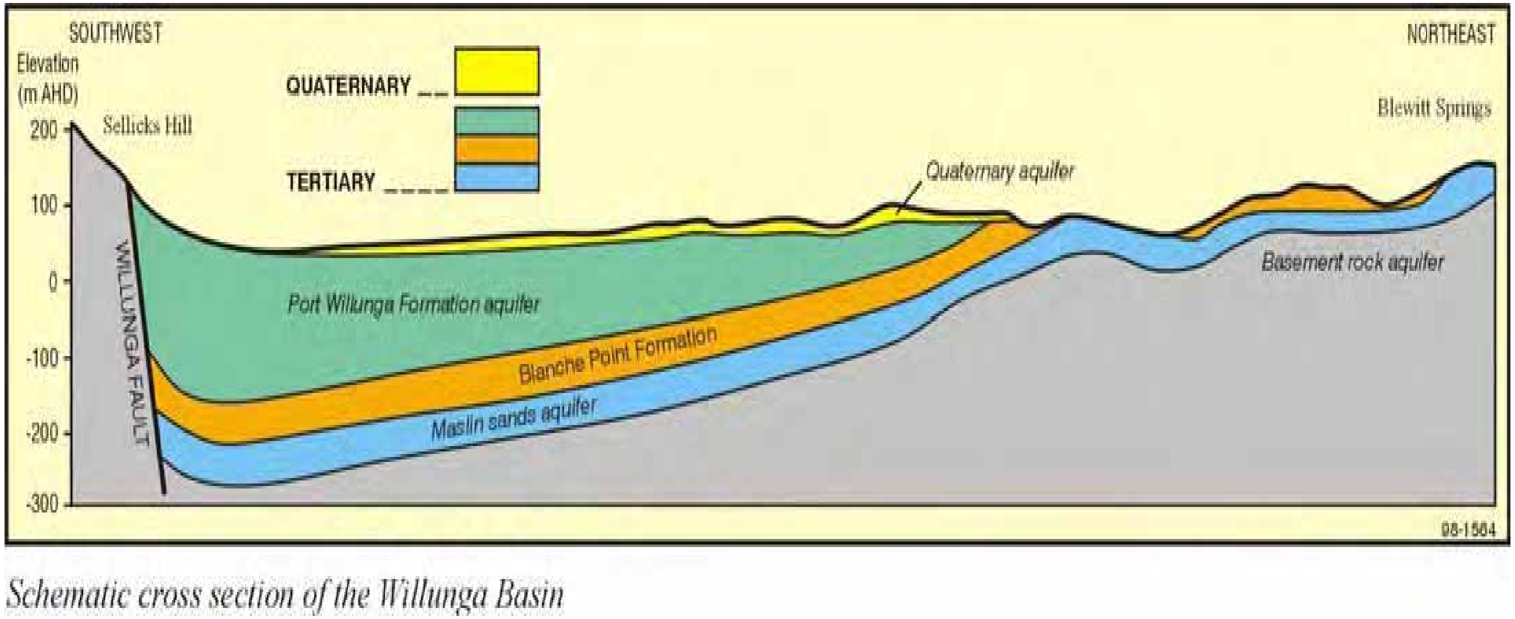


Figure 6 Limits and major structures of the St Vincent Basin (after Cooper, 1985)



Schematic cross section of the Willunga Basin

Figure 7 Schematic cross-section of the Willunga Basin (after Clarke, 2002)

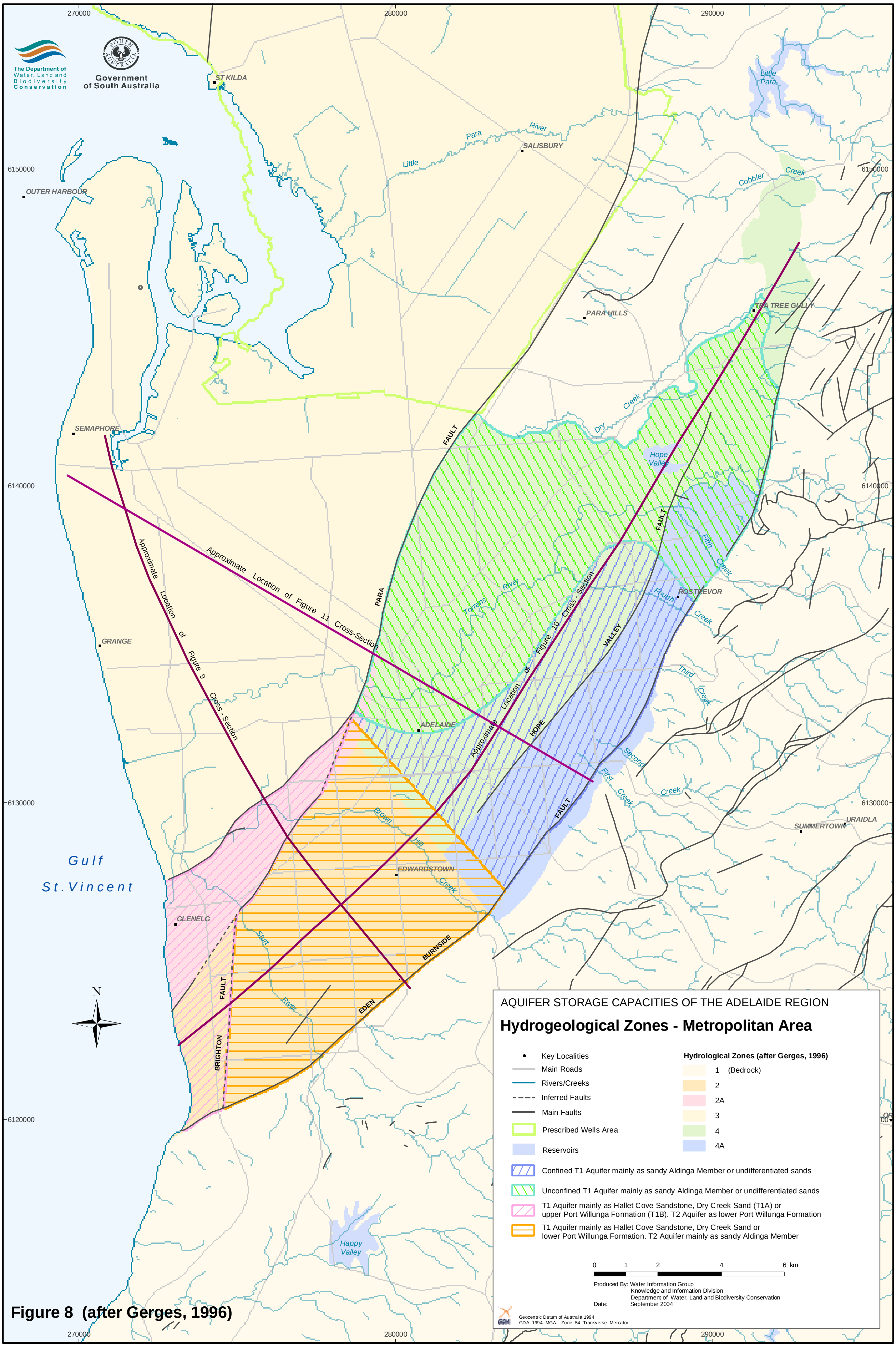


Figure 8 (after Gerges, 1996)

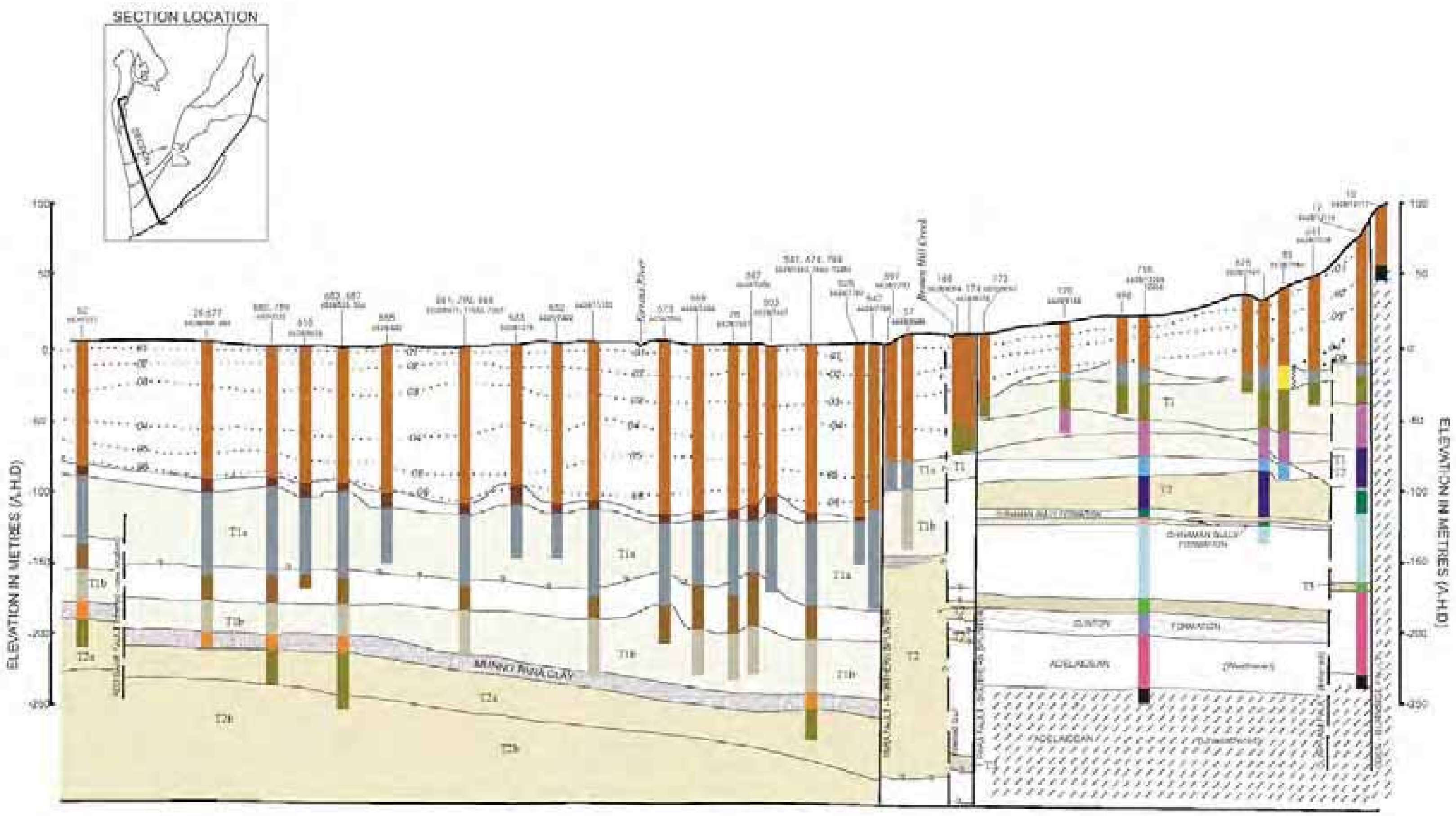


Figure 9 North-south hydrogeological cross-section, Adelaide metropolitan area

Reference

Age		No.	Unit	Hydrogeology
PLEISTOCENE		1	HINDMARSH CLAY: Clay with interbedded sand and gravel layers	Generally confining bed: contains up to six thin gravel aquifers
PLEISTOCENE		2	LOWER QUARTERNARY CLAY: Dark grey clay to reddish brown, sandy clay	Confining bed
PLIO-PLEISTO		3	CARISBROOKE SAND: Fine yellow sand	Aquifer
PLIOCENE		4	HALLET COVE SANDSTONE AND DRY CREEK SAND: Shelly dark grey	Aquifer
PLIOCENE		5	CROYDON FACIES: Fossiliferous, glauconitic silt, sand and clay	Semi - confining bed
EARLY-MIDDLE MIOCENE	PORT WILLUNGA FORMATION	6	UPPER PORT WILLUNGA FORMATION: Yellow and light grey limestone	Aquifer
EARLY-MIDDLE MIOCENE	PORT WILLUNGA FORMATION	7	MUNNO PARA CLAY: Stiff dark grey clay	Confining bed
EARLY-MIDDLE MIOCENE	PORT WILLUNGA FORMATION	8	LOWER PORT WILLUNGA FORMATION: Light grey to yellow limestone, silty and clayey	Aquifer
OLIGOCENE	PORT WILLUNGA FORMATION	9	RUWARUNG MEMBER: Clay, chert, limestone, silt and sand	Confining bed (clay, chert) Aquifer (sand, silt and limestone)
OLIGOCENE	PORT WILLUNGA FORMATION	10	ALDINGA CLAYEY MEMBER: Dark grey clay	Confining bed
OLIGOCENE	PORT WILLUNGA FORMATION	11	ALDINGA SANDY MEMBER: Light grey to yellow sand - fossiliferous	Aquifer
OLIGOCENE		12	CHINAMAN GULLY FORMATION: Lignitic - clay	Confining bed
OLIGOCENE		13	CHINAMAN GULLY FORMATION: Sand and silt	Aquifer
LATE EOCENE		14	BLANCHE POINT FORMATION: Clay - chert, marl, Tortachilla Limestone included	Confining bed
MIDDLE-LATE EOCENE		15	SOUTH MASLIN SAND - Dark grey carbonaceous sand	Aquifer
MIDDLE-LATE EOCENE		16	CLINTON FORMATION: Lignite and clay	Confining bed
		17	UNDIFFERENTIATED TERTIARY: Sand	Aquifer
PRE-CAMBRIAN		18	ADELAIDEAN (weathered): Mostly clay and 'clay-bound' gravel	Confining bed
PRE-CAMBRIAN		19	ADELAIDEAN (unweathered): Phyllite, slate, quartz, dolomite and others	Fractured rock aquifer

QUARTERNARY AQUIFERS

First	• • •01• • •
Second	• • •02• • •
Third	• • •03• • •
Fourth	• • •04• • •
Fifth	• • •05• • •
Sixth	• • •06• • •

TERTIARY AQUIFERS

First	T1
Second	T2
Third	T3
Fourth	T4

BEDROCK AQUIFER

CONFINING BED

Figure 9 continued Legend for Figures 9,10 and 11

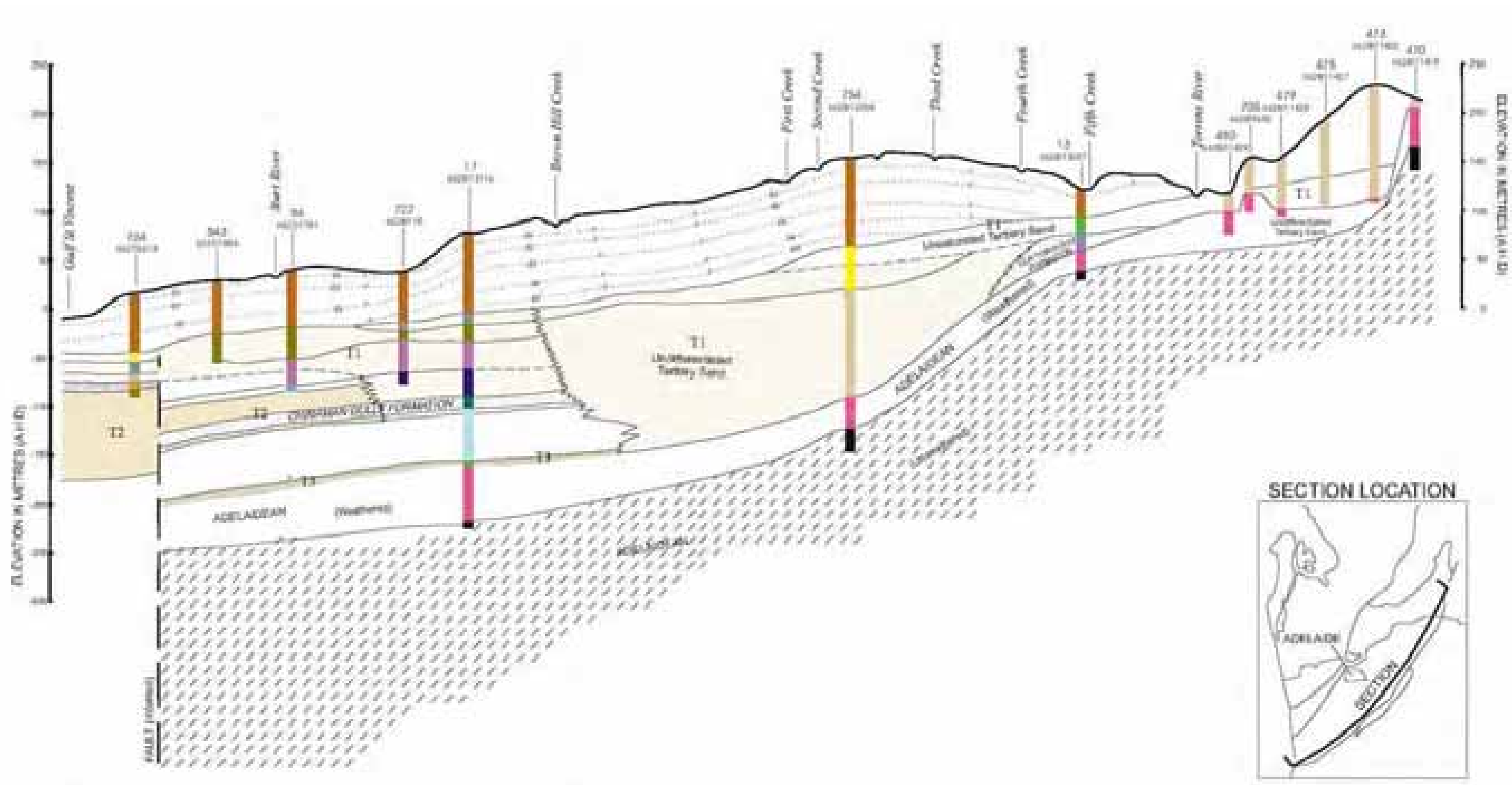


Figure 10 Northeast-southwest hydrogeological cross-section, Adelaide metropolitan area

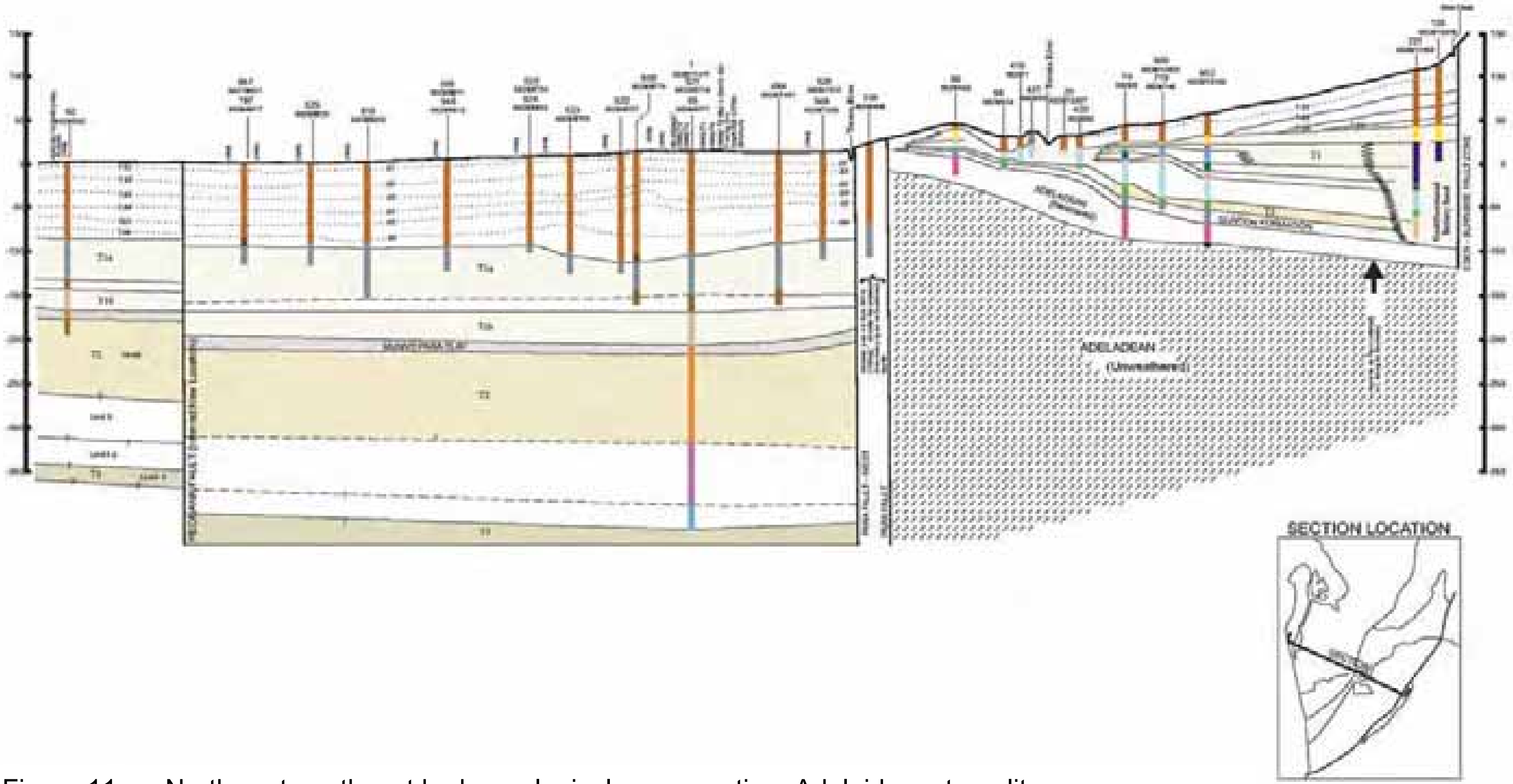


Figure 11 Northwest-southeast hydrogeological cross-section, Adelaide metropolitan area

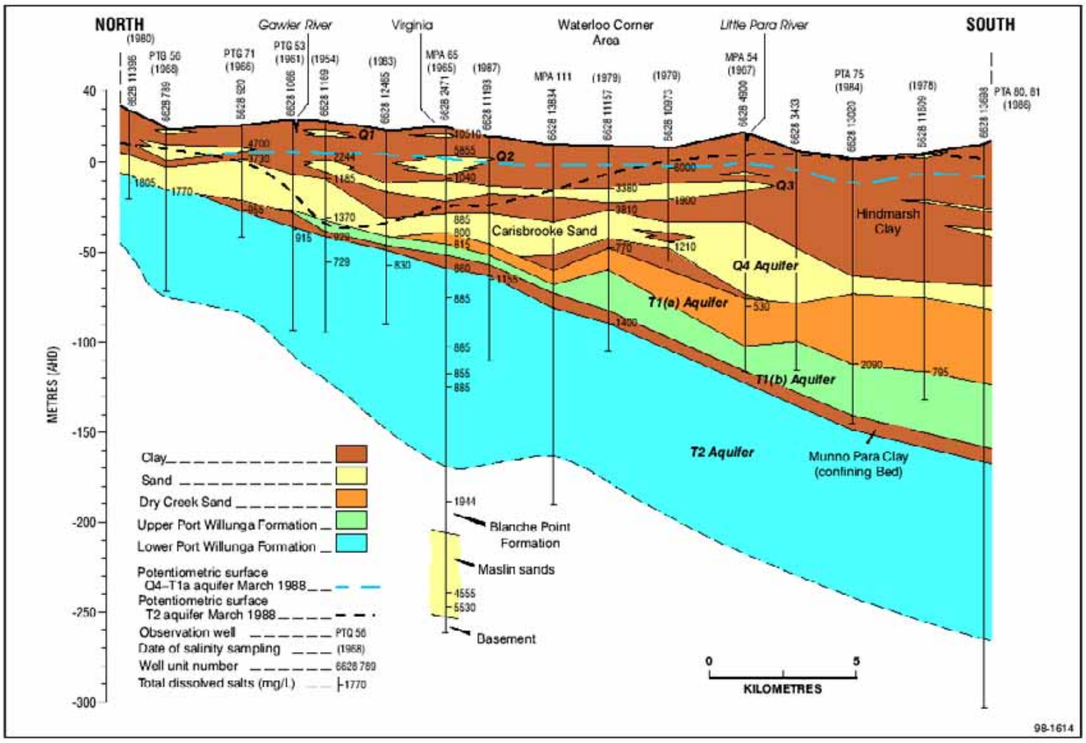


Figure 12 North-south hydrogeological cross-section, Northern Adelaide Plains (after Zulfic, 2002)

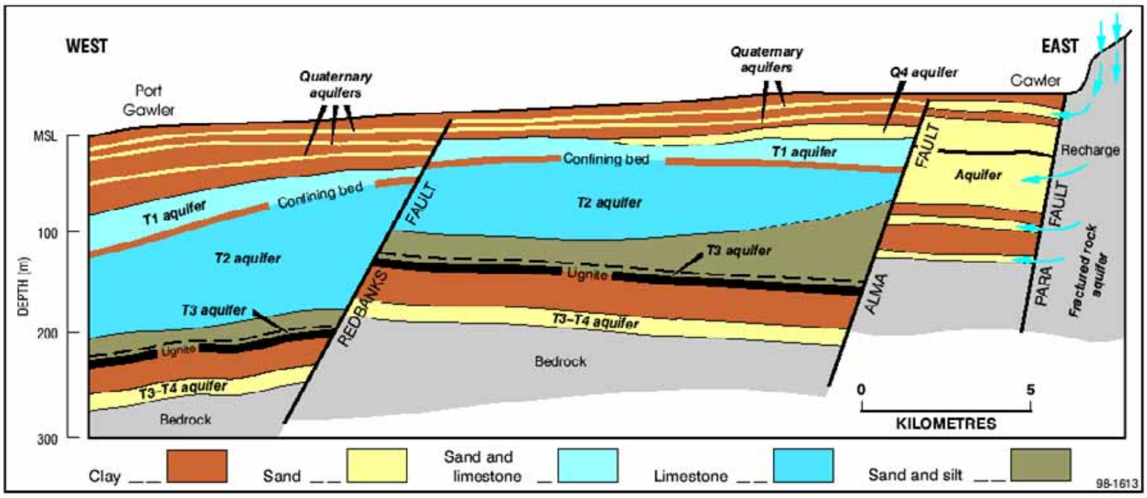
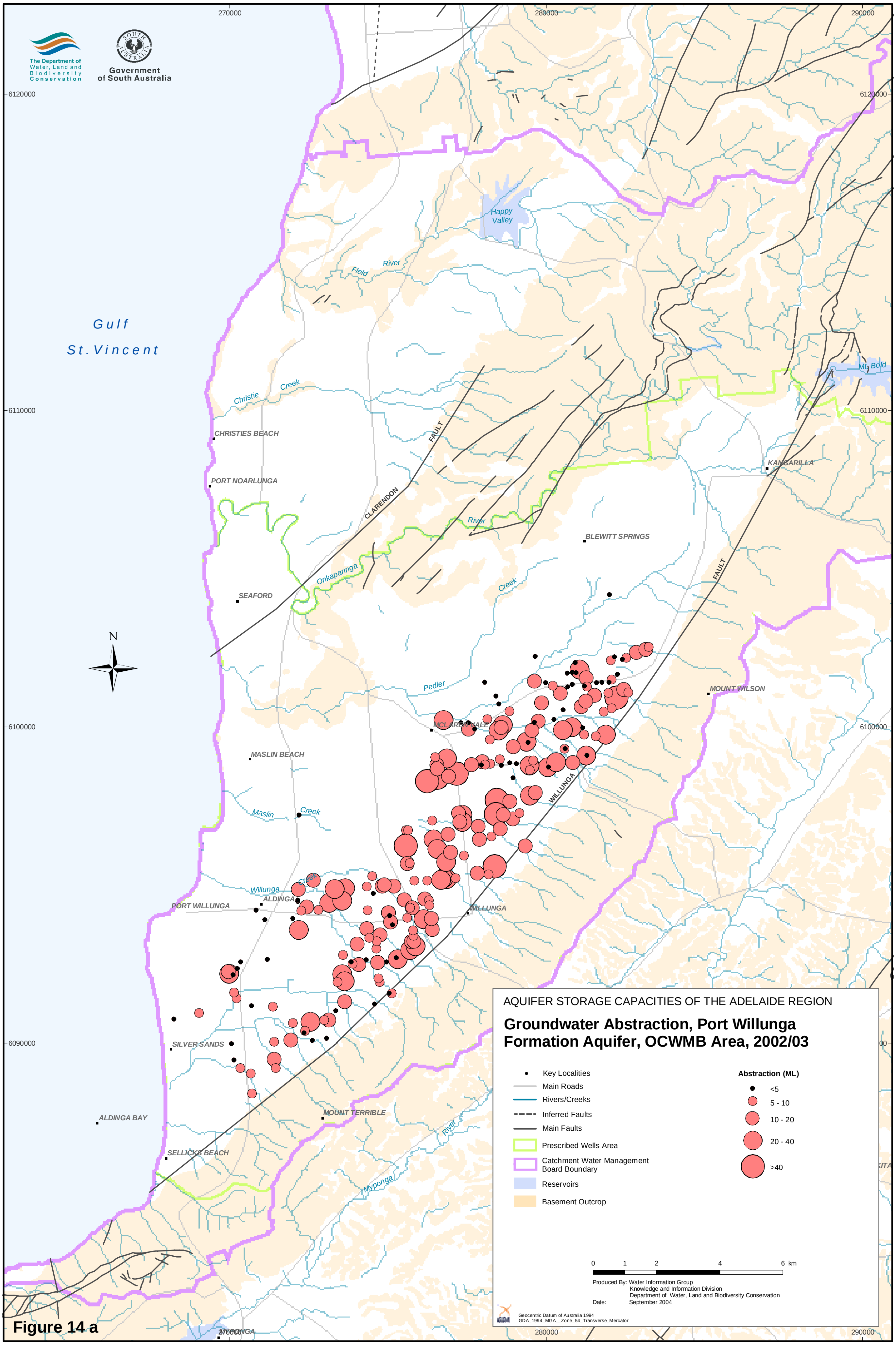


Figure 13 West-east hydrogeological cross-section along Gawler River, Northern Adelaide Plains (after Zulfic, 2002)



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Gulf
St. Vincent
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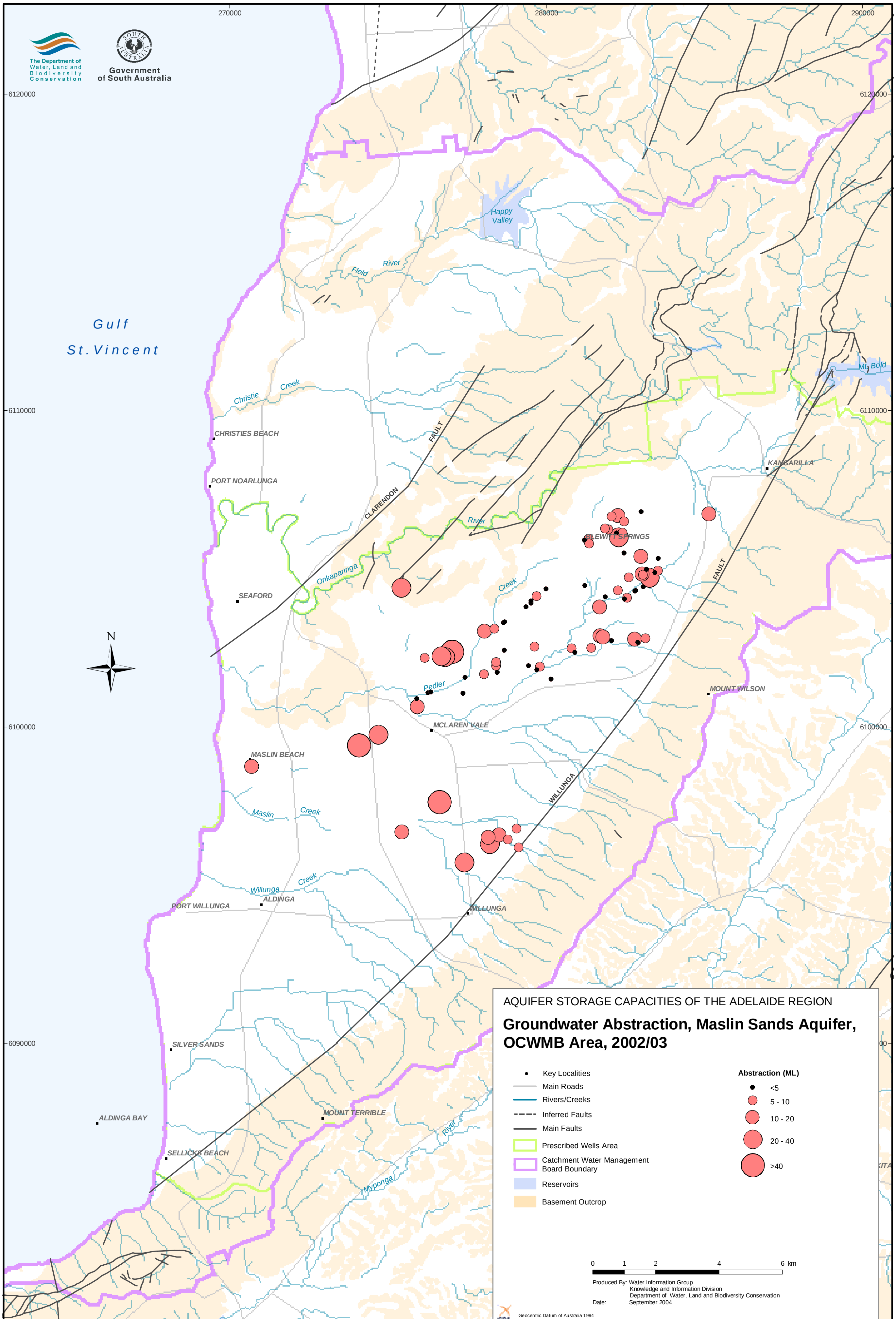
Happy Valley
Field
River
Christie
Creek
CHRISTIES BEACH
PORT NOARLUNGA
CLARENDON
FAULT
Onkaparinga
River
BLEWITT SPRINGS
Creek
SEAFORD
KANGARILLA
Mt. Bold
Pedler
MOUNT WILSON
MCLAREN VALE
MASLIN BEACH
WILLUNGA
FAULT
Maslin
Creek
Willunga
Creek
ALDINGA
PORT WILLUNGA
WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
River
SELLICKS BEACH
Myponga
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Groundwater Abstraction, Port Willunga Formation Aquifer, OCWMB Area, 2002/03
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Abstraction (ML)
<5
5 - 10
10 - 20
20 - 40
>40
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 14 a


AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Groundwater Abstraction, Maslin Sands Aquifer, OCWMB Area, 2002/03
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Abstraction (ML)
<5
5 - 10
10 - 20
20 - 40
>40
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
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270000
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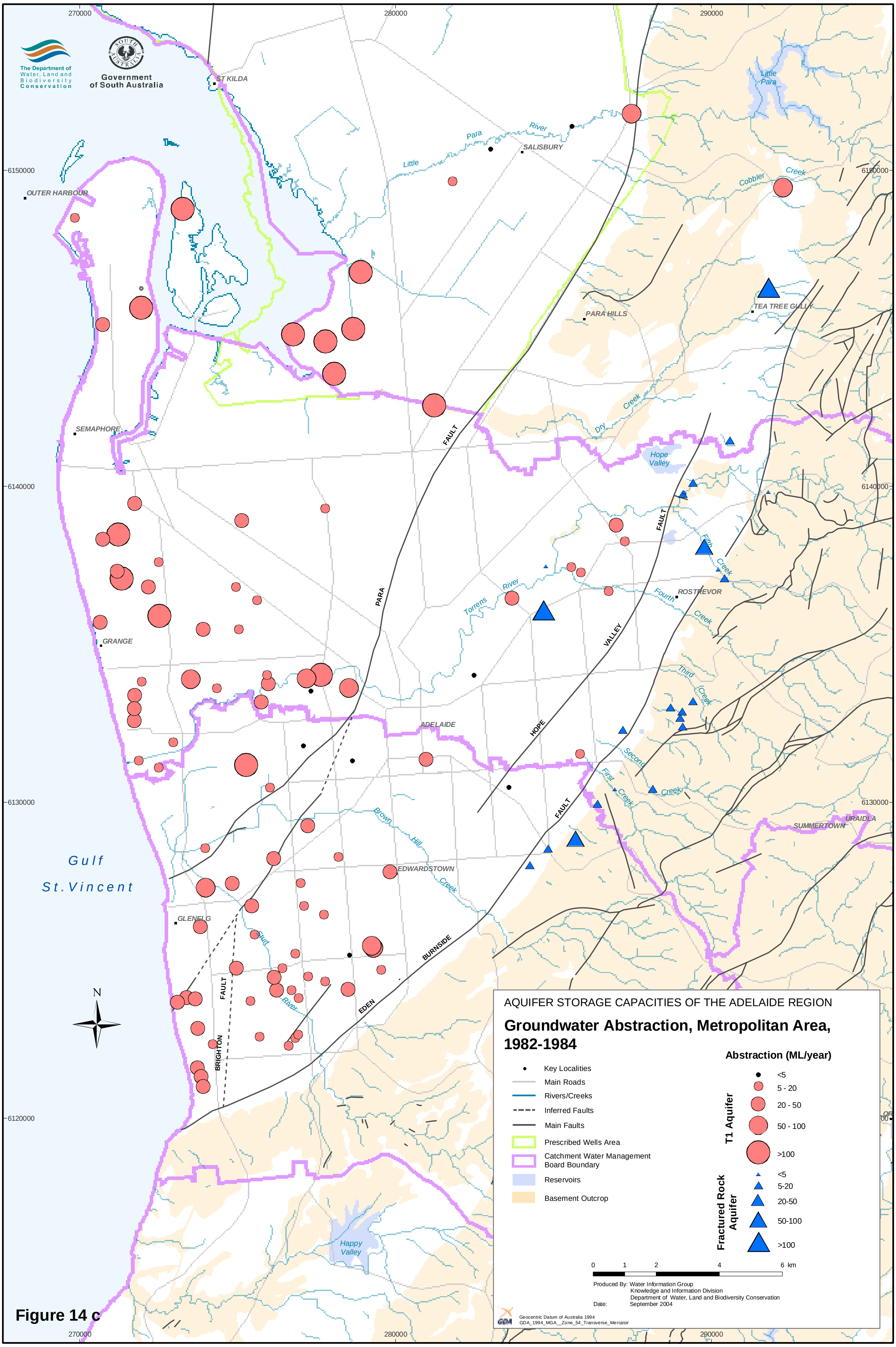
Happy Valley
Field River
Christie Creek
CHRISTIES BEACH
PORT NOARLUNGA
CLARENDON FAULT
Onkaparinga River
SEAFORD
Creek
CLEWITT SPRINGS
Pedler
MCLAREN VALE
MASLIN BEACH
Maslin Creek
Willunga Creek
ALDINGA
PORT WILLUNGA
WILLUNGA
WILLUNGA FAULT
KANGARILLA
MOUNT WILSON
Mt Bold
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Myponga River

Figure 14 b



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Government of South Australia
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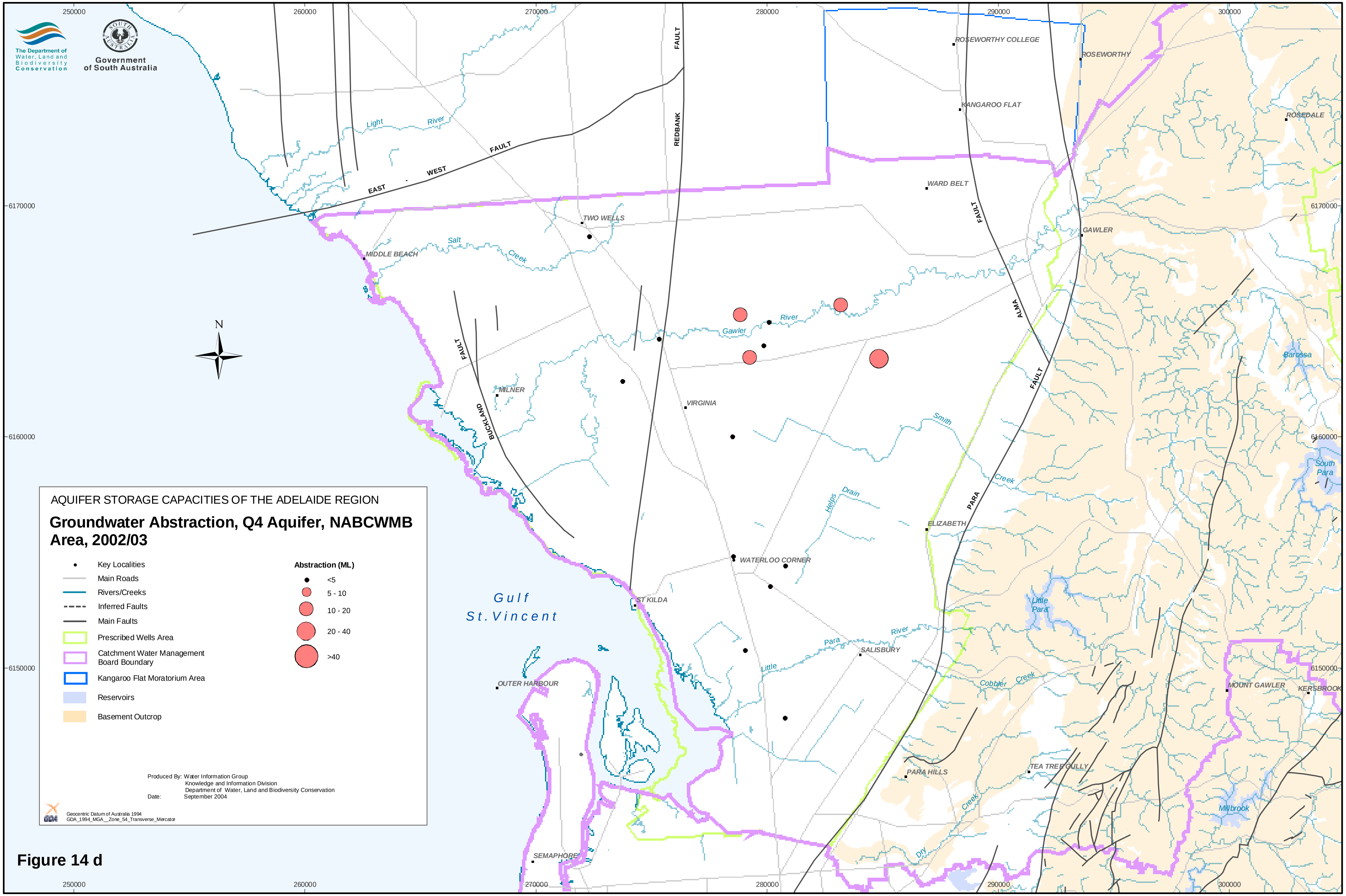
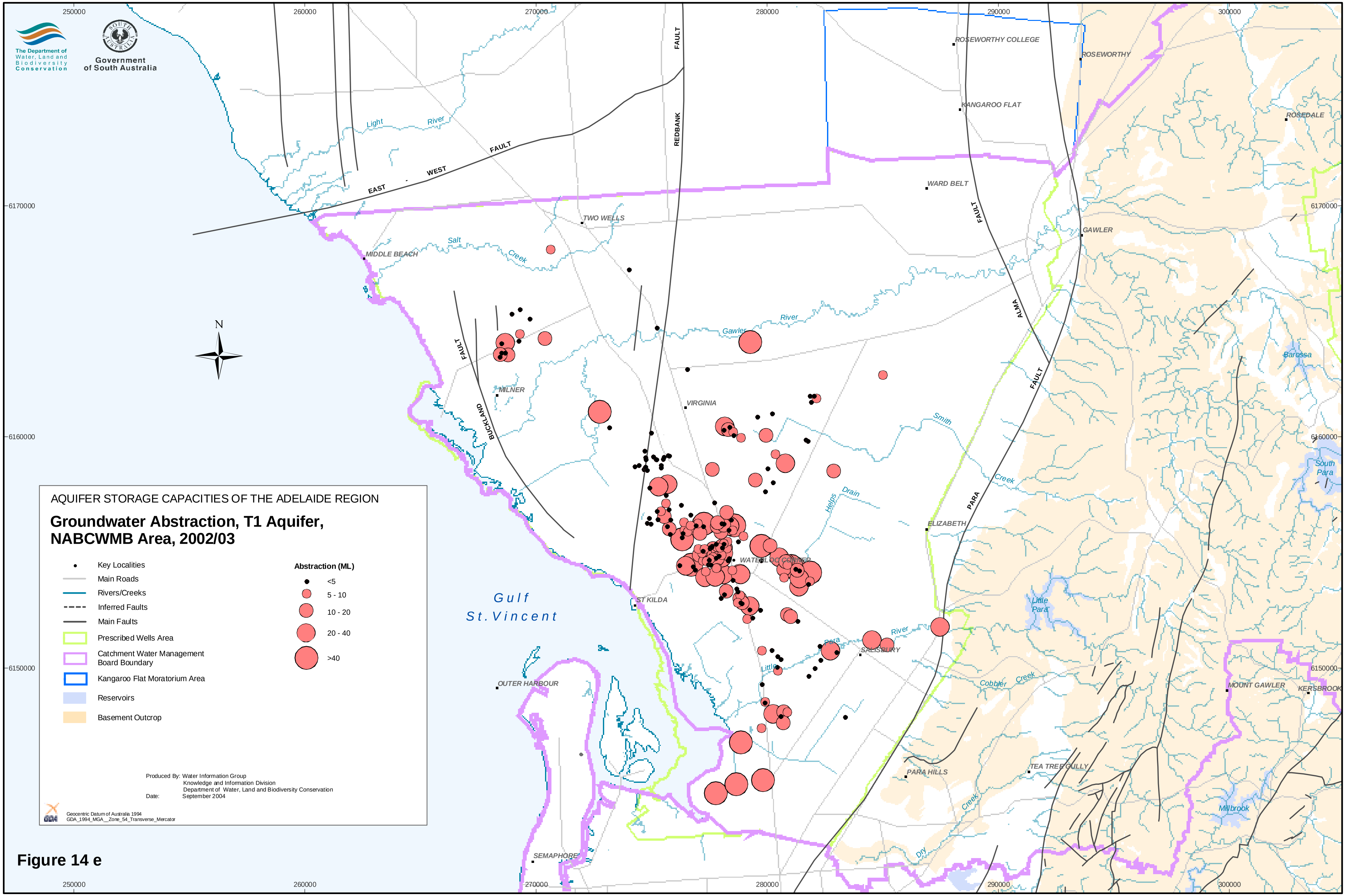
ST KILDA
OUTER HARBOUR
SALISBURY
Little
Para
River
Little Para
Cobbler
Creek
PARA HILLS
TEA TREE GULLY
SEMAPHORE
Dry
Creek
Hope Valley
FAULT
PARA
Torrens
River
Fifth
Creek
Fourth
Creek
ROSTREVOR
VALLEY
HOPE
GRANGE
Third
Creek
ADELAIDE
Second
First
Creek
Brown
Hill
Creek
EDWARDSTOWN
SUMMERTOWN
URAIDLA
GLENELG
Sturt
River
BURNSIDE
EDEN
BRIGHTON
Gulf
St.Vincent
N
Happy Valley
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Groundwater Abstraction, Metropolitan Area, 1982-1984
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Abstraction (ML/year)
T1 Aquifer
<5
5 - 20
20 - 50
50 - 100
>100
Fractured Rock Aquifer
<5
5-20
20-50
50-100
>100
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 14 c



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Groundwater Abstraction, Q4 Aquifer, NABCWMB Area, 2002/03
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Abstraction (ML)
<5
5 - 10
10 - 20
20 - 40
>40
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf St.Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
WATERLOO CORNER
ELIZABETH
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
SEMAPHORE
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
EAST - WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 14 d


The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Groundwater Abstraction, T1 Aquifer, NABCWMB Area, 2002/03
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Abstraction (ML)
<5
5 - 10
10 - 20
20 - 40
>40
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
250000
260000
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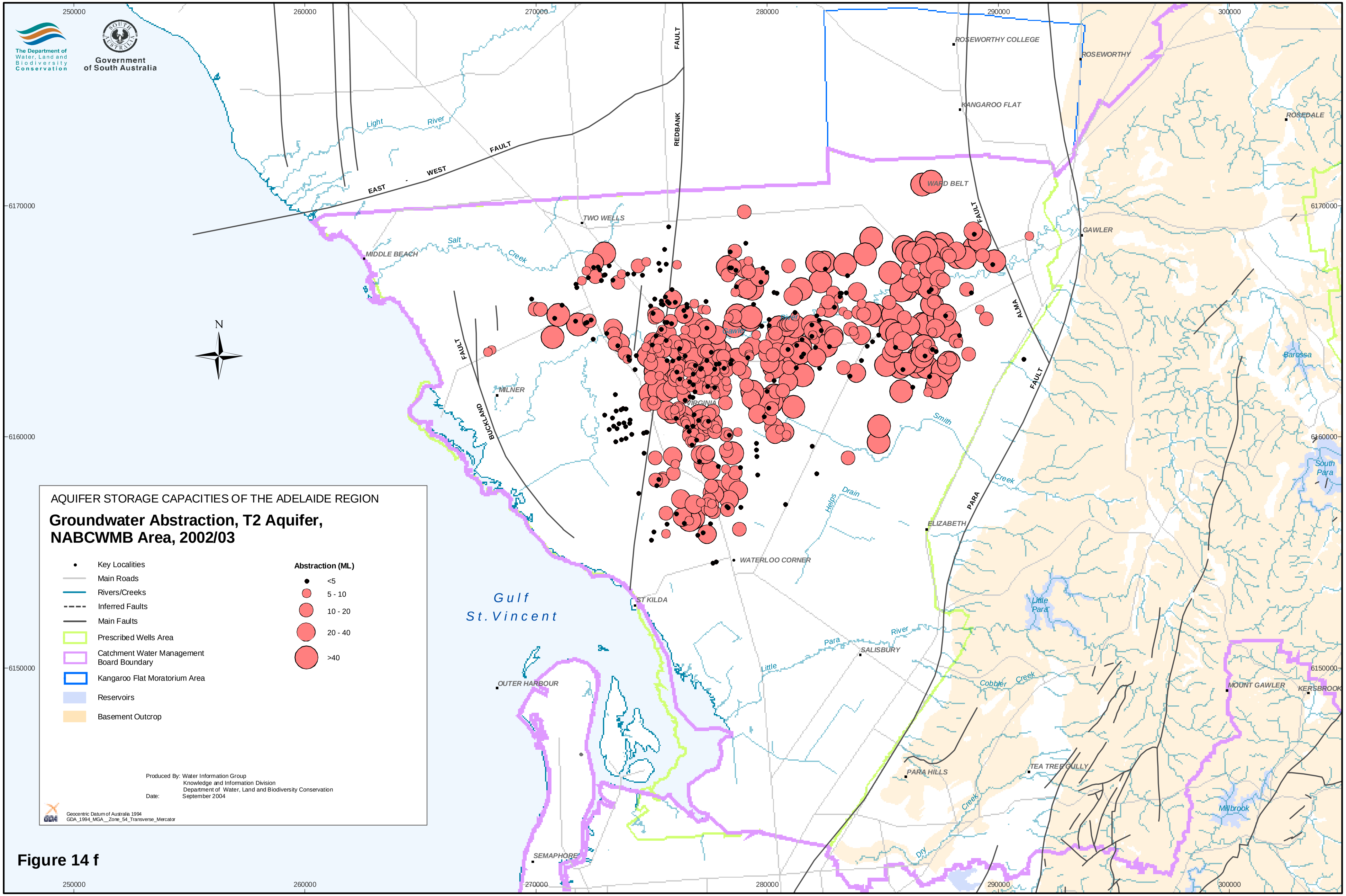
290000
300000
6170000
6160000
6150000
Figure 14 e



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Groundwater Abstraction, T2 Aquifer, NABCWMB Area, 2002/03
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Abstraction (ML)
<5
5 - 10
10 - 20
20 - 40
>40
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf St.Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
WATERLOO CORNER
ELIZABETH
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
Light River
Salt Creek
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 14 f

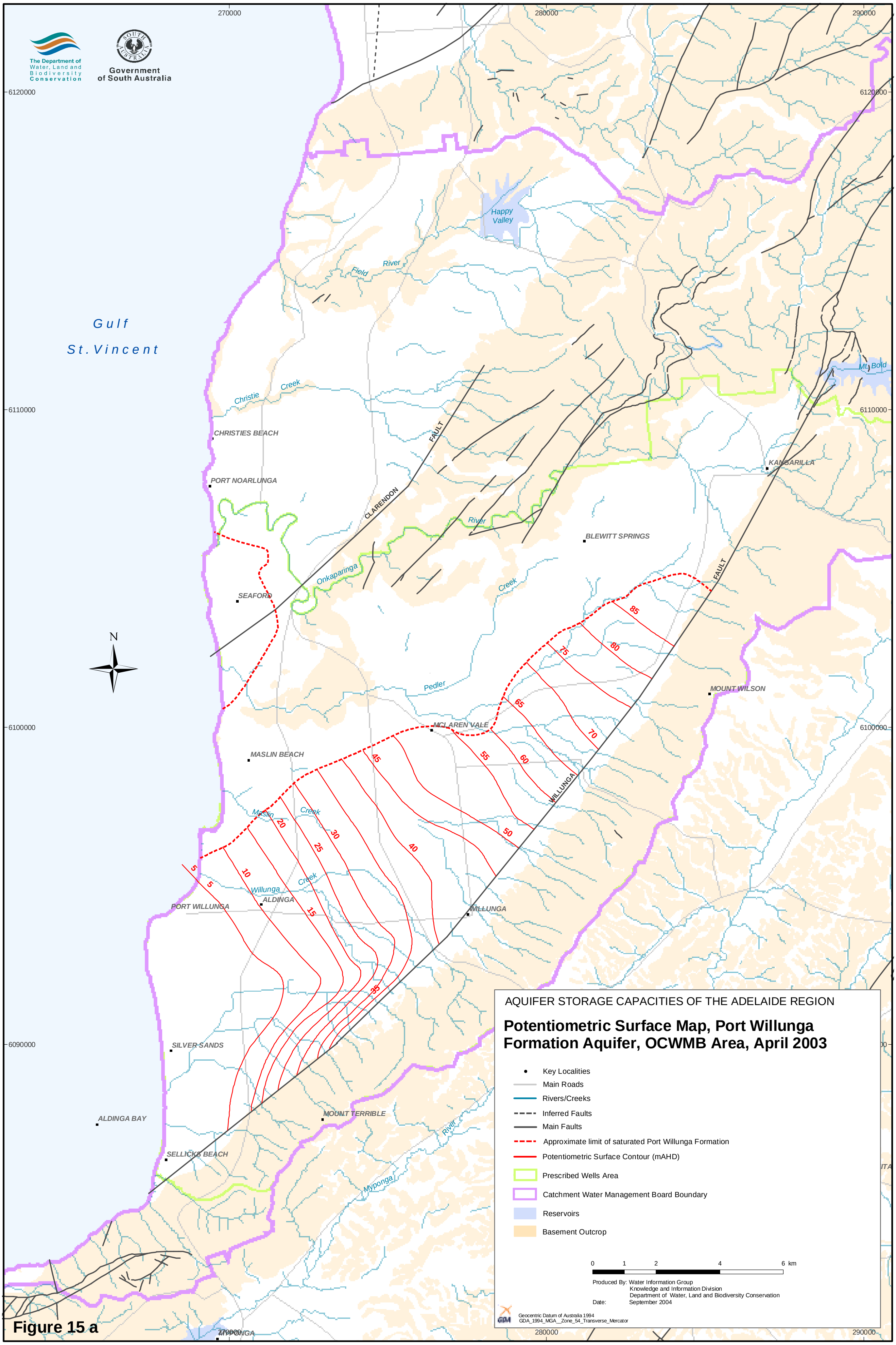

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Potentiometric Surface Map, Port Willunga Formation Aquifer, OCWMB Area, April 2003
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate limit of saturated Port Willunga Formation
Potentiometric Surface Contour (mAHD)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf
St.Vincent
N
270000
280000
290000
6120000
6110000
6100000
6090000
Happy Valley
Field River
Christie Creek
CHRISTIES BEACH
PORT NOARLUNGA
CLARENDON FAULT
Onkaparinga River
Mt Bold
KANGARILLA
BLEWITT SPRINGS
SEAFORD
Creek
Pedler
MOUNT WILSON
WILLUNGA FAULT
McLAREN VALE
MASLIN BEACH
Maslin Creek
Willunga Creek
ALDINGA
PORT WILLUNGA
WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Myponga River
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85

Figure 15 a

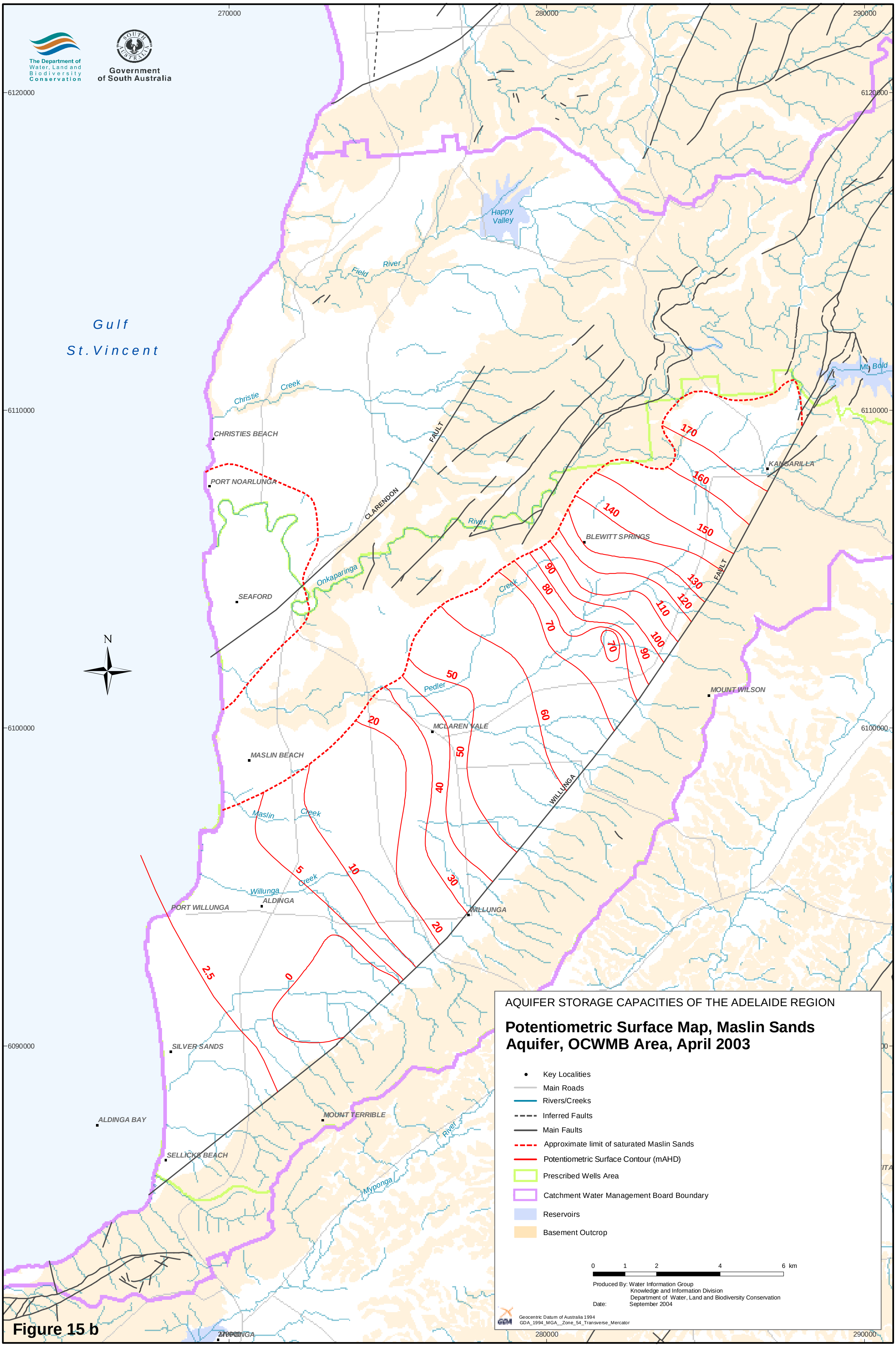

AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Potentiometric Surface Map, Maslin Sands Aquifer, OCWMB Area, April 2003
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate limit of saturated Maslin Sands
Potentiometric Surface Contour (mAHD)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf
St. Vincent
N
270000
280000
290000
6120000
6110000
6100000
6090000
Happy Valley
Field River
Christie Creek
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
Onkaparinga River
CLARENDON
FAULT
BLEWITT SPRINGS
KANGARILLA
Mt Bold
MOUNT WILSON
Pedler Creek
MCLAREN VALE
MASLIN BEACH
Maslin Creek
WILLUNGA
Willunga Creek
ALDINGA
PORT WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Myponga River
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
5
2.5
0

Figure 15 b

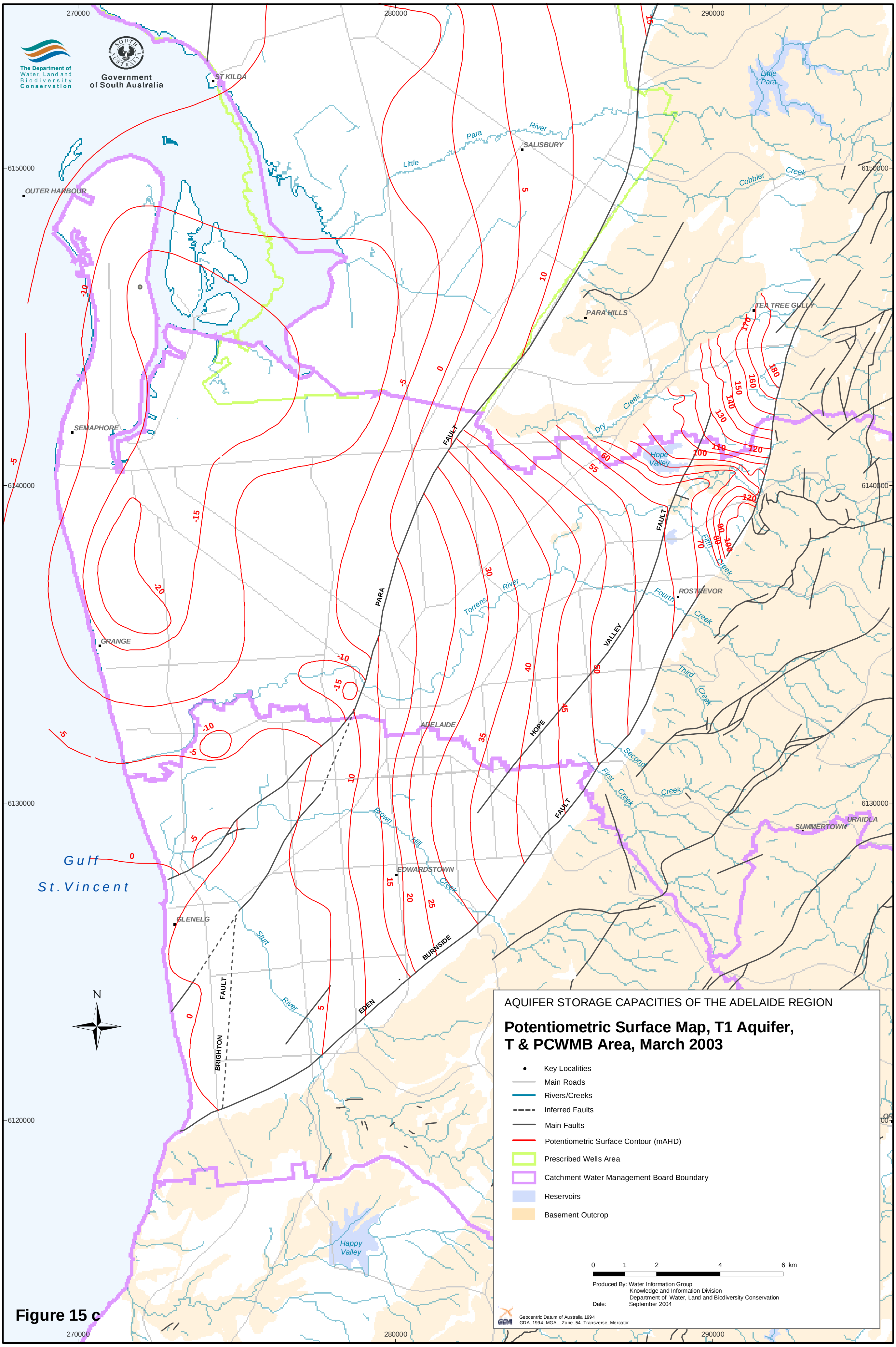

AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Potentiometric Surface Map, T1 Aquifer, T & PCWMB Area, March 2003
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Potentiometric Surface Contour (mAHD)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Gulf
St.Vincent
Little Para River
Cobbler Creek
Dry Creek
Hope Valley
Torrens River
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
Happy Valley
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
270000
280000
290000
6150000
6140000
6130000
6120000
N

Figure 15 c

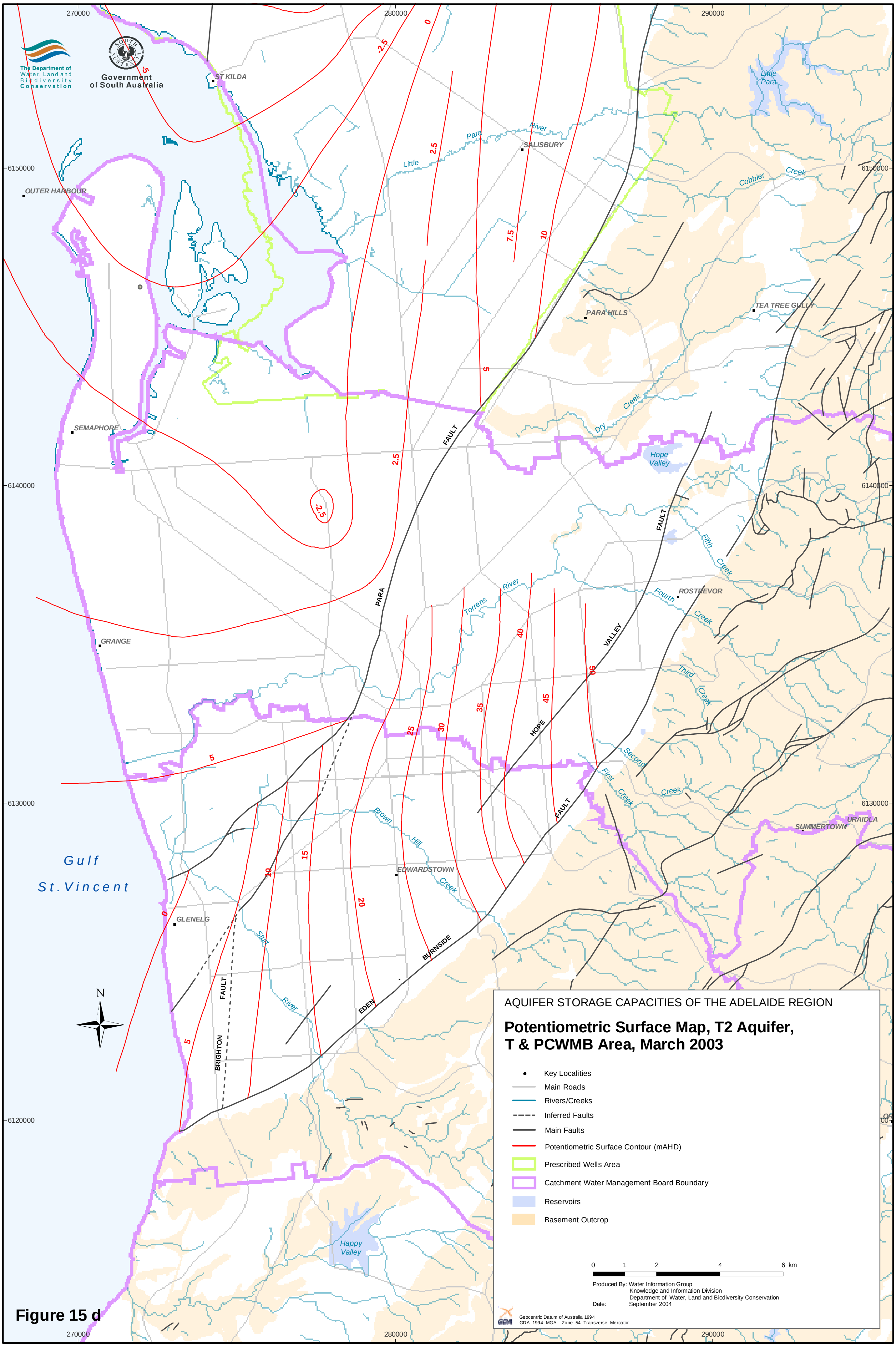
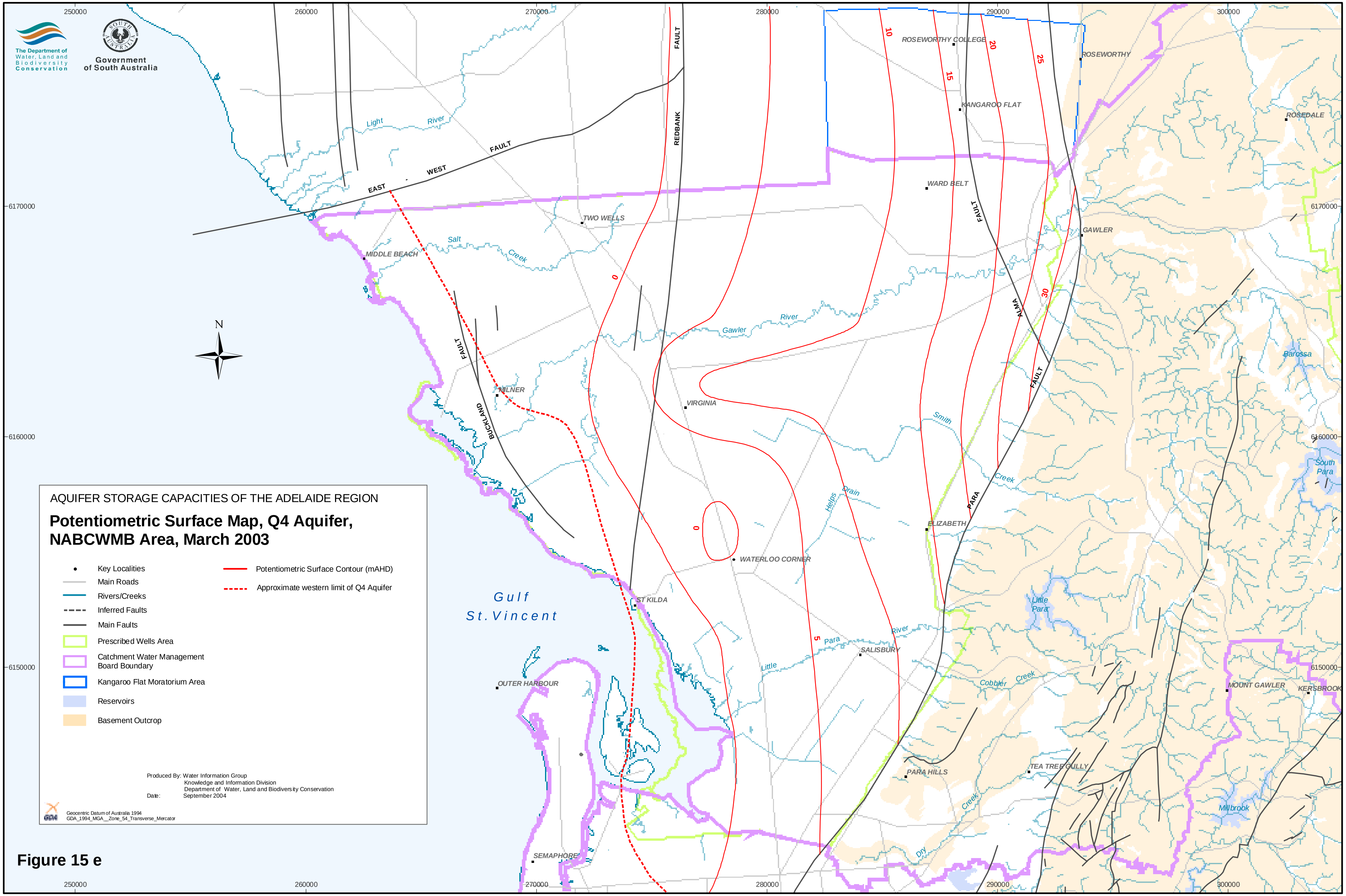

AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Potentiometric Surface Map, T2 Aquifer, T & PCWMB Area, March 2003
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Potentiometric Surface Contour (mAHD)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
270000
280000
290000
6150000
6140000
6130000
6120000
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Gulf
St.Vincent
Little Para
Little
Para
River
Cobbler
Creek
Dry
Creek
Hope Valley
Fifth
Creek
Fourth
Creek
Third
Creek
Torrens
River
Second
First
Creek
Brown
Hill
Creek
Sturt
River
Happy Valley
PARA
FAULT
HOPE
VALLEY
FAULT
EDEN
BURNSIDE
BRIGHTON
N
-2.5
0
2.5
5
7.5
10
15
20
25
30
35
40
45
50

Figure 15 d


The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Potentiometric Surface Map, Q4 Aquifer, NABCWMB Area, March 2003
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Potentiometric Surface Contour (mAHD)
Approximate western limit of Q4 Aquifer
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf
St. Vincent
EAST - WEST FAULT
BUCKLAND FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Little Para
South Para
Barossa
Millbrook
0
5
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15
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25
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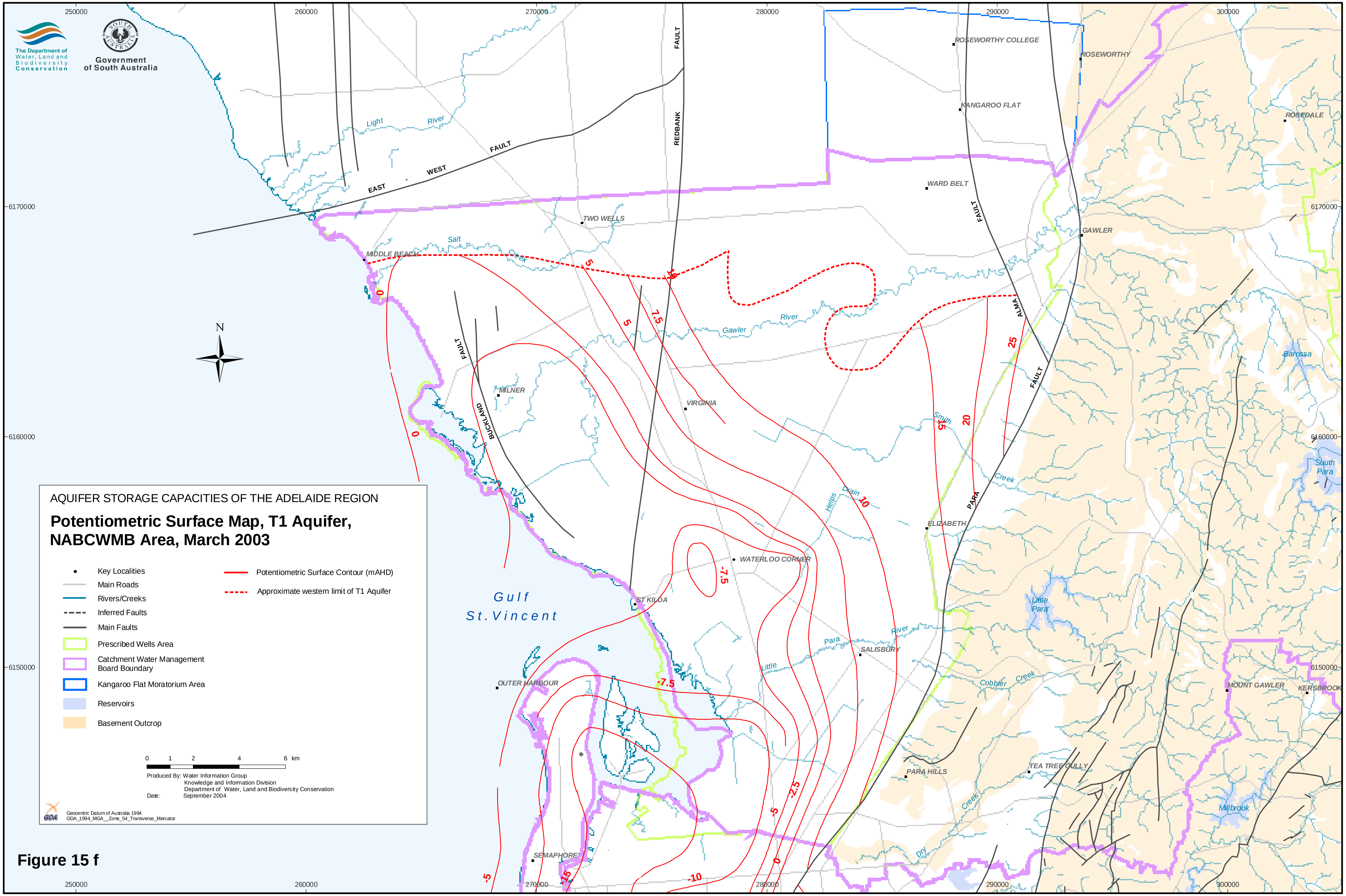
250000
260000
270000
280000
290000
300000
6150000
6160000
6170000

Figure 15 e



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Potentiometric Surface Map, T1 Aquifer, NABCWMB Area, March 2003
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Potentiometric Surface Contour (mAHD)
Approximate western limit of T1 Aquifer
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf St.Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
SEMAPHORE
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Para River
Little Para
Cobbler Creek
Dry Creek
Barossa
South Para
Millbrook
25
20
15
10
7.5
5
0
-2.5
-5
-7.5
-10
-15
250000
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290000
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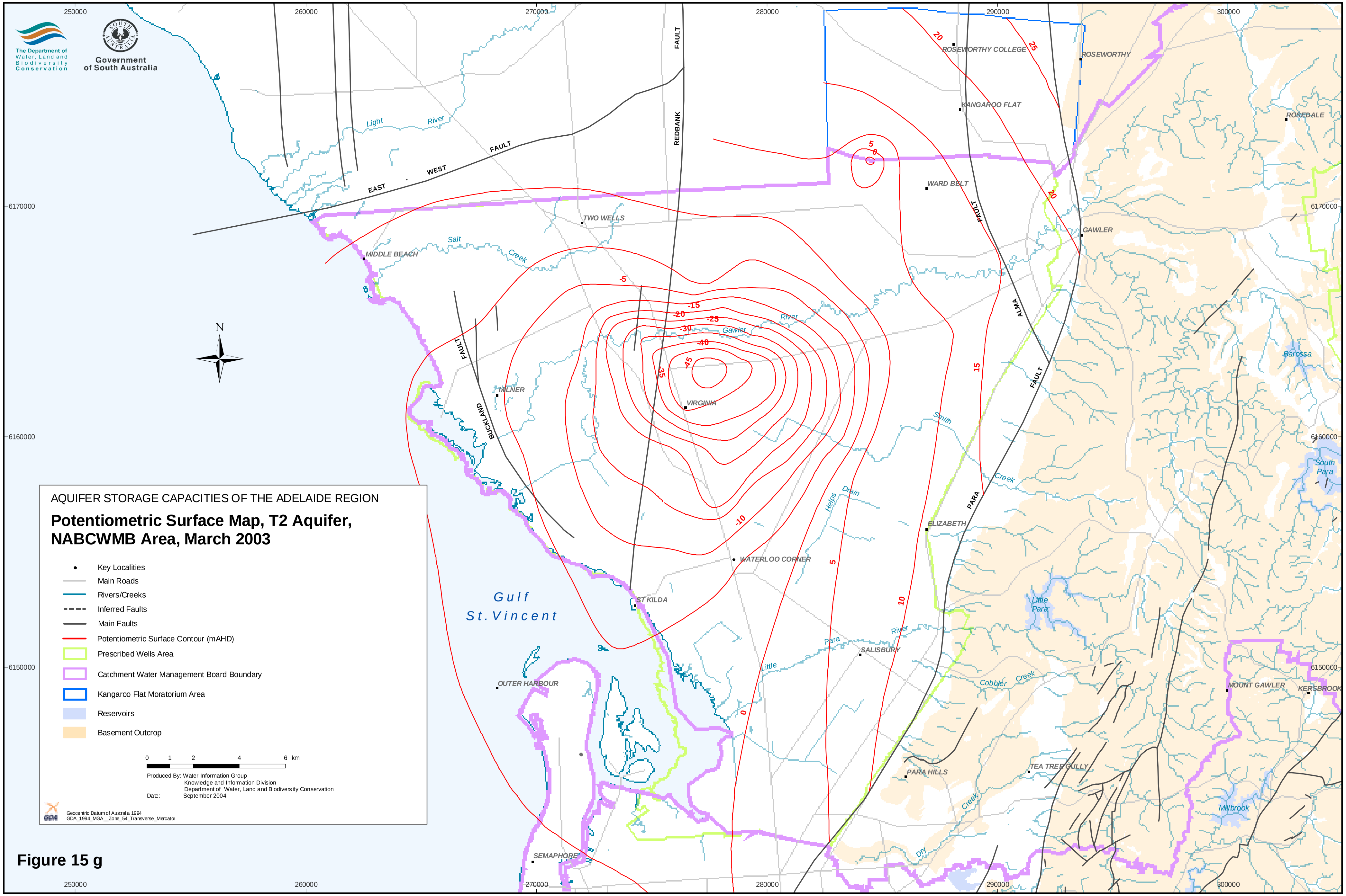
Figure 15 f



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Potentiometric Surface Map, T2 Aquifer, NABCWMB Area, March 2003
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Potentiometric Surface Contour (mAHD)
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
N
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
ROSEDALE
KANGAROO FLAT
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
SEMAPHORE
EAST WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
250000
260000
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290000
300000
6170000
6160000
6150000
25
20
15
10
5
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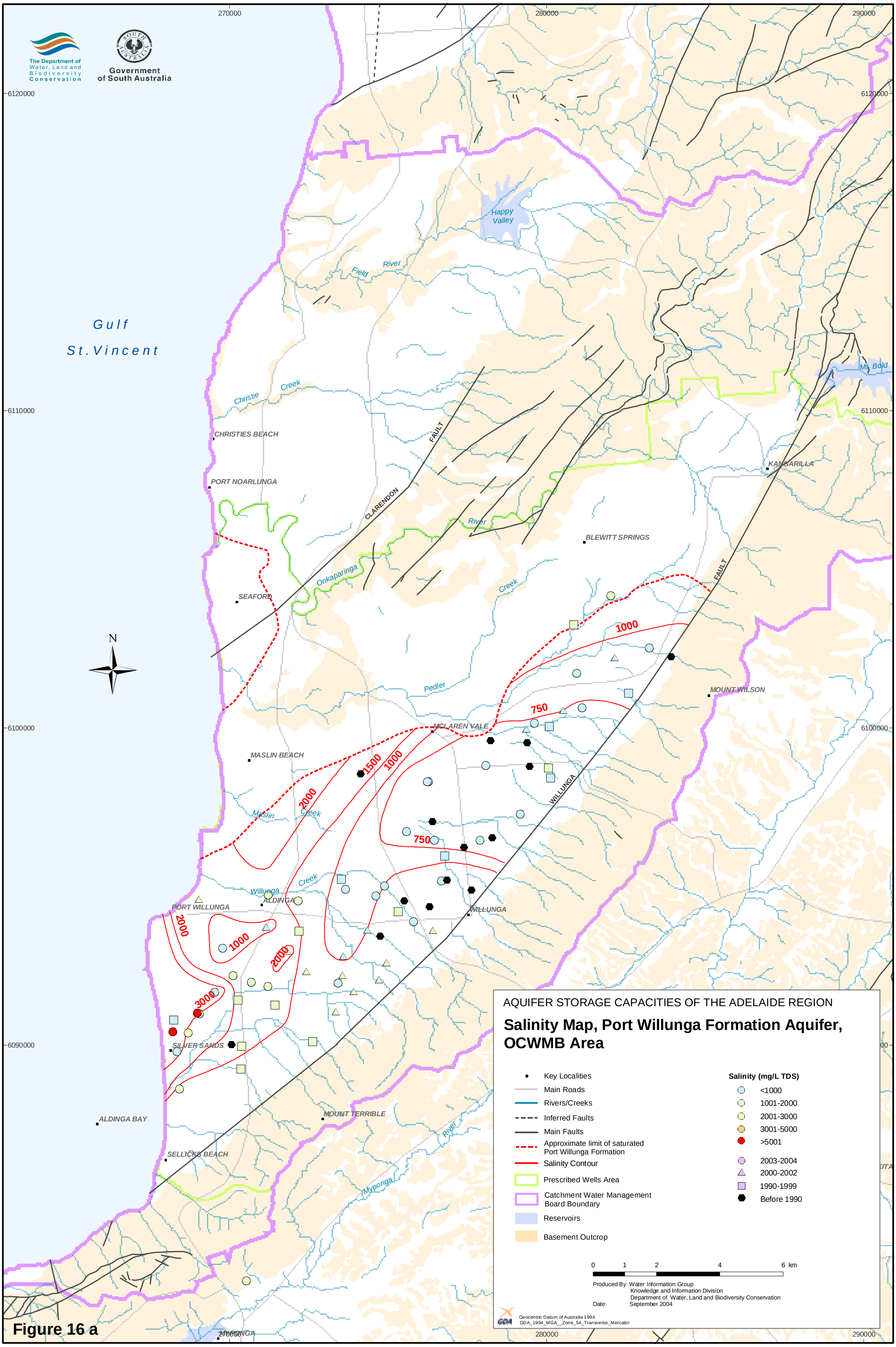
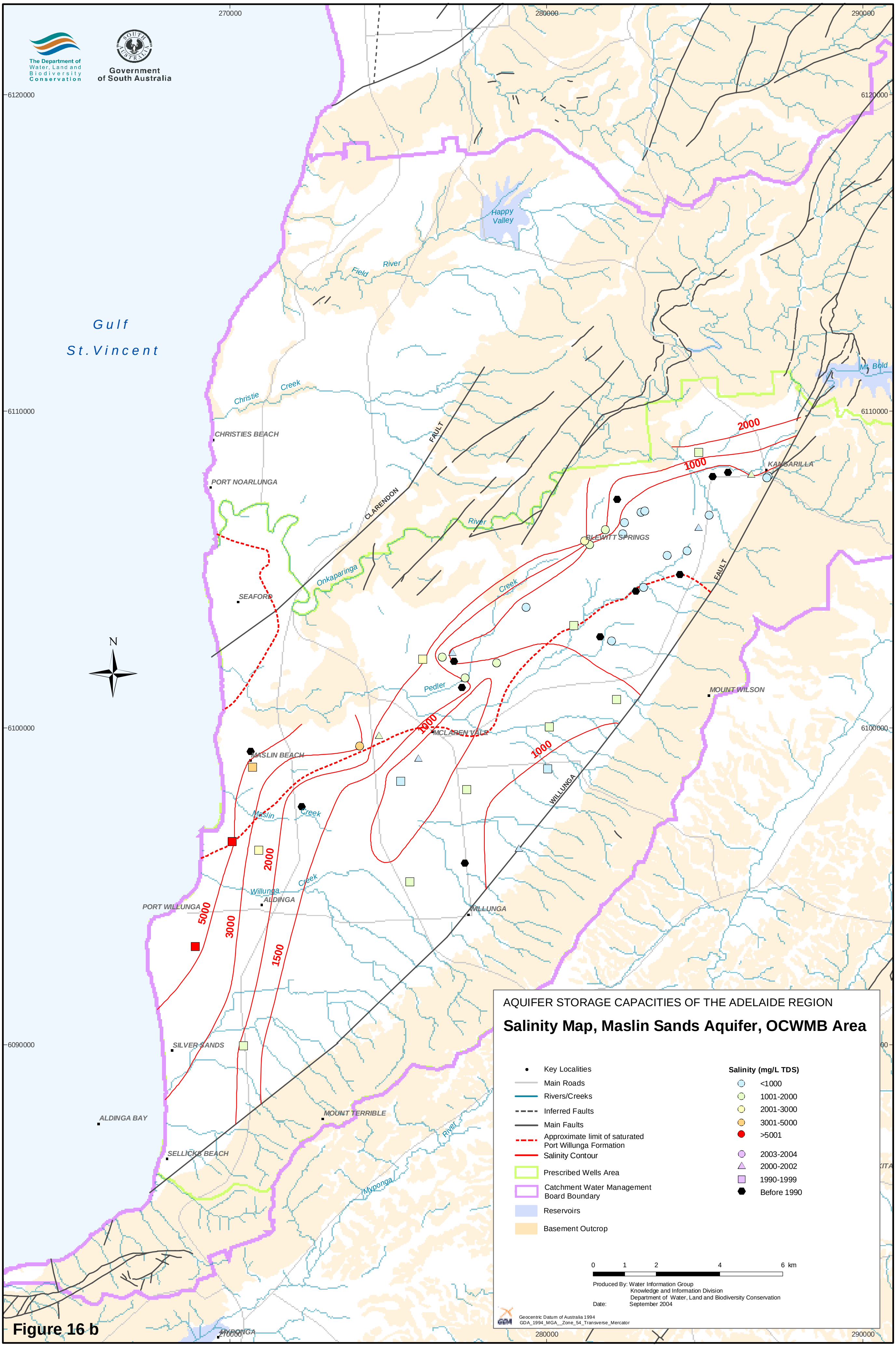
-5
-10
-15
-20
-25
-30
-35
-40
-45

Figure 15 g



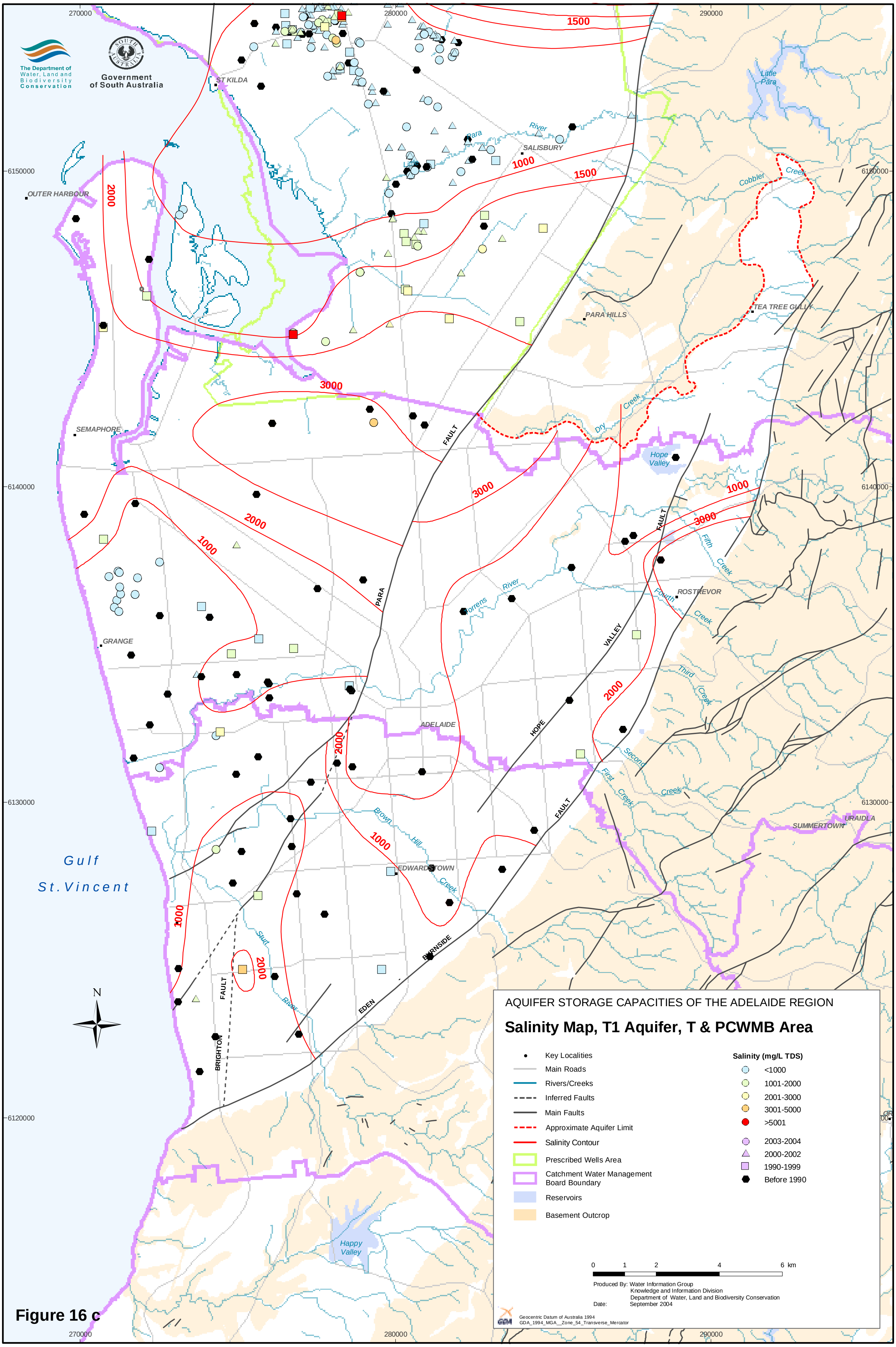
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
Happy Valley
Field River
Christie Creek
CHRISTIES BEACH
PORT NOARLUNGA
CLARENDON FAULT
Onkaparinga River
SEAFORD
BLEWITT SPRINGS
Creek
KANGARILLA
Mt Bold
Pedler
MOUNT WILSON
MCLAREN VALE
MASLIN BEACH
Maslin Creek
WILLUNGA FAULT
Willunga Creek
ALDINGA
PORT WILLUNGA
WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Myponga River
MYPONGA
1000
750
1500
2000
3000
N
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Salinity Map, Port Willunga Formation Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate limit of saturated Port Willunga Formation
Salinity Contour
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Salinity (mg/L TDS)
<1000
1001-2000
2001-3000
3001-5000
>5001
2003-2004
2000-2002
1990-1999
Before 1990
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 16 a



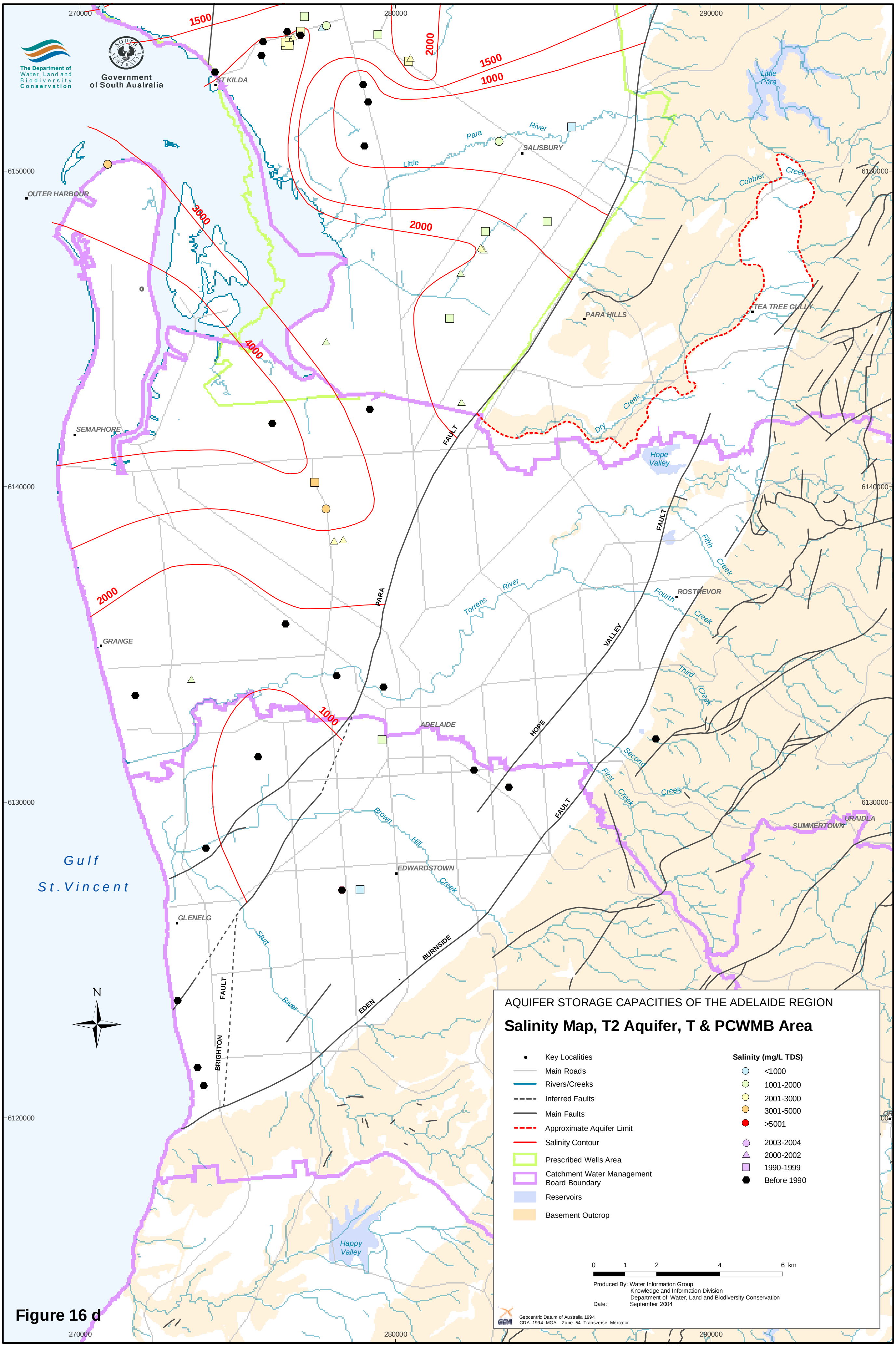
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf
St. Vincent
N
Happy Valley
Field
River
Christie
Creek
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
CLARENDON
FAULT
Onkaparinga
River
Creek
BLEWITT SPRINGS
KANGARILLA
Mt Bold
2000
1000
Pedler
MCLAREN VALE
MASLIN BEACH
Maslin
Creek
2000
1000
1000
WILLUNGA
MOUNT WILSON
Willunga
Creek
ALDINGA
PORT WILLUNGA
WILLUNGA
5000
3000
1500
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
River
Myponga
MYPONGA
270000
280000
290000
6120000
6110000
6100000
6090000
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Salinity Map, Maslin Sands Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate limit of saturated Port Willunga Formation
Salinity Contour
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Salinity (mg/L TDS)
<1000
1001-2000
2001-3000
3001-5000
>5001
2003-2004
2000-2002
1990-1999
Before 1990
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 16 b



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Salinity Map, T1 Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Salinity Contour
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Salinity (mg/L TDS)
<1000
1001-2000
2001-3000
3001-5000
>5001
2003-2004
2000-2002
1990-1999
Before 1990
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
SUMMERTOWN
URAIDLA
Hope Valley
Little Para
Happy Valley
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
270000
280000
290000
6150000
6140000
6130000
6120000
N

Figure 16 c



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Salinity Map, T2 Aquifer, T & PCWMB Area
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Salinity Contour
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Salinity (mg/L TDS)
<1000
1001-2000
2001-3000
3001-5000
>5001
2003-2004
2000-2002
1990-1999
Before 1990
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
270000
280000
290000
6150000
6140000
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1500
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2000
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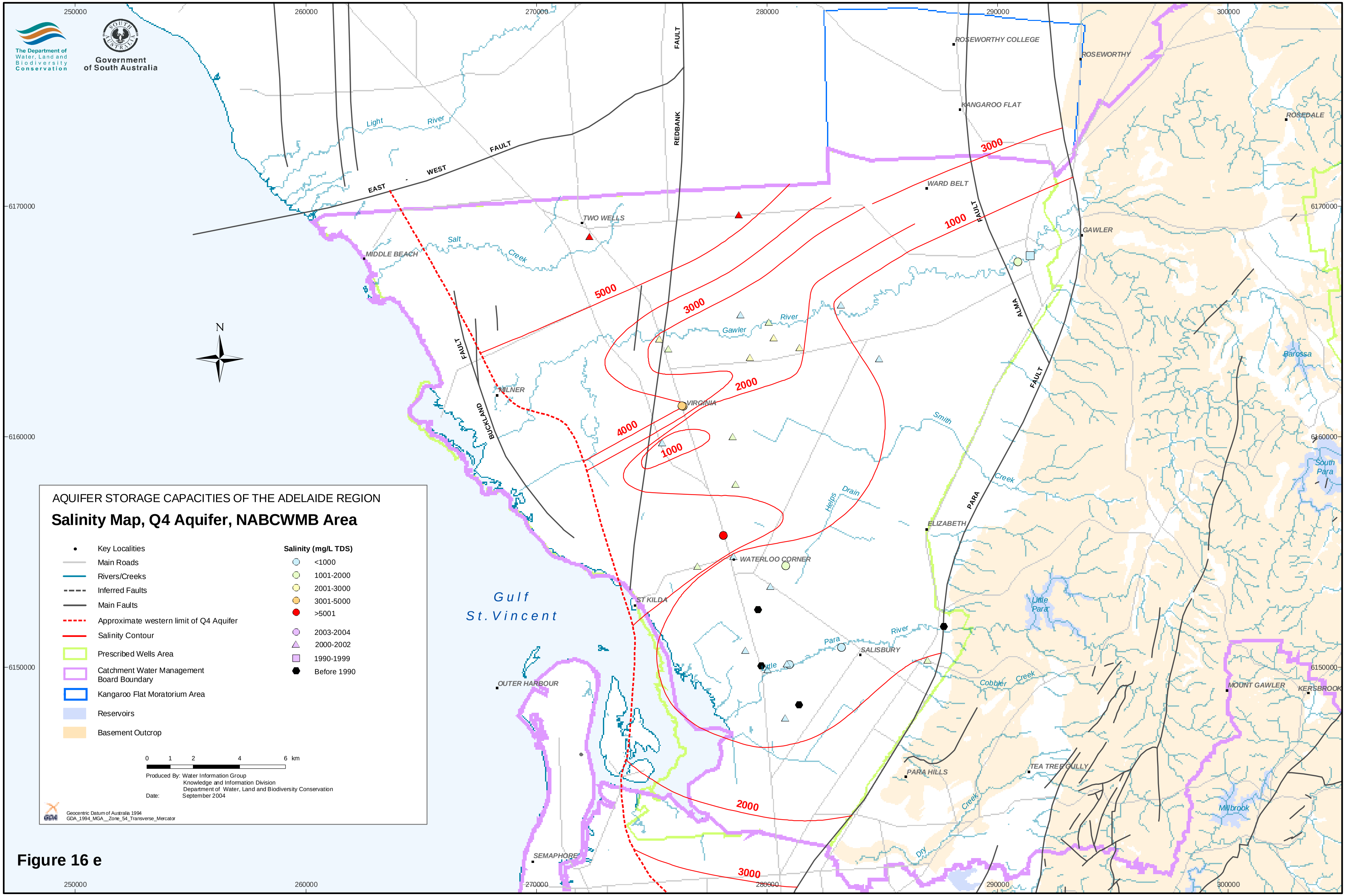
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ROSTREVOR
ADELAIDE
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Little Para
Para River
Little
Cobbler Creek
Dry Creek
Hope Valley
Fifth Creek
Fourth Creek
Torrens River
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
Happy Valley
Gulf St. Vincent
PARA FAULT
FAULT
VALLEY
HOPE
FAULT
EDEN
BURNSIDE
BRIGHTON
FAULT
N

Figure 16 d



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Salinity Map, Q4 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate western limit of Q4 Aquifer
Salinity Contour
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Salinity (mg/L TDS)
<1000
1001-2000
2001-3000
3001-5000
>5001
2003-2004
2000-2002
1990-1999
Before 1990
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf
St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
SEMAPHORE
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Para River
Little Para
Cobbler Creek
Dry Creek
Barossa
South Para
Millbrook
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280000
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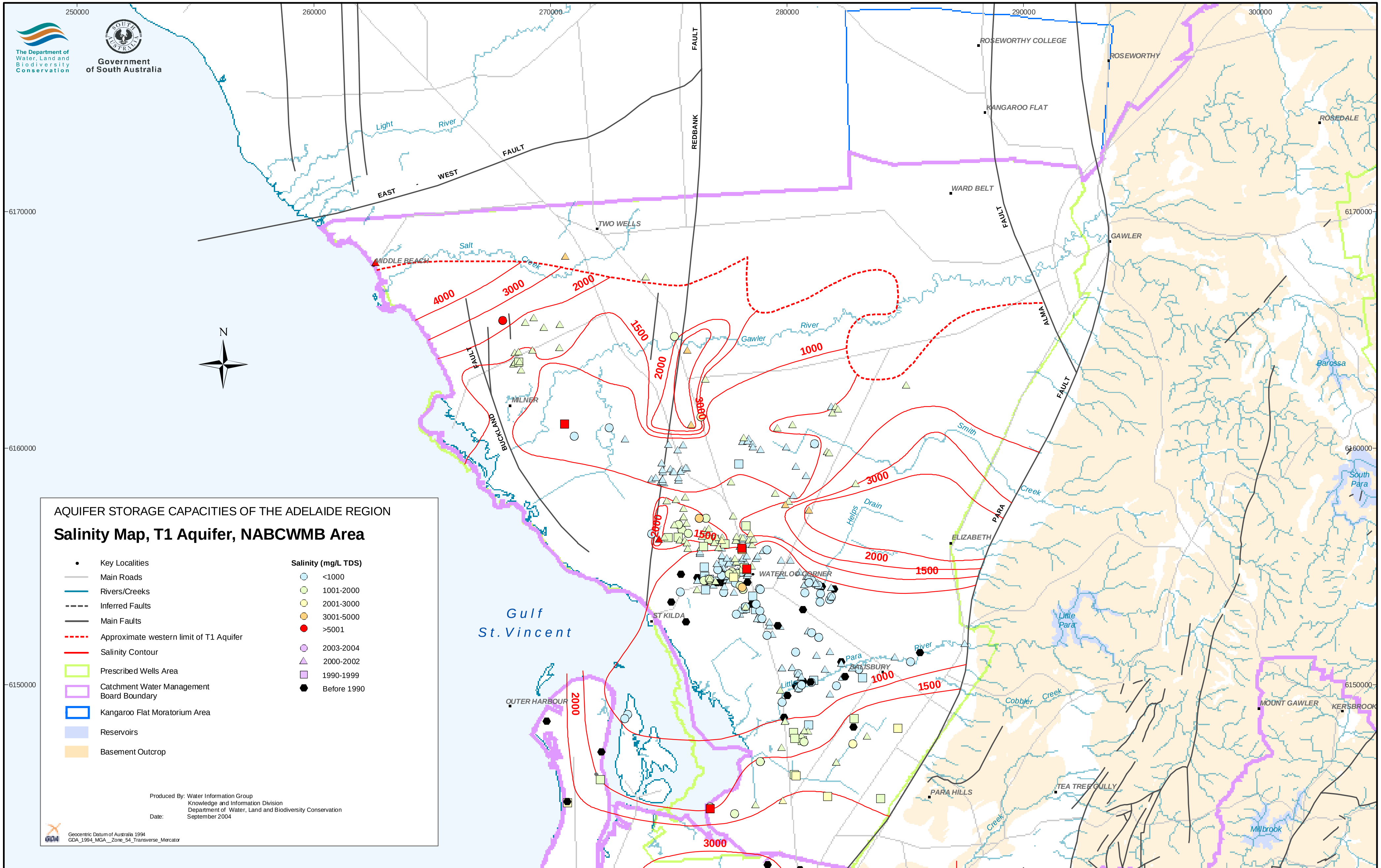
Figure 16 e


The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Salinity Map, T1 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate western limit of T1 Aquifer
Salinity Contour
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Salinity (mg/L TDS)
<1000
1001-2000
2001-3000
3001-5000
>5001
2003-2004
2000-2002
1990-1999
Before 1990
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf
St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST - WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para
Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Millbrook
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6170000
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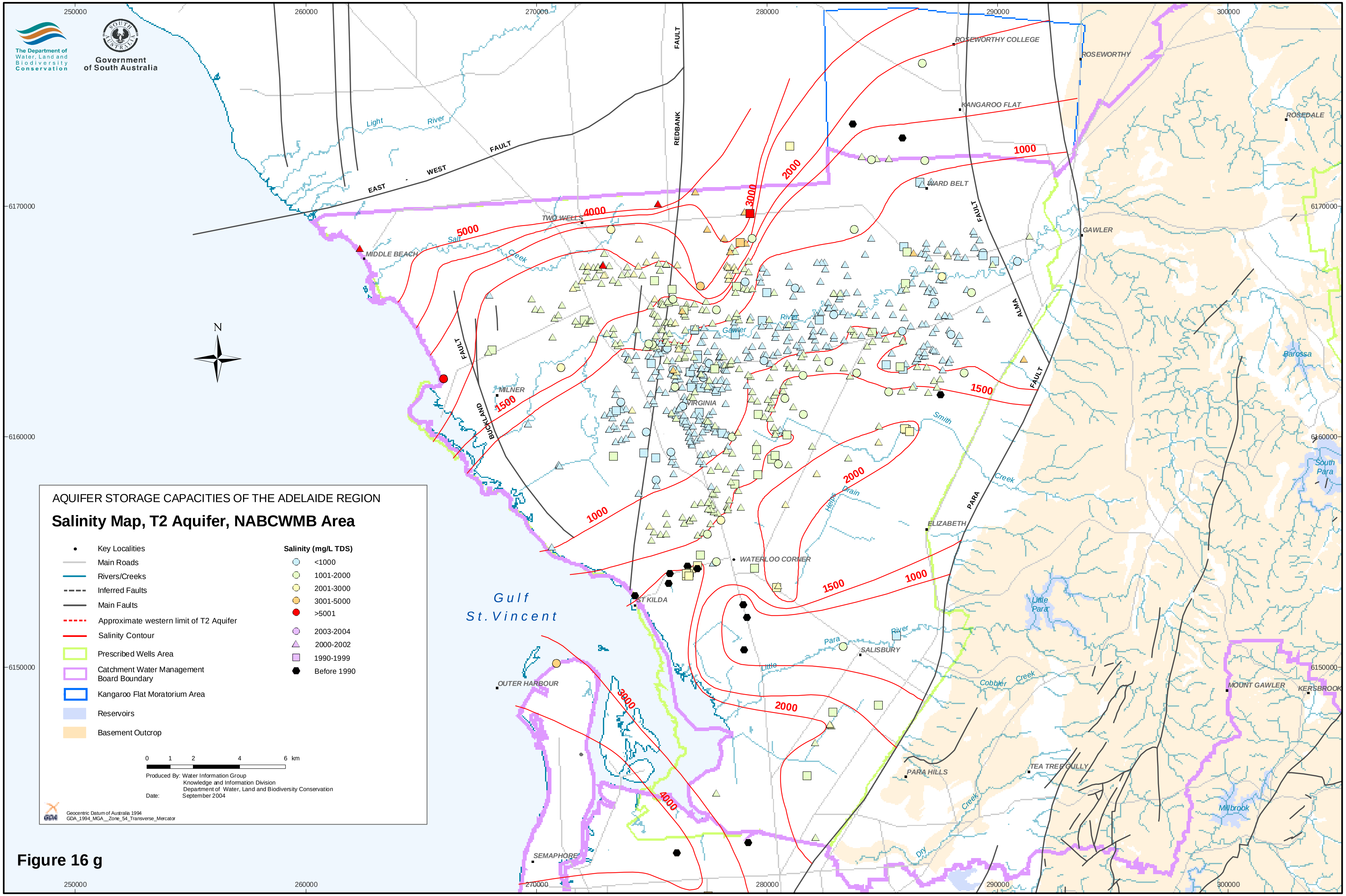
6150000
4000
3000
2000
1500
1000

Figure 16 f


The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Salinity Map, T2 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate western limit of T2 Aquifer
Salinity Contour
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Salinity (mg/L TDS)
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1001-2000
2001-3000
3001-5000
>5001
2003-2004
2000-2002
1990-1999
Before 1990
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
WATERLOO CORNER
ELIZABETH
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
SEMAPHORE
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Gawler River
Salt Creek
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
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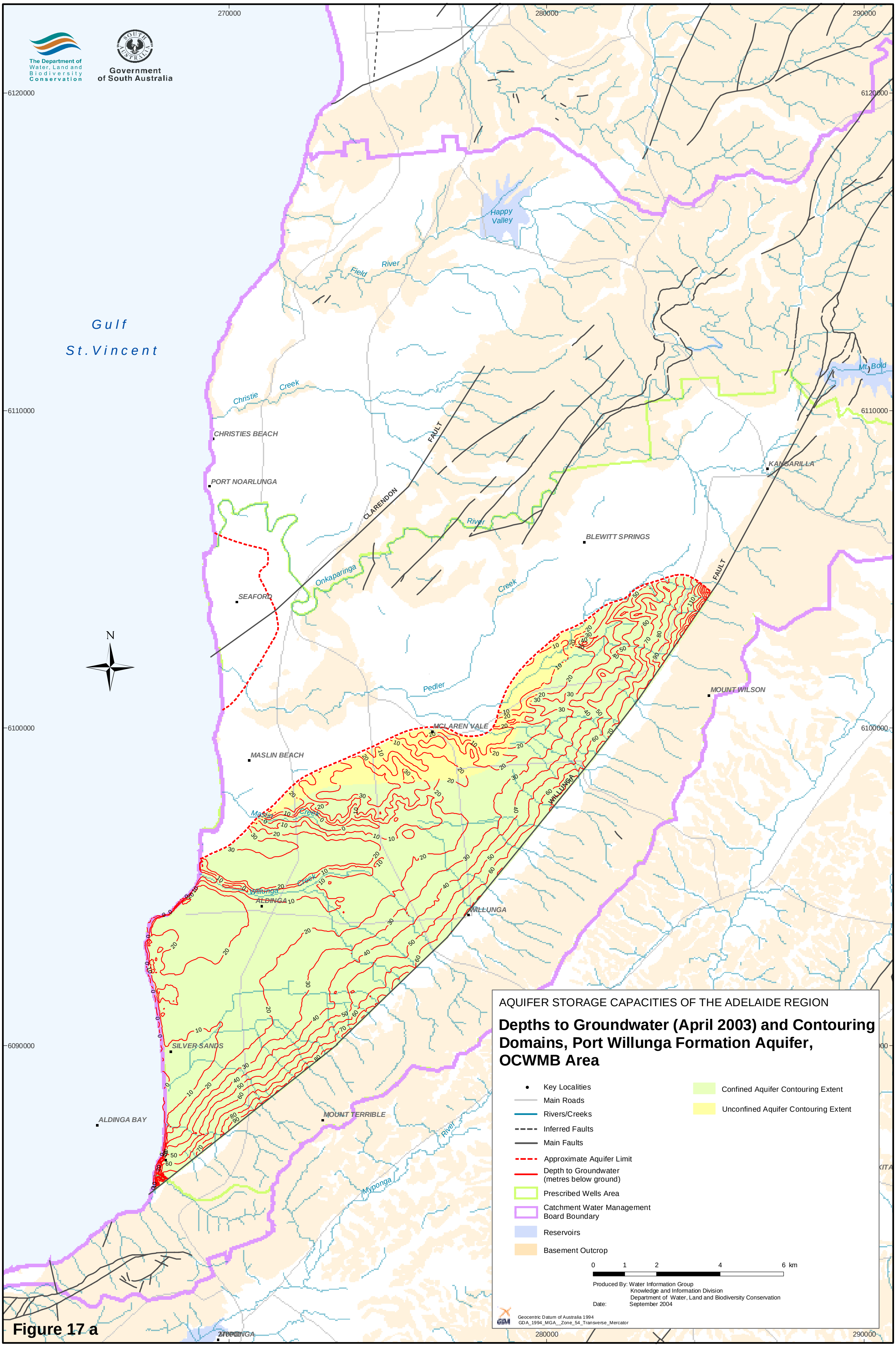
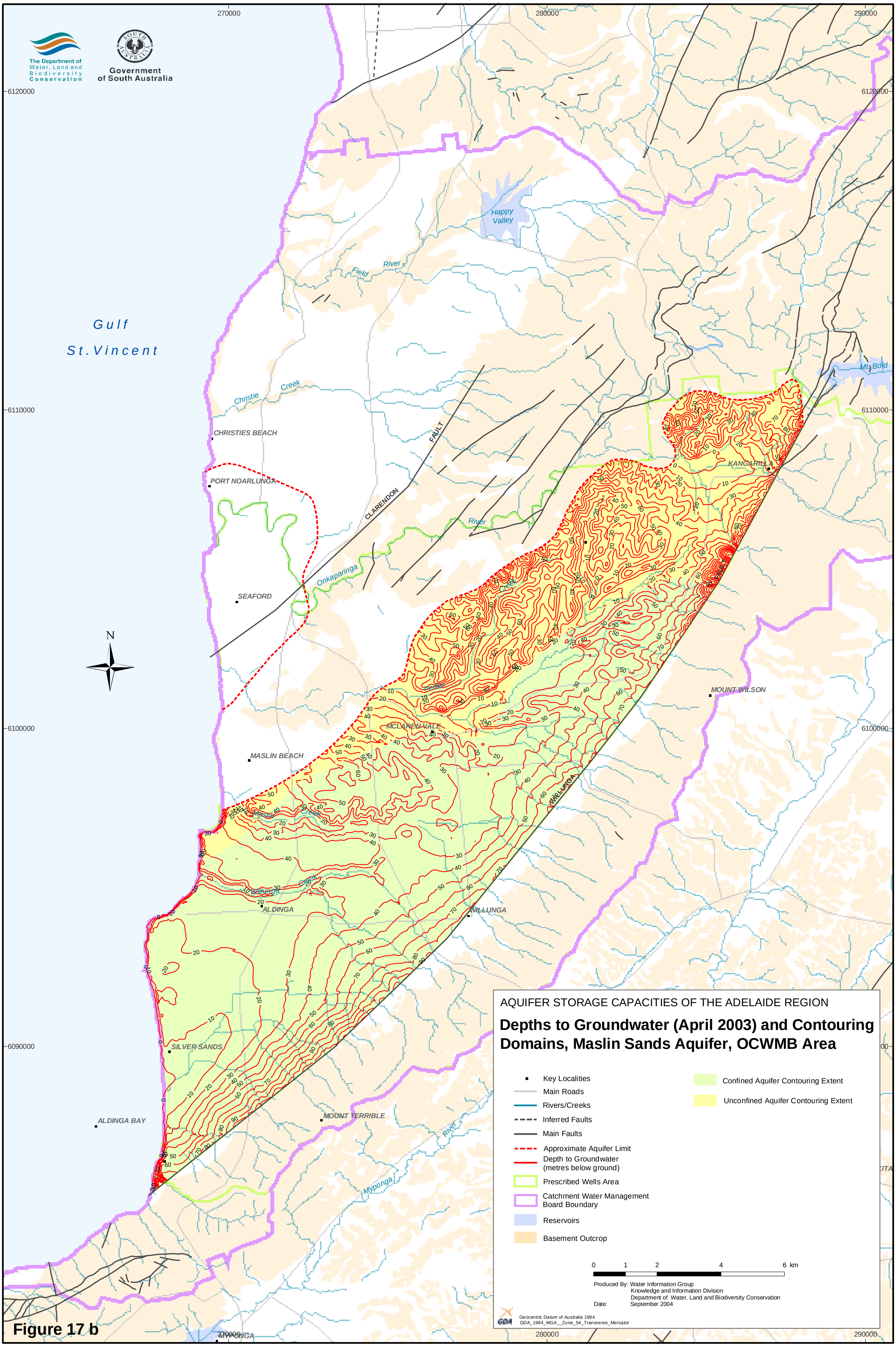
Figure 16 g



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf
St.Vincent
N
270000
280000
290000
6120000
6110000
6100000
6090000
Happy Valley
Field
River
Christie
Creek
CHRISTIES BEACH
PORT NOARLUNGA
CLARENDON
FAULT
Onkaparinga
River
SEAFORD
BLEWITT SPRINGS
Creek
KANGARILLA
Mt. Bold
Pedler
MOUNT WILSON
MCLAREN VALE
MASLIN BEACH
Maslin
Creek
WILLUNGA
Willunga
Creek
ALDINGA
WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
River
Myponga
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depths to Groundwater (April 2003) and Contouring Domains, Port Willunga Formation Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Depth to Groundwater (metres below ground)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Confined Aquifer Contouring Extent
Unconfined Aquifer Contouring Extent
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 17 a


AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depths to Groundwater (April 2003) and Contouring Domains, Maslin Sands Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Depth to Groundwater (metres below ground)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Confined Aquifer Contouring Extent
Unconfined Aquifer Contouring Extent
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
Happy Valley
Field River
Christie Creek
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
Onkaparinga River
CLARENDON FAULT
KANGARILLA
Mt Bold
MCLAREN VALE
MASLIN BEACH
MOUNT WILSON
ALDINGA
WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
Myponga River
MYPONGA
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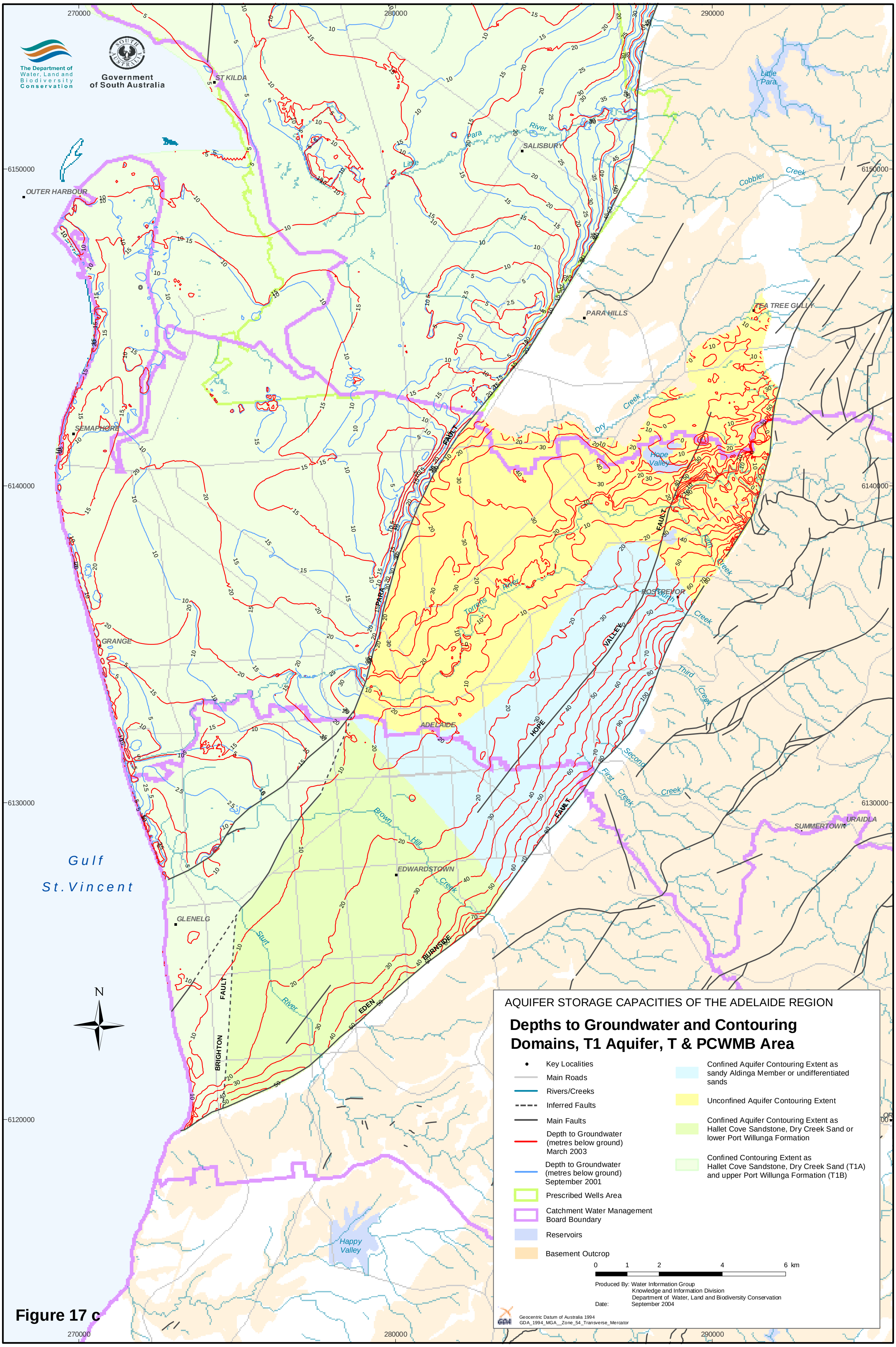
6090000
N

Figure 17 b



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depths to Groundwater and Contouring Domains, T1 Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Depth to Groundwater (metres below ground) March 2003
Depth to Groundwater (metres below ground) September 2001
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Confined Aquifer Contouring Extent as sandy Aldinga Member or undifferentiated sands
Unconfined Aquifer Contouring Extent
Confined Aquifer Contouring Extent as Hallet Cove Sandstone, Dry Creek Sand or lower Port Willunga Formation
Confined Contouring Extent as Hallet Cove Sandstone, Dry Creek Sand (T1A) and upper Port Willunga Formation (T1B)
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf
St.Vincent
N
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Little Para
Happy Valley
Hope Valley
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
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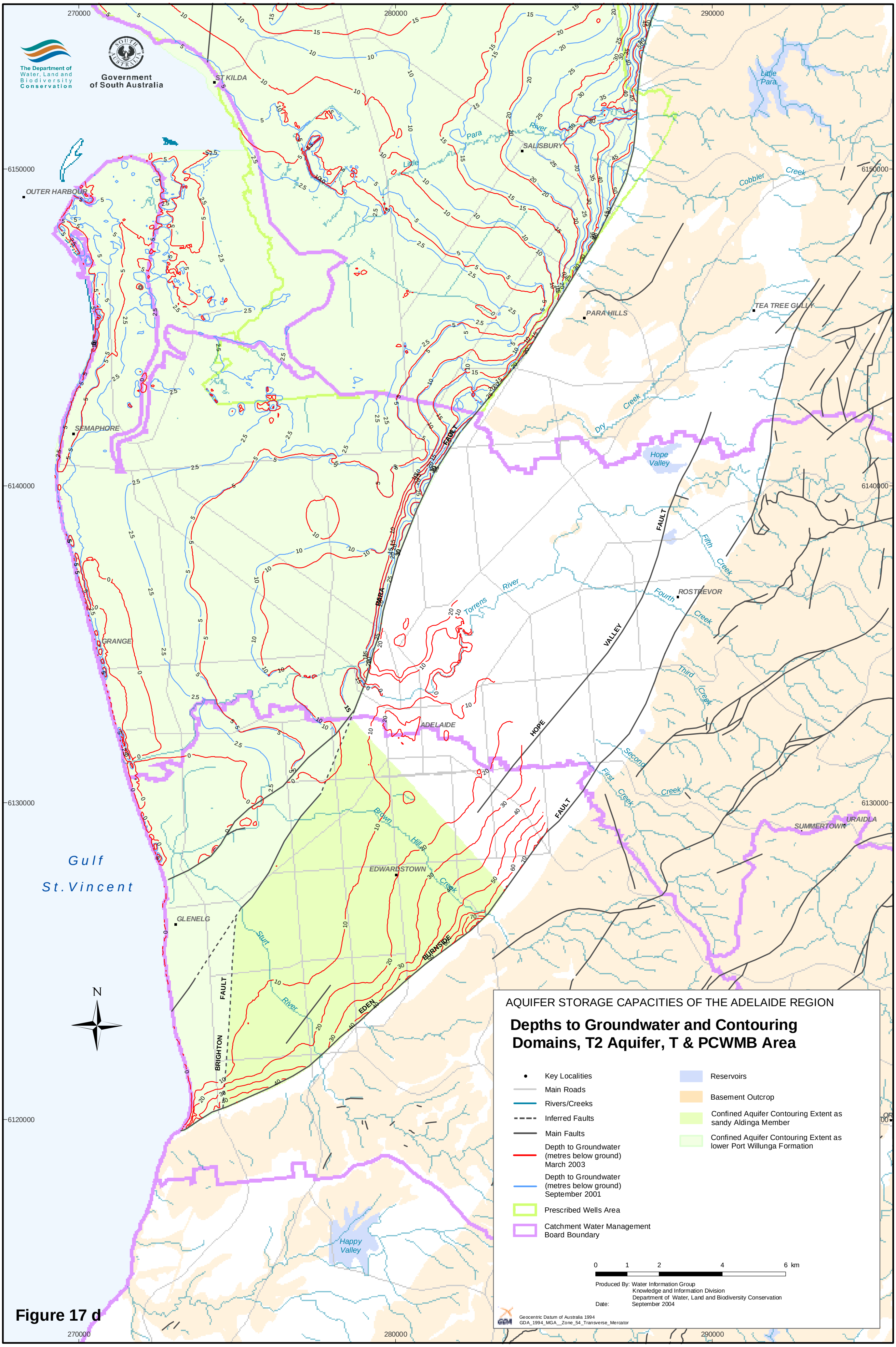
Figure 17 c



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depths to Groundwater and Contouring Domains, T2 Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Depth to Groundwater (metres below ground) March 2003
Depth to Groundwater (metres below ground) September 2001
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Confined Aquifer Contouring Extent as sandy Aldinga Member
Confined Aquifer Contouring Extent as lower Port Willunga Formation
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
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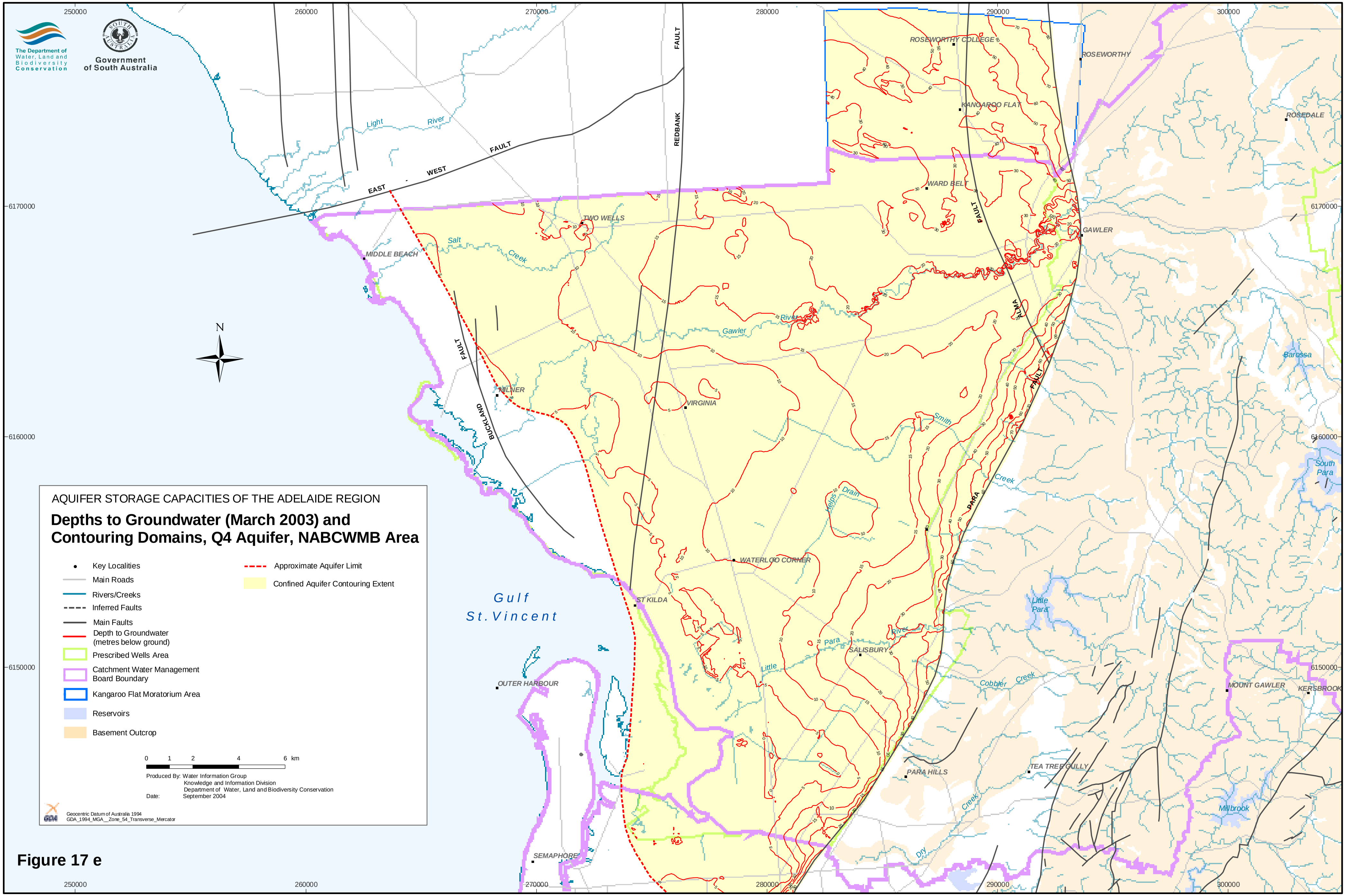
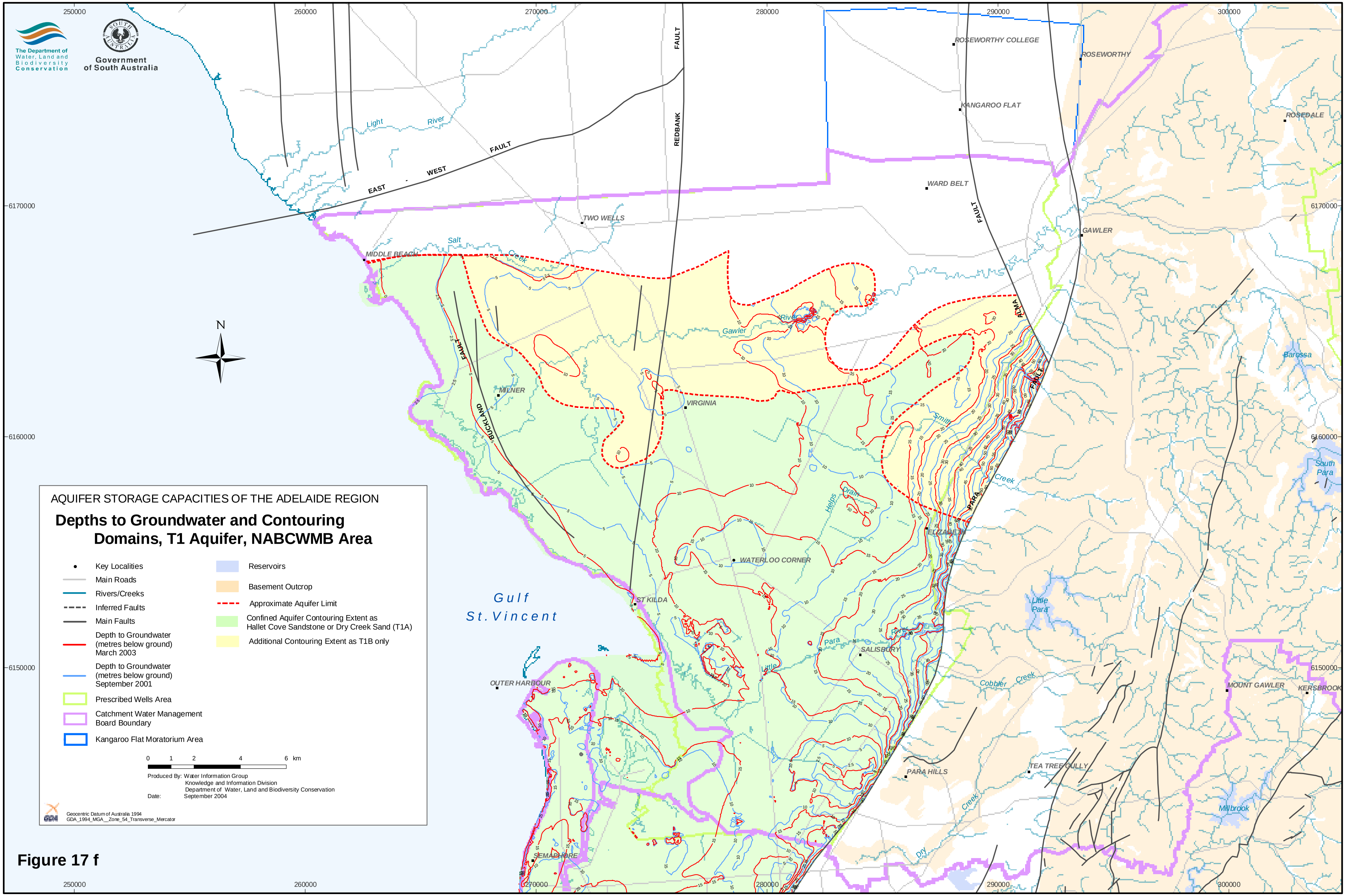
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Gulf
St.Vincent
Little Para
Para River
Cobbler Creek
Dry Creek
Hope Valley
Torrens River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
Happy Valley
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
N

Figure 17 d



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depths to Groundwater (March 2003) and Contouring Domains, Q4 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Depth to Groundwater (metres below ground)
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Approximate Aquifer Limit
Confined Aquifer Contouring Extent
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
N
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook

Figure 17 e



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depths to Groundwater and Contouring Domains, T1 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Depth to Groundwater (metres below ground) March 2003
Depth to Groundwater (metres below ground) September 2001
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Approximate Aquifer Limit
Confined Aquifer Contouring Extent as Hallet Cove Sandstone or Dry Creek Sand (T1A)
Additional Contouring Extent as T1B only
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para
Cobbler Creek
Dry Creek
Barossa
South Para
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Figure 17 f

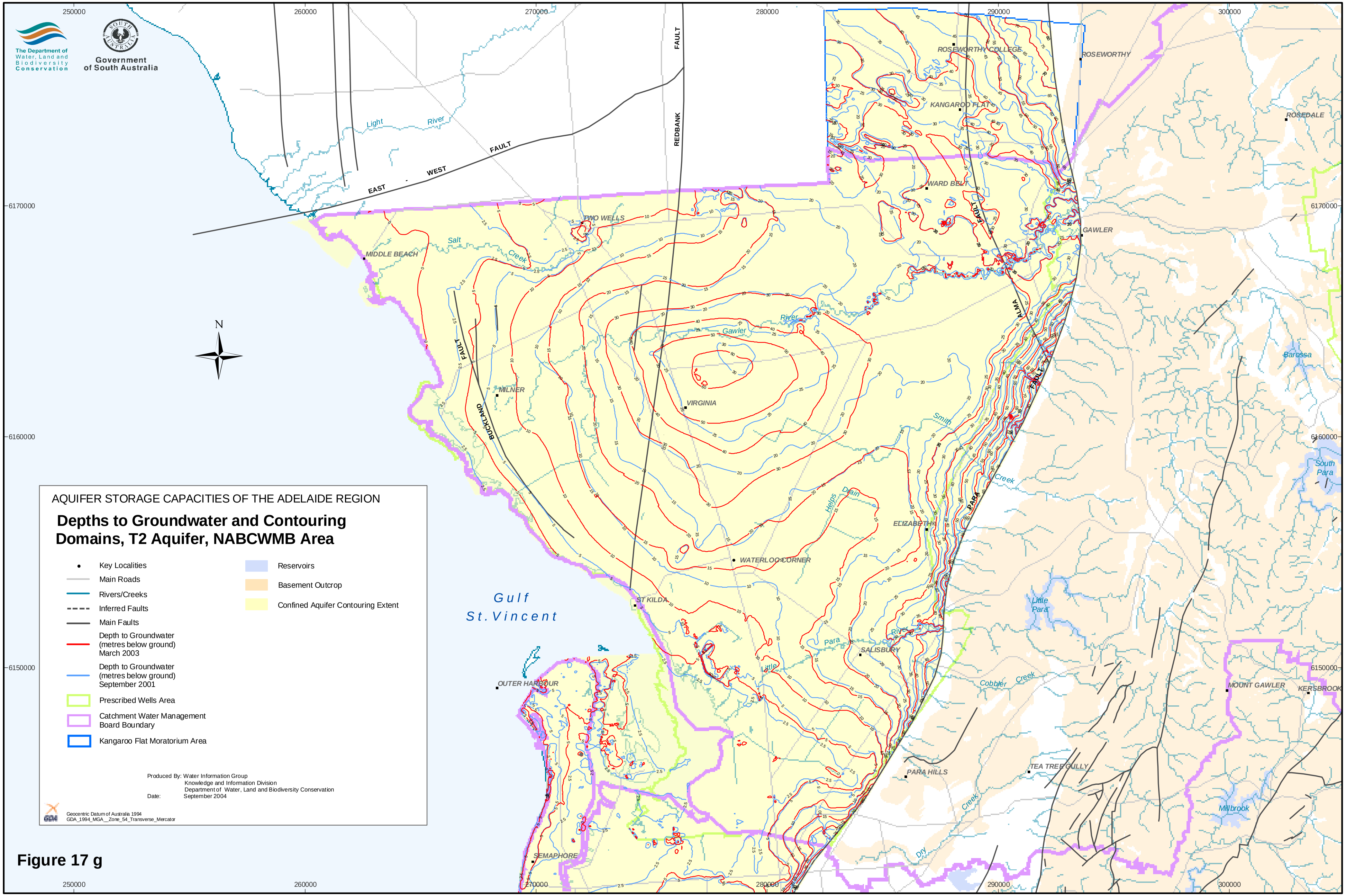
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depths to Groundwater and Contouring Domains, T2 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Depth to Groundwater (metres below ground) March 2003
Depth to Groundwater (metres below ground) September 2001
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Confined Aquifer Contouring Extent
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf
St.Vincent
EAST - WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Little Para
South Para
Barossa
Millbrook
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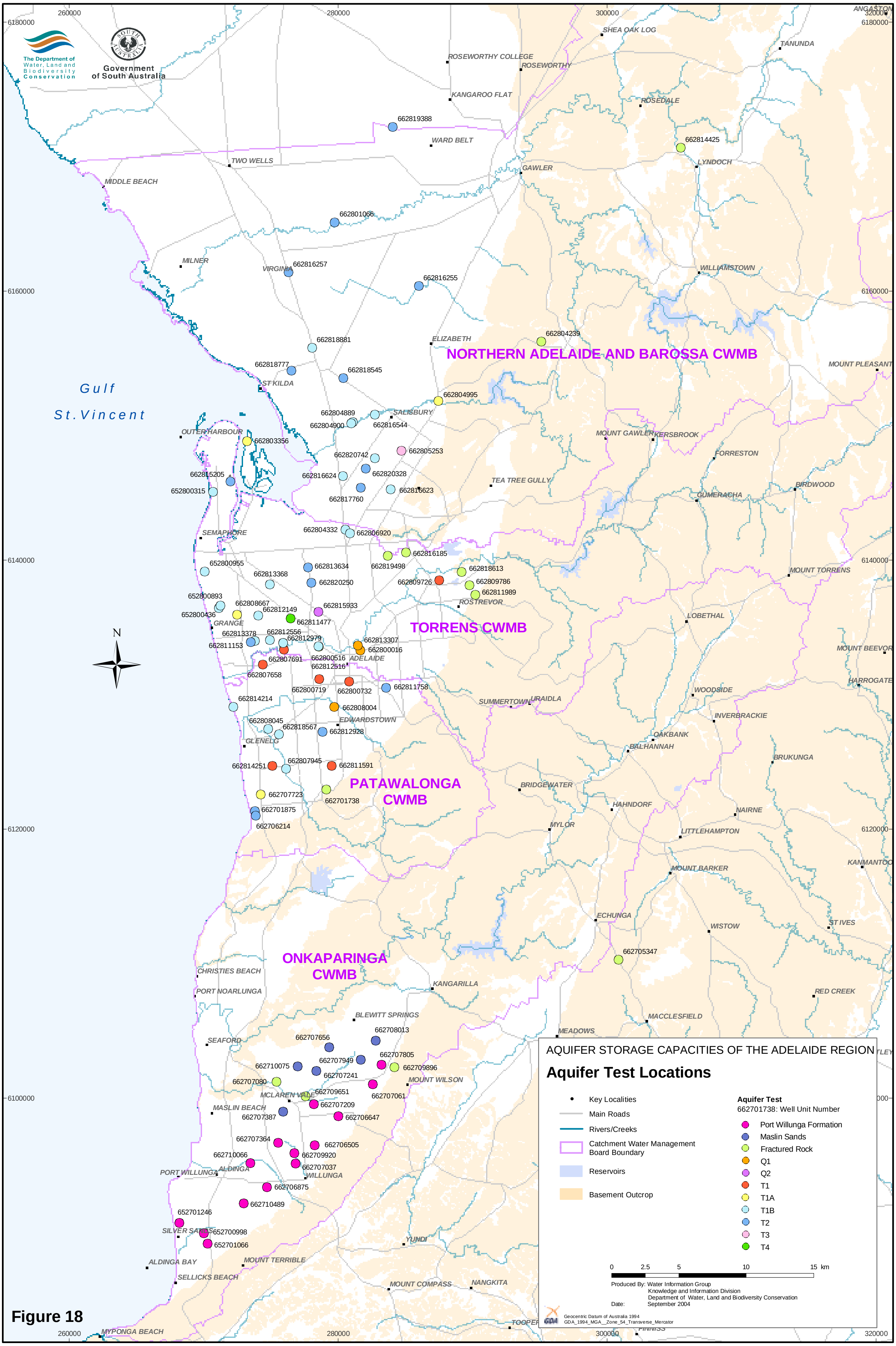
Figure 17 g



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Aquifer Test Locations
Key Localities
Main Roads
Rivers/Creeks
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Aquifer Test
662701738: Well Unit Number
Port Willunga Formation
Maslin Sands
Fractured Rock
Q1
Q2
T1
T1A
T1B
T2
T3
T4
0 2.5 5 10 15 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf
St.Vincent
N
NORTHERN ADELAIDE AND BAROSSA CWMB
TORRENS CWMB
PATAWALONGA CWMB
ONKAPARINGA CWMB
260000
280000
300000
320000
6180000
6160000
6140000
6120000
6100000
ANGASTON
SHEA OAK LOG
TANUNDA
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
TWO WELLS
GAWLER
LYNDOCH
MIDDLE BEACH
MILNER
VIRGINIA
WILLIAMSTOWN
ELIZABETH
MOUNT PLEASANT
ST KILDA
SALISBURY
OUTER HARBOUR
MOUNT GAWLER
KERSBROOK
FORRESTON
TEA TREE GULLY
GUMERACHA
BIRDWOOD
SEMAPHORE
MOUNT TORRENS
ROSTREVOR
GRANGE
LOBETHAL
MOUNT BEEVOR
ADELAIDE
HARROGATE
WOODSIDE
SUMMERTOWN
URAIDLA
EDWARDSTOWN
INVERBRACKIE
OAKBANK
GLENELG
BALHANNAH
BRUKUNGA
BRIDGEWATER
HAHNDORF
NAIRNE
MYLOR
LITTLEHAMPTON
MOUNT BARKER
KANMANTOO
ECHUNGA
WISTOW
ST IVES
CHRISTIES BEACH
PORT NOARLUNGA
KANGARILLA
RED CREEK
BLEWITT SPRINGS
MACCLESFIELD
MEADOWS
SEAFORD
MOUNT WILSON
MCLAREN VALE
MASLIN BEACH
PORT WILLUNGA
ALDINGA
WILLUNGA
SILVER SANDS
YUNDI
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
MOUNT COMPASS
NANGKITA
TOOPERANG
MYPONGA BEACH
FINNISS
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Figure 18

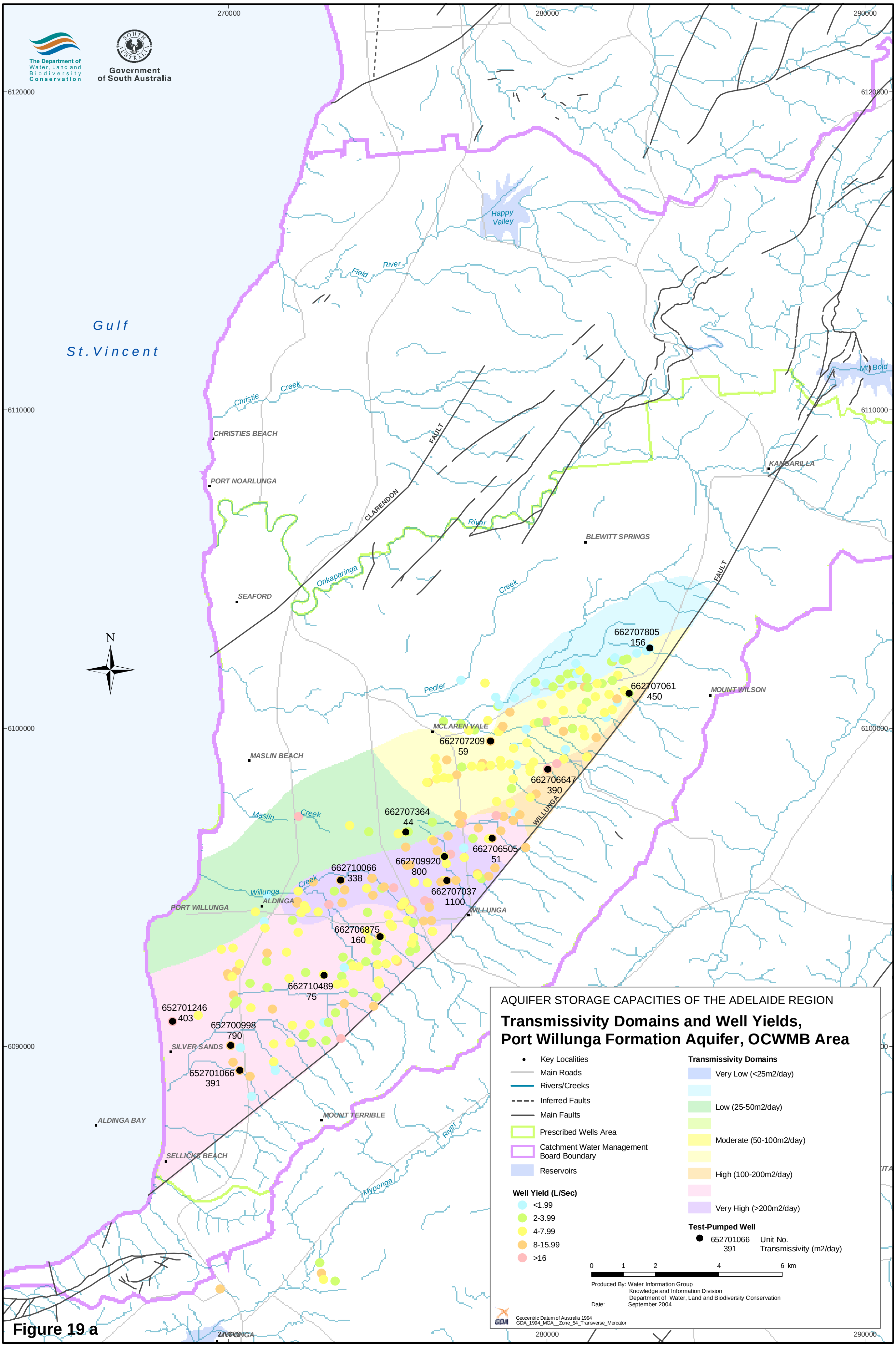

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
MASLIN BEACH
PORT WILLUNGA
ALDINGA
SILVER SANDS
ALDINGA BAY
SELLICKS BEACH
MOUNT TERRIBLE
MCLAREN VALE
WILLUNGA
BLEWITT SPRINGS
MOUNT WILSON
KANGARILLA
Happy Valley
Mt Bold
Field River
Christie Creek
Onkaparinga River
Pedler Creek
Maslin Creek
Willunga Creek
Myponga River
CLARENDON FAULT
WILLUNGA FAULT
662707805
156
662707061
450
662707209
59
662706647
390
662707364
44
662706505
51
662709920
800
662710066
338
662707037
1100
662706875
160
662710489
75
652701246
403
652700998
790
652701066
391
270000
280000
290000
6120000
6110000
6100000
6090000
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Transmissivity Domains and Well Yields,
Port Willunga Formation Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Well Yield (L/Sec)
<1.99
2-3.99
4-7.99
8-15.99
>16
Transmissivity Domains
Very Low (<25m2/day)
Low (25-50m2/day)
Moderate (50-100m2/day)
High (100-200m2/day)
Very High (>200m2/day)
Test-Pumped Well
652701066 Unit No.
391 Transmissivity (m2/day)
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 19 a

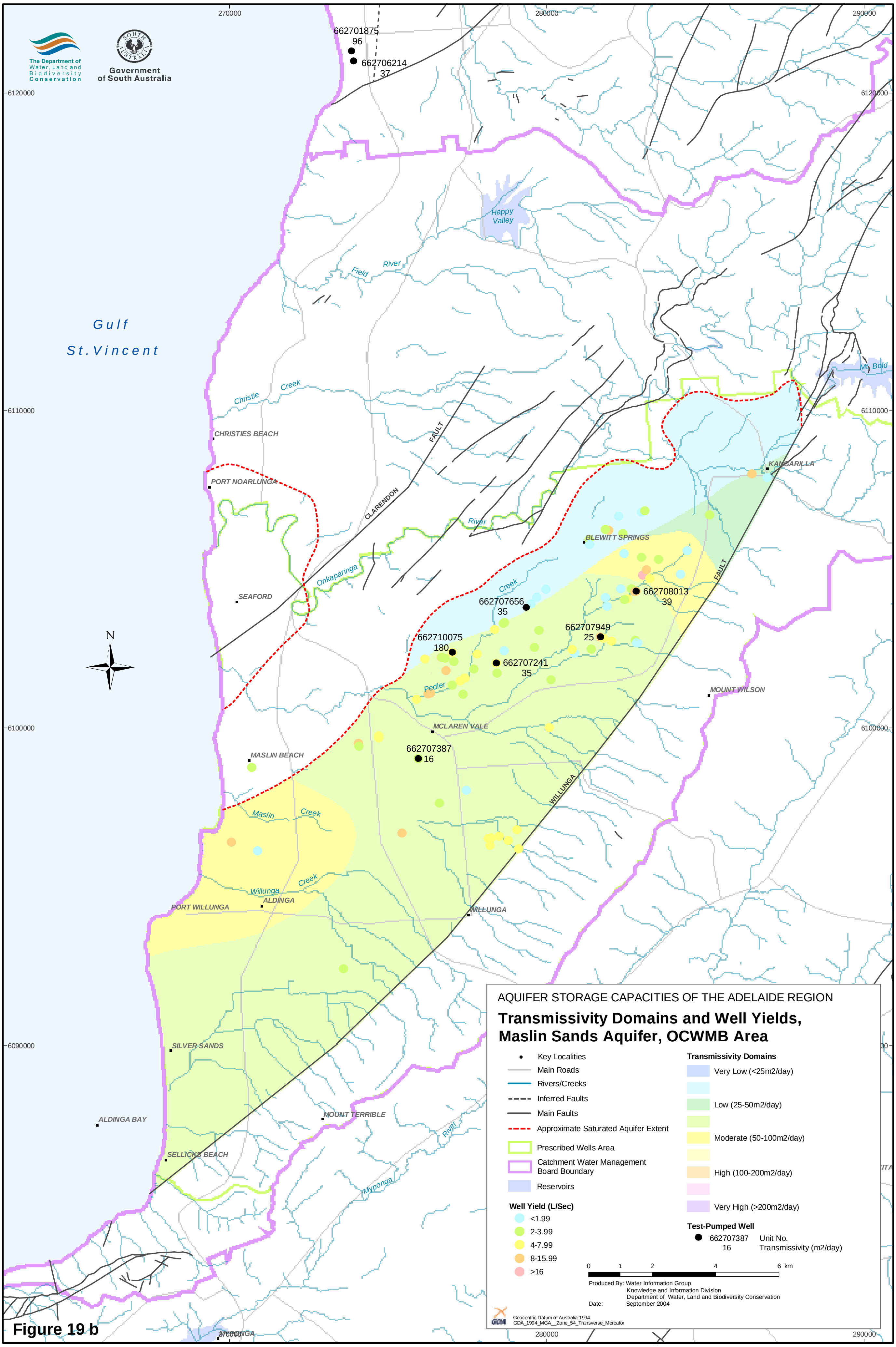
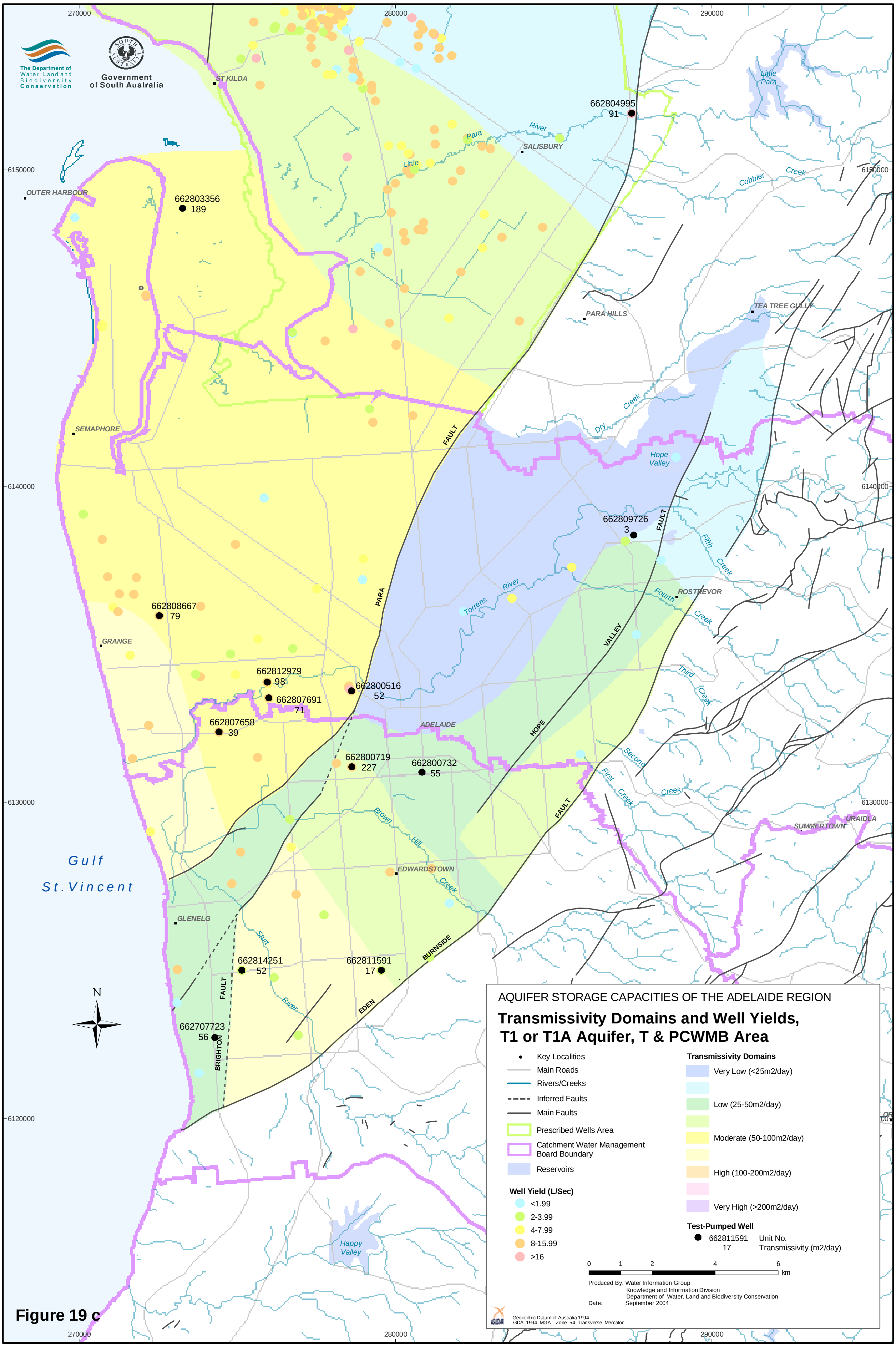
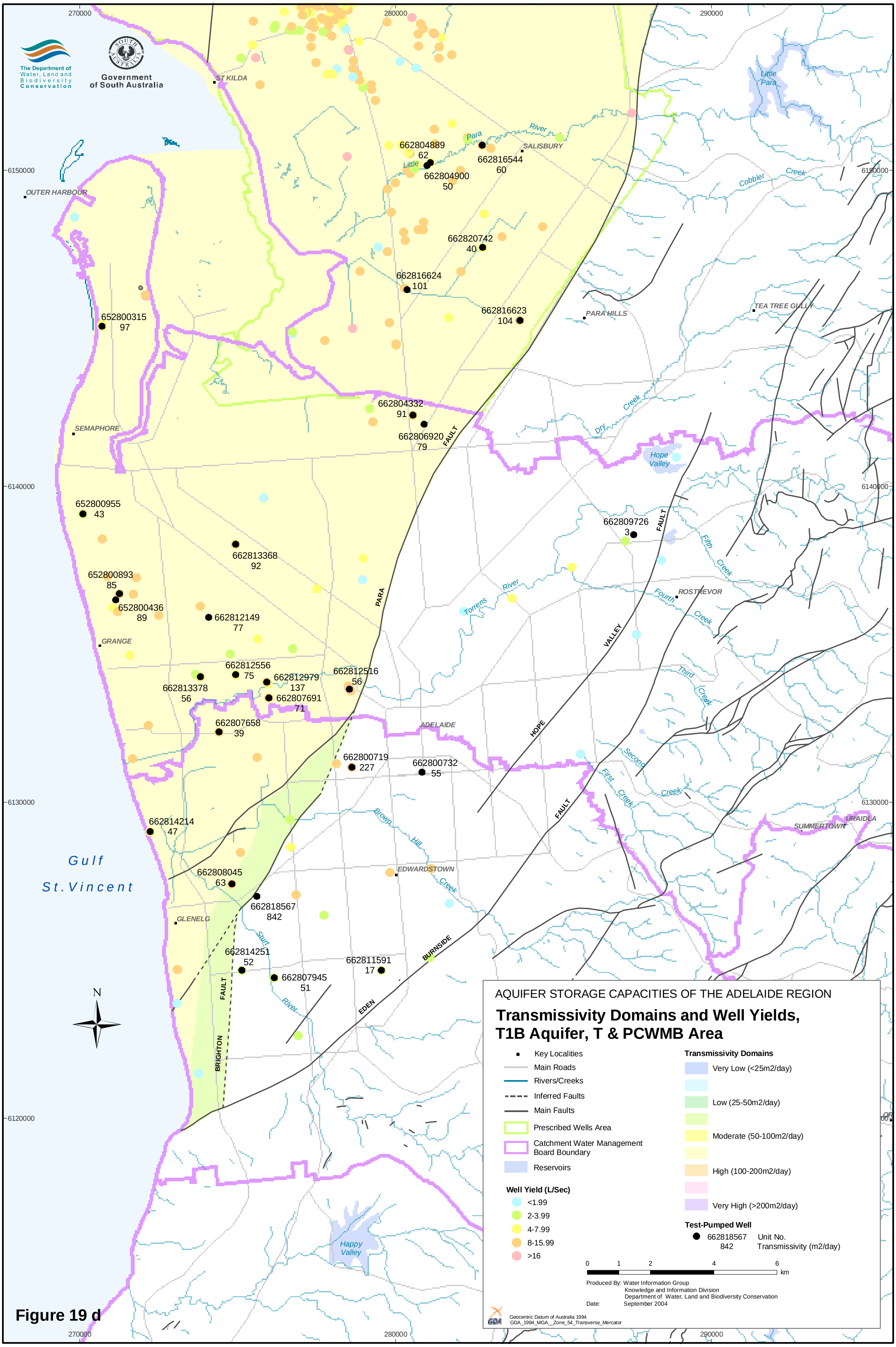

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Transmissivity Domains and Well Yields, Maslin Sands Aquifer, OCWMB Area
Gulf St.Vincent
N
270000
280000
290000
6120000
6110000
6100000
6090000
662701875
96
662706214
37
662708013
39
662707656
35
662707949
25
662710075
180
662707241
35
662707387
16
Happy Valley
Field River
Christie Creek
CHRISTIES BEACH
PORT NOARLUNGA
CLARENDON
FAULT
Onkaparinga River
SEAFORD
BLEWITT SPRINGS
KANGARILLA
Mt Bold
Creek
Pedler
MOUNT WILSON
MCLAREN VALE
MASLIN BEACH
WILLUNGA
Maslin Creek
Willunga Creek
ALDINGA
PORT WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Myponga
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Transmissivity Domains
Very Low (<25m2/day)
Low (25-50m2/day)
Moderate (50-100m2/day)
High (100-200m2/day)
Very High (>200m2/day)
Well Yield (L/Sec)
<1.99
2-3.99
4-7.99
8-15.99
>16
Test-Pumped Well
662707387 Unit No.
16 Transmissivity (m2/day)
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 19 b



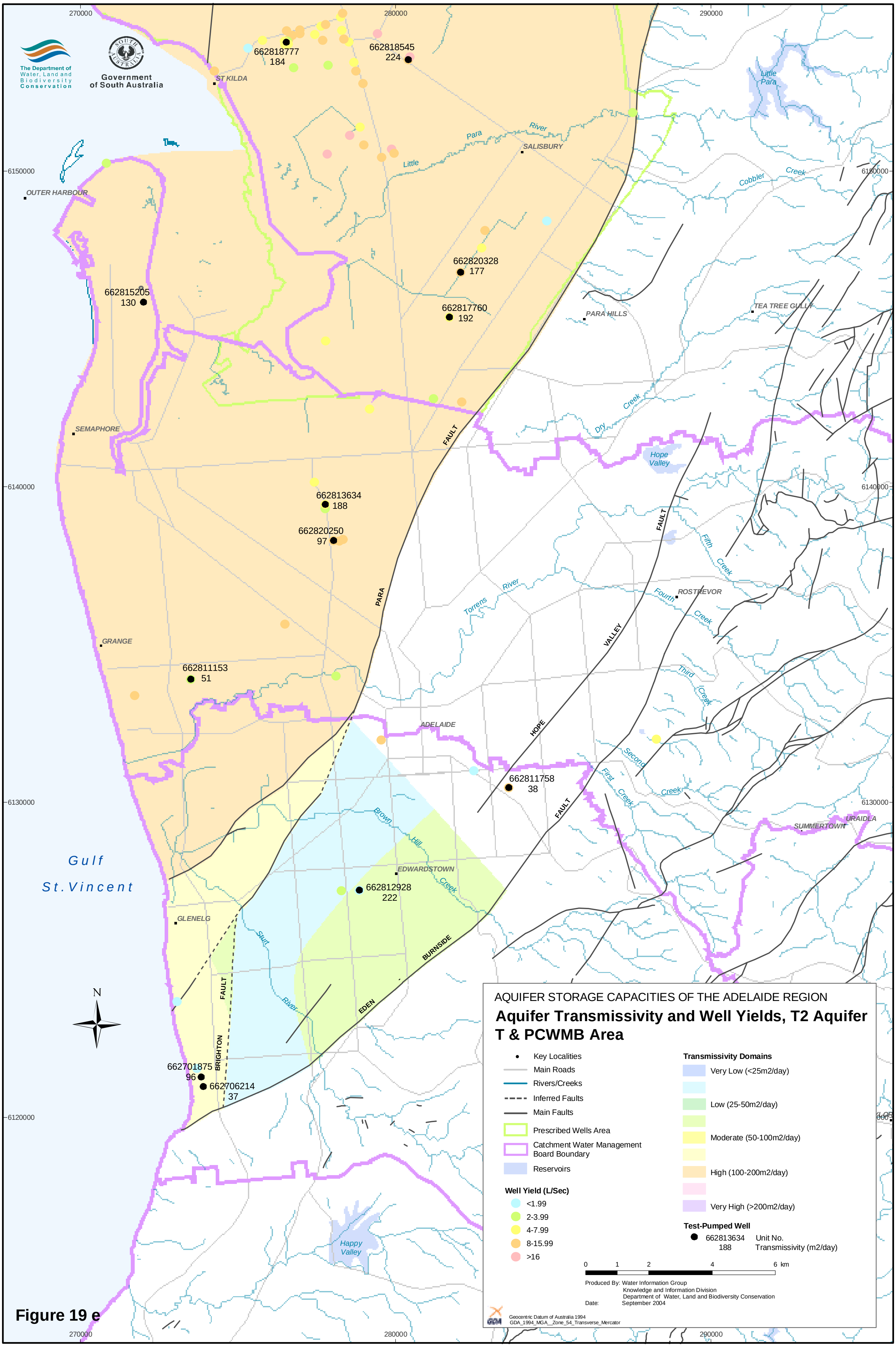
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
270000
280000
290000
6150000
6140000
6130000
6120000
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
GRANGE
PARA HILLS
TEA TREE GULLY
ROSTREVOR
ADELAIDE
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Gulf
St.Vincent
662804995
91
662803356
189
662809726
3
662808667
79
662812979
98
662800516
52
662807691
71
662807658
39
662800719
227
662800732
55
662814251
52
662811591
17
662707723
56
PARA
FAULT
HOPE
VALLEY
EDEN
BURNSIDE
BRIGHTON
Little Para
Para
River
Cobbler
Creek
Dry
Hope Valley
Fifth
Fourth
Third
Second
First
Torrens
Brown
Hill
Sturt
Happy Valley
N
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Transmissivity Domains and Well Yields,
T1 or T1A Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Transmissivity Domains
Very Low (<25m2/day)
Low (25-50m2/day)
Moderate (50-100m2/day)
High (100-200m2/day)
Very High (>200m2/day)
Well Yield (L/Sec)
<1.99
2-3.99
4-7.99
8-15.99
>16
Test-Pumped Well
662811591 Unit No.
17 Transmissivity (m2/day)
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 19 c



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Transmissivity Domains and Well Yields, T1B Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Transmissivity Domains
Very Low (<25m2/day)
Low (25-50m2/day)
Moderate (50-100m2/day)
High (100-200m2/day)
Very High (>200m2/day)
Well Yield (L/Sec)
<1.99
2-3.99
4-7.99
8-15.99
>16
Test-Pumped Well
662818567 842
Unit No.
Transmissivity (m2/day)
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf St.Vincent
N
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
SEMAPHORE
Hope Valley
ROSTREVOR
GRANGE
ADELAIDE
SUMMERTOWN
URAIDLA
EDWARDSTOWN
GLENELG
Happy Valley
Little Para
Little Para River
Cobbler Creek
Dry Creek
Torrens River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
270000
280000
290000
6150000
6140000
6130000
6120000
662804889 62
662816544 60
662804900 50
662820742 40
662816624 101
662816623 104
652800315 97
662804332 91
662806920 79
652800955 43
662809726 3
662813368 92
652800893 85
652800436 89
662812149 77
662812556 75
662812979 137
662812516 56
662813378 56
662807691 71
662807658 39
662800719 227
662800732 55
662814214 47
662808045 63
662818567 842
662814251 52
662811591 17
662807945 51

Figure 19 d



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Aquifer Transmissivity and Well Yields, T2 Aquifer
T & PCWMB Area
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
270000
280000
290000
6150000
6140000
6130000
6120000
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Gulf
St.Vincent
Little Para
Para River
Little
Cobbler Creek
Dry Creek
Hope Valley
Fifth Creek
Fourth Creek
Third Creek
Second
First Creek
Torrens River
Brown Hill Creek
Sturt River
Happy Valley
PARA FAULT
FAULT
VALLEY
HOPE
FAULT
BURNSIDE
EDEN
BRIGHTON
FAULT
662818777
184
662818545
224
662820328
177
662815205
130
662817760
192
662813634
188
662820250
97
662811153
51
662811758
38
662812928
222
662701875
96
662706214
37
N
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Well Yield (L/Sec)
<1.99
2-3.99
4-7.99
8-15.99
>16
Transmissivity Domains
Very Low (<25m2/day)
Low (25-50m2/day)
Moderate (50-100m2/day)
High (100-200m2/day)
Very High (>200m2/day)
Test-Pumped Well
662813634
188
Unit No.
Transmissivity (m2/day)
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 19 e

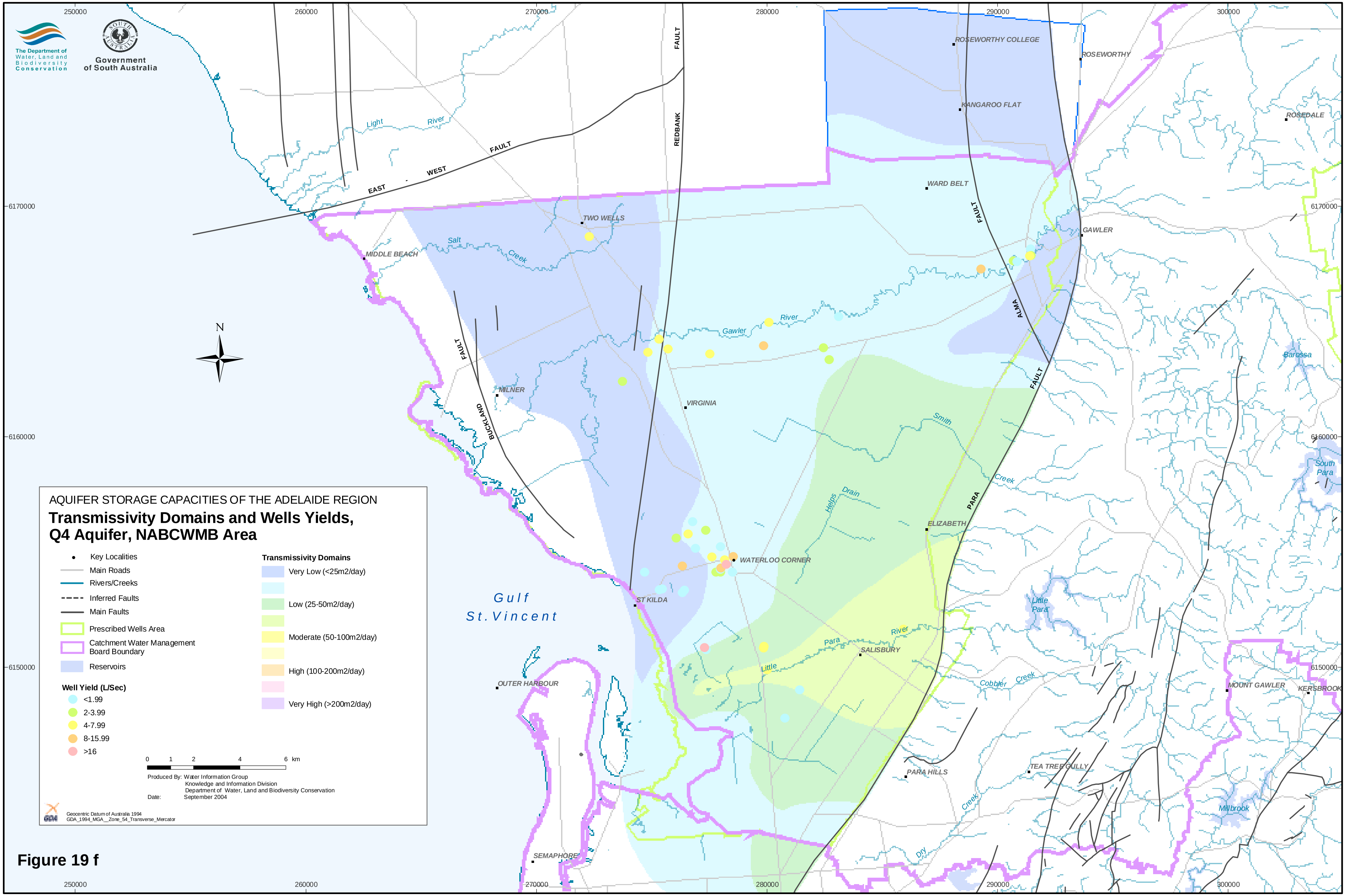

AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Transmissivity Domains and Wells Yields, Q4 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Well Yield (L/Sec)
<1.99
2-3.99
4-7.99
8-15.99
>16
Transmissivity Domains
Very Low (<25m2/day)
Low (25-50m2/day)
Moderate (50-100m2/day)
High (100-200m2/day)
Very High (>200m2/day)
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
N
Gulf St.Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
WATERLOO CORNER
ST KILDA
ELIZABETH
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST - WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 19 f

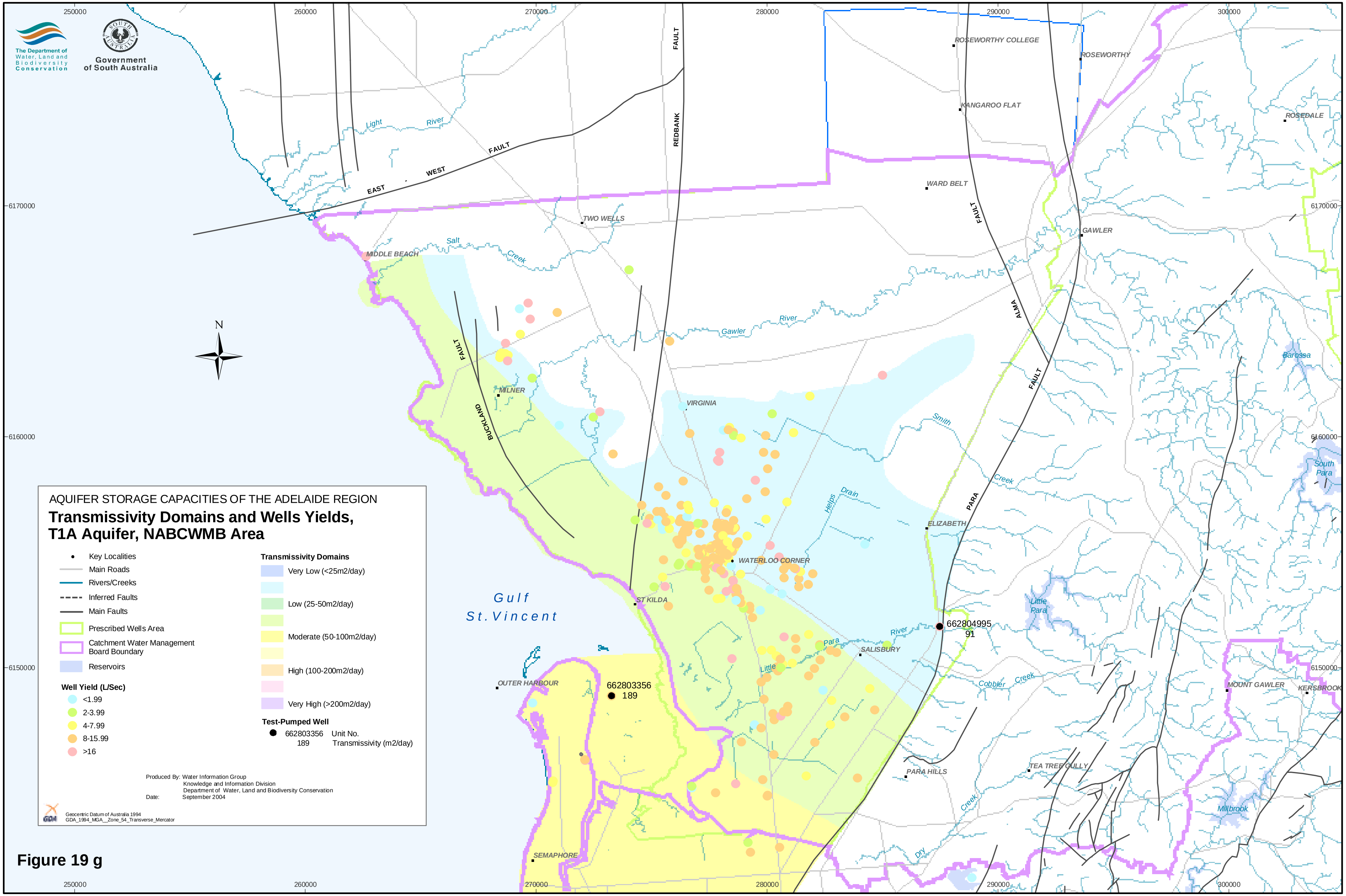
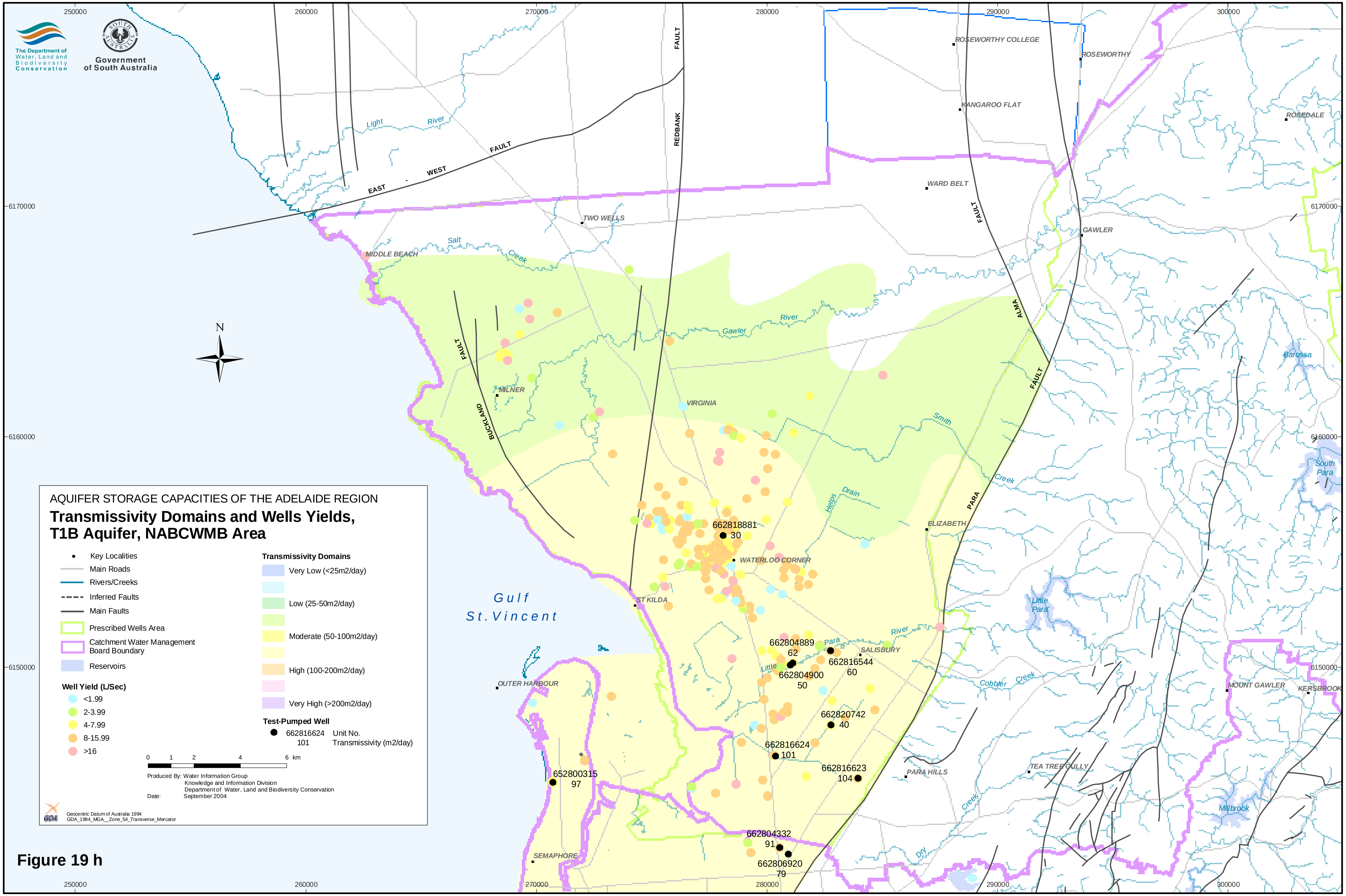
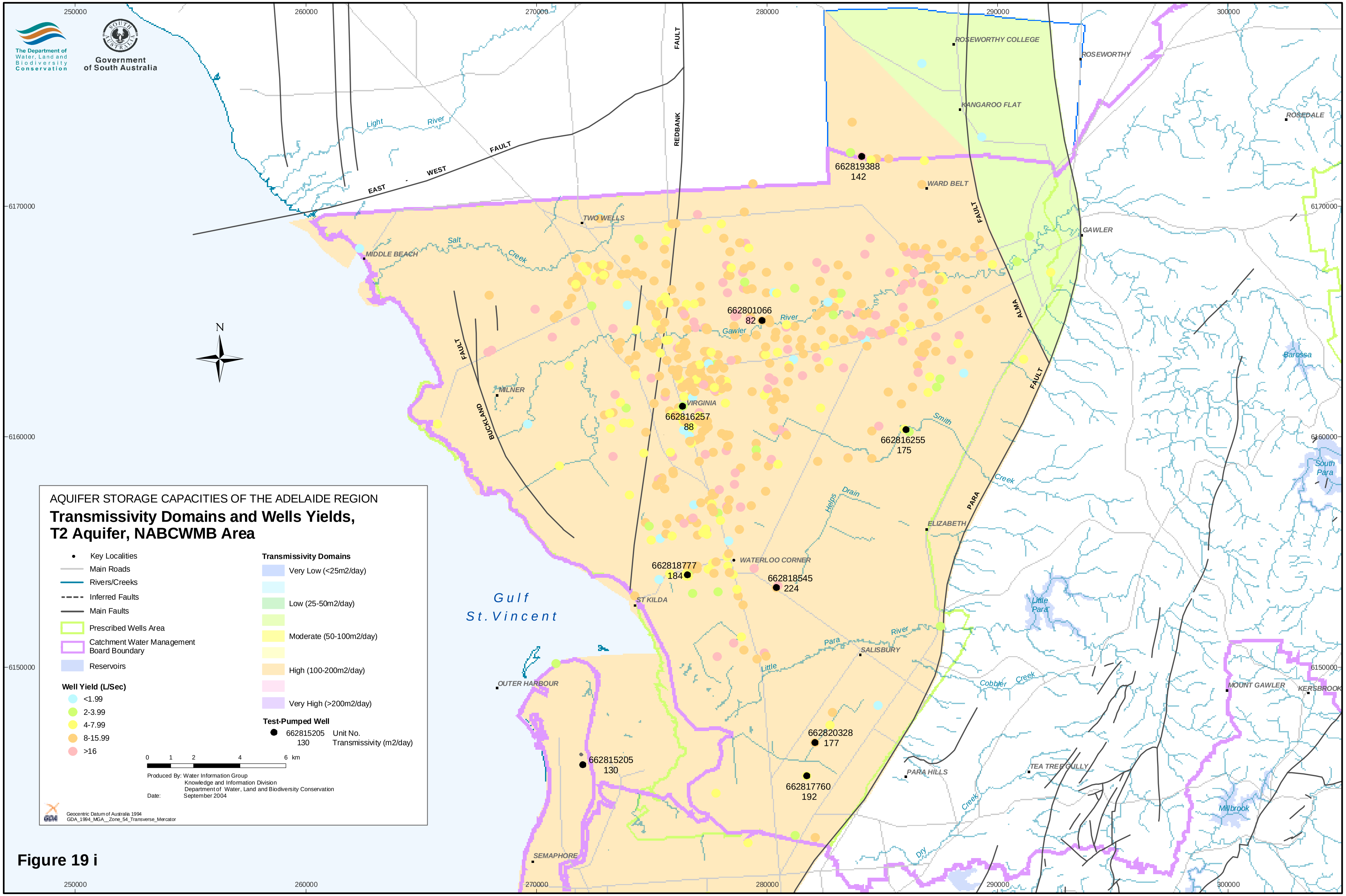

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Transmissivity Domains and Wells Yields, T1A Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Well Yield (L/Sec)
<1.99
2-3.99
4-7.99
8-15.99
>16
Transmissivity Domains
Very Low (<25m2/day)
Low (25-50m2/day)
Moderate (50-100m2/day)
High (100-200m2/day)
Very High (>200m2/day)
Test-Pumped Well
662803356 Unit No.
189 Transmissivity (m2/day)
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf St. Vincent
662804995
91
662803356
189
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST WEST FAULT
BUCKLAND FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Little Para
South Para
Barossa
Millbrook
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 19 g



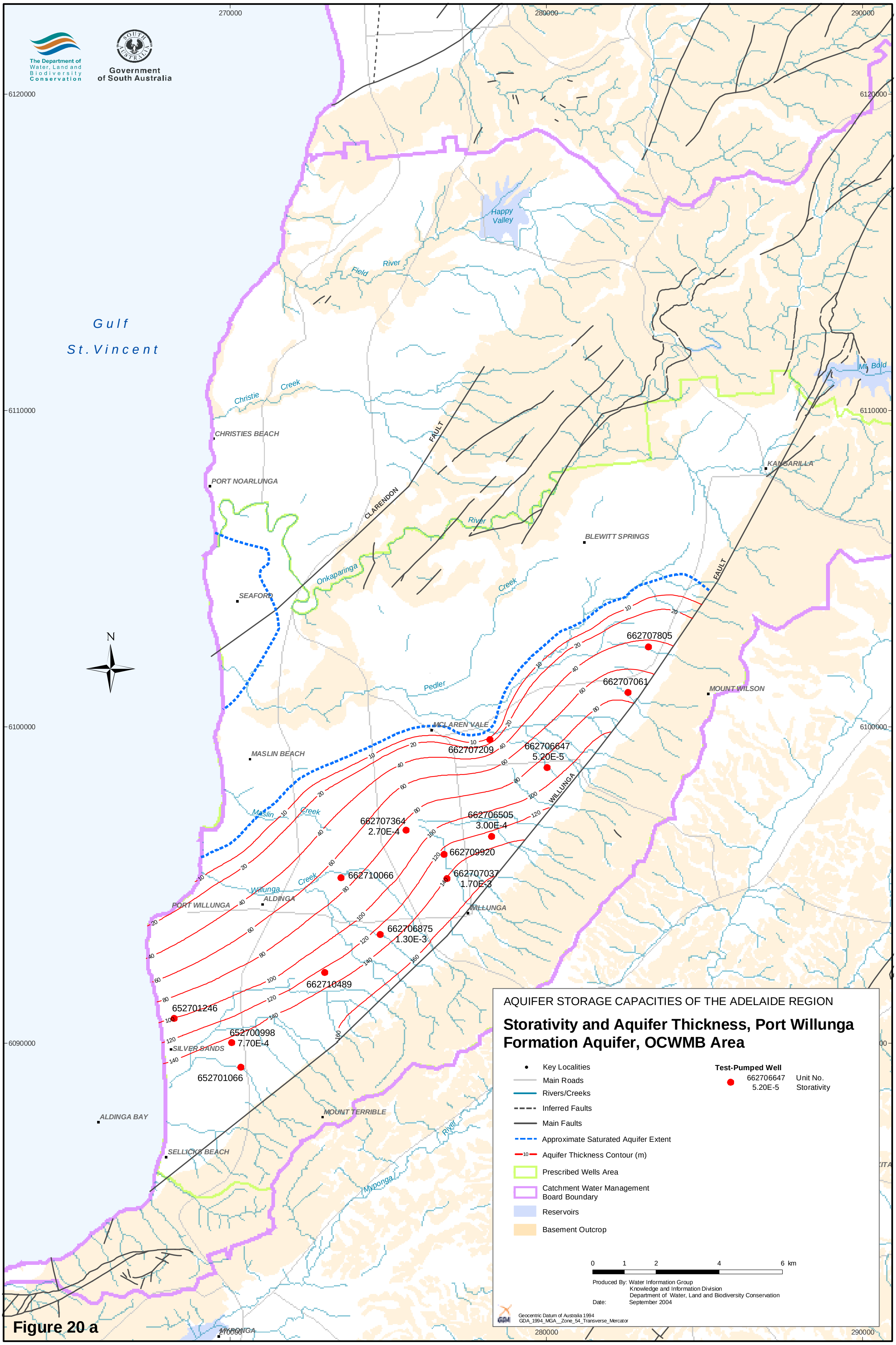
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Transmissivity Domains and Wells Yields, T1B Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Well Yield (L/Sec)
<1.99
2-3.99
4-7.99
8-15.99
>16
Transmissivity Domains
Very Low (<25m2/day)
Low (25-50m2/day)
Moderate (50-100m2/day)
High (100-200m2/day)
Very High (>200m2/day)
Test-Pumped Well
662816624 Unit No.
101 Transmissivity (m2/day)
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
Gulf St.Vincent
N
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Gawler River
Salt Creek
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
662818881 30
662804889 62
662816544 60
662804900 50
662820742 40
662816624 101
662816623 104
652800315 97
662804332 91
662806920 79
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 19 h



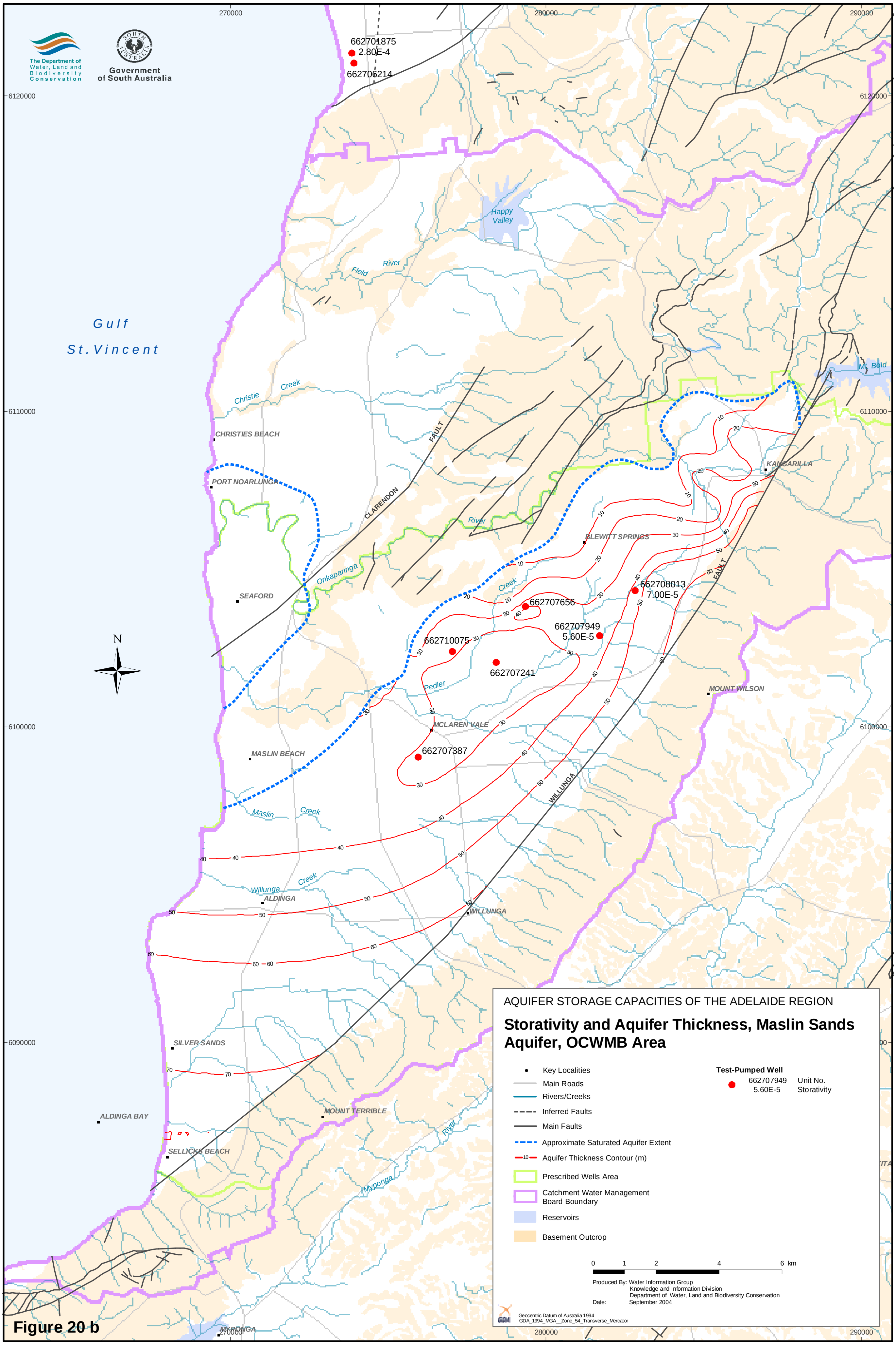
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Transmissivity Domains and Wells Yields, T2 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Well Yield (L/Sec)
<1.99
2-3.99
4-7.99
8-15.99
>16
Transmissivity Domains
Very Low (<25m2/day)
Low (25-50m2/day)
Moderate (50-100m2/day)
High (100-200m2/day)
Very High (>200m2/day)
Test-Pumped Well
662815205 Unit No.
130 Transmissivity (m2/day)
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
N
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
WATERLOO CORNER
ST KILDA
ELIZABETH
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
EAST WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
662819388
142
662801066
82
662816257
88
662816255
175
662818777
184
662818545
224
662820328
177
662817760
192
662815205
130
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 19 i



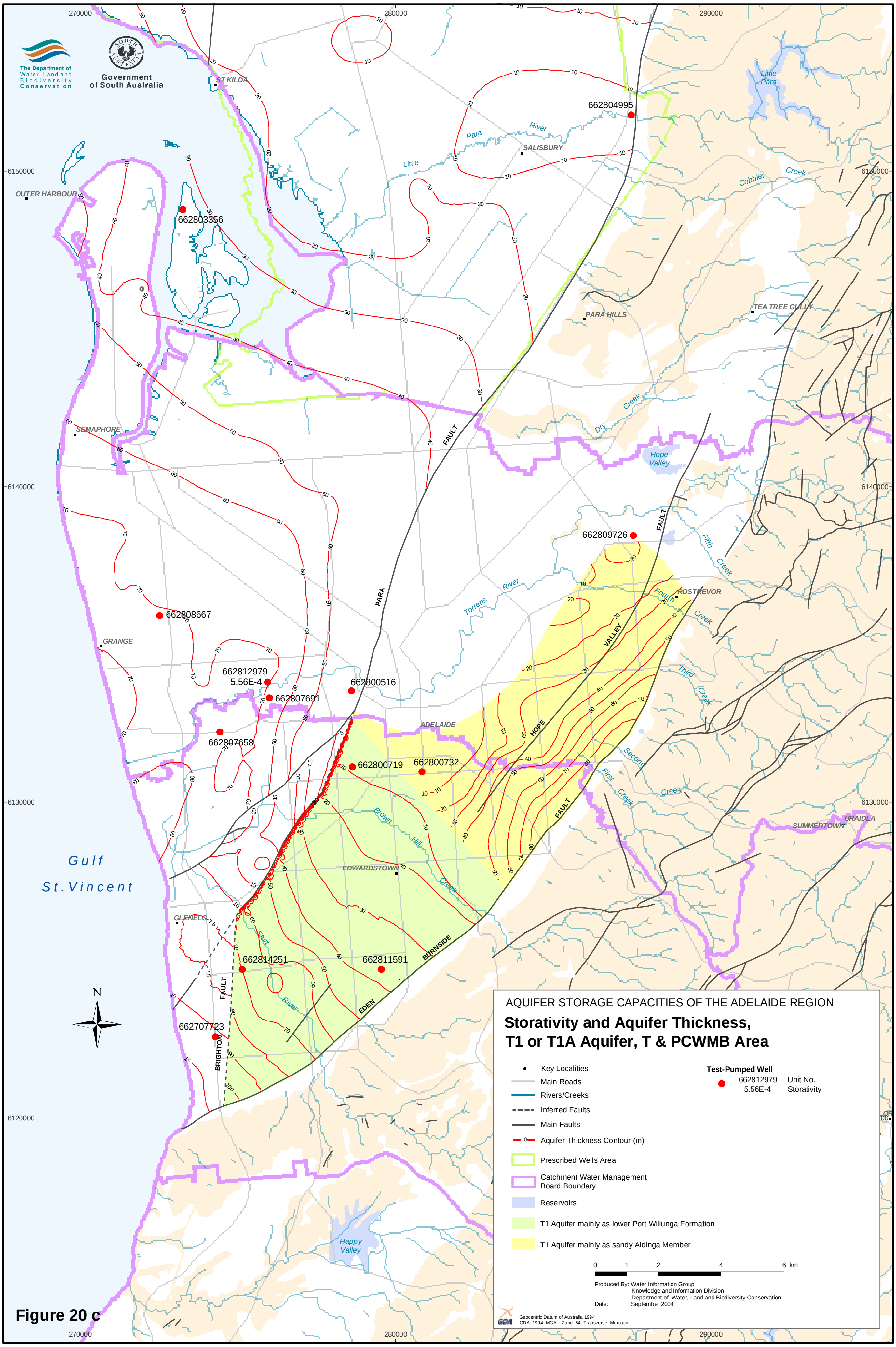
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St. Vincent
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Storativity and Aquifer Thickness, Port Willunga Formation Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Aquifer Thickness Contour (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Test-Pumped Well
662706647 Unit No.
5.20E-5 Storativity
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
MASLIN BEACH
PORT WILLUNGA
ALDINGA
SILVER SANDS
ALDINGA BAY
SELLICKS BEACH
MOUNT TERRIBLE
McLAREN VALE
WILLUNGA
BLEWITT SPRINGS
MOUNT WILSON
KANGARILLA
Happy Valley
CLARENDON FAULT
WILLUNGA FAULT
662707805
662707061
662707209
662706647
5.20E-5
662707364
2.70E-4
662706505
3.00E-4
662709920
662710066
662707037
1.70E-3
662706875
1.30E-3
662710489
652701246
652700998
7.70E-4
652701066

Figure 20 a



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Storativity and Aquifer Thickness, Maslin Sands Aquifer, OCWMB Area
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Aquifer Thickness Contour (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Test-Pumped Well
662707949 5.60E-5
Unit No.
Storativity
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
662701875
2.80E-4
662706214
662708013
7.00E-5
662707656
662707949
5.60E-5
662710075
662707241
662707387
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
MASLIN BEACH
MCLAREN VALE
BLEWITT SPRINGS
KANGARILLA
MOUNT WILSON
ALDINGA
WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
MYPONGA
CLARENDON FAULT
WILLUNGA FAULT
Happy Valley
Mt. Bold
Field River
Christie Creek
Onkaparinga River
Pedler Creek
Maslin Creek
Willunga Creek
Myponga River
270000
280000
290000
6120000
6110000
6100000
6090000

Figure 20 b



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Storativity and Aquifer Thickness,
T1 or T1A Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Aquifer Thickness Contour (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
T1 Aquifer mainly as lower Port Willunga Formation
T1 Aquifer mainly as sandy Aldinga Member
Test-Pumped Well
662812979 Unit No.
5.56E-4 Storativity
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
N
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
GRANGE
PARA HILLS
TEA TREE GULLY
ROSTREVOR
ADELAIDE
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE
BRIGHTON FAULT
Little Para River
Cobbler Creek
Dry Creek
Hope Valley
Little Para
Torrens River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
Happy Valley
662804995
662803356
662808667
662812979
5.56E-4
662807691
662800516
662807658
662800719
662800732
662809726
662814251
662811591
662707723
270000
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290000
6150000
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6130000
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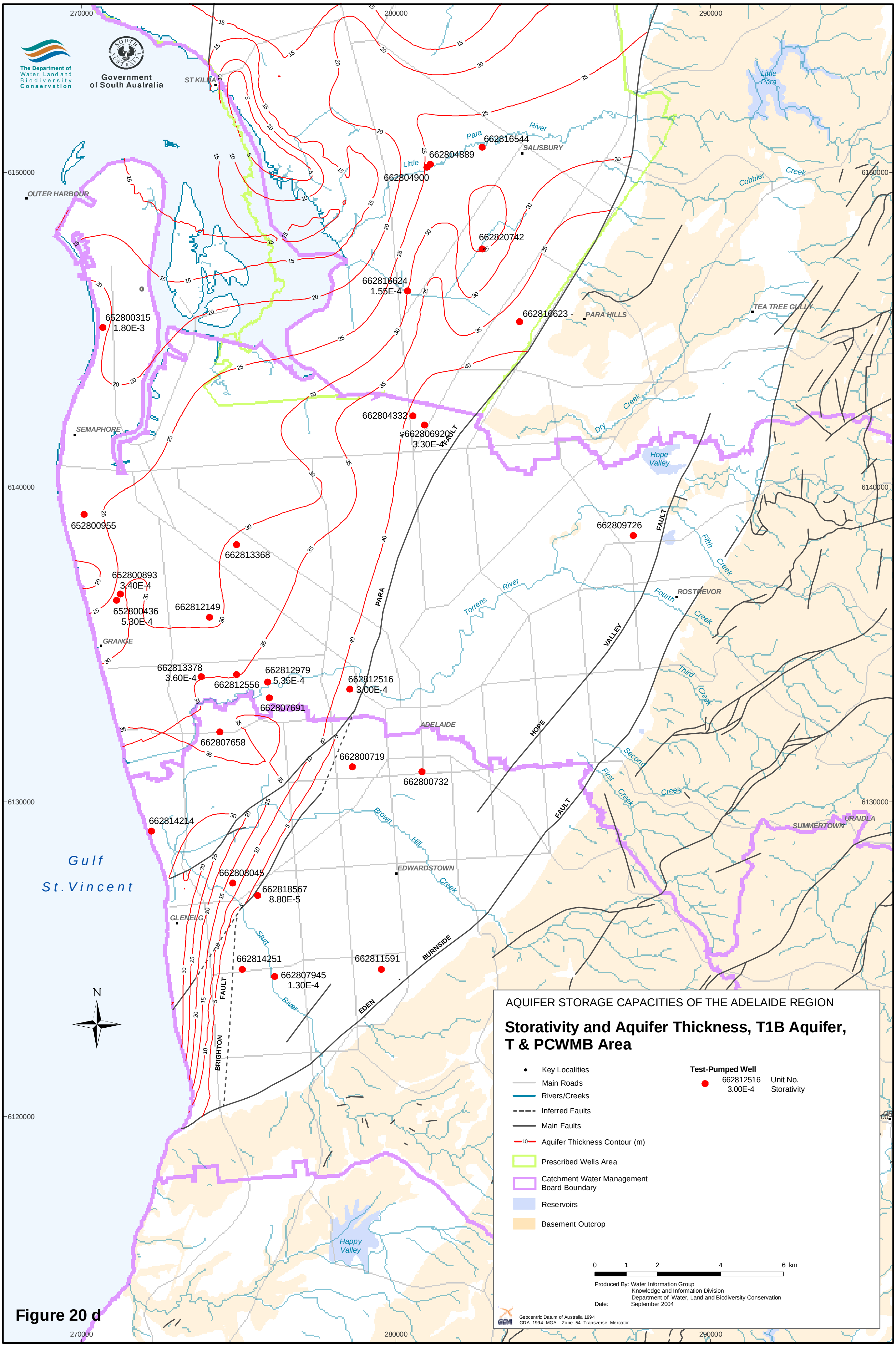
Figure 20 c



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Storativity and Aquifer Thickness, T1B Aquifer, T & PCWMB Area
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Aquifer Thickness Contour (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Test-Pumped Well
662812516 Unit No.
3.00E-4 Storativity
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf
St.Vincent
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ROSTREVOR
ADELAIDE
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Little Para
Para River
Little
Cobbler Creek
Dry Creek
Hope Valley
Torrens River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
Happy Valley
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
662816544
662804889
662804900
662820742
662816624
1.55E-4
662816623 -
652800315
1.80E-3
662804332
662806920
3.30E-4
652800955
662813368
662809726
652800893
3.40E-4
652800436
5.30E-4
662812149
662813378
3.60E-4
662812556
662812979
5.35E-4
662812516
3.00E-4
662807691
662807658
662800719
662800732
662814214
662808045
662818567
8.80E-5
662814251
662807945
1.30E-4
662811591
270000
280000
290000
6150000
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6130000
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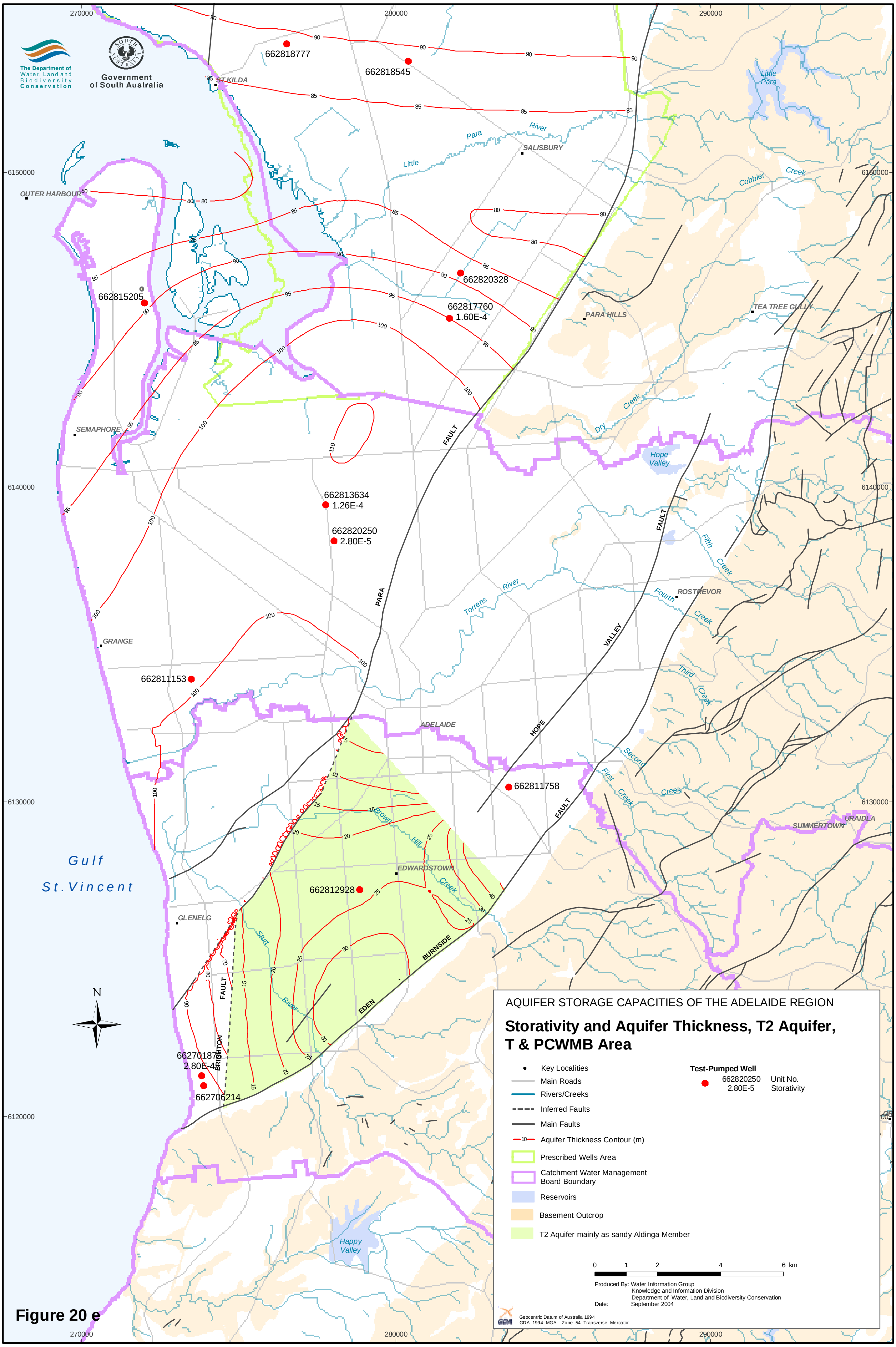
Figure 20 d



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Storativity and Aquifer Thickness, T2 Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Aquifer Thickness Contour (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
T2 Aquifer mainly as sandy Aldinga Member
Test-Pumped Well
662820250 2.80E-5
Unit No. Storativity
0 1 2 4 6 km
Produced By: Water Information Group Knowledge and Information Division Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
OUTER HARBOUR
ST KILDA
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Little Para
Little Para River
Dry Creek
Cobbler Creek
Hope Valley
Torrens River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
Happy Valley
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
662818777
662818545
662820328
662815205
662817760 1.60E-4
662813634 1.26E-4
662820250 2.80E-5
662811153
662811758
662812928
662701873 2.80E-4
662706214
270000
280000
290000
6150000
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6120000
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Figure 20 e

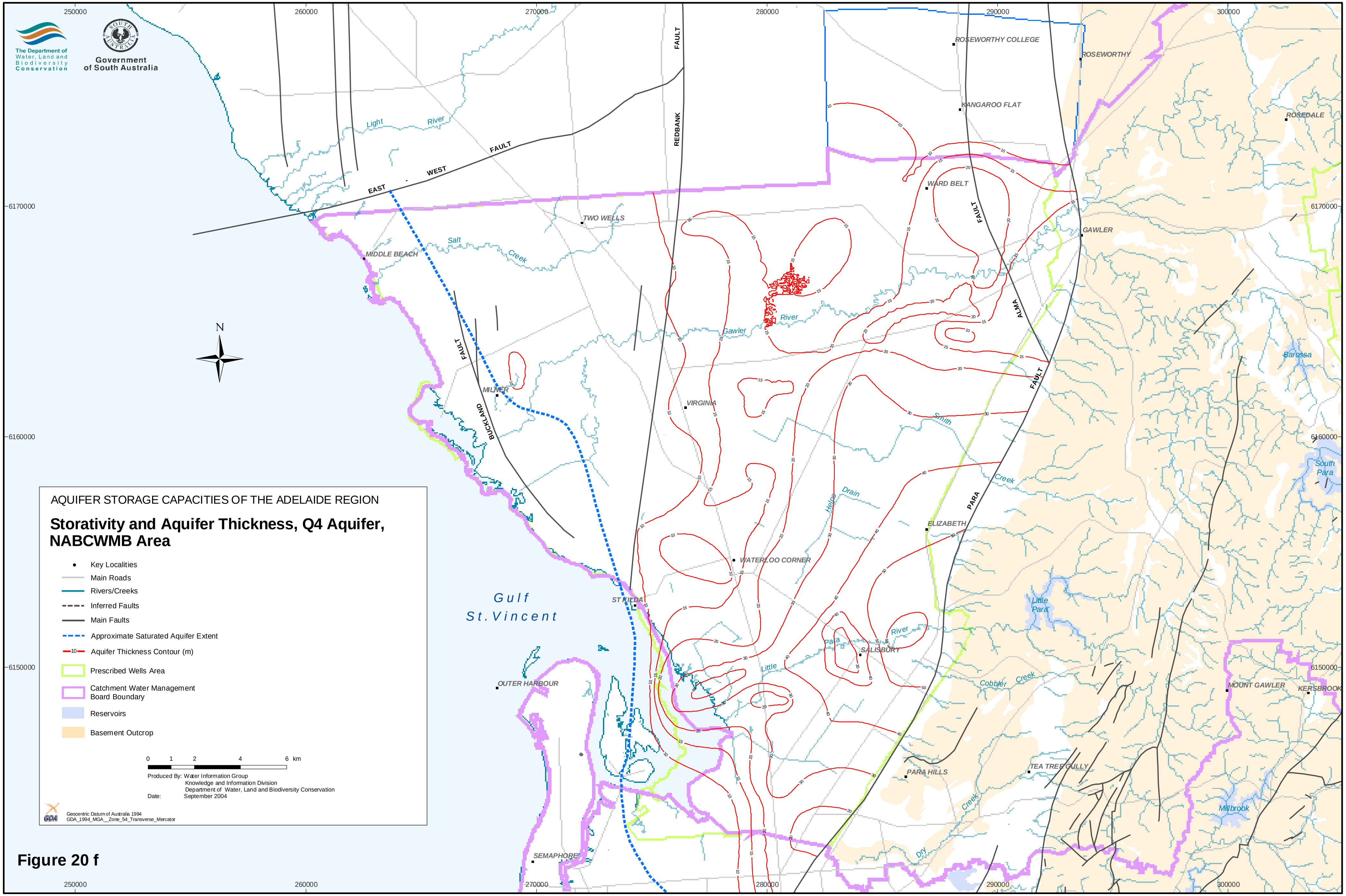
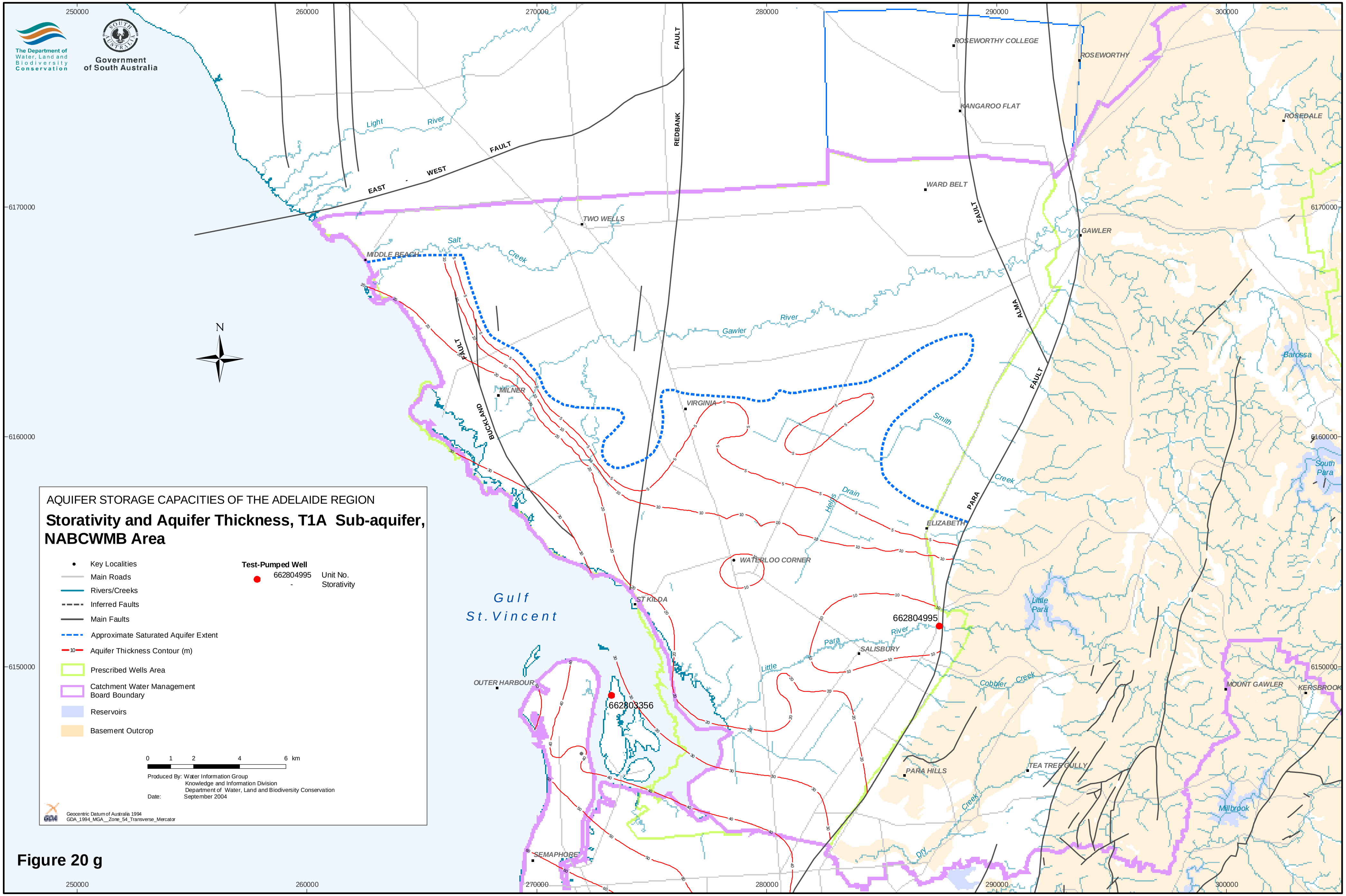

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Storativity and Aquifer Thickness, Q4 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Aquifer Thickness Contour (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
N
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
SEMAPHORE
EAST WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 20 f



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Storativity and Aquifer Thickness, T1A Sub-aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Aquifer Thickness Contour (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Test-Pumped Well
662804995 Unit No.
- Storativity
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
SEMAPHORE
EAST - WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
South Para
Little Para
Barossa
Millbrook
662804995
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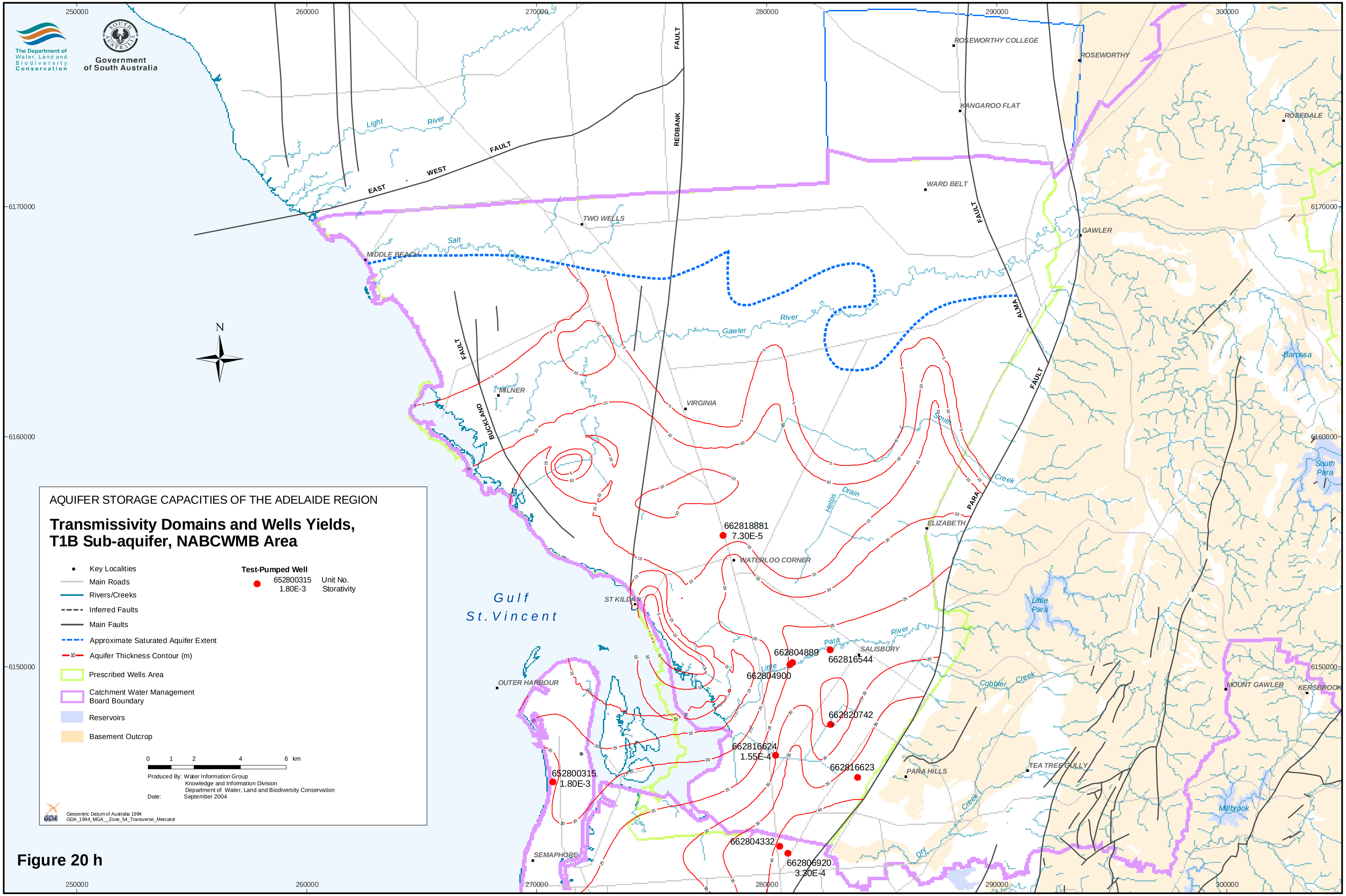
6150000

Figure 20 g



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION

Transmissivity Domains and Wells Yields, T1B Sub-aquifer, NABCWMB Area

- Key Localities
- Main Roads
- Rivers/Creeks
- Inferred Faults
- Main Faults
- Approximate Saturated Aquifer Extent
- Aquifer Thickness Contour (m)
- Prescribed Wells Area
- Catchment Water Management Board Boundary
- Reservoirs
- Basement Outcrop

Test-Pumped Well
652800315 Unit No.
1.80E-3 Storativity

0 1 2 4 6 km

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Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004

Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 20 h

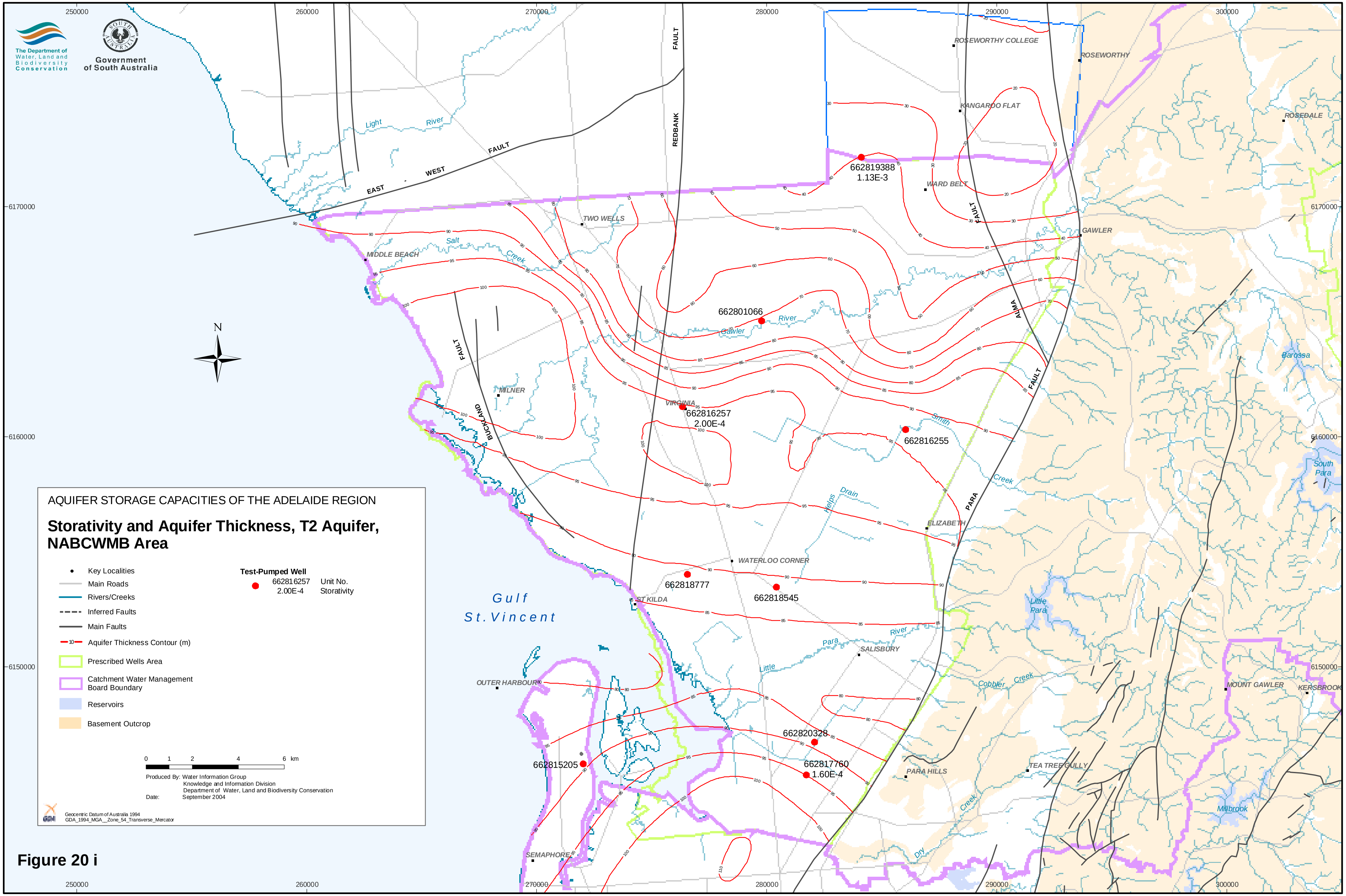
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Storativity and Aquifer Thickness, T2 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Aquifer Thickness Contour (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Test-Pumped Well
662816257 Unit No.
2.00E-4 Storativity
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
N
Gulf
St. Vincent
662819388
1.13E-3
662801066
662816257
2.00E-4
662816255
662818777
662818545
662820328
662817760
1.60E-4
662815205
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
SEMAPHORE
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
EAST - WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
250000
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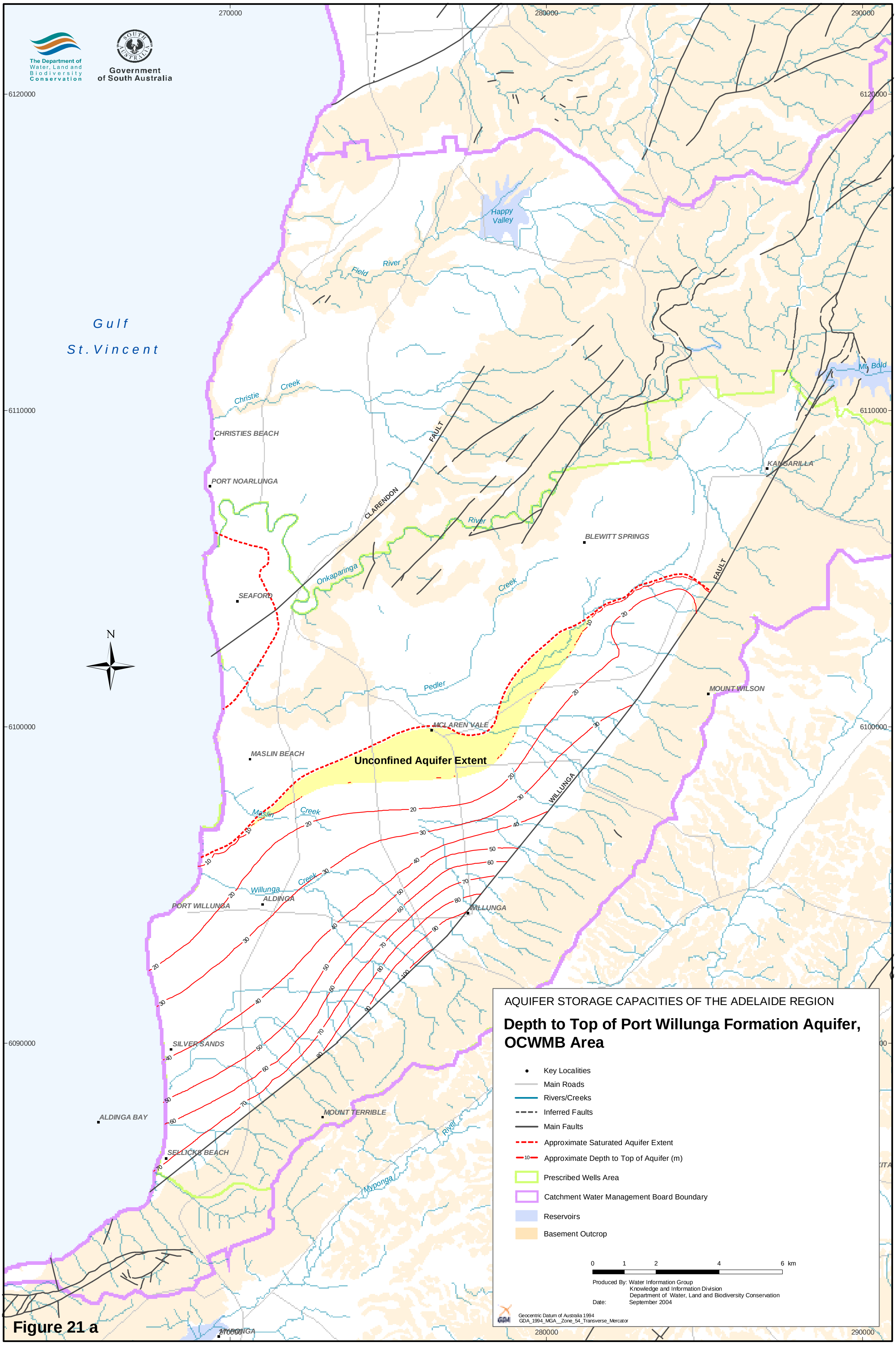
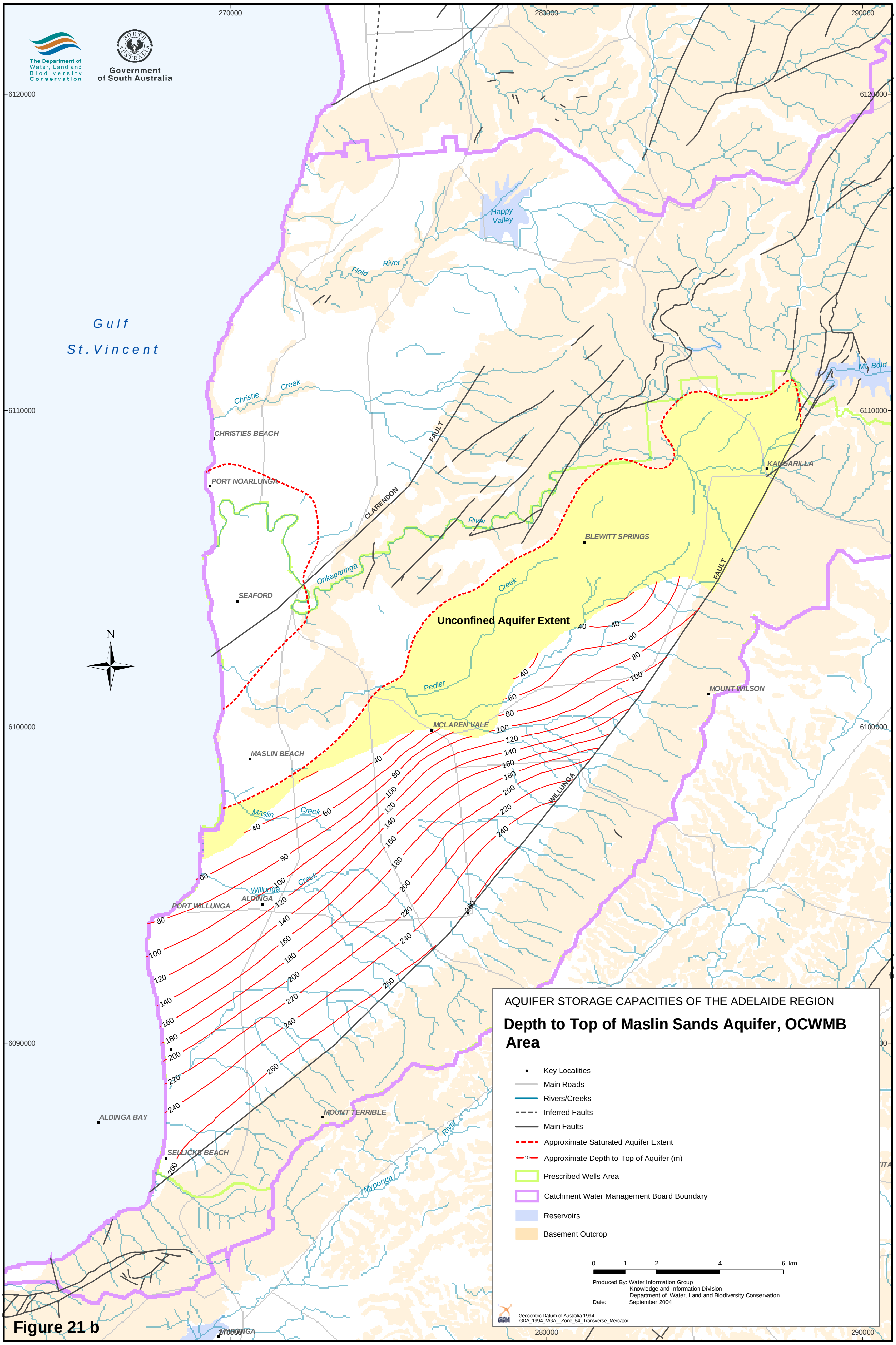
Figure 20 i



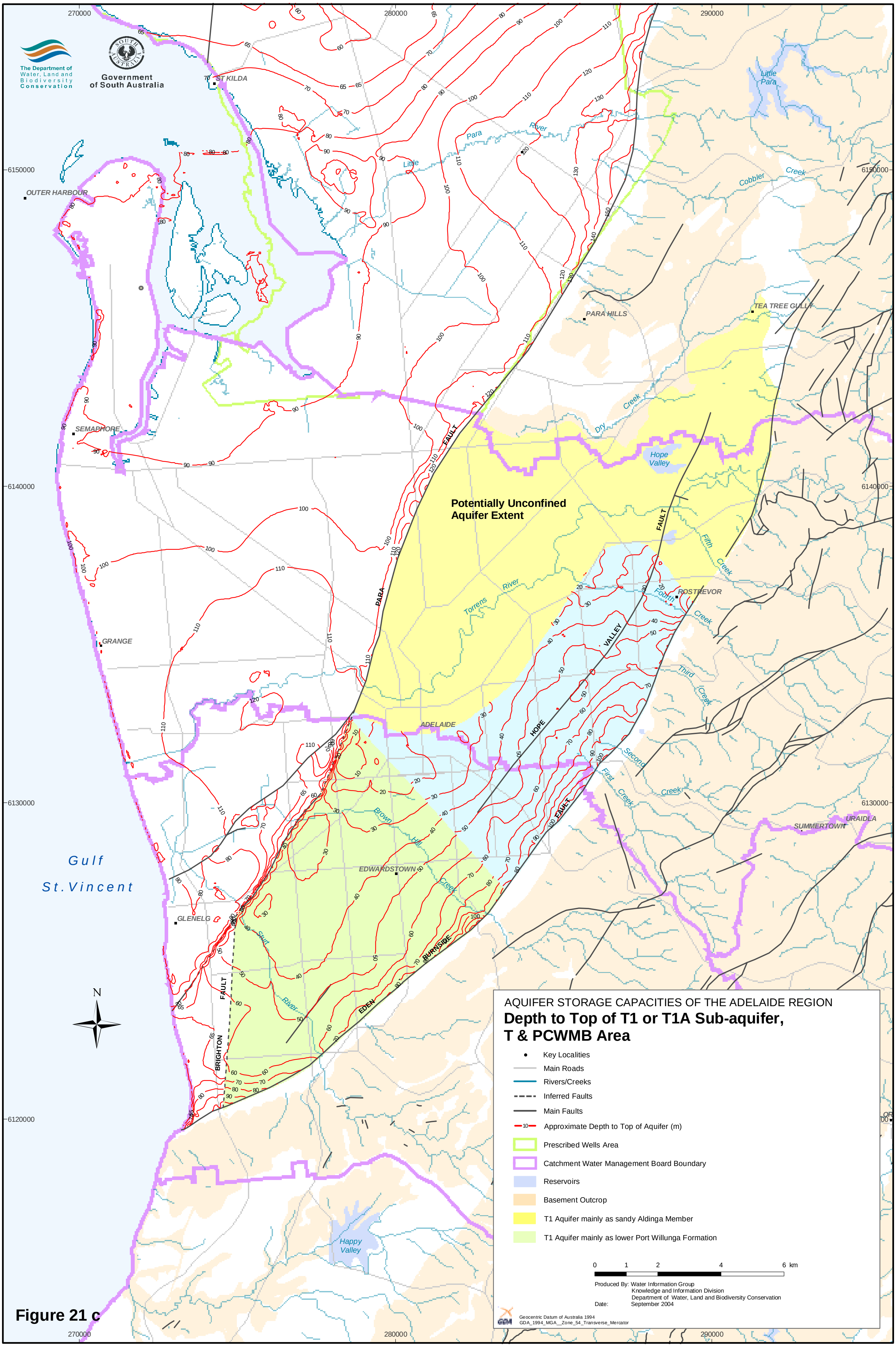
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
Happy Valley
Field River
Christie Creek
CHRISTIES BEACH
PORT NOARLUNGA
CLARENDON FAULT
Onkaparinga River
SEAFORD
BLEWITT SPRINGS
Creek
Pedler
MCLAREN VALE
Unconfined Aquifer Extent
MASLIN BEACH
Maslin Creek
Willunga Creek
ALDINGA
PORT WILLUNGA
WILLUNGA
WILLUNGA FAULT
MOUNT WILSON
KANGARILLA
Mt Bold
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Myponga River
N
270000
280000
290000
6120000
6110000
6100000
6090000
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depth to Top of Port Willunga Formation Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 21 a



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf
St. Vincent
N
270000
280000
290000
6120000
6110000
6100000
6090000
Happy Valley
Field
River
Christie
Creek
CHRISTIES BEACH
PORT NOARLUNGA
CLARENDON
FAULT
Onkaparinga
River
SEAFORD
BLEWITT SPRINGS
KANGARILLA
Mt Bold
Creek
Unconfined Aquifer Extent
Pedler
MCLAREN VALE
MOUNT WILSON
MASLIN BEACH
Maslin
Creek
Willunga
Creek
ALDINGA
PORT WILLUNGA
WILLUNGA
FAULT
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Myponga
River
40
60
80
100
120
140
160
180
200
220
240
260
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depth to Top of Maslin Sands Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 21 b



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depth to Top of T1 or T1A Sub-aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
T1 Aquifer mainly as sandy Aldinga Member
T1 Aquifer mainly as lower Port Willunga Formation
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Potentially Unconfined Aquifer Extent
Gulf St.Vincent
ST KILDA
OUTER HARBOUR
SEMAPHORE
GRANGE
GLENELG
ADELAIDE
EDWARDSTOWN
PARA HILLS
TEA TREE GULLY
ROSTREVOR
SUMMERTOWN
URAIDLA
Little Para
Para River
Little Para
Cobbler Creek
Dry Creek
Hope Valley
Torrens River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
Happy Valley
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
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Figure 21 c

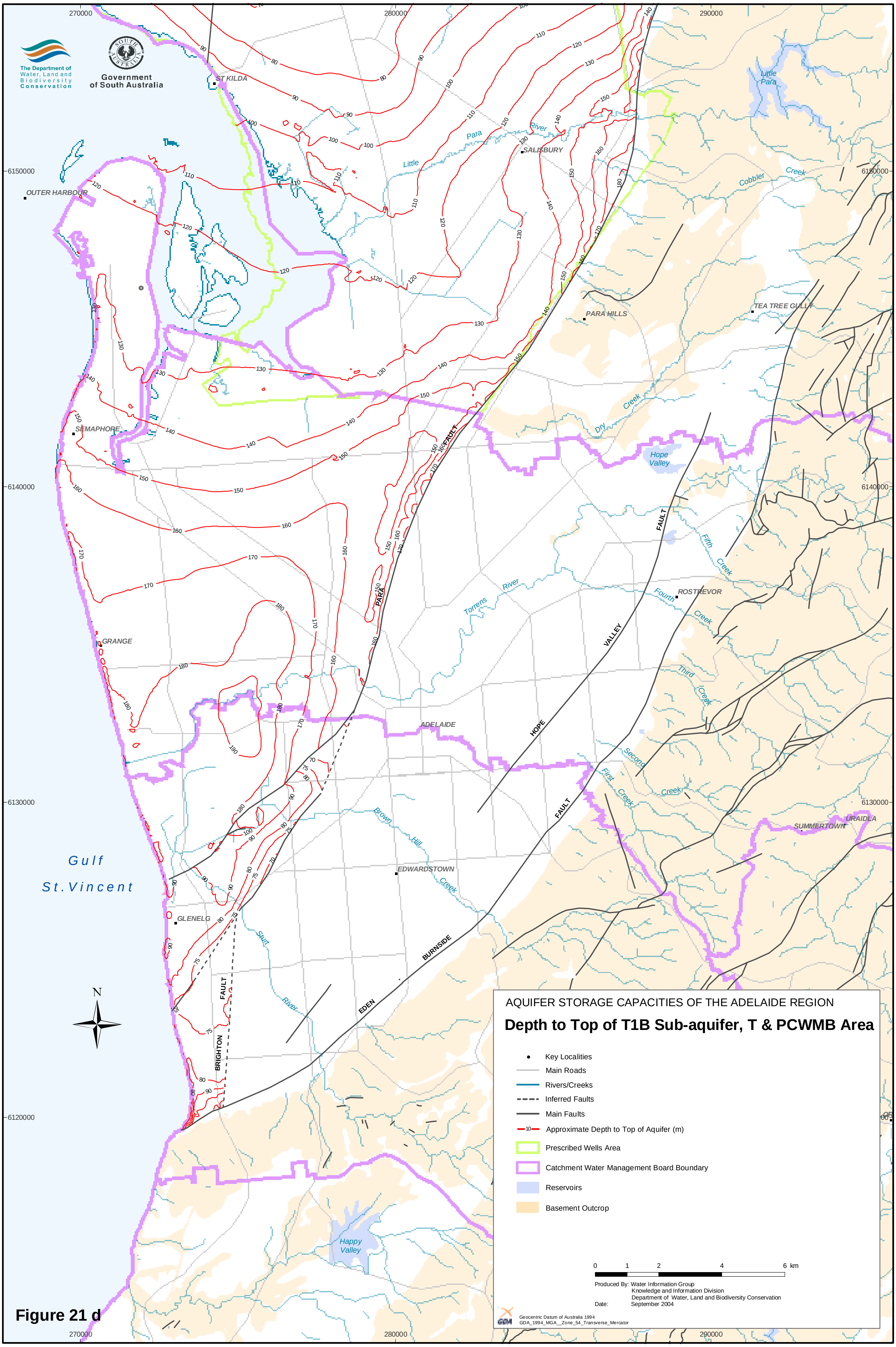
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depth to Top of T1B Sub-aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf
St.Vincent
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Little Para
Hope Valley
Happy Valley
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
Torrens River
Sturt River
Brown Hill Creek
Dry Creek
Cobbler Creek
Little Para River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
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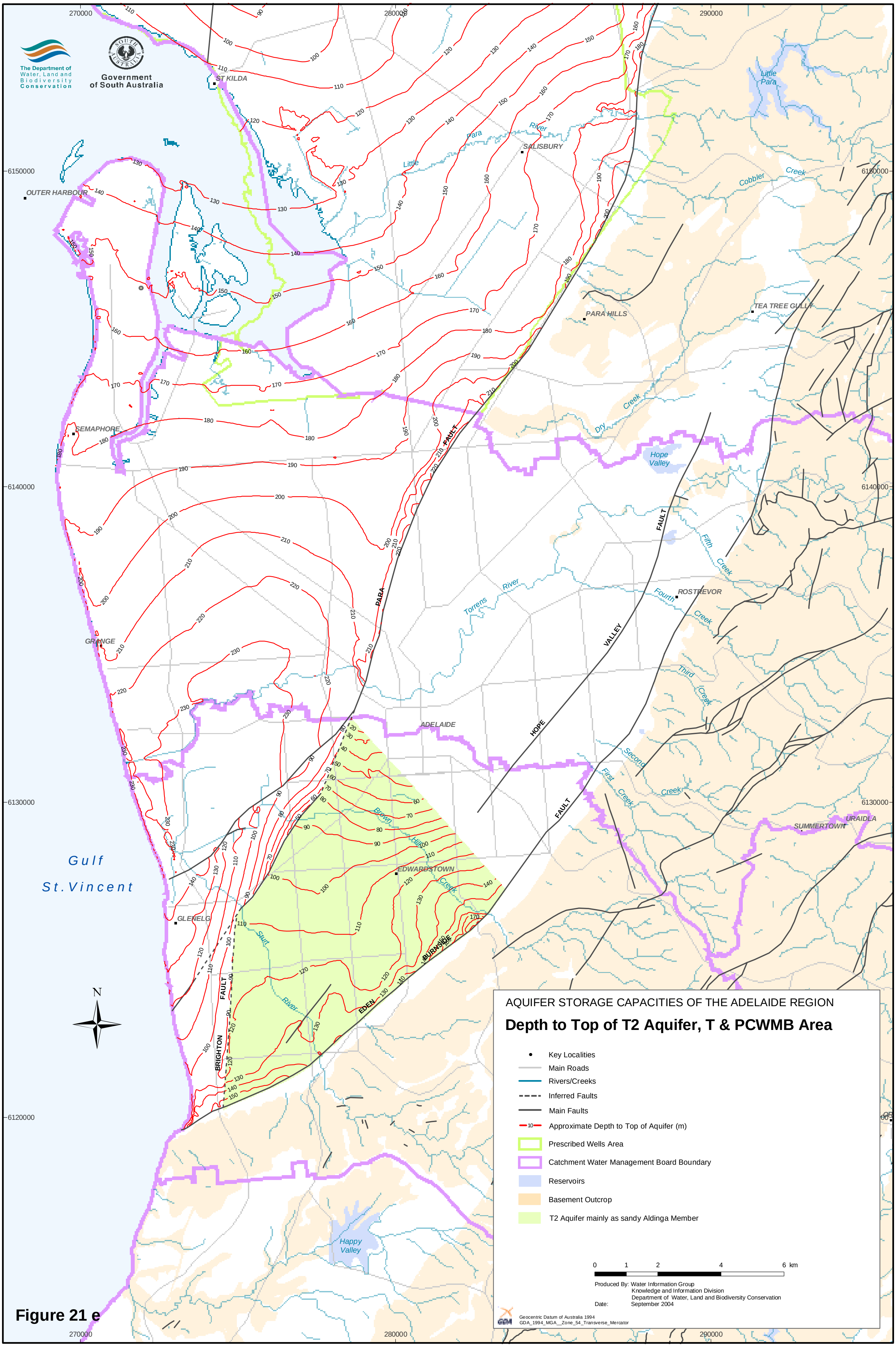
Figure 21 d



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depth to Top of T2 Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
T2 Aquifer mainly as sandy Aldinga Member
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf
St.Vincent
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Little Para
Hope Valley
Happy Valley
Little Para River
Cobbler Creek
Dry Creek
Torrens River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
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Figure 21 e

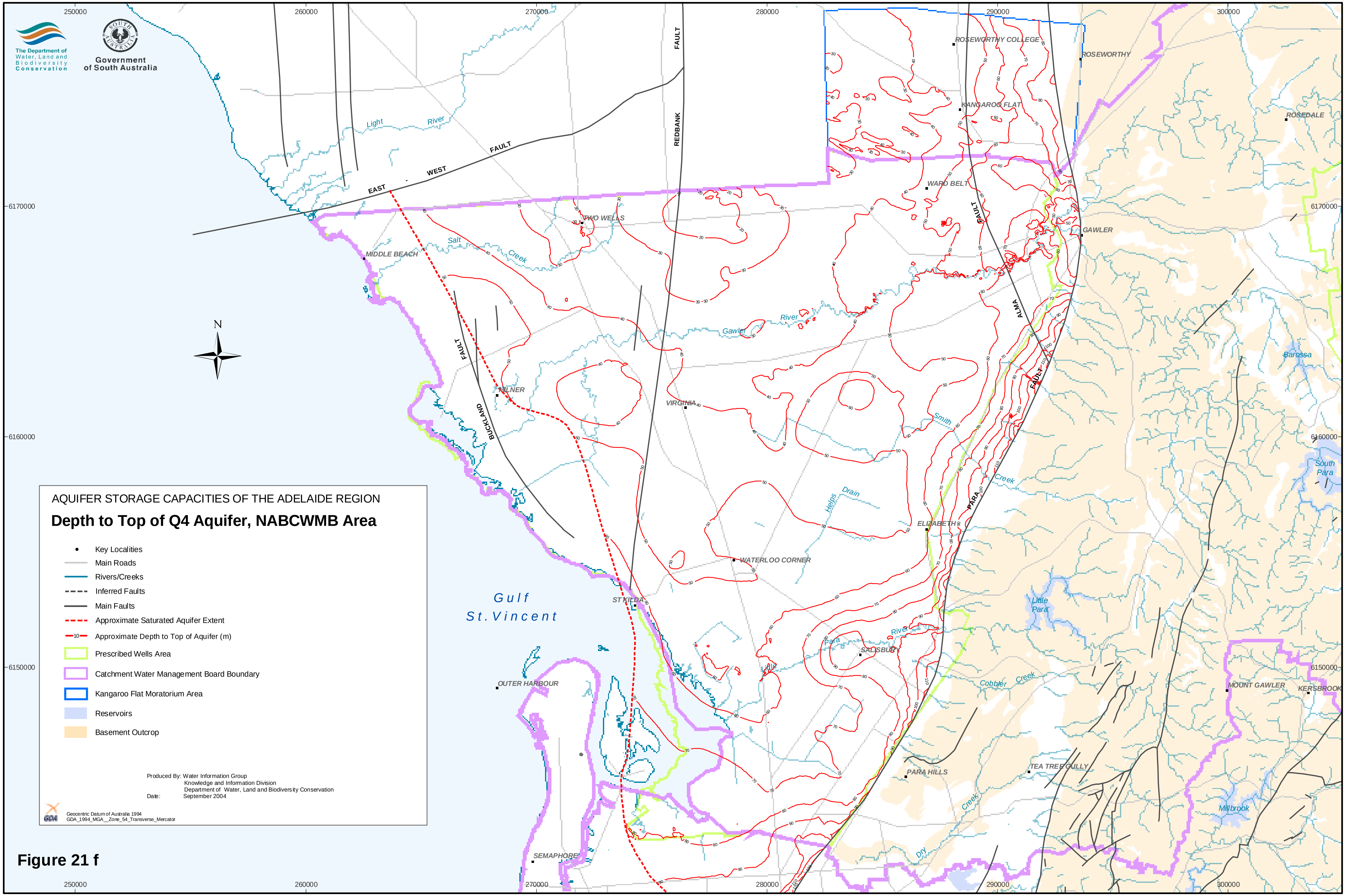
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depth to Top of Q4 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf
St. Vincent
EAST WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Para River
Cobbler Creek
Dry Creek
Little Para
South Para
Barossa
Millbrook
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Figure 21 f

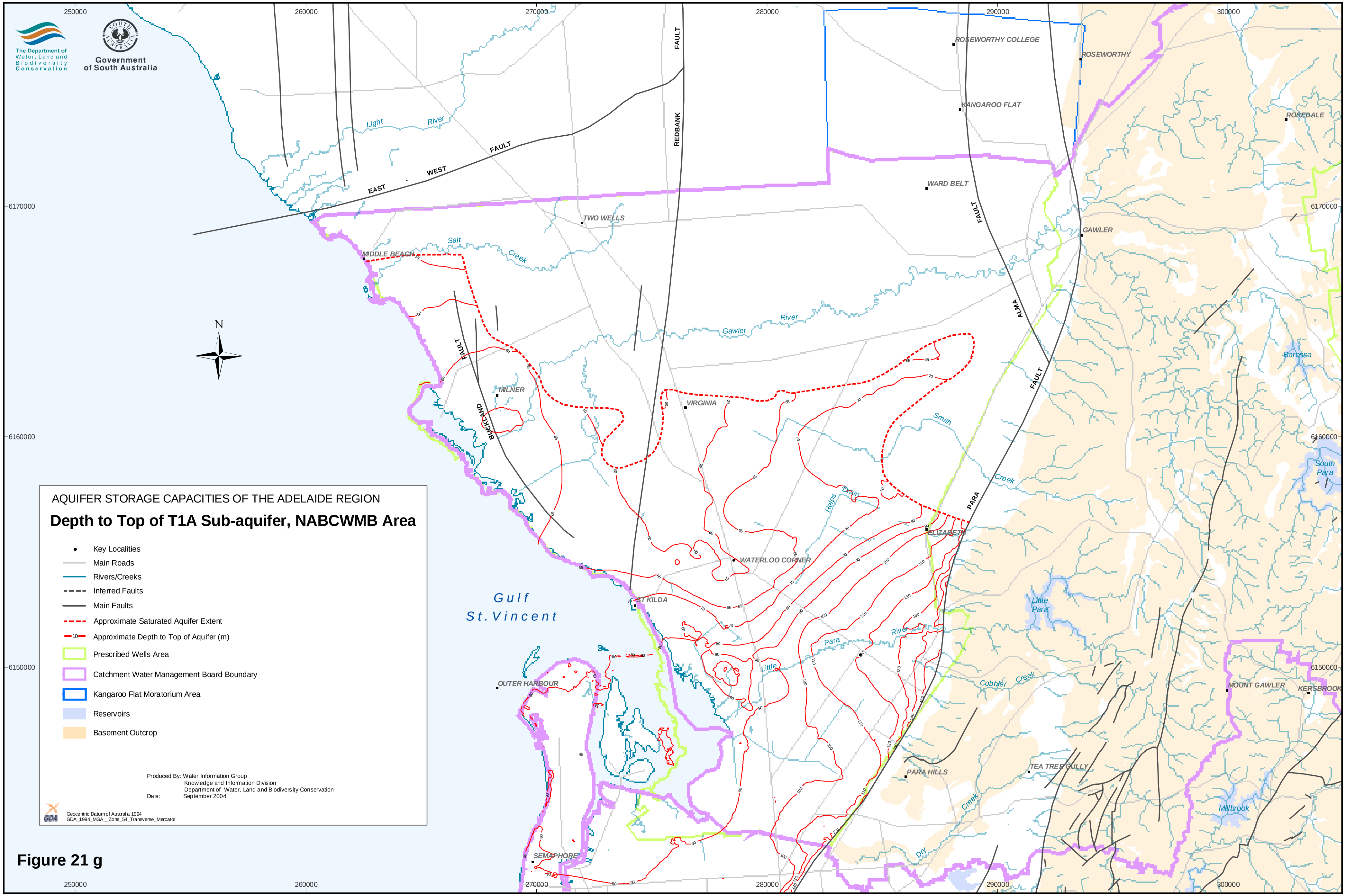
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depth to Top of T1A Sub-aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
N
Gulf St.Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Gawler River
Salt Creek
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
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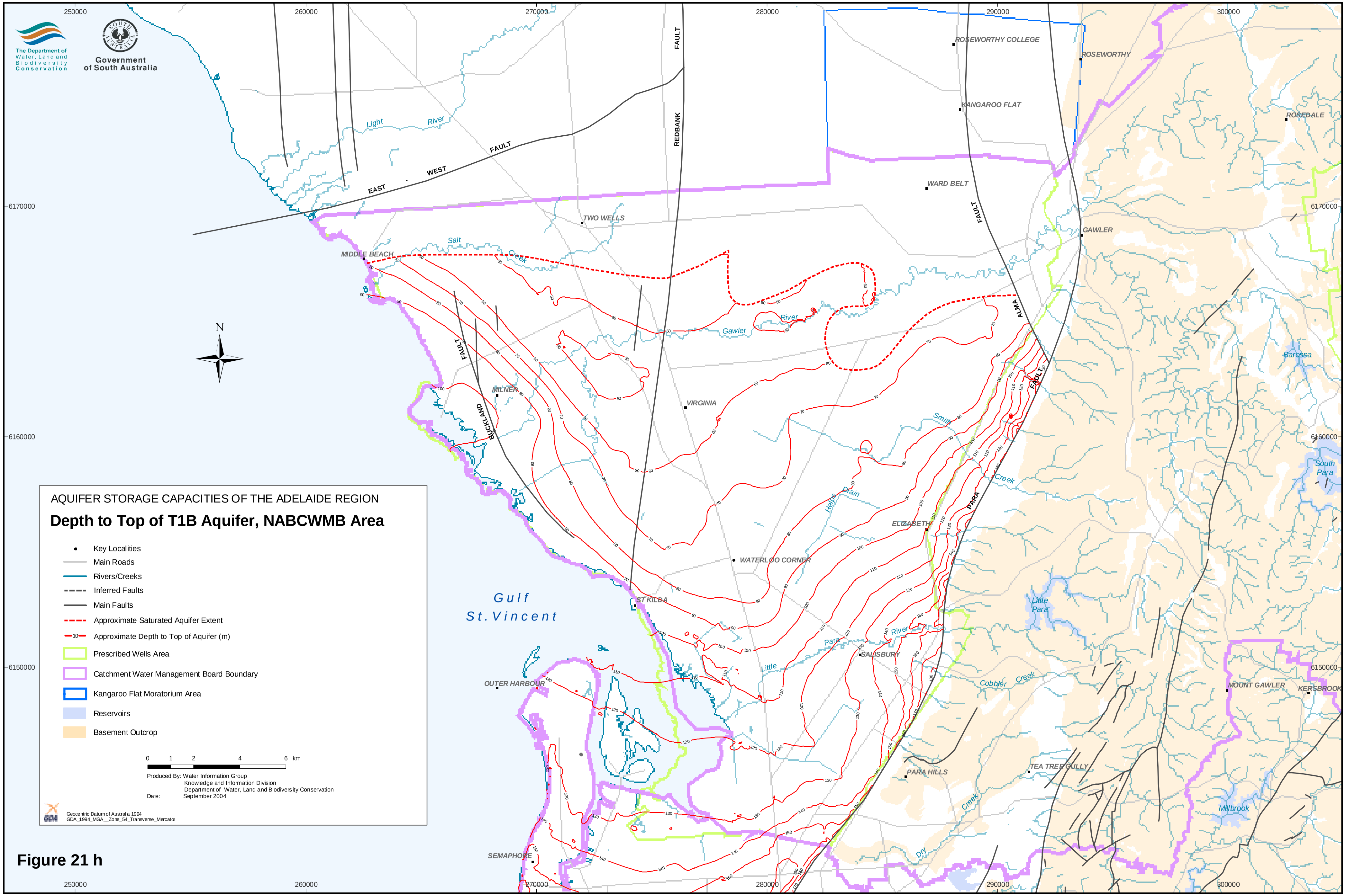
Figure 21 g



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Depth to Top of T1B Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf St. Vincent
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
WATERLOO CORNER
ELIZABETH
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
Barossa
South Para
Little Para
Millbrook
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Para River
Little Para
Cobbler Creek
Dry Creek
250000
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6170000
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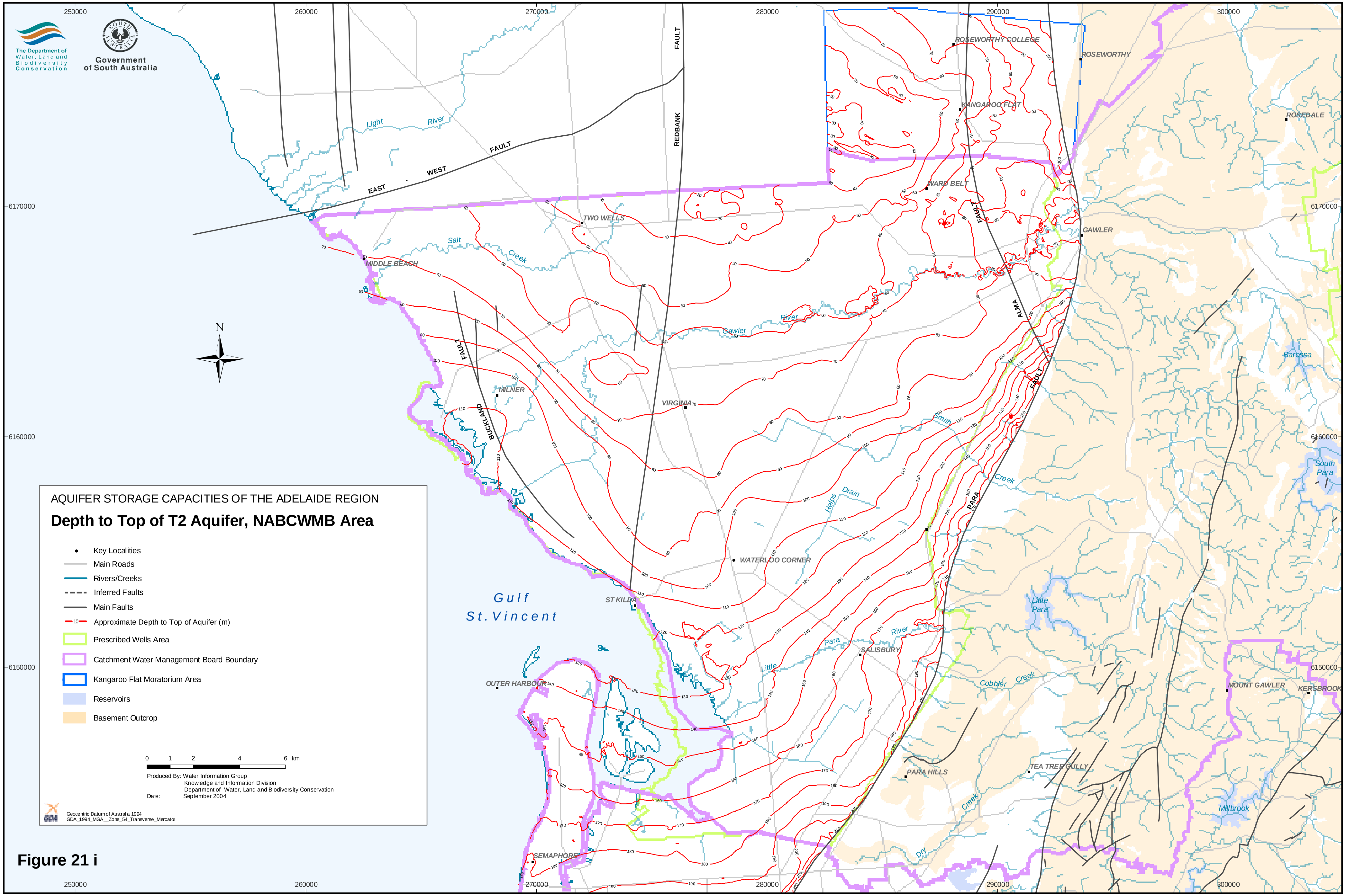
Figure 21 h



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION

Depth to Top of T2 Aquifer, NABCWMB Area

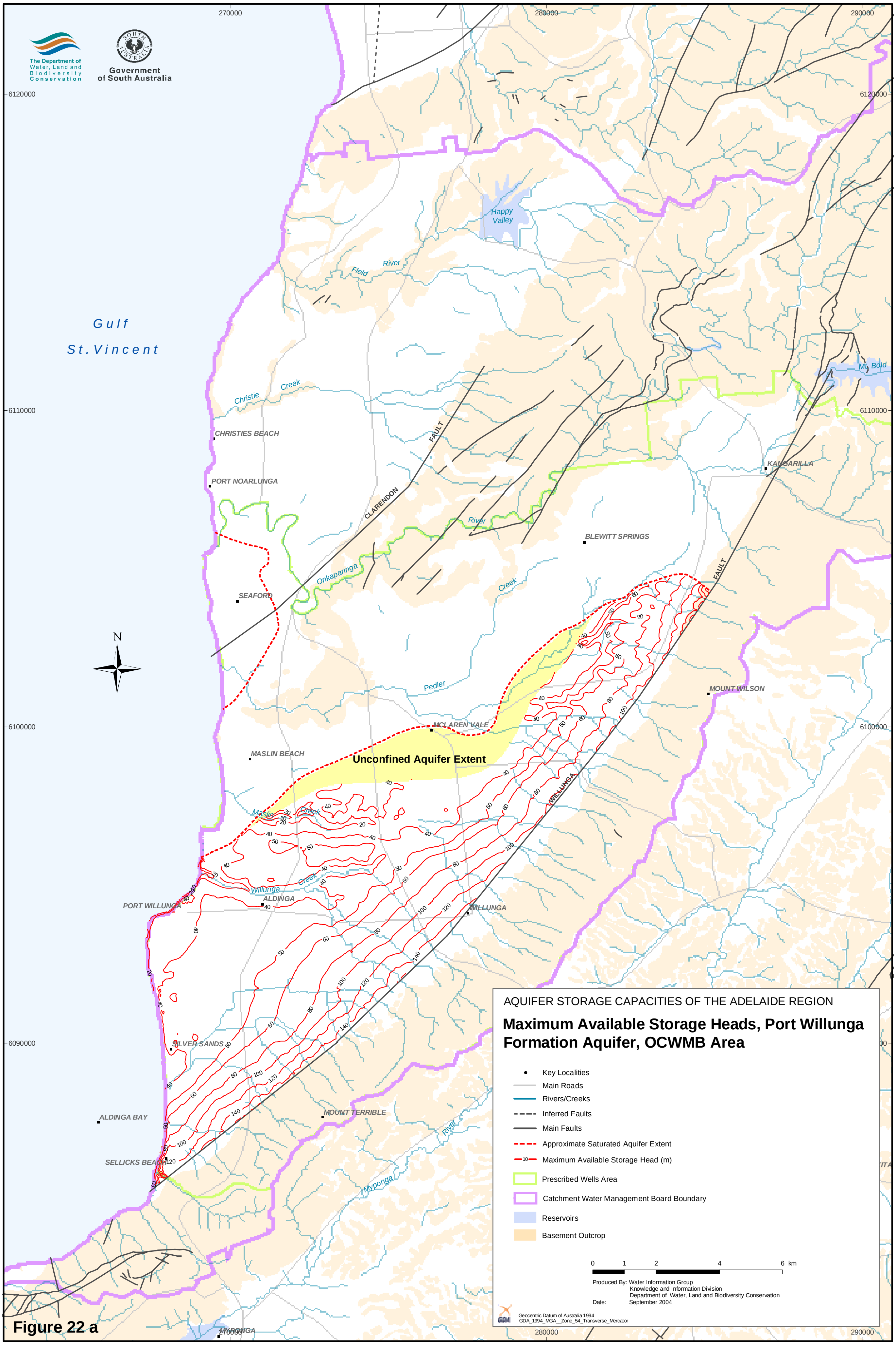
- Key Localities
- Main Roads
- Rivers/Creeks
- Inferred Faults
- Main Faults
- Approximate Depth to Top of Aquifer (m)
- Prescribed Wells Area
- Catchment Water Management Board Boundary
- Kangaroo Flat Moratorium Area
- Reservoirs
- Basement Outcrop

0 1 2 4 6 km

Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004

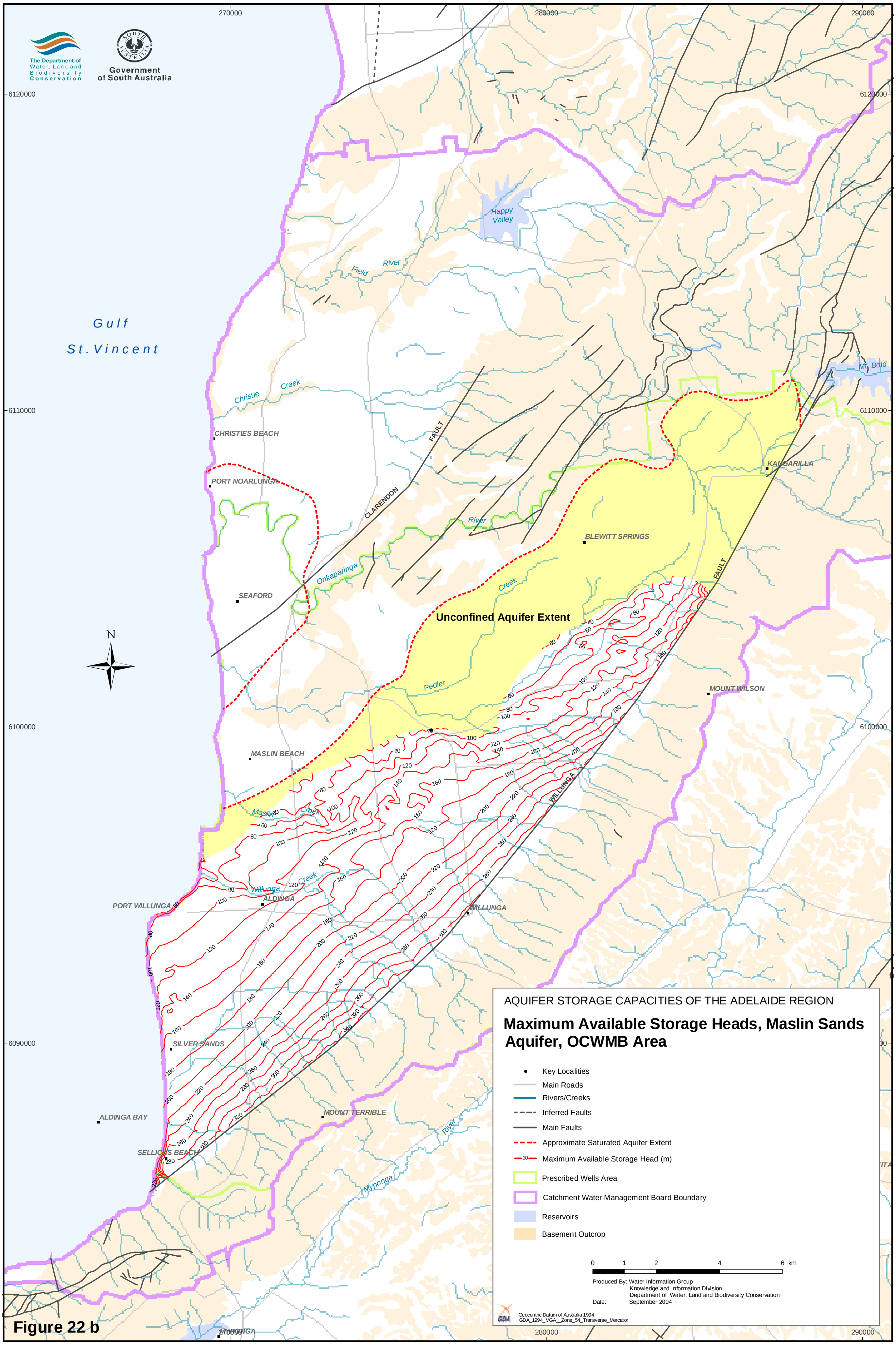
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 21 i



Gulf
St. Vincent
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Happy Valley
Field River
Christie Creek
CHRISTIES BEACH
PORT NOARLUNGA
CLARENDON FAULT
Onkaparinga River
Creek
BLEWITT SPRINGS
SEAFORD
Pedler
MCLAREN VALE
MASLIN BEACH
Unconfined Aquifer Extent
Maslin Creek
Willunga Creek
ALDINGA
PORT WILLUNGA
WILLUNGA
WILLUNGA FAULT
MOUNT WILSON
KANGARILLA
Mt Bold
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Myponga River
MYPONGA
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Maximum Available Storage Heads, Port Willunga Formation Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Maximum Available Storage Head (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 22 a


The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
N
Happy Valley
Field River
Christie Creek
CHRISTIES BEACH
PORT NOARLUNGA
CLARENDON FAULT
Onkaparinga River
SEAFORD
BLEWITT SPRINGS
KANGARILLA
Mt Bold
FAULT
Unconfined Aquifer Extent
Pedler Creek
MOUNT WILSON
MASLIN BEACH
Maslin Creek
WILLUNGA FAULT
Willunga Creek
ALDINGA
PORT WILLUNGA
WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Myponga River
270000
280000
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AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Maximum Available Storage Heads, Maslin Sands Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Maximum Available Storage Head (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 22 b

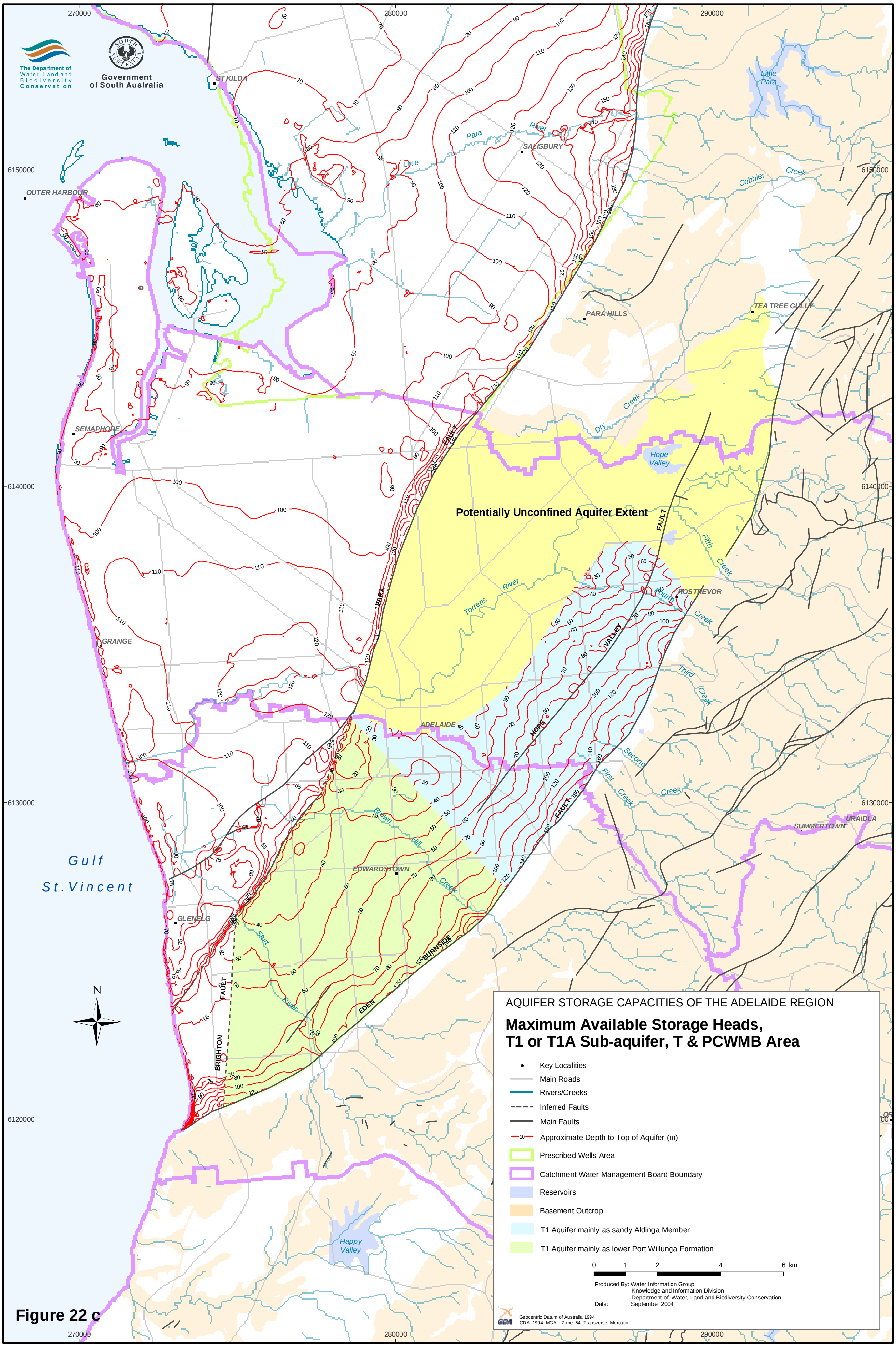
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Maximum Available Storage Heads,
T1 or T1A Sub-aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
T1 Aquifer mainly as sandy Aldinga Member
T1 Aquifer mainly as lower Port Willunga Formation
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Potentially Unconfined Aquifer Extent
Gulf
St.Vincent
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Little Para
Hope Valley
Happy Valley
Torrens River
Dry Creek
Cobbler Creek
Fifth Creek
Third Creek
Second Creek
First Creek
Sturt River
Brown Hill Creek
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
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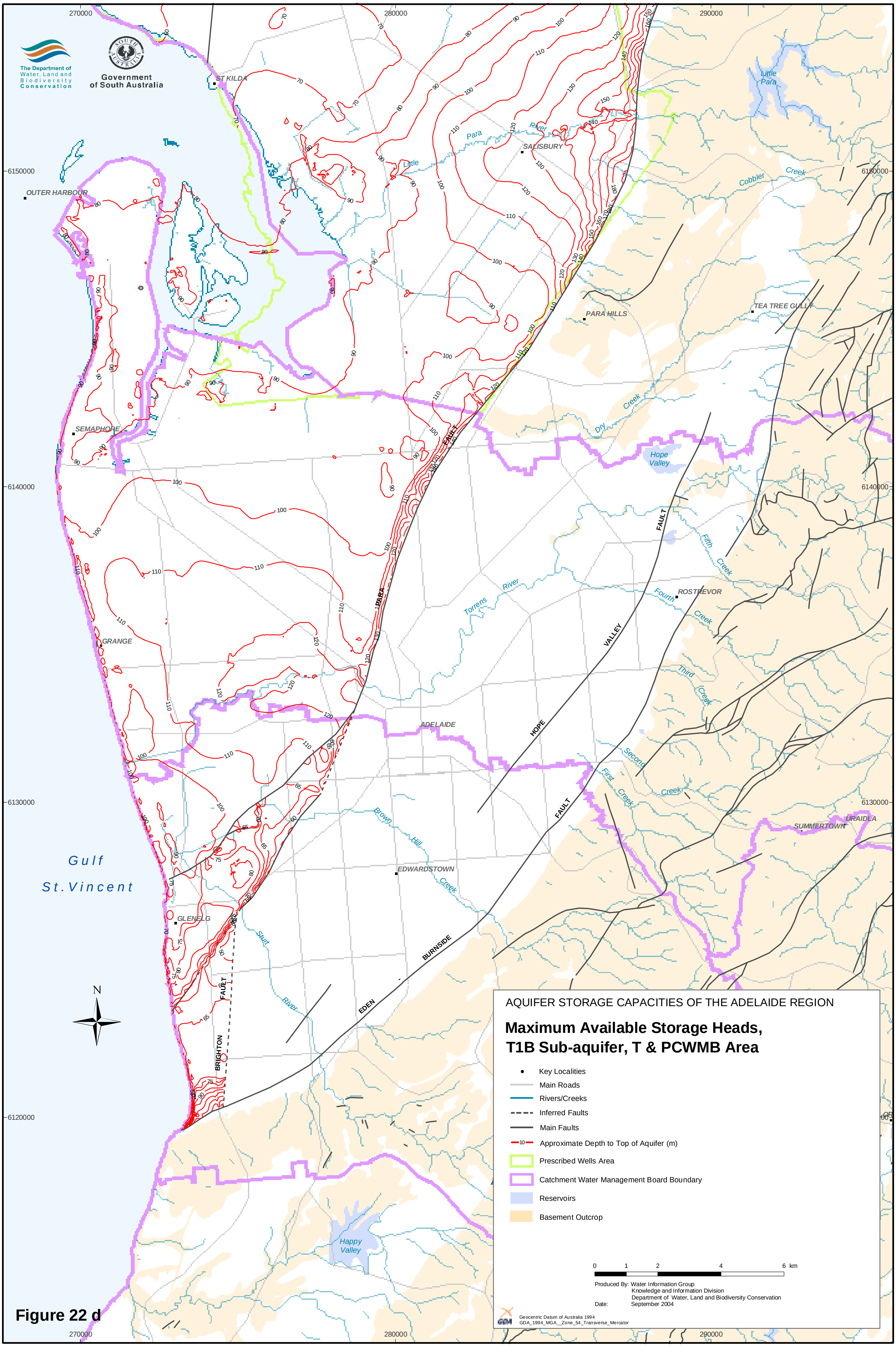
Figure 22 c



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Maximum Available Storage Heads, T1B Sub-aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf St.Vincent
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ROSTREVOR
ADELAIDE
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Little Para
Hope Valley
Happy Valley
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
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Figure 22 d

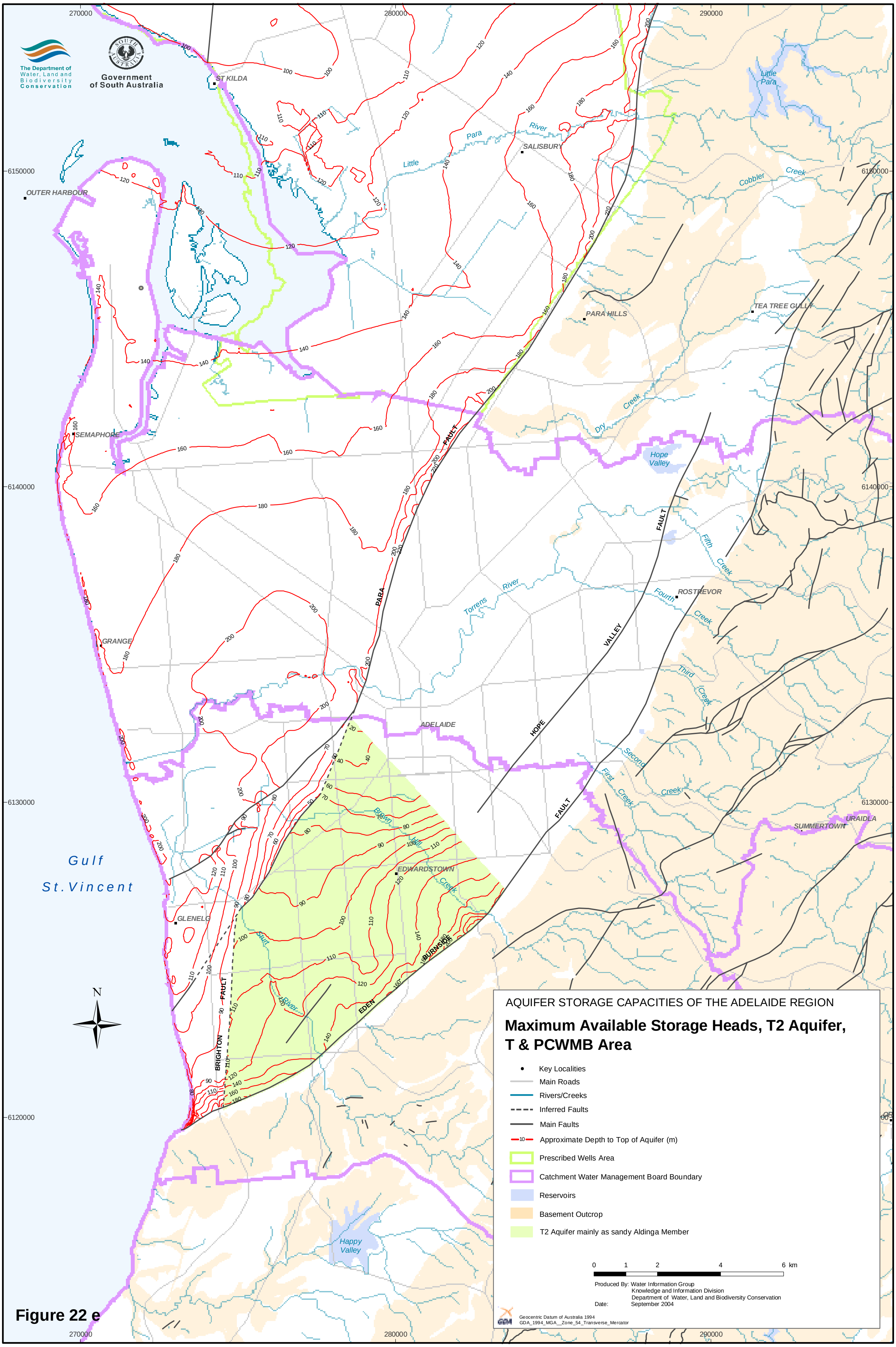
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Maximum Available Storage Heads, T2 Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
T2 Aquifer mainly as sandy Aldinga Member
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Little Para
Hope Valley
Happy Valley
Torrens River
Dry Creek
Cobbler Creek
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE
BRIGHTON FAULT
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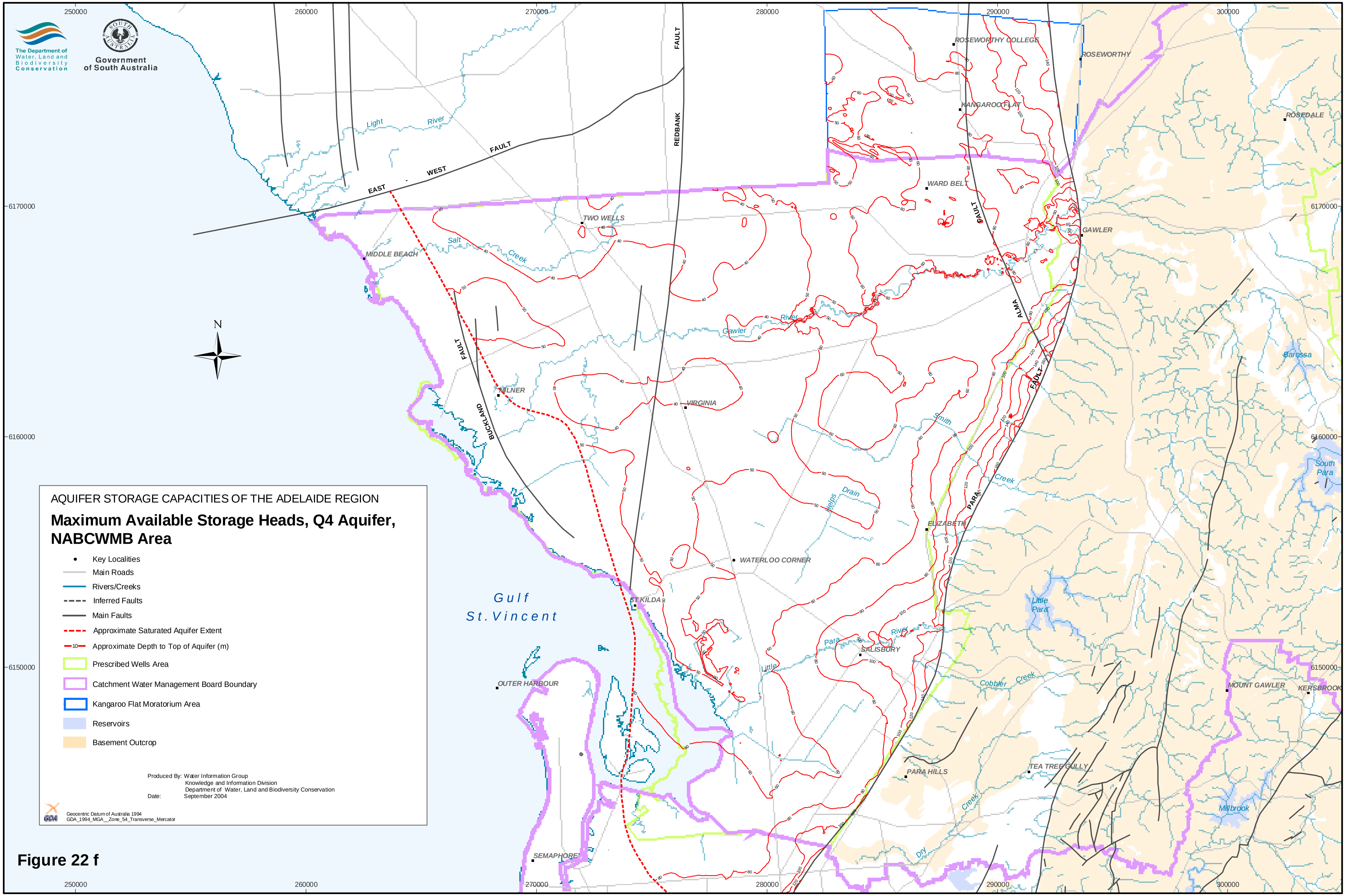
Figure 22 e



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Maximum Available Storage Heads, Q4 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
SEMAPHORE
EAST WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
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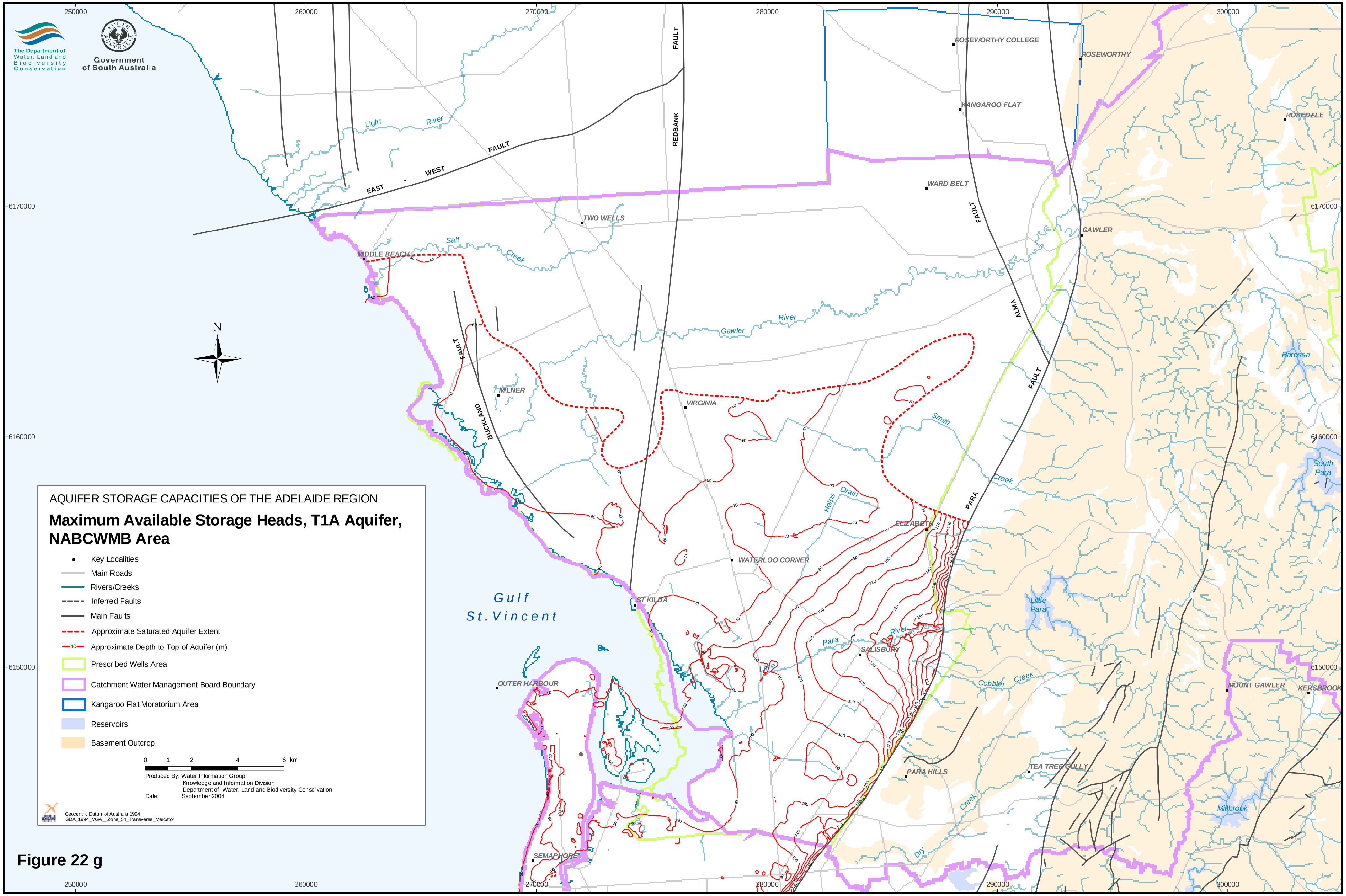
Figure 22 f



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Maximum Available Storage Heads, T1A Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Approximate Depth to Top of Aquifer (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Para River
Cobbler Creek
Dry Creek
Little Para
South Para
Barossa
Millbrook
EAST - WEST FAULT
BUCKLAND FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
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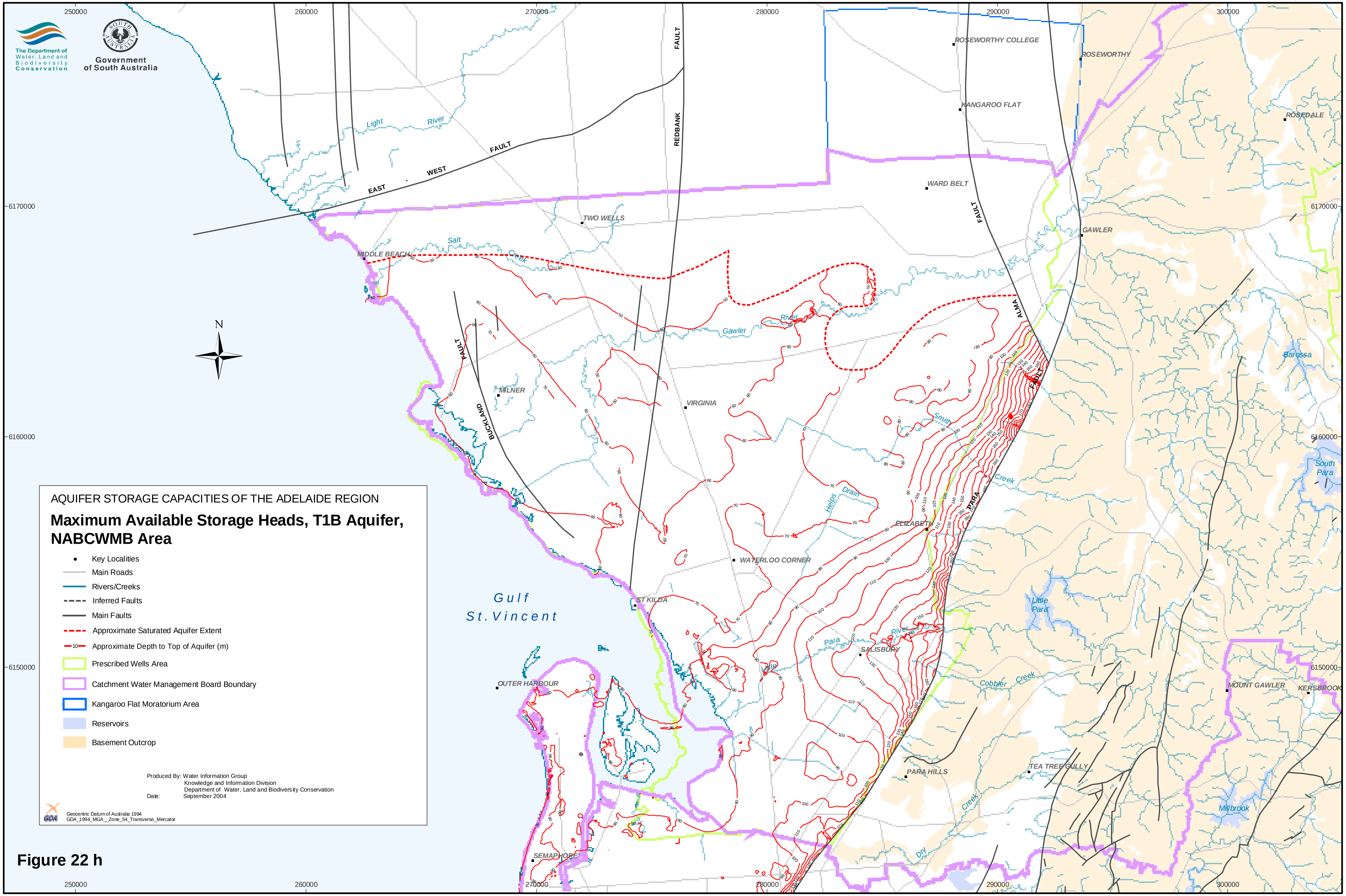
Figure 22 g



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION

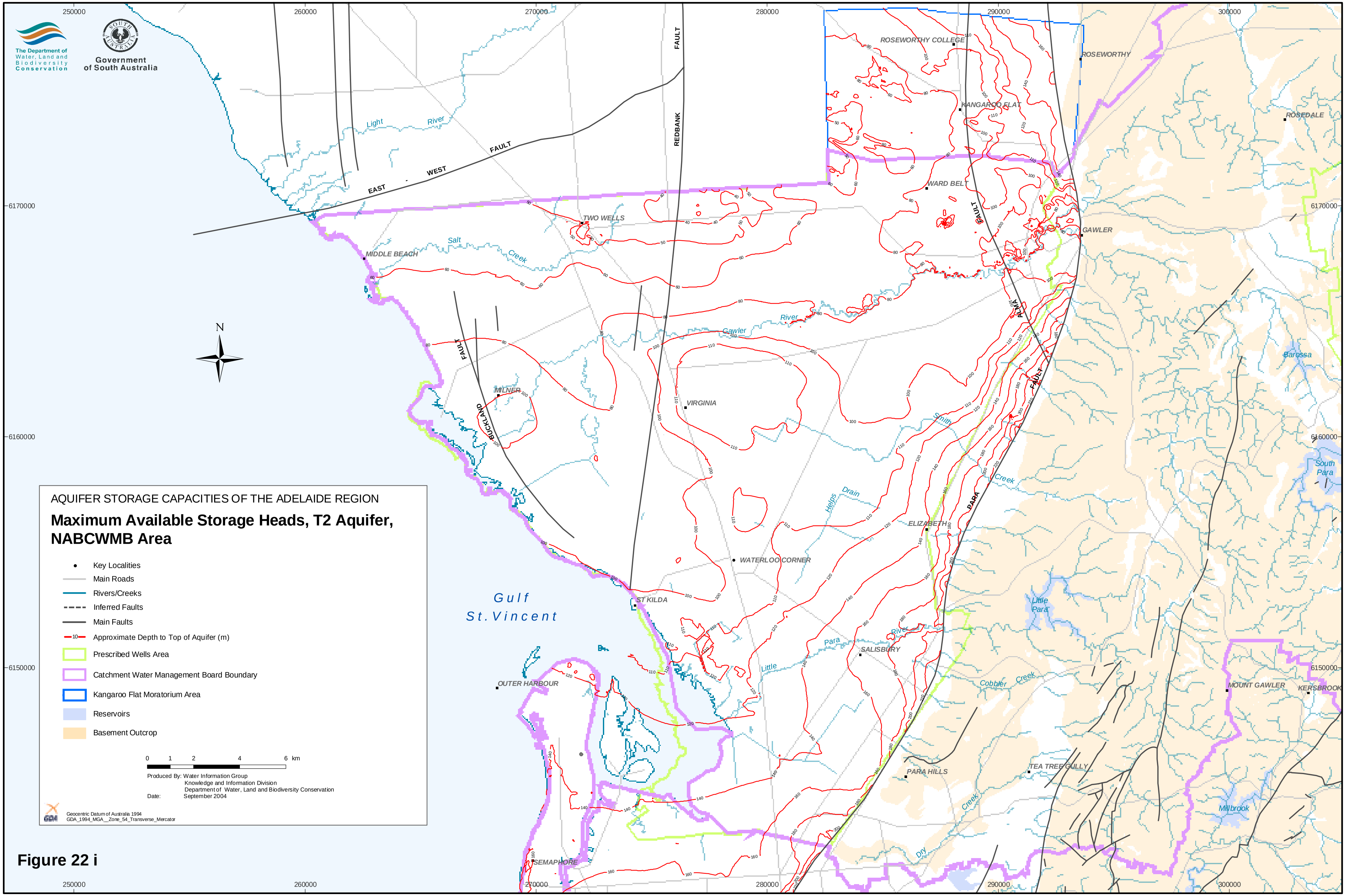
Maximum Available Storage Heads, T1B Aquifer, NABCWMB Area

- Key Localities
- Main Roads
- Rivers/Creeks
- Inferred Faults
- Main Faults
- Approximate Saturated Aquifer Extent
- Approximate Depth to Top of Aquifer (m)
- Prescribed Wells Area
- Catchment Water Management Board Boundary
- Kangaroo Flat Moratorium Area
- Reservoirs
- Basement Outcrop

Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004

Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 22 h



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION

Maximum Available Storage Heads, T2 Aquifer, NABCWMB Area

- Key Localities
- Main Roads
- Rivers/Creeks
- Inferred Faults
- Main Faults
- Approximate Depth to Top of Aquifer (m)
- Prescribed Wells Area
- Catchment Water Management Board Boundary
- Kangaroo Flat Moratorium Area
- Reservoirs
- Basement Outcrop

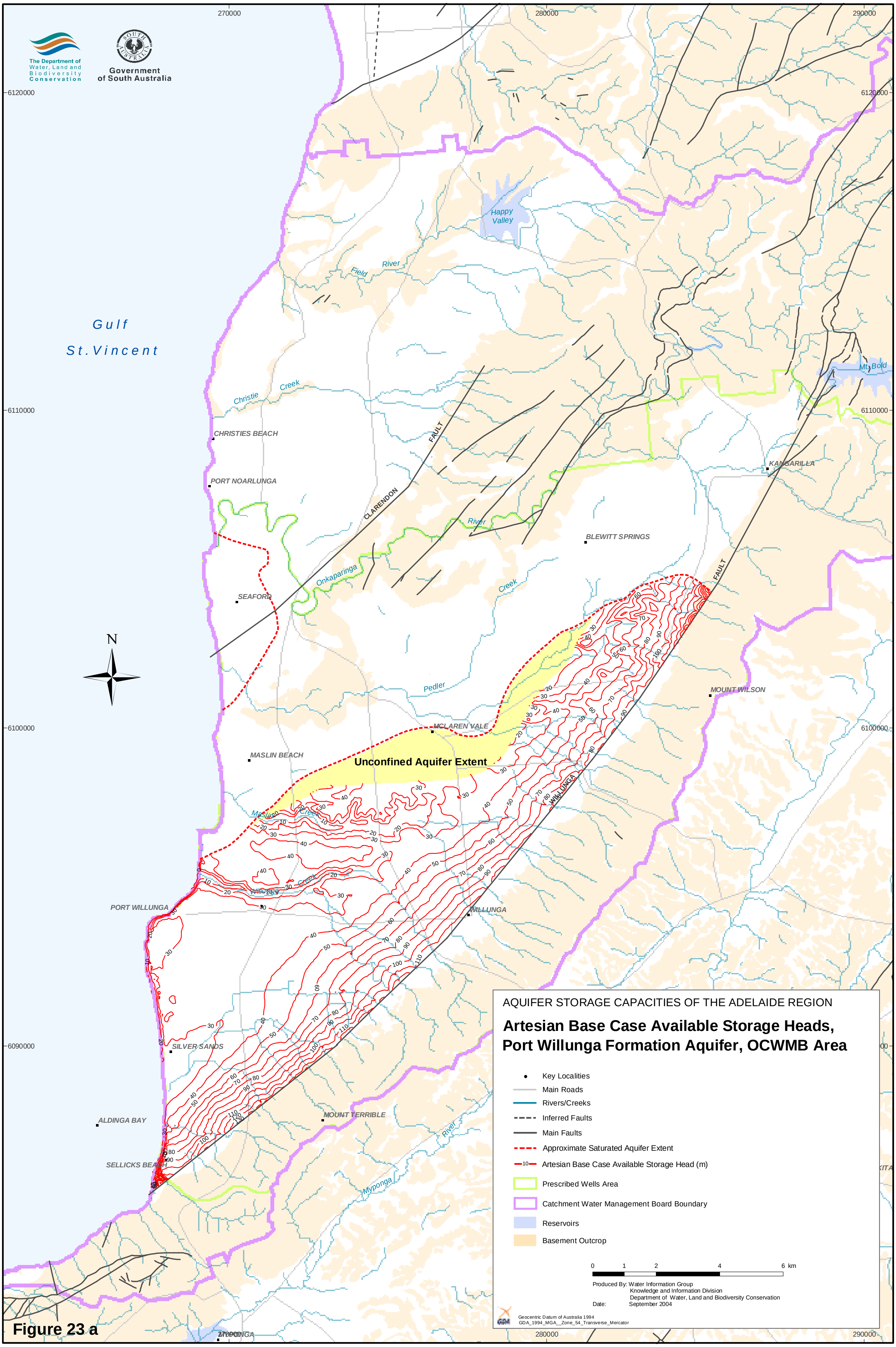
0 1 2 4 6 km

Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation

Date: September 2004

Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 22 i



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
Happy Valley
Field River
Christie Creek
CHRISTIES BEACH
PORT NOARLUNGA
CLARENDON FAULT
Onkaparinga River
SEAFORD
BLEWITT SPRINGS
KANGARILLA
Mt Bold
FAULT
Pedler Creek
MOUNT WILSON
MCLAREN VALE
MASLIN BEACH
Unconfined Aquifer Extent
Maslin Creek
WILLUNGA FAULT
Willunga Creek
PORT WILLUNGA
WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Myponga River
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Artesian Base Case Available Storage Heads, Port Willunga Formation Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Artesian Base Case Available Storage Head (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
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Figure 23 a

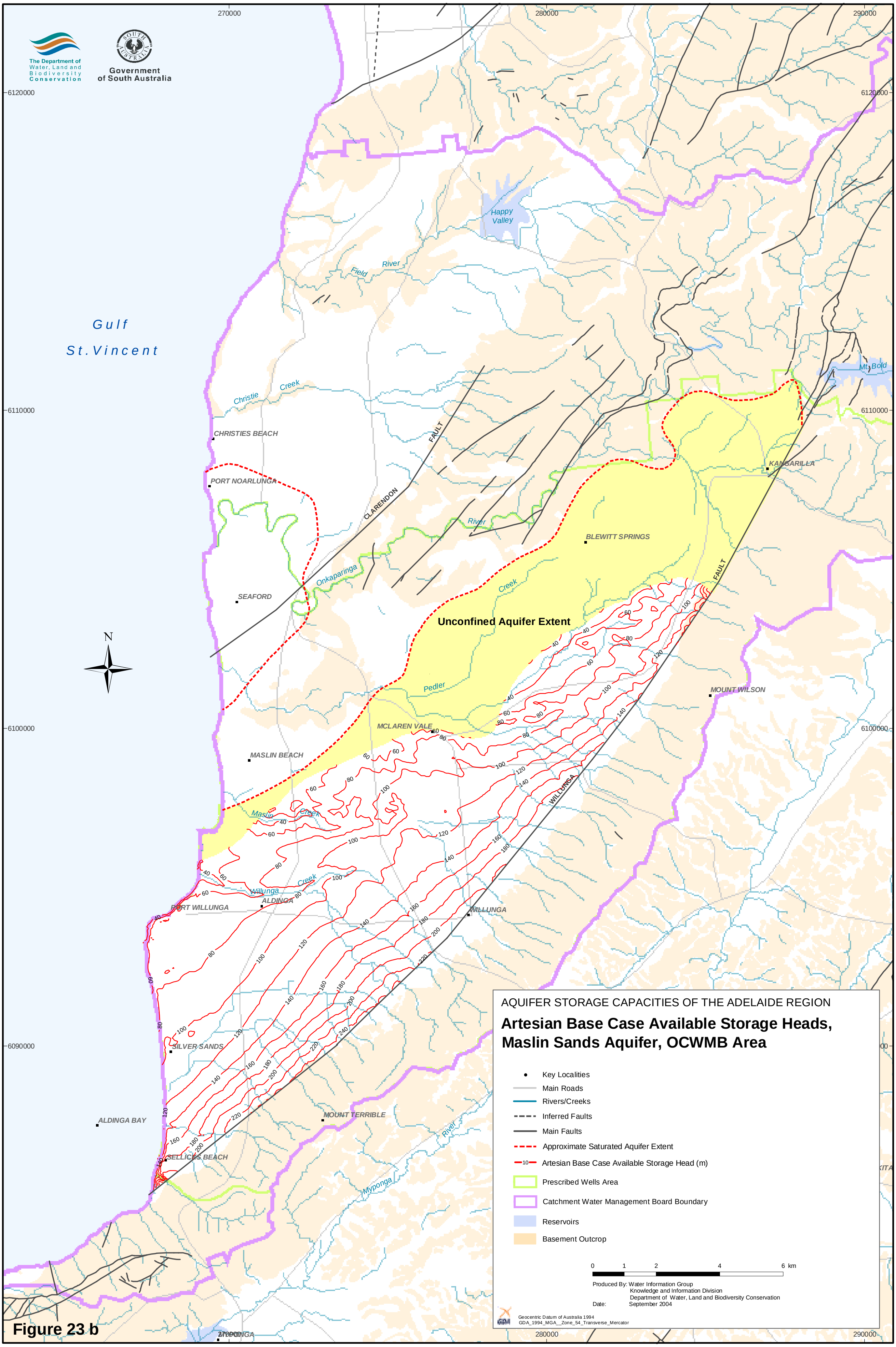
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Artesian Base Case Available Storage Heads, Maslin Sands Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Artesian Base Case Available Storage Head (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
Unconfined Aquifer Extent
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
MASLIN BEACH
MCLAREN VALE
BLEWITT SPRINGS
KANGARILLA
MOUNT WILSON
PORT WILLUNGA
ALDINGA
WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Happy Valley
Mt Bold
Field River
Christie Creek
Onkaparinga River
Pedler Creek
Maslin Creek
Willunga Creek
Myponga River
CLARENDON FAULT
WILLUNGA FAULT
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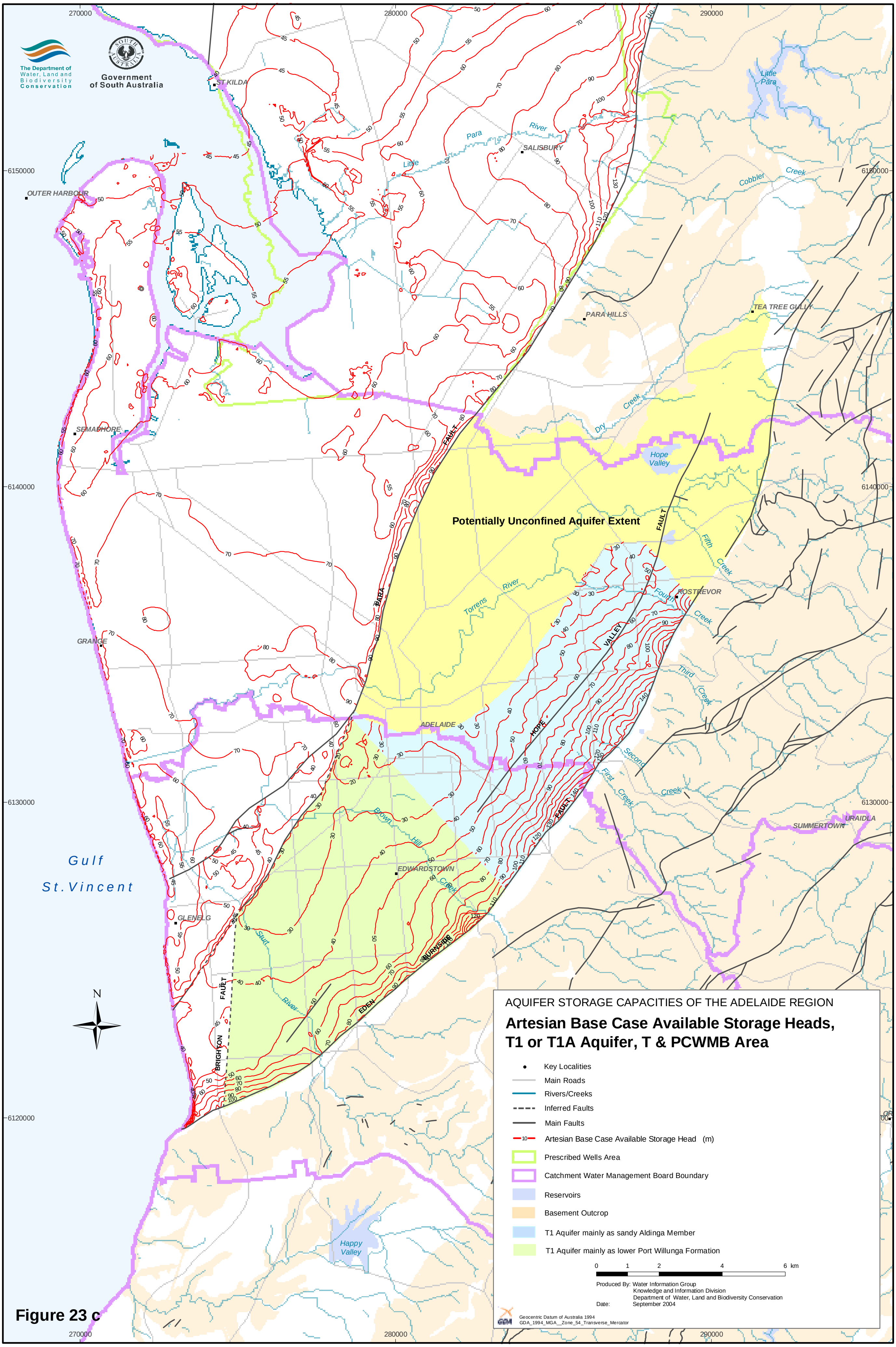
Figure 23 b



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Artesian Base Case Available Storage Heads, T1 or T1A Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Artesian Base Case Available Storage Head (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
T1 Aquifer mainly as sandy Aldinga Member
T1 Aquifer mainly as lower Port Willunga Formation
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Potentially Unconfined Aquifer Extent
Gulf St.Vincent
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
Little Para
Para River
Cobbler Creek
Dry Creek
Hope Valley
Torrens River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
Happy Valley
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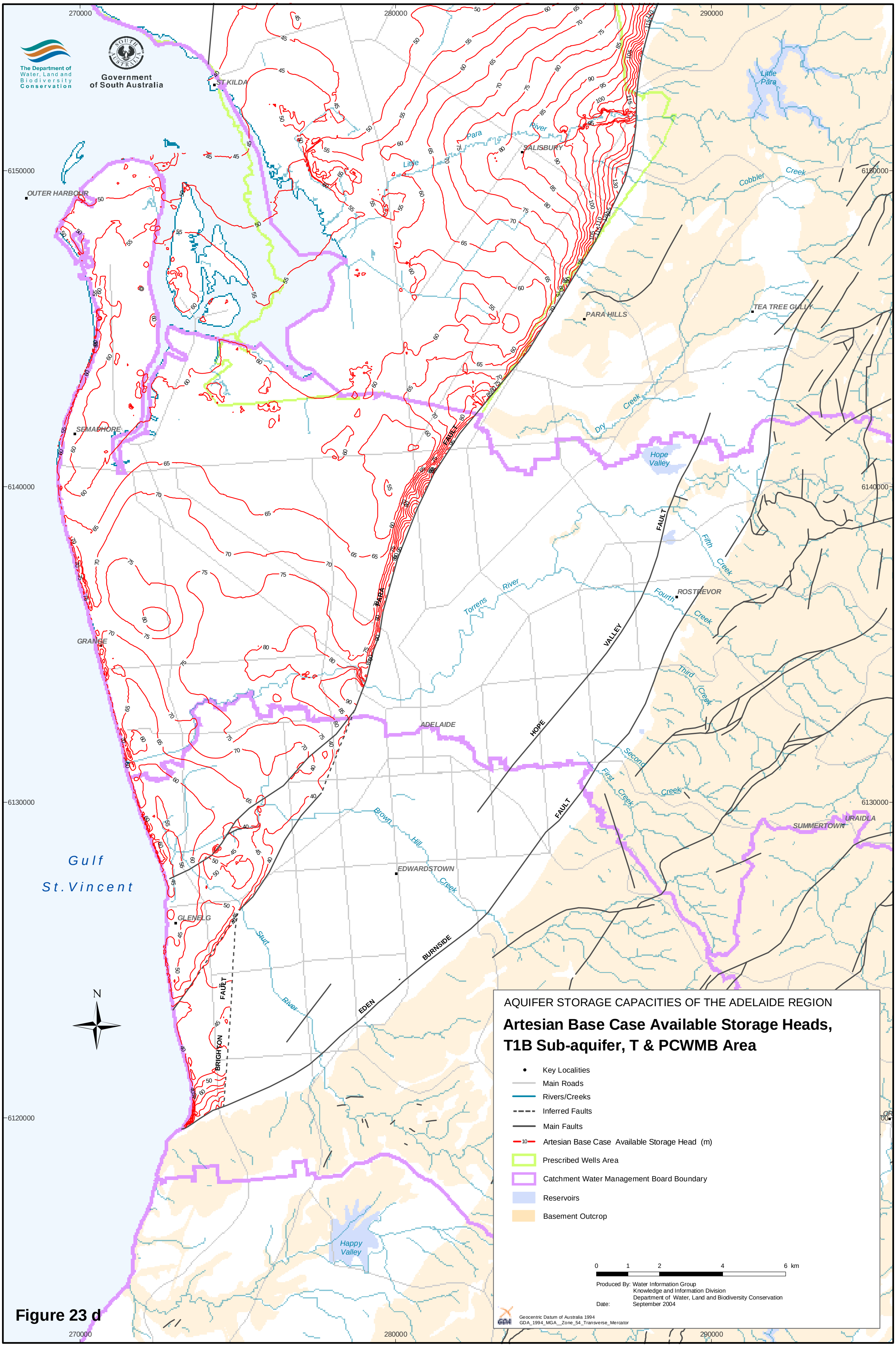
Figure 23 c


The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Artesian Base Case Available Storage Heads, T1B Sub-aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Artesian Base Case Available Storage Head (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
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ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Gulf
St.Vincent
Little Para
Hope Valley
Happy Valley
Little Para River
Dry Creek
Cobbler Creek
Torrens River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
N

Figure 23 d

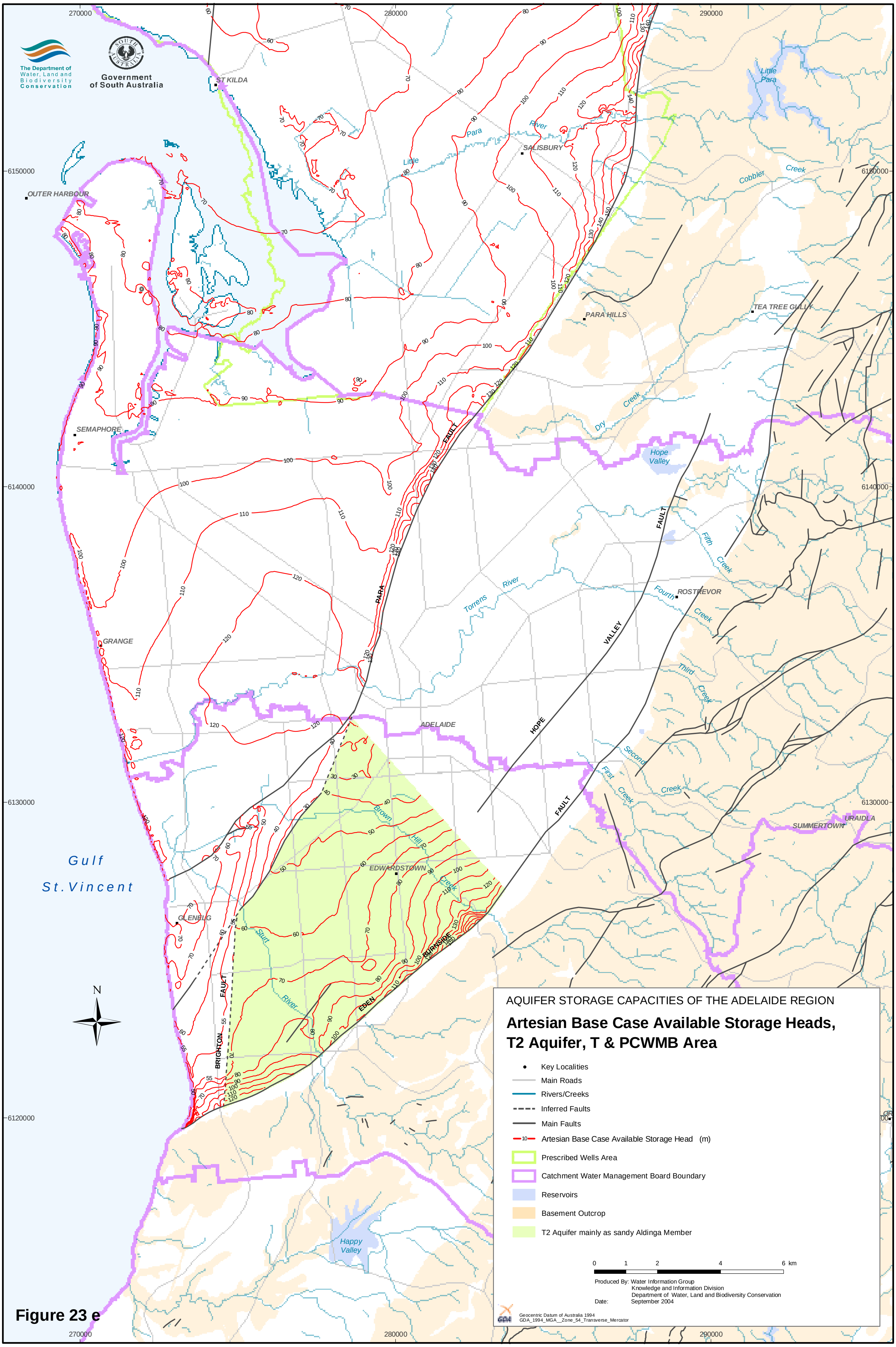
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Artesian Base Case Available Storage Heads, T2 Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Artesian Base Case Available Storage Head (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
T2 Aquifer mainly as sandy Aldinga Member
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ROSTREVOR
ADELAIDE
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Gulf
St.Vincent
Little Para
Cobbler Creek
Para River
Little Para
Dry Creek
Hope Valley
Torrens River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
Happy Valley
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE
BRIGHTON FAULT
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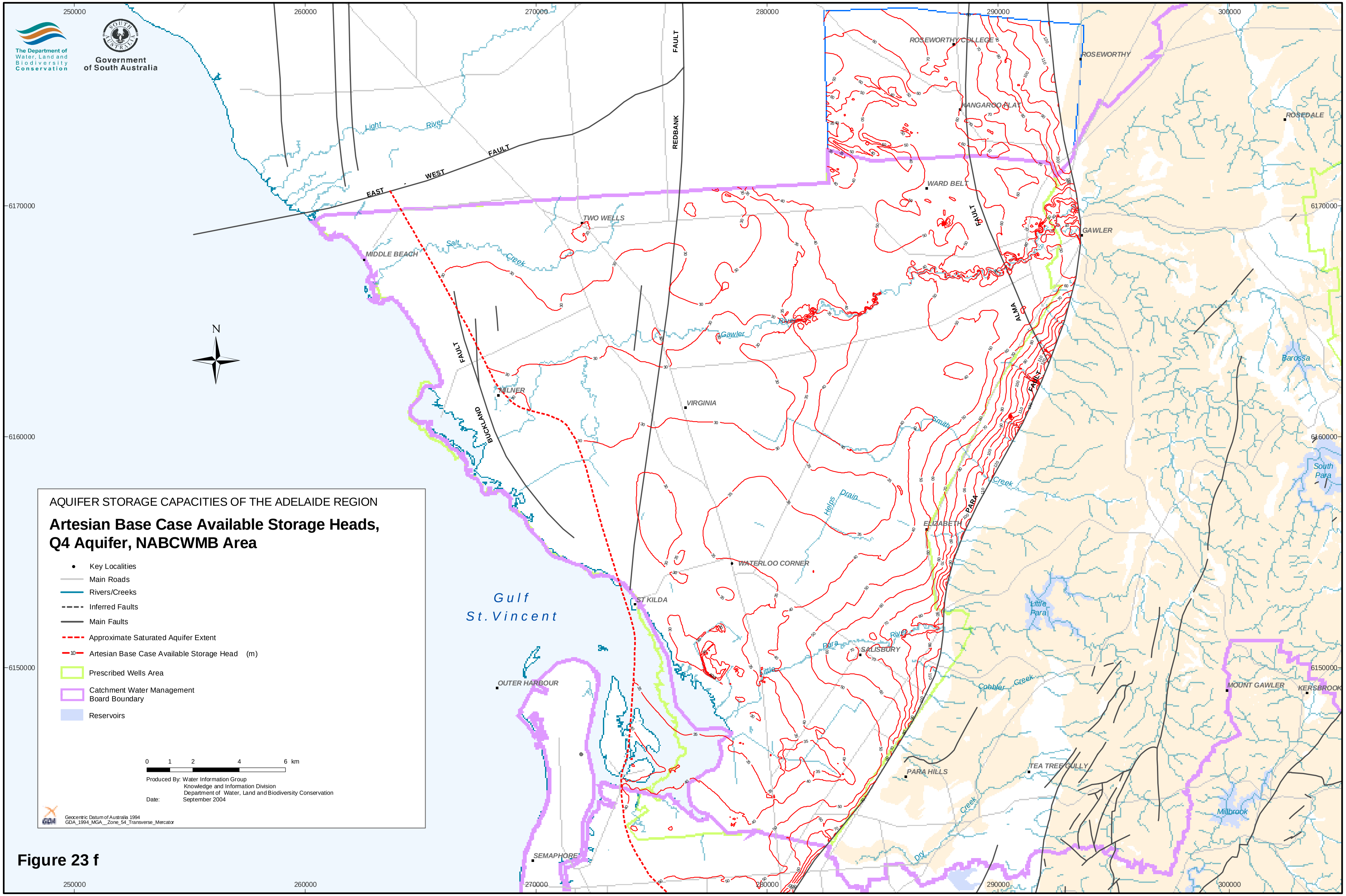
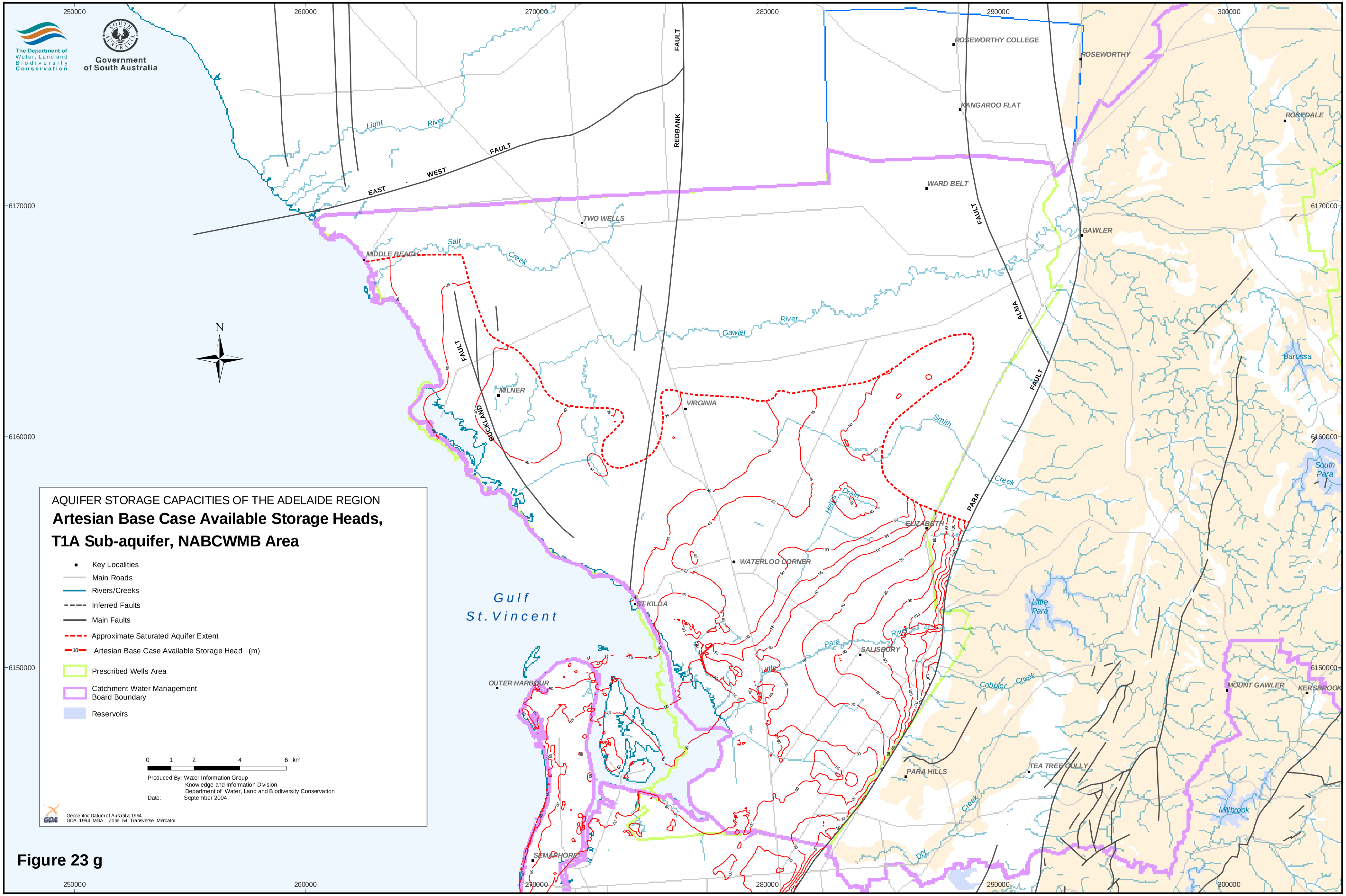
Figure 23 e



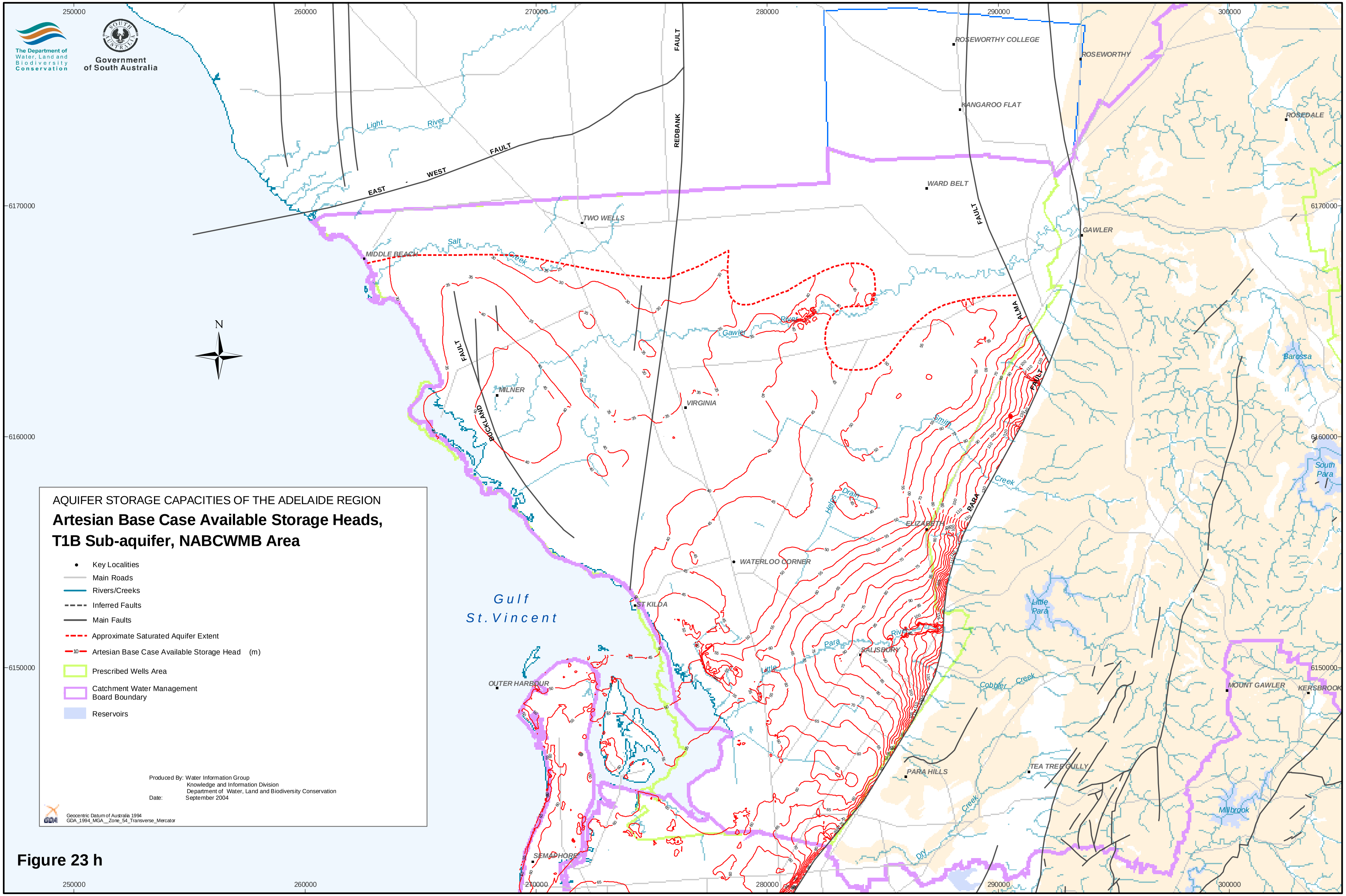
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Artesian Base Case Available Storage Heads, Q4 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Artesian Base Case Available Storage Head (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf St.Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 23 f



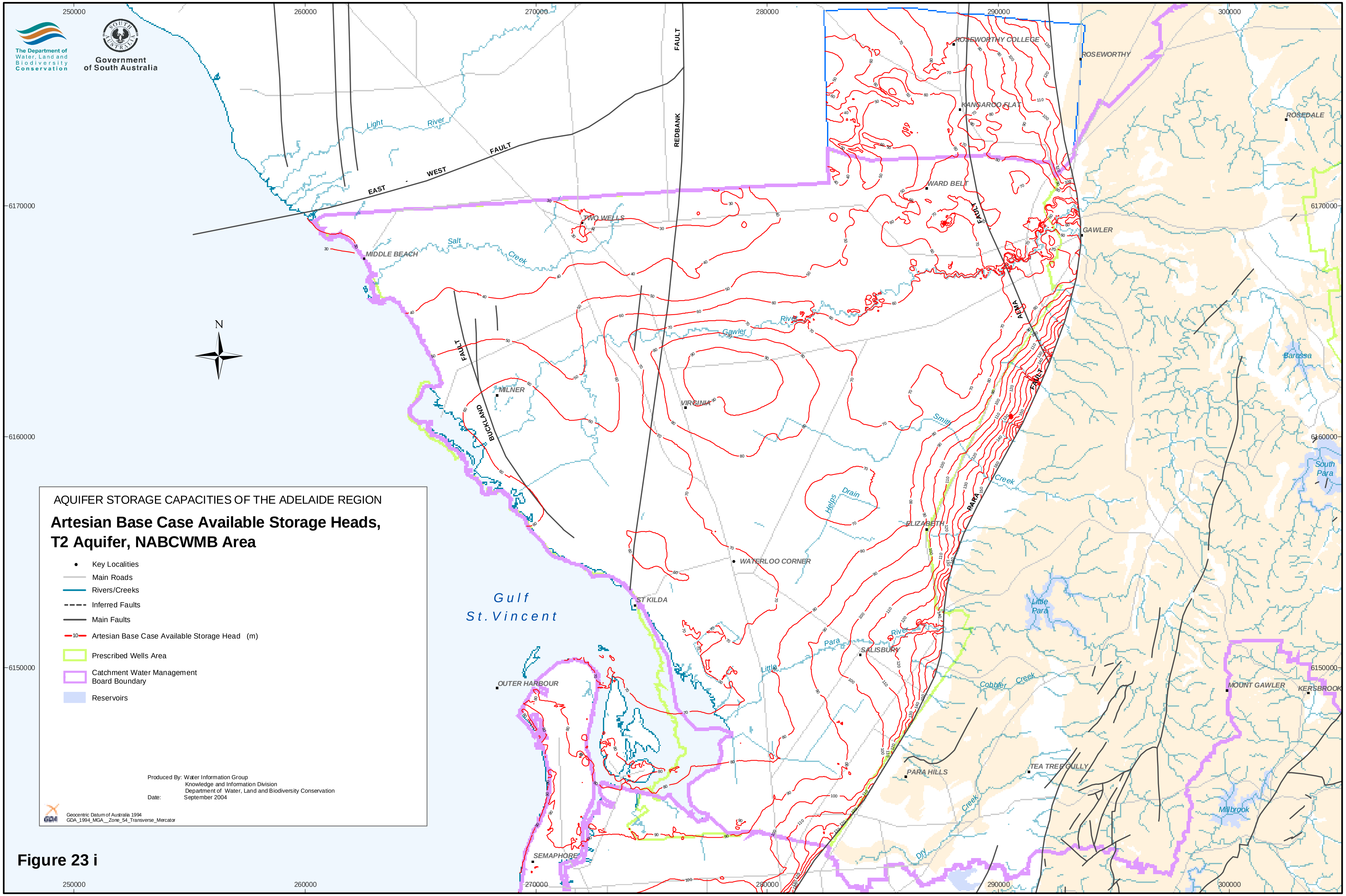
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
Light
River
Salt
Creek
Gawler
River
Smith
Creek
Helps
Drain
Para
River
Little
Cobbler
Creek
Dry
Creek
Barossa
South Para
Little Para
Millbrook
EAST
WEST
FAULT
REDBANK
FAULT
BUCKLAND
FAULT
ALMA
FAULT
PARA
FAULT
N
Gulf
St. Vincent
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Artesian Base Case Available Storage Heads,
T1A Sub-aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Artesian Base Case Available Storage Head (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 23 g



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Artesian Base Case Available Storage Heads, T1B Sub-aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Saturated Aquifer Extent
Artesian Base Case Available Storage Head (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
N
Gulf St.Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
SEMAPHORE
Barossa
South Para
Little Para
Millbrook
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 23 h



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Artesian Base Case Available Storage Heads, T2 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Artesian Base Case Available Storage Head (m)
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST - WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
AEMA FAULT
PARA FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook

Figure 23 i

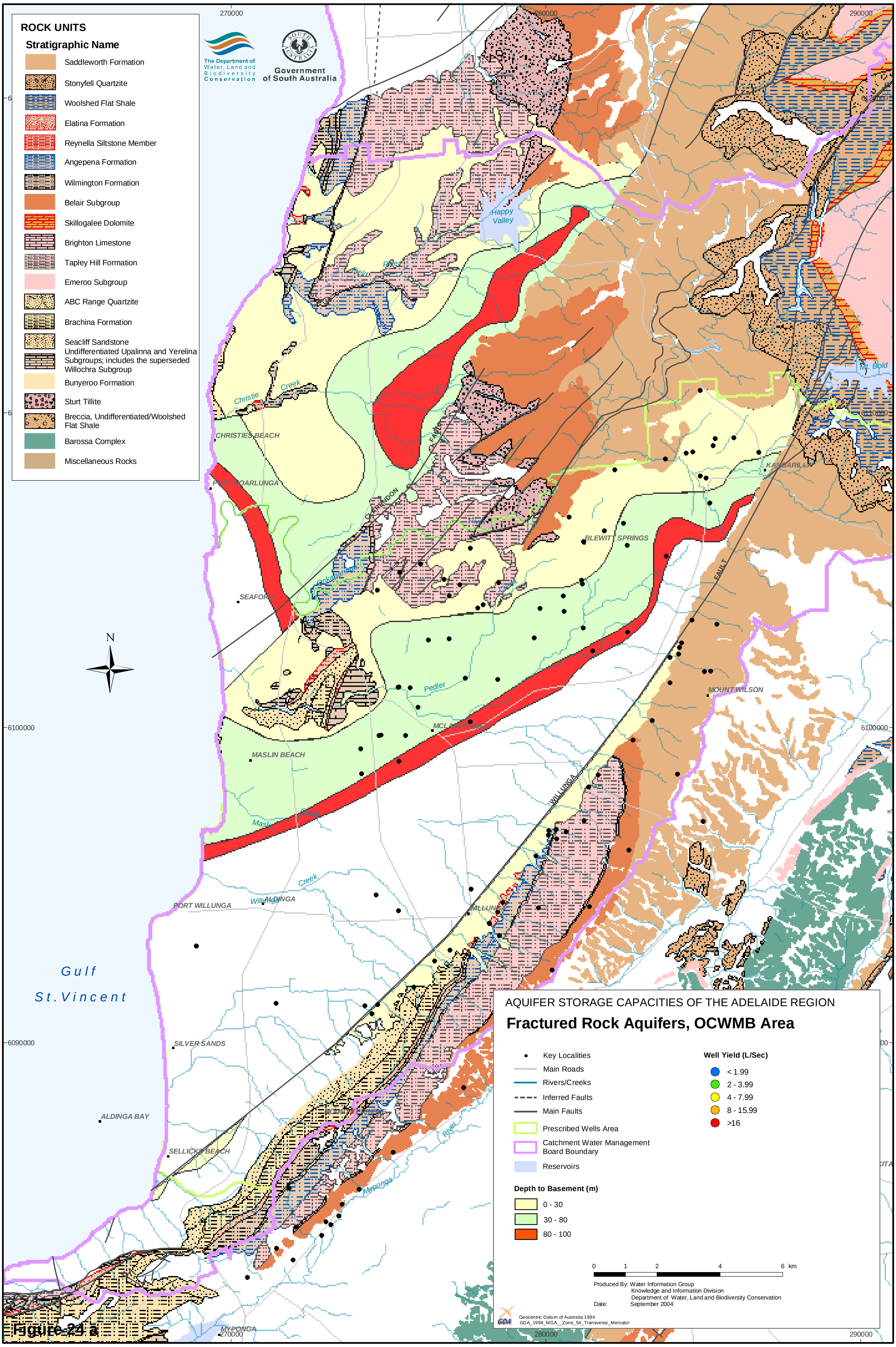
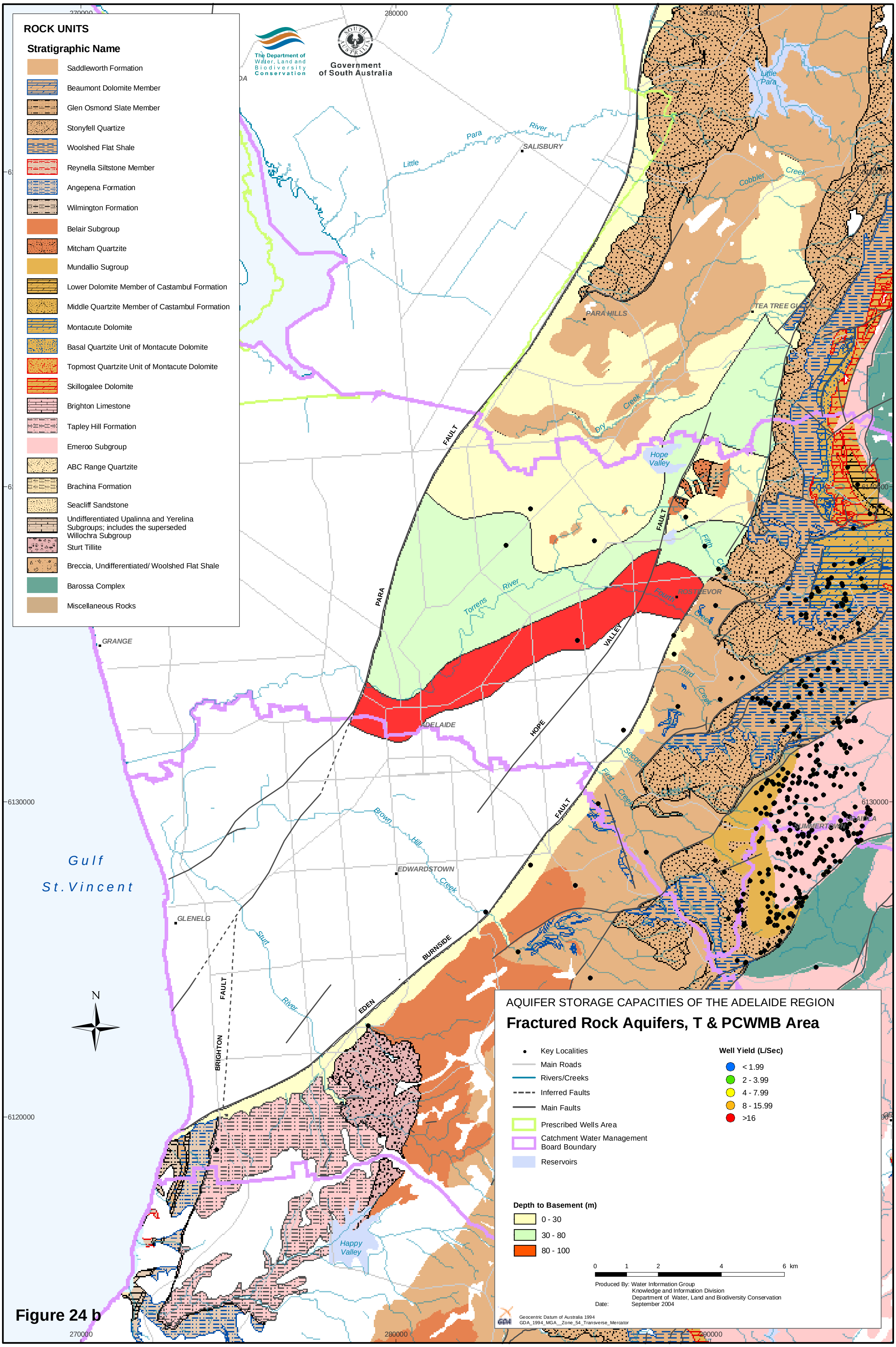

ROCK UNITS
Stratigraphic Name
Saddleworth Formation
Stonyfell Quartzite
Woolshed Flat Shale
Elatina Formation
Reynella Siltstone Member
Angepena Formation
Wilmington Formation
Belair Subgroup
Skillogalee Dolomite
Brighton Limestone
Tapley Hill Formation
Emeroo Subgroup
ABC Range Quartzite
Brachina Formation
Seacliff Sandstone
Undifferentiated Upalinna and Yerelina Subgroups; includes the superseded Willochra Subgroup
Bunyeroo Formation
Sturt Tillite
Breccia, Undifferentiated/Woolshed Flat Shale
Barossa Complex
Miscellaneous Rocks
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
N
270000
280000
290000
6100000
6090000
Happy Valley
Christie Creek
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
Onkaparinga
Pedler
MCLAREN VALE
MASLIN BEACH
BLEWITT SPRINGS
KANGARILLA
Mt. Bold
MOUNT WILSON
PORT WILLUNGA
ALDINGA
WILLUNGA
FAULT
SILVER SANDS
ALDINGA BAY
SELLICKS BEACH
MYPONGA
Myponga
River
Creek
Gulf
St. Vincent
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Fractured Rock Aquifers, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Well Yield (L/Sec)
< 1.99
2 - 3.99
4 - 7.99
8 - 15.99
>16
Depth to Basement (m)
0 - 30
30 - 80
80 - 100
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 24 a



ROCK UNITS
Stratigraphic Name
Saddleworth Formation
Beaumont Dolomite Member
Glen Osmond Slate Member
Stonyfell Quartzite
Woolshed Flat Shale
Reynella Siltstone Member
Angepena Formation
Wilmington Formation
Belair Subgroup
Mitcham Quartzite
Mundallio Sugroup
Lower Dolomite Member of Castambul Formation
Middle Quartzite Member of Castambul Formation
Montacute Dolomite
Basal Quartzite Unit of Montacute Dolomite
Topmost Quartzite Unit of Montacute Dolomite
Skillogalee Dolomite
Brighton Limestone
Tapley Hill Formation
Emeroo Subgroup
ABC Range Quartzite
Brachina Formation
Seacliff Sandstone
Undifferentiated Upalinna and Yerelina Subgroups; includes the superseded Willochra Subgroup
Sturt Tillite
Breccia, Undifferentiated/ Woolshed Flat Shale
Barossa Complex
Miscellaneous Rocks
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
270000
280000
290000
6130000
6120000
SALISBURY
Little
Para
River
Little Para
Cobbler
Creek
PARA HILLS
TEA TREE GULLY
Dry
Creek
Hope Valley
FAULT
PARA
Fifth
Creek
Torrens
River
Fourth
Creek
ROSTREVOR
VALLEY
FAULT
GRANGE
Third
Creek
ADELAIDE
HOPE
Second
First
Creek
FAULT
Brown
Hill
Creek
EDWARDSTOWN
SUMMERTOWN
GLENELG
Sturt
River
BURNSIDE
EDEN
FAULT
BRIGHTON
Gulf
St.Vincent
N
Happy Valley
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Fractured Rock Aquifers, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Well Yield (L/Sec)
< 1.99
2 - 3.99
4 - 7.99
8 - 15.99
>16
Depth to Basement (m)
0 - 30
30 - 80
80 - 100
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 24 b

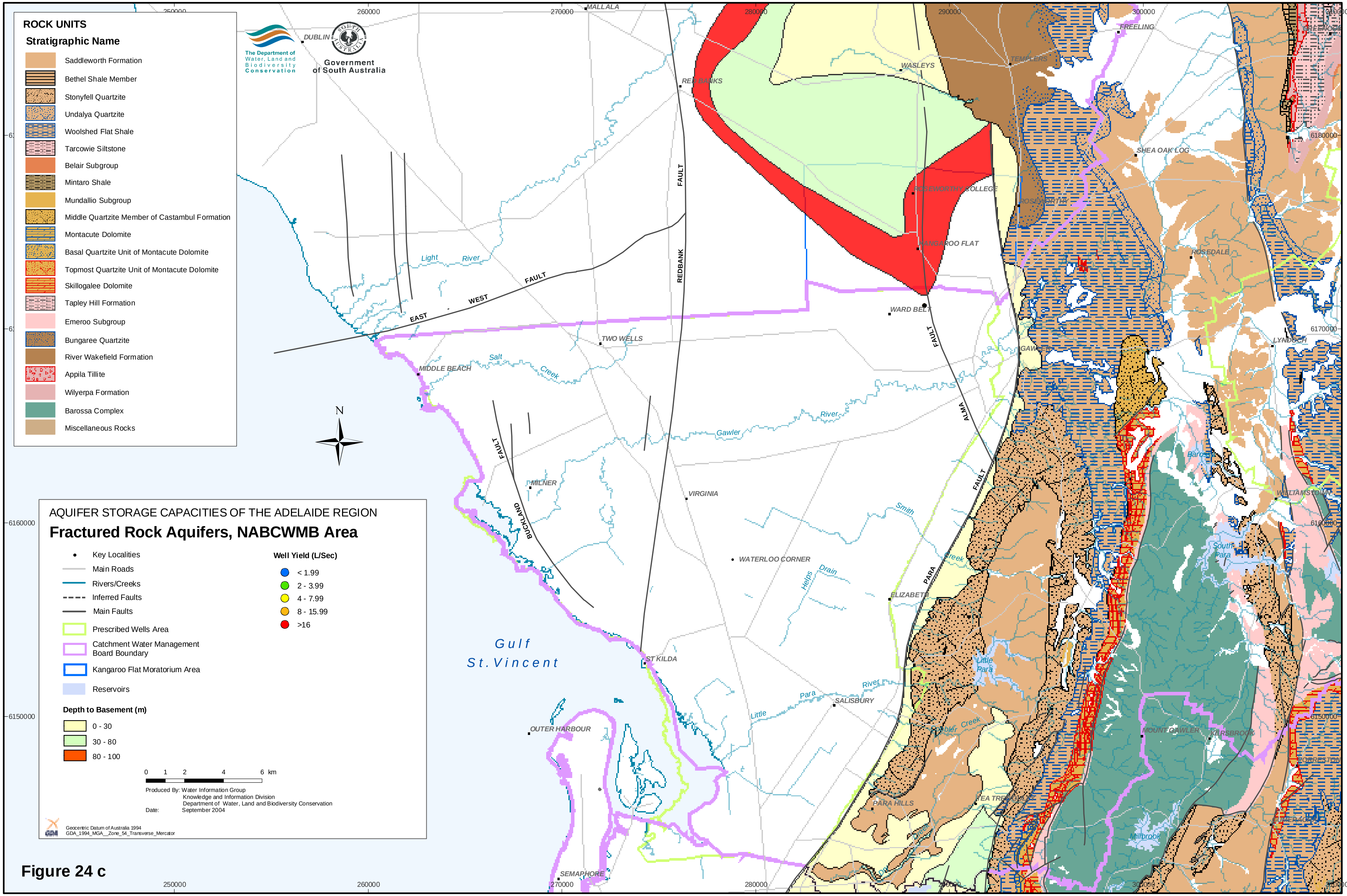
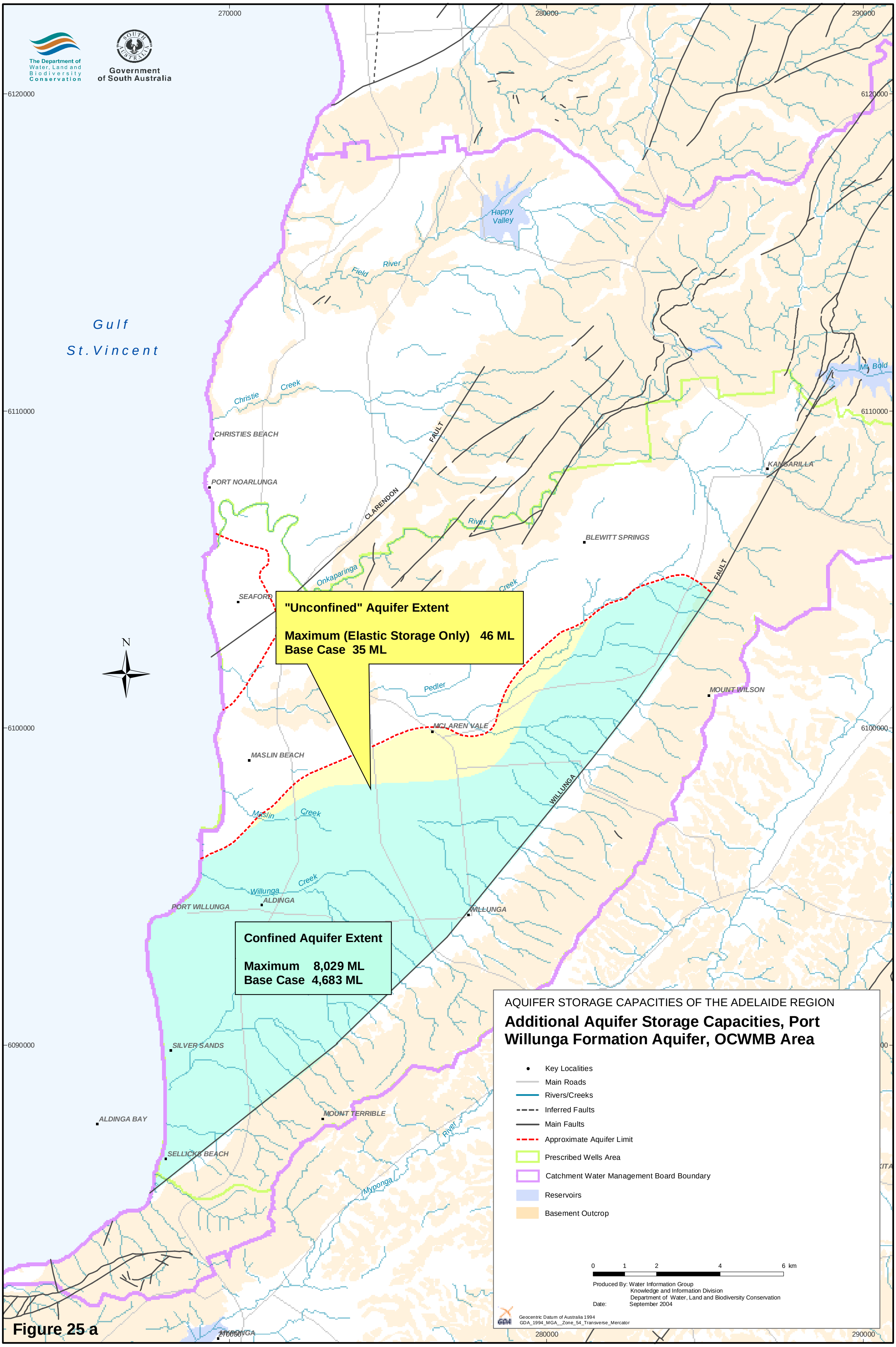
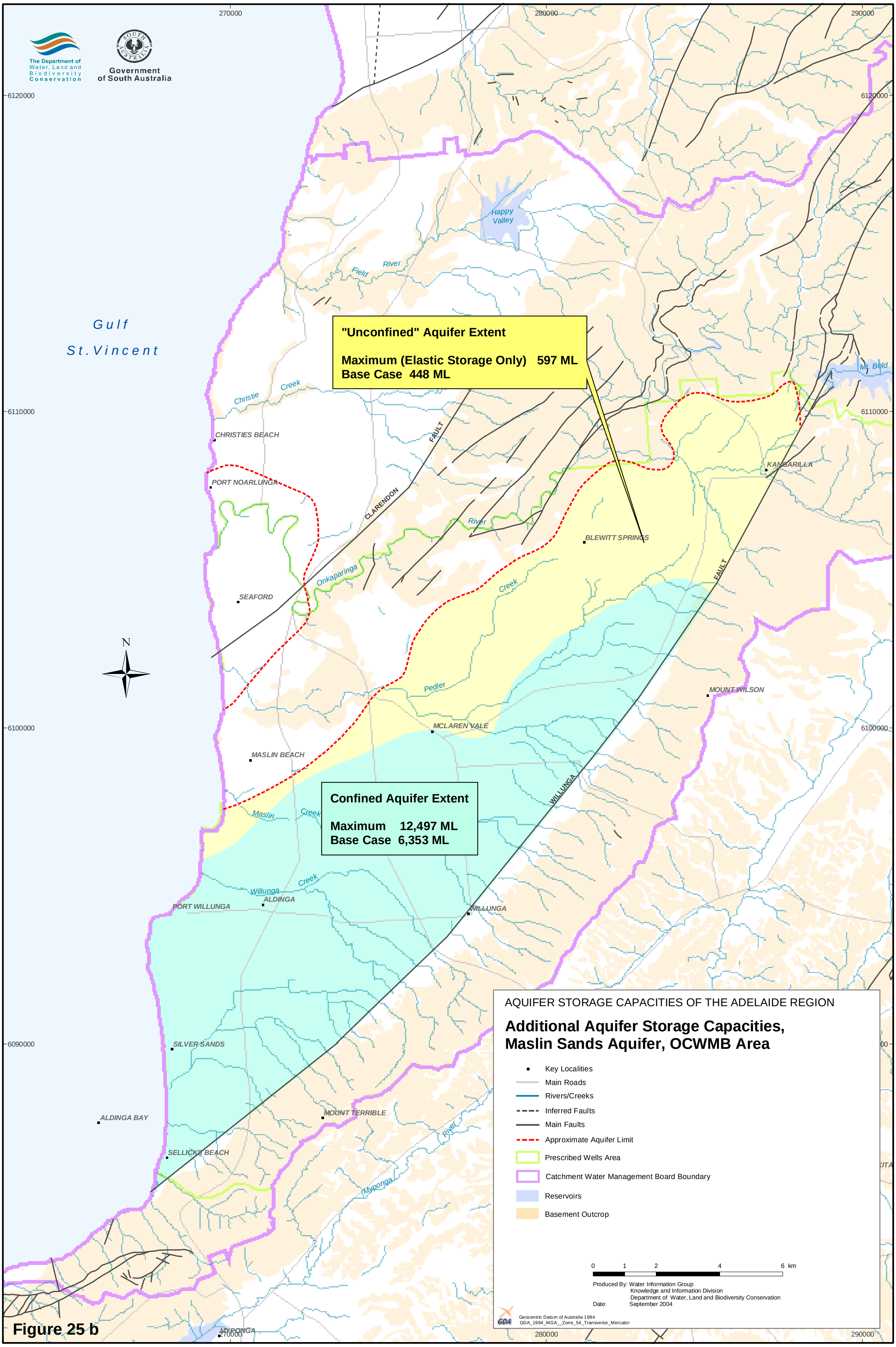

ROCK UNITS
Stratigraphic Name
Saddleworth Formation
Bethel Shale Member
Stonyfell Quartzite
Undalya Quartzite
Woolshed Flat Shale
Tarcowie Siltstone
Belair Subgroup
Mintaro Shale
Mundallio Subgroup
Middle Quartzite Member of Castambul Formation
Montacute Dolomite
Basal Quartzite Unit of Montacute Dolomite
Topmost Quartzite Unit of Montacute Dolomite
Skillogalee Dolomite
Tapley Hill Formation
Emeroo Subgroup
Bungaree Quartzite
River Wakefield Formation
Appila Tillite
Wilyerpa Formation
Barossa Complex
Miscellaneous Rocks
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Fractured Rock Aquifers, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Depth to Basement (m)
0 - 30
30 - 80
80 - 100
Well Yield (L/Sec)
< 1.99
2 - 3.99
4 - 7.99
8 - 15.99
>16
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
N
DUBLIN
MALLALA
REDBANKS
WASLEYS
TEMPLERS
FREELING
SHEA OAK LOG
ROSEDALE
ROSEWORTHY COLLEGE
KANGAROO FLAT
WARD BELT
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
WATERLOO CORNER
ELIZABETH
ST KILDA
OUTER HARBOUR
SEMAPHORE
SALISBURY
PARA HILLS
TEA TREE
LYNDOCH
WILLIAMSTOWN
MOUNT GAWLER
KERSBROOK
GAWLER
Gulf St.Vincent
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Little Para
South Para
Millbrook
EAST WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
250000
260000
270000
280000
290000
300000
6150000
6160000
6170000
6180000

Figure 24 c



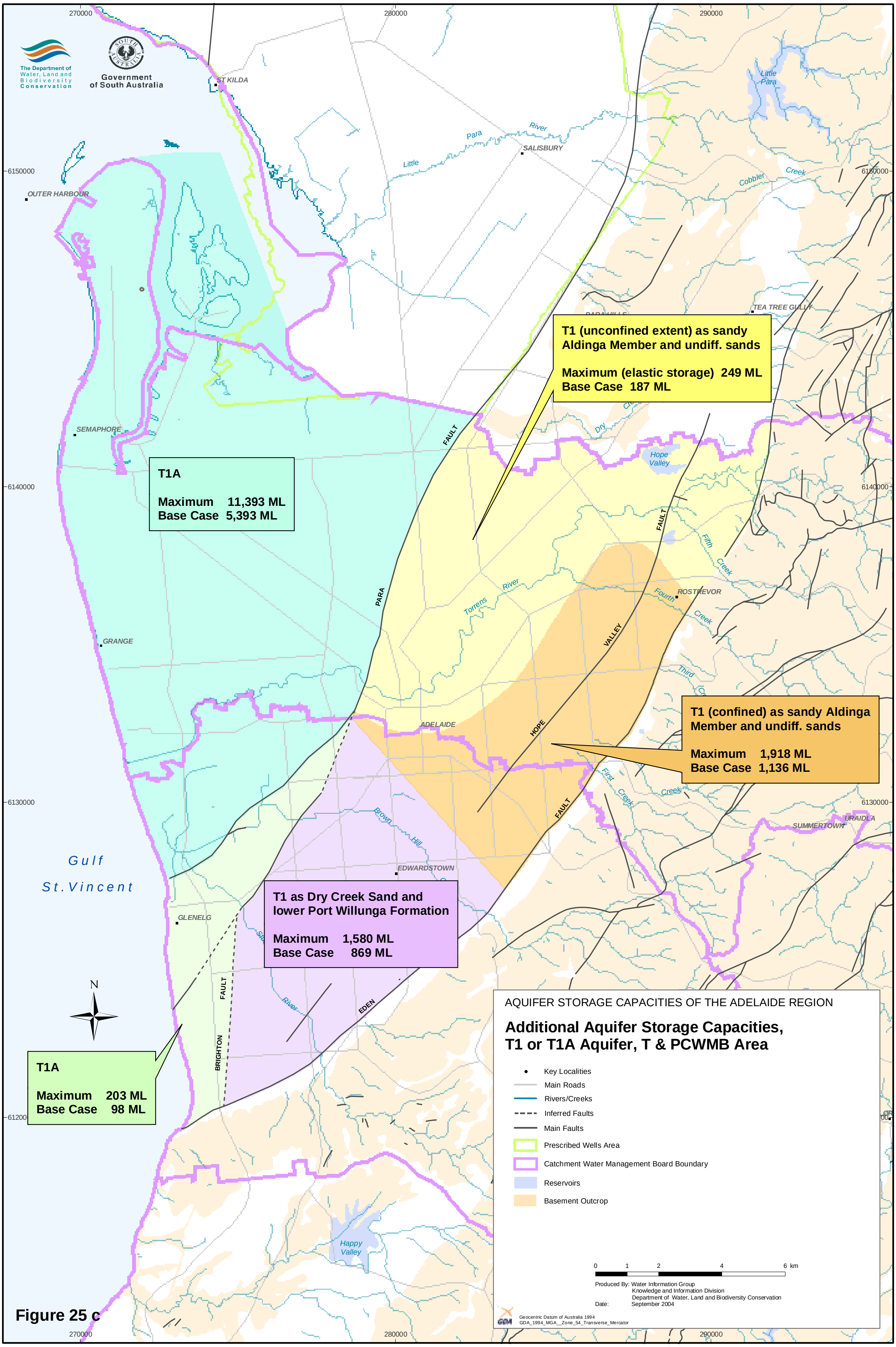
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St. Vincent
"Unconfined" Aquifer Extent
Maximum (Elastic Storage Only) 46 ML
Base Case 35 ML
Confined Aquifer Extent
Maximum 8,029 ML
Base Case 4,683 ML
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
MASLIN BEACH
PORT WILLUNGA
ALDINGA
SILVER SANDS
ALDINGA BAY
SELLICKS BEACH
MOUNT TERRIBLE
WILLUNGA
MCLAREN VALE
BLEWITT SPRINGS
MOUNT WILSON
KANGARILLA
Happy Valley
Field River
Christie Creek
Onkaparinga River
Pedler Creek
Maslin Creek
Willunga Creek
Myponga River
CLARENDON FAULT
WILLUNGA FAULT
270000
280000
290000
6120000
6110000
6100000
6090000
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities, Port Willunga Formation Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 25 a



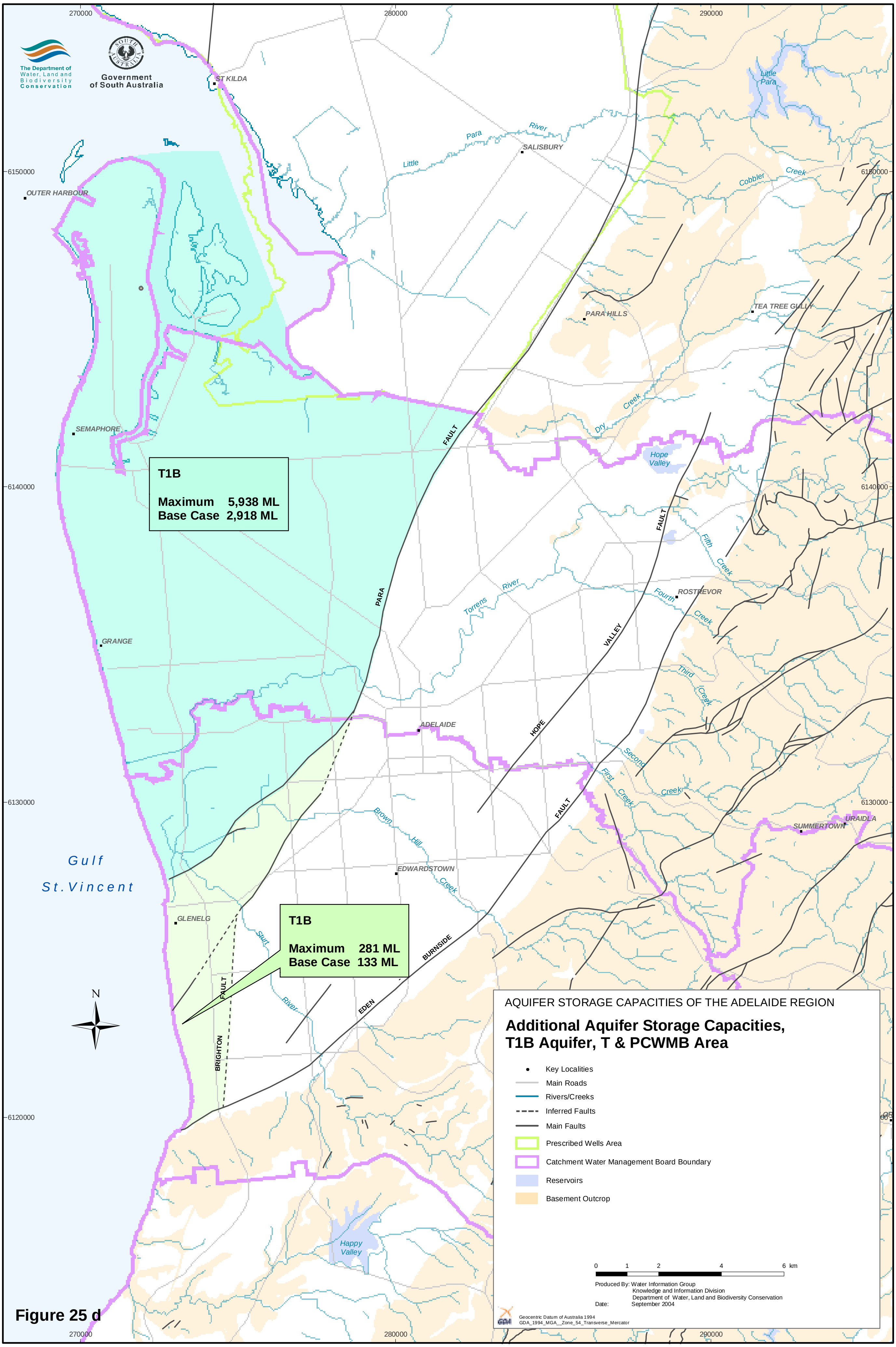
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf
St. Vincent
"Unconfined" Aquifer Extent
Maximum (Elastic Storage Only) 597 ML
Base Case 448 ML
Confined Aquifer Extent
Maximum 12,497 ML
Base Case 6,353 ML
Happy Valley
Field River
Christie Creek
CHRISTIES BEACH
PORT NOARLUNGA
Onkaparinga River
SEAFORD
CLARENDON
FAULT
BLEWITT SPRINGS
KANGARILLA
Mt Bold
Pedler Creek
MOUNT WILSON
MCLAREN VALE
MASLIN BEACH
Maslin Creek
WILLUNGA
Willunga Creek
ALDINGA
PORT WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Myponga River
MYPONGA
N
270000
280000
290000
6120000
6110000
6100000
6090000
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities, Maslin Sands Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 25 b



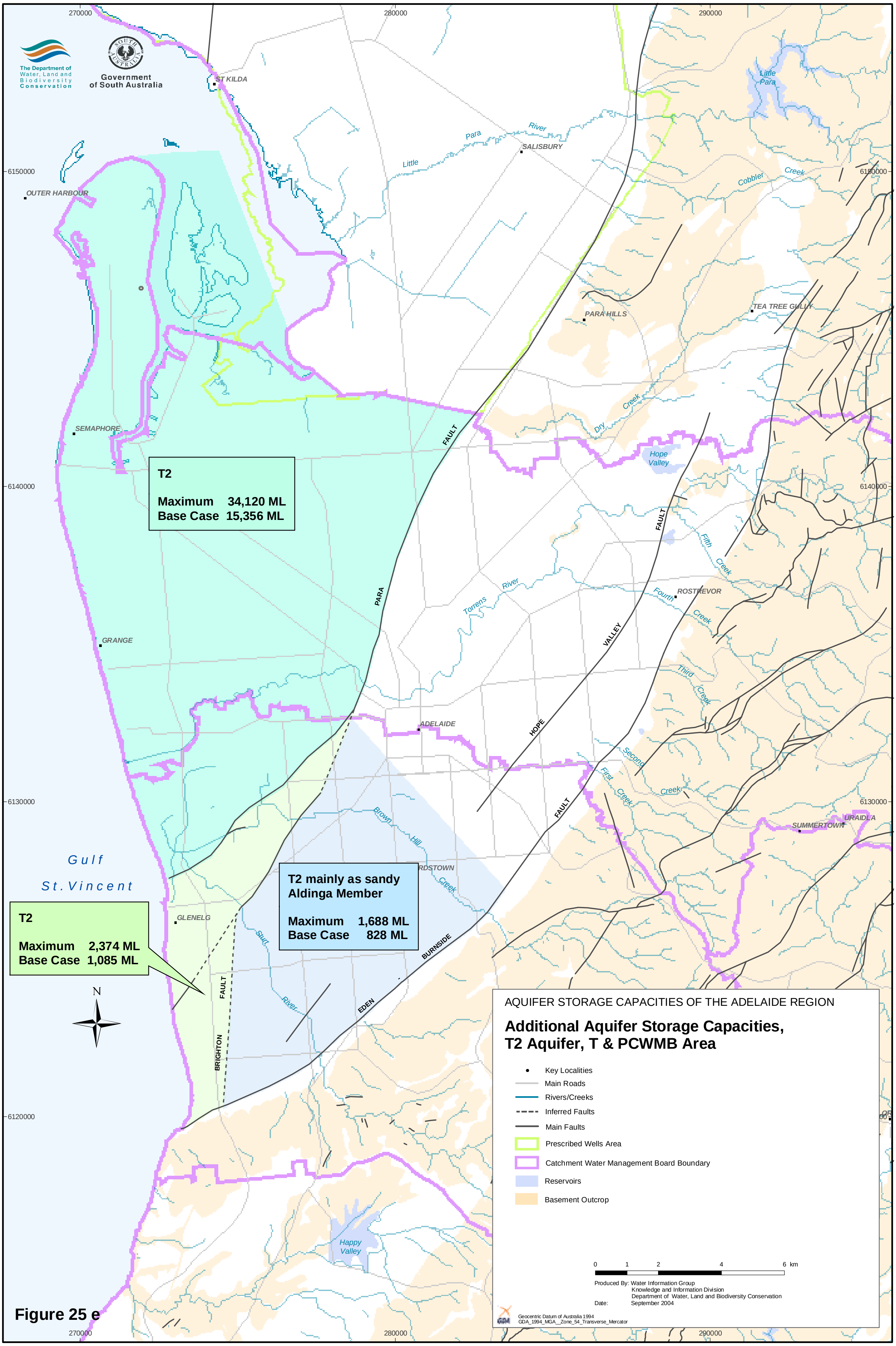
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
ST KILDA
OUTER HARBOUR
SALISBURY
Little
Para
River
Cobbler
Creek
Little Para
TEA TREE GULLY
PARAFIELD
T1 (unconfined extent) as sandy Aldinga Member and undiff. sands
Maximum (elastic storage) 249 ML
Base Case 187 ML
SEMAPHORE
T1A
Maximum 11,393 ML
Base Case 5,393 ML
PARA FAULT
Dry
Hope Valley
FAULT
Fifth Creek
Torrens River
Fourth Creek
ROSTREVOR
GRANGE
VALLEY
Third
HOPE
ADELAIDE
T1 (confined) as sandy Aldinga Member and undiff. sands
Maximum 1,918 ML
Base Case 1,136 ML
First Creek
FAULT
Brown Hill
EDWARDSTOWN
SUMMERTOWN
URAIDLA
Gulf St.Vincent
GLENELG
T1 as Dry Creek Sand and lower Port Willunga Formation
Maximum 1,580 ML
Base Case 869 ML
N
FAULT
BRIGHTON
River
EDEN
T1A
Maximum 203 ML
Base Case 98 ML
Happy Valley
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities, T1 or T1A Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
270000
280000
290000
6150000
6140000
6130000

Figure 25 c



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities, T1B Aquifer, T & PCWMB Area
T1B
Maximum 5,938 ML
Base Case 2,918 ML
T1B
Maximum 281 ML
Base Case 133 ML
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
GRANGE
GLENELG
ADELAIDE
EDWARDSTOWN
PARA HILLS
TEA TREE GULLY
ROSTREVOR
SUMMERTOWN
URAIDLA
Little Para River
Little Para
Cobbler Creek
Dry Creek
Hope Valley
Torrens River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
Happy Valley
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
N
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
270000
280000
290000
6150000
6140000
6130000
6120000

Figure 25 d



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
T2
Maximum 34,120 ML
Base Case 15,356 ML
T2 mainly as sandy Aldinga Member
Maximum 1,688 ML
Base Case 828 ML
T2
Maximum 2,374 ML
Base Case 1,085 ML
Gulf St.Vincent
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
GLENELG
SUMMERTOWN
URAIDLA
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
Hope Valley
Happy Valley
Little Para
Torrens River
Sturt River
Brown Hill Creek
N
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities, T2 Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 25 e

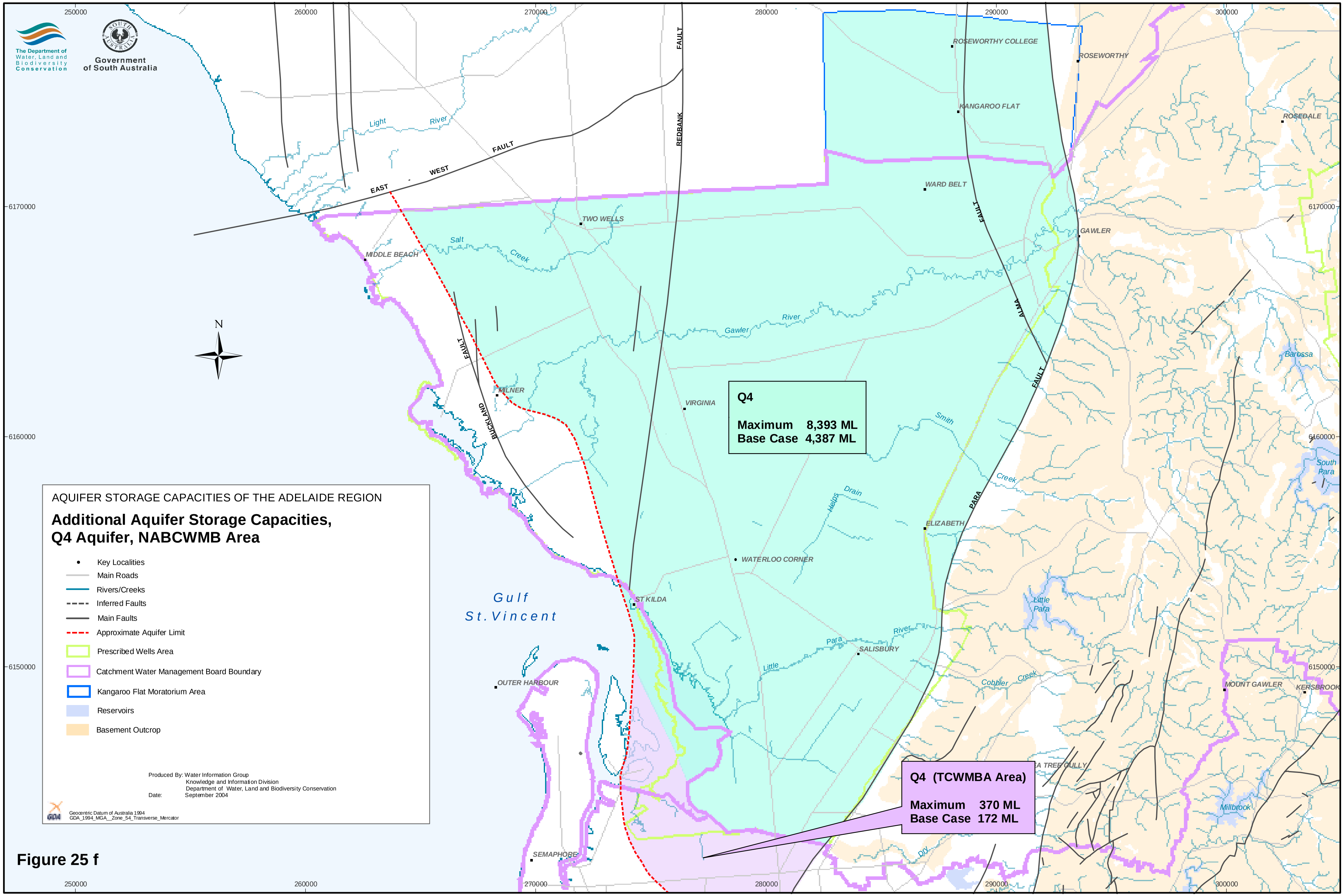

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities, Q4 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
Q4
Maximum 8,393 ML
Base Case 4,387 ML
Q4 (TCWMBA Area)
Maximum 370 ML
Base Case 172 ML
Gulf St. Vincent
N
EAST - WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
MOUNT GAWLER
KERSBROOK
TEA TREE GULLY
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 25 f

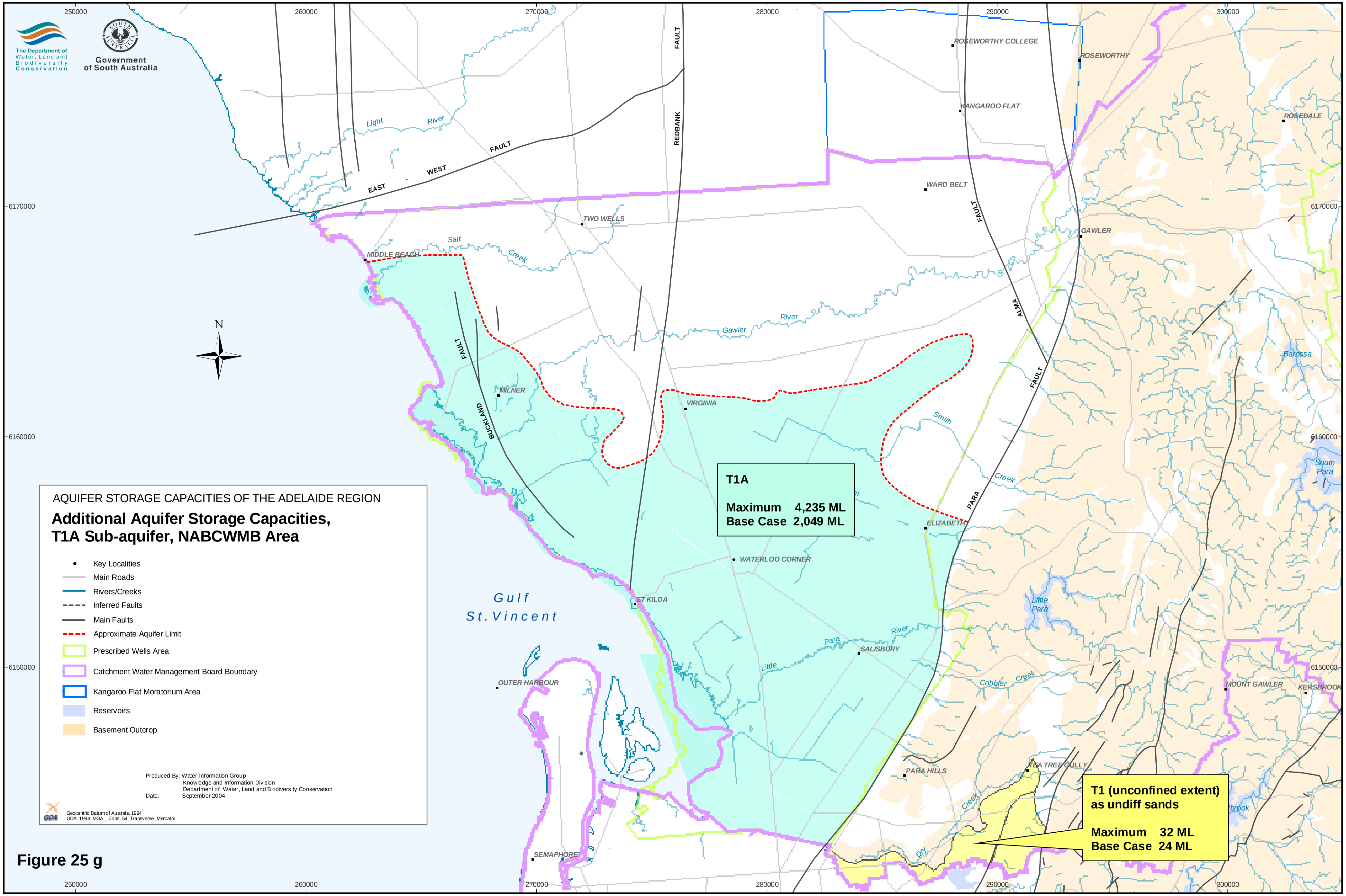
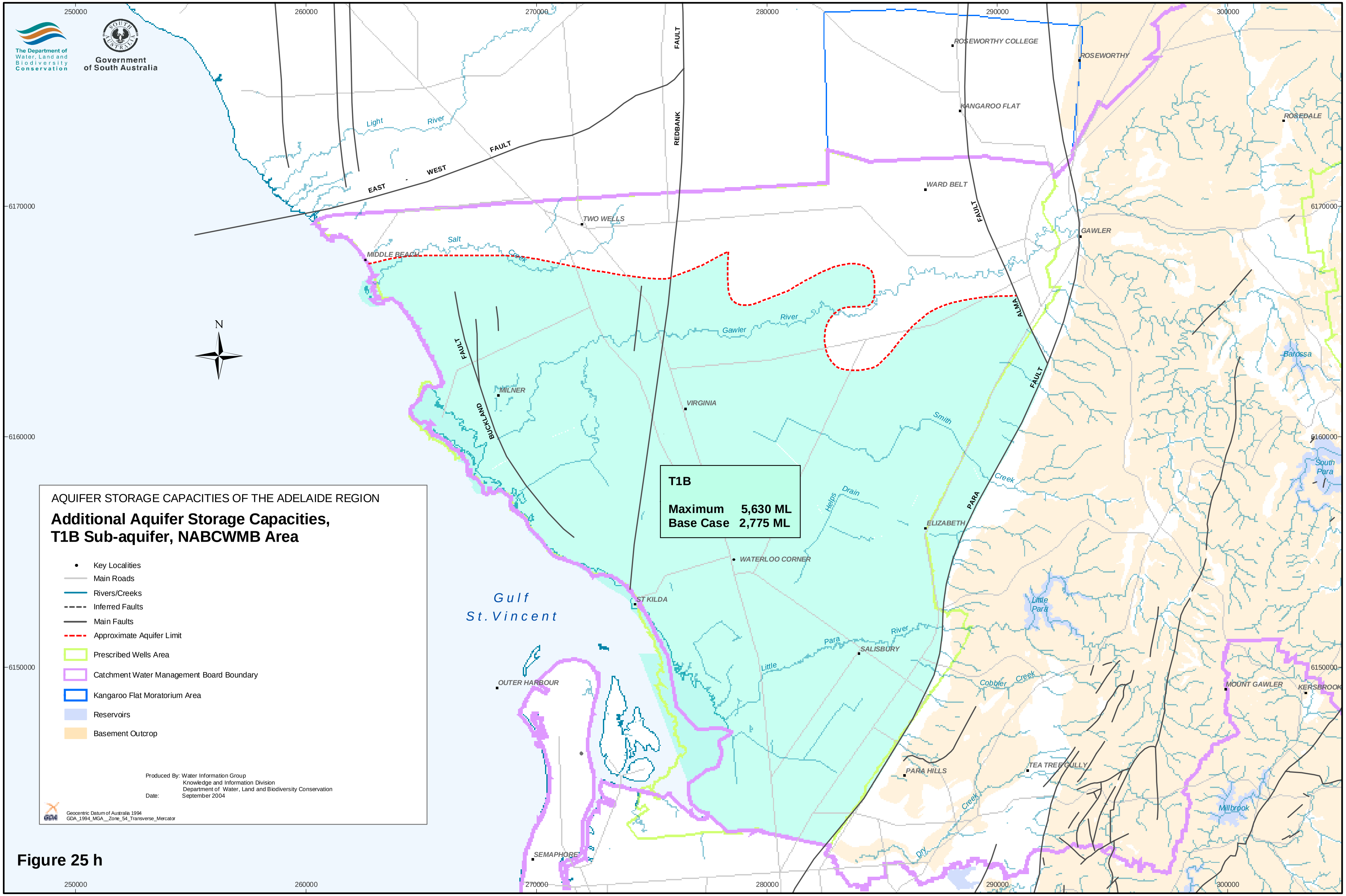
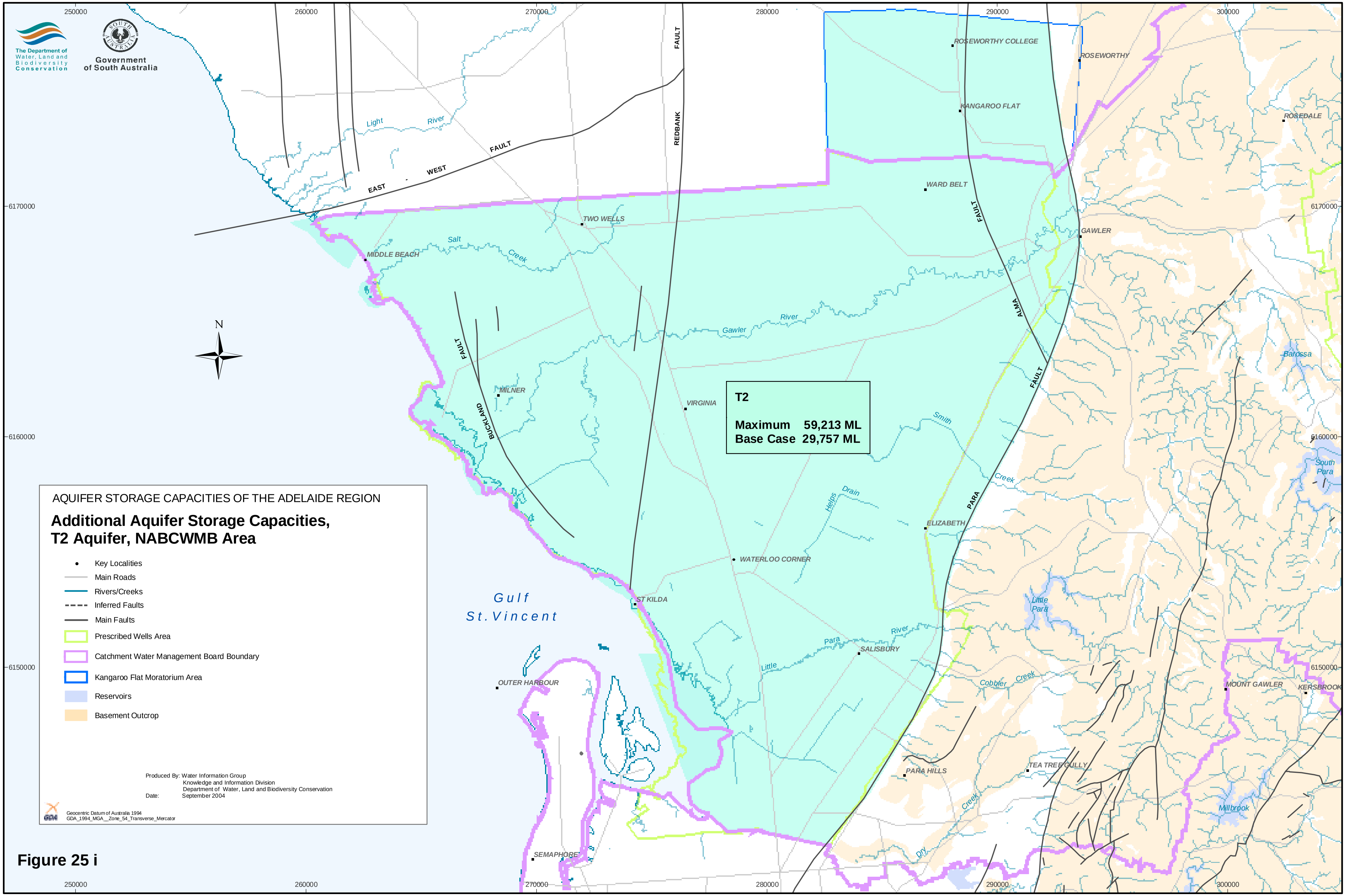

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities, T1A Sub-aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
T1A
Maximum 4,235 ML
Base Case 2,049 ML
T1 (unconfined extent)
as undiff sands
Maximum 32 ML
Base Case 24 ML
Gulf
St. Vincent
N
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 25 g



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities, T1B Sub-aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
T1B
Maximum 5,630 ML
Base Case 2,775 ML
N
Gulf St.Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

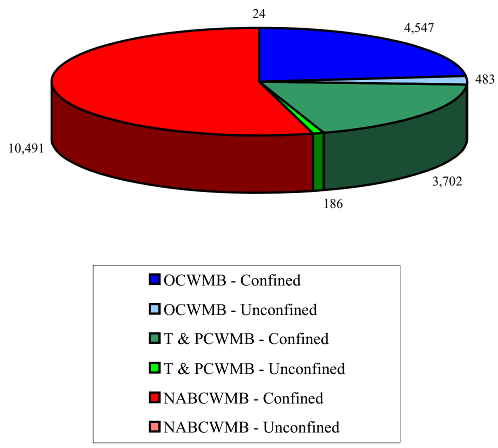
Figure 25 h



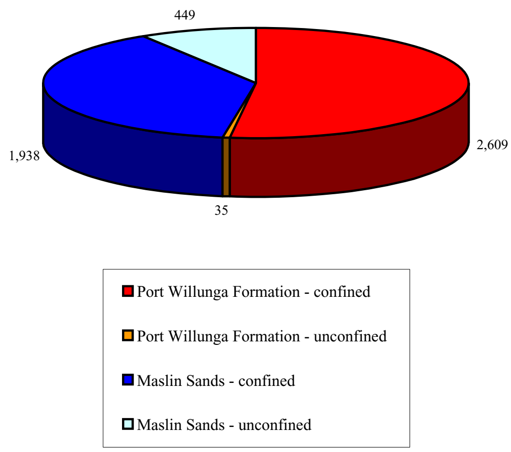
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities, T2 Aquifer, NABCWMB Area
T2
Maximum 59,213 ML
Base Case 29,757 ML
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf St.Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST - WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Little Para
South Para
Barossa
Millbrook
N
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 25 i

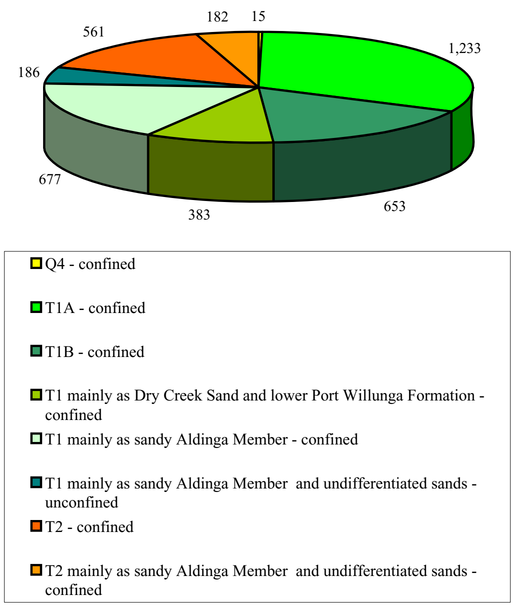
Total Additional Storage Capacity (ML) by CWMB



OCWMB Additional Storage Capacity (ML) by Aquifer



T & PCWMB Additional Storage Capacity (ML) by Aquifer



NABCWMB Additional Storage Capacity (ML) by Aquifer

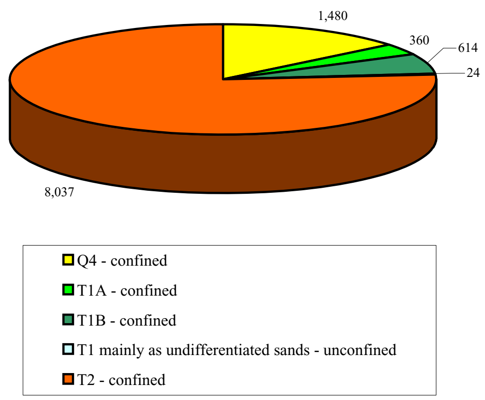
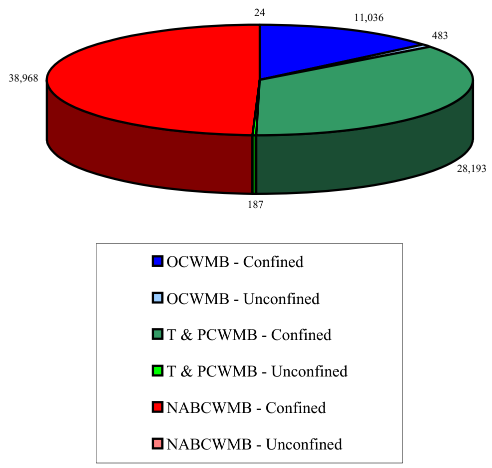
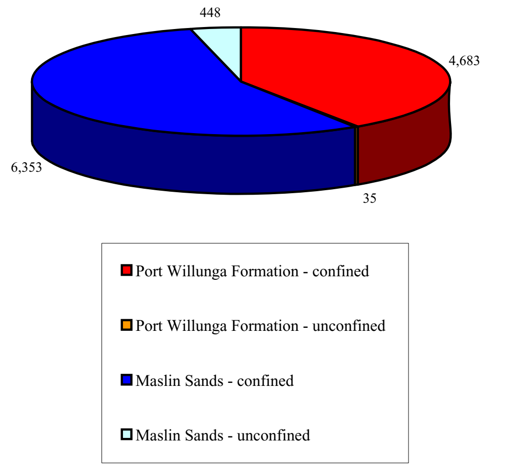


Figure 26 a - Additional Aquifer Storage Capacity Graphs - Sub-artesian Scenario

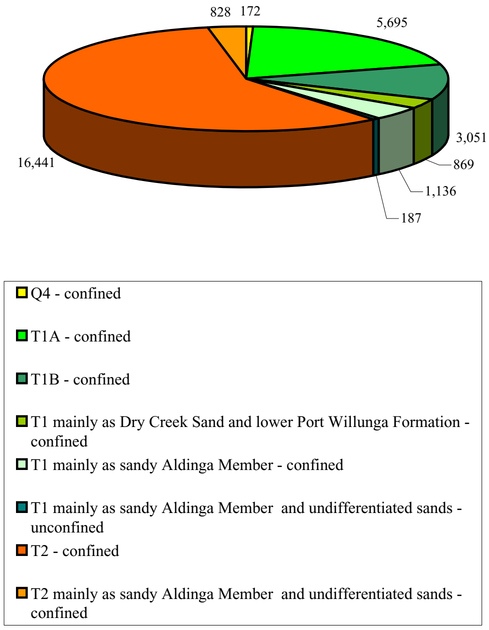
Total Additional Storage Capacity (ML) by CWMB



OCWMB Additional Storage Capacity (ML) by Aquifer



T & PCWMB Additional Storage Capacity (ML) by Aquifer



NABCWMB Additional Storage Capacity (ML) by Aquifer

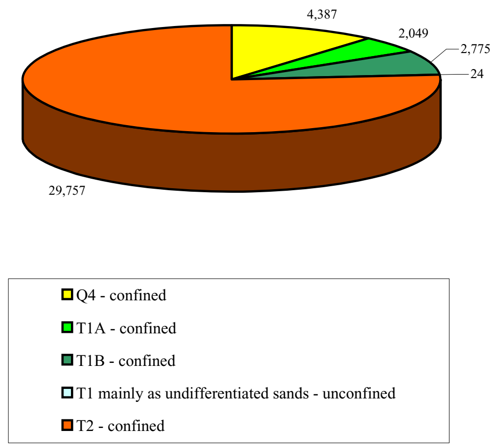
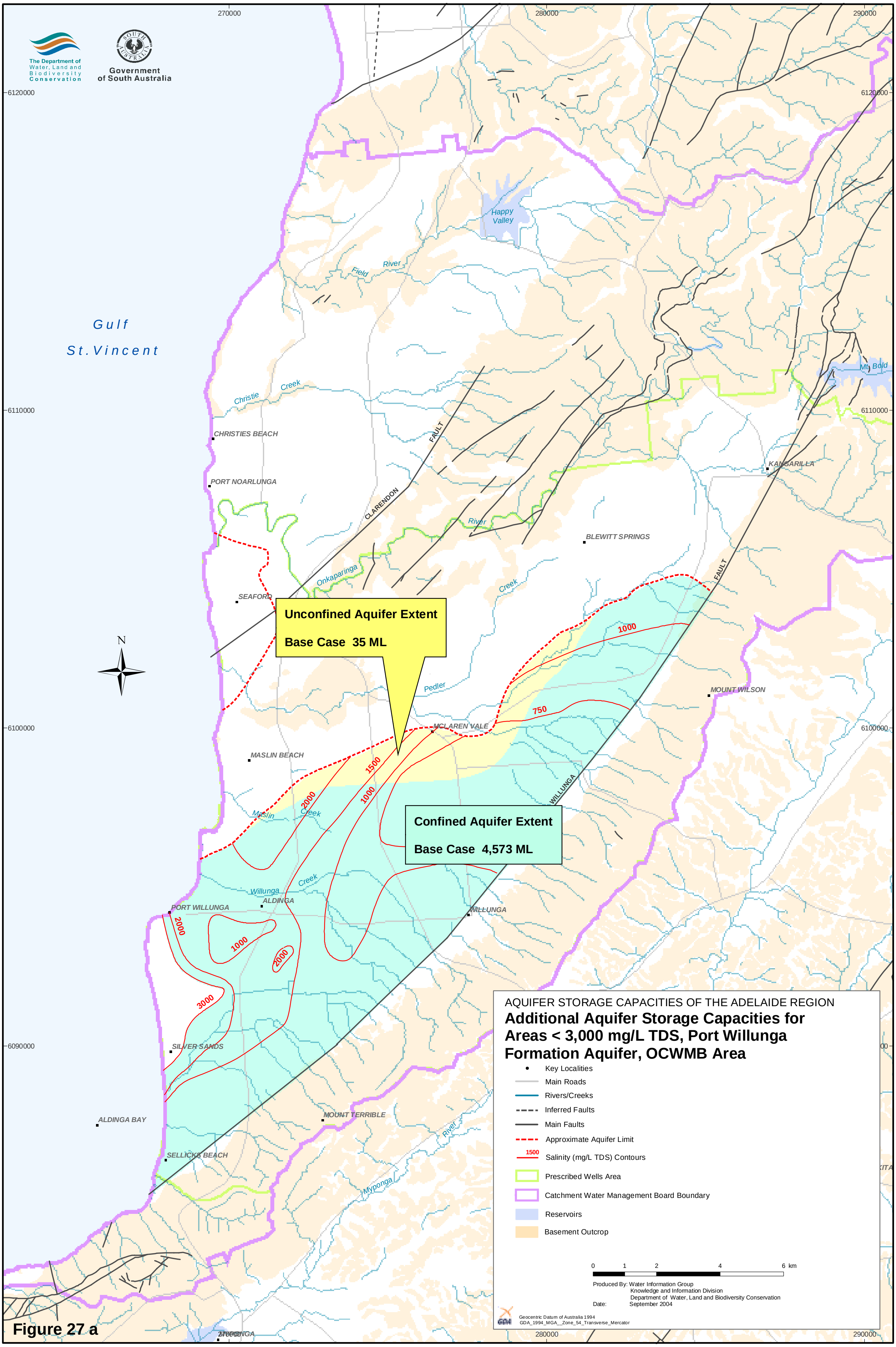
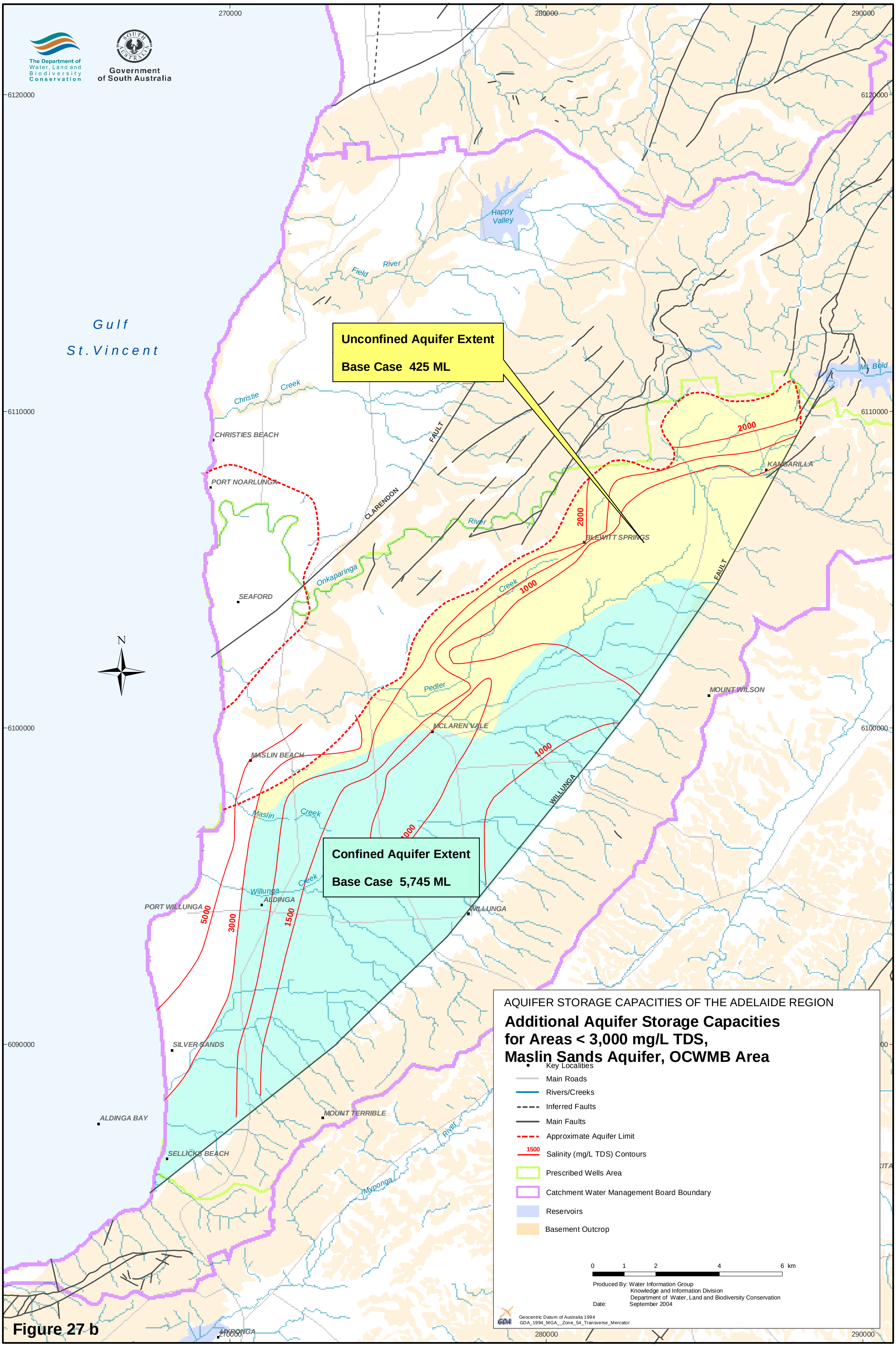


Figure 26 b - Additional Aquifer Storage Capacity Graphs - Base Case Artesian Scenaric



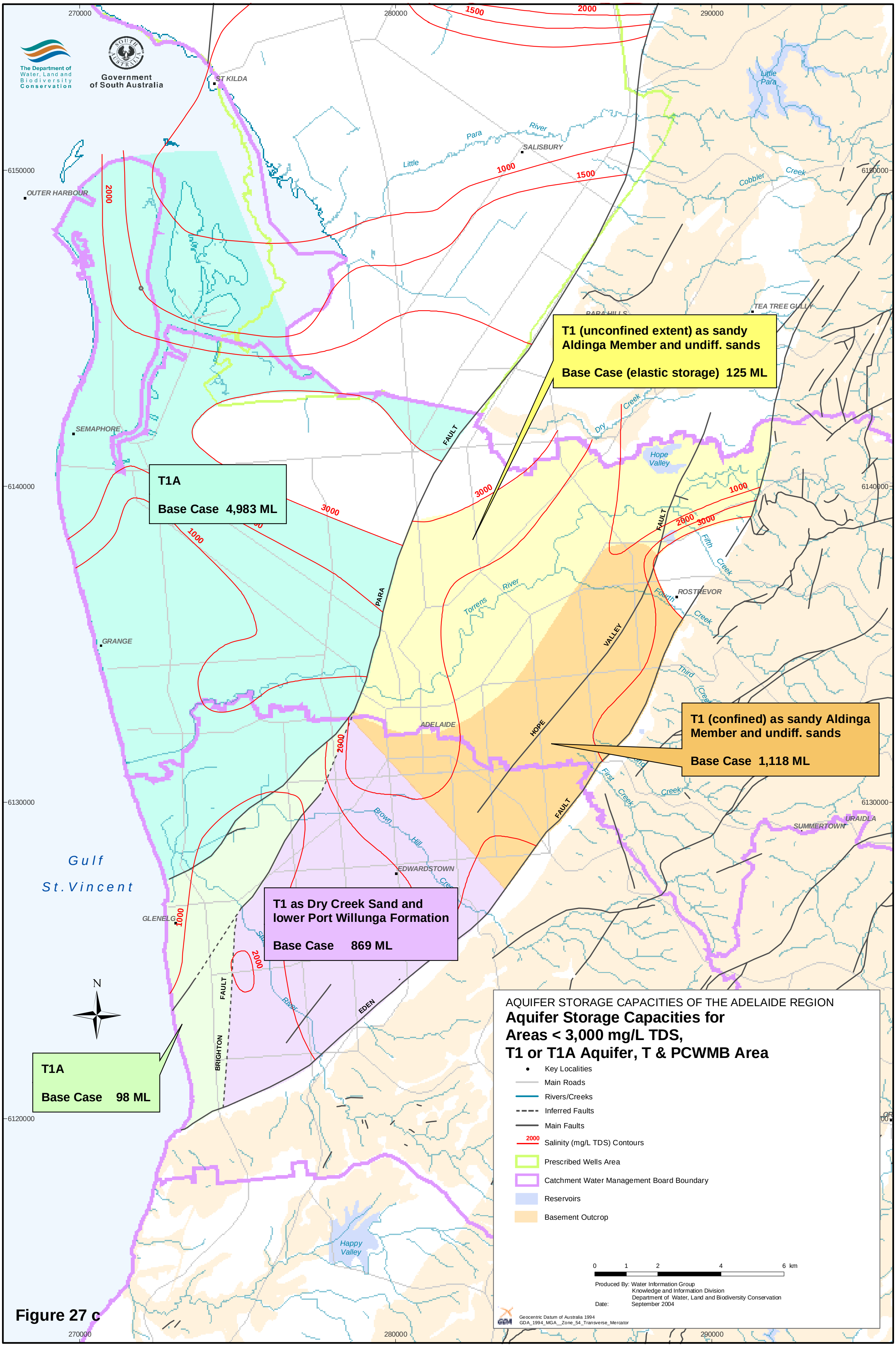
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities for Areas < 3,000 mg/L TDS, Port Willunga Formation Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Salinity (mg/L TDS) Contours
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Unconfined Aquifer Extent
Base Case 35 ML
Confined Aquifer Extent
Base Case 4,573 ML
Gulf St.Vincent
Happy Valley
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
MASLIN BEACH
MCLAREN VALE
BLEWITT SPRINGS
KANGARILLA
MOUNT WILSON
PORT WILLUNGA
ALDINGA
WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
CLARENDON FAULT
WILLUNGA FAULT
Field River
Christie Creek
Onkaparinga River
Pedler Creek
Maslin Creek
Willunga Creek
Myponga River
Mt Bold
270000
280000
290000
6120000
6110000
6100000
6090000
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 27 a



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
Unconfined Aquifer Extent
Base Case 425 ML
Confined Aquifer Extent
Base Case 5,745 ML
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
BLEWITT SPRINGS
KANGARILLA
MOUNT WILSON
MCLAREN VALE
MASLIN BEACH
PORT WILLUNGA
ALDINGA
WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
Happy Valley
Mt Bold
CLARENDON
FAULT
WILLUNGA
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities for Areas < 3,000 mg/L TDS, Maslin Sands Aquifer, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Salinity (mg/L TDS) Contours
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 27 b



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
T1 (unconfined extent) as sandy Aldinga Member and undiff. sands
Base Case (elastic storage) 125 ML
T1A
Base Case 4,983 ML
T1 (confined) as sandy Aldinga Member and undiff. sands
Base Case 1,118 ML
T1 as Dry Creek Sand and lower Port Willunga Formation
Base Case 869 ML
T1A
Base Case 98 ML
Gulf St.Vincent
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
GRANGE
ADELAIDE
EDWARDSTOWN
GLENELG
ROSTREVOR
TEA TREE GULLY
SUMMERTOWN
URAIDLA
PARA FAULT
HOPE VALLEY FAULT
EDEN FAULT
BRIGHTON FAULT
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Aquifer Storage Capacities for Areas < 3,000 mg/L TDS, T1 or T1A Aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Salinity (mg/L TDS) Contours
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Produced By: Water Information Group Knowledge and Information Division Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994 GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 27 c

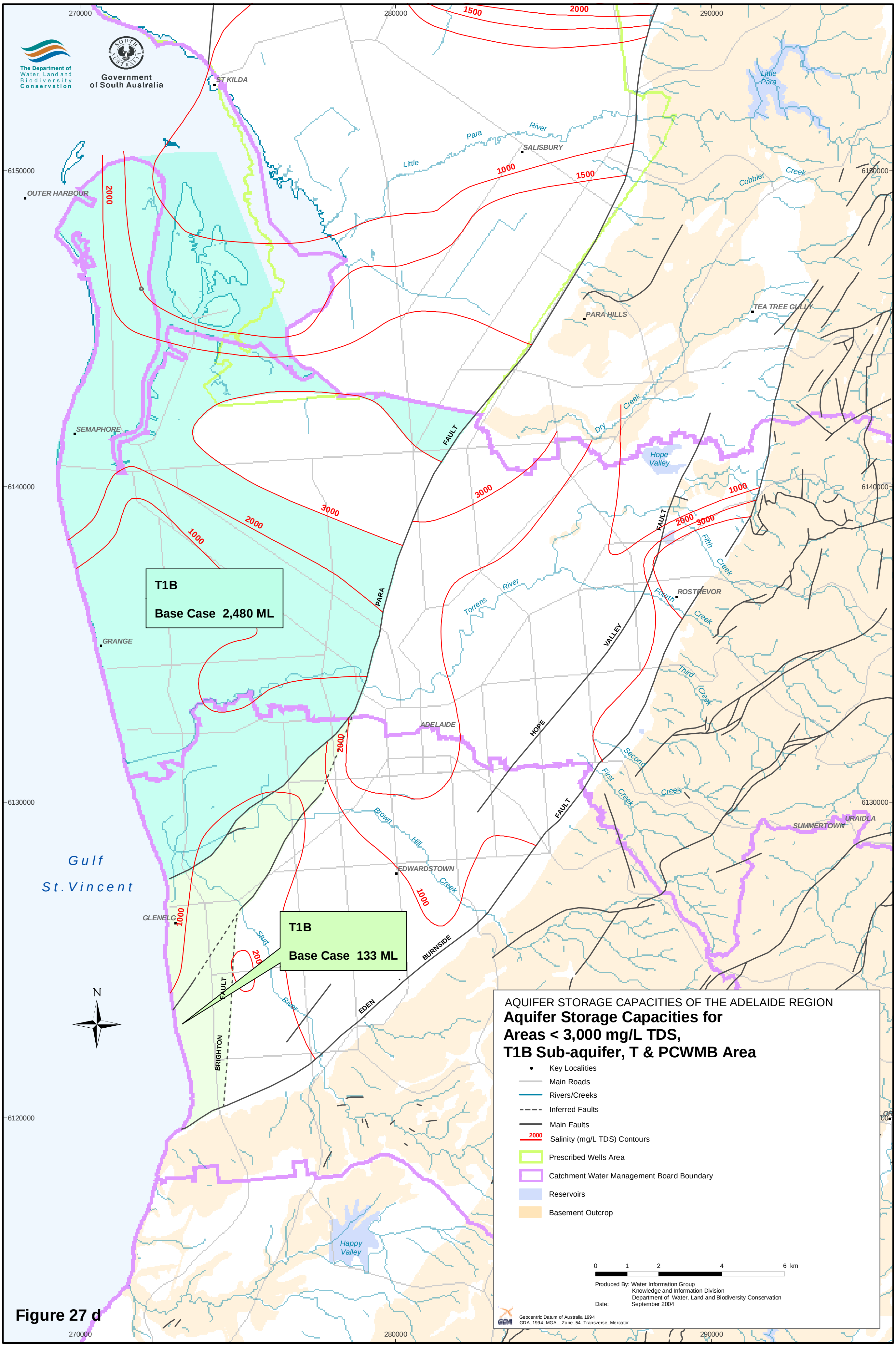
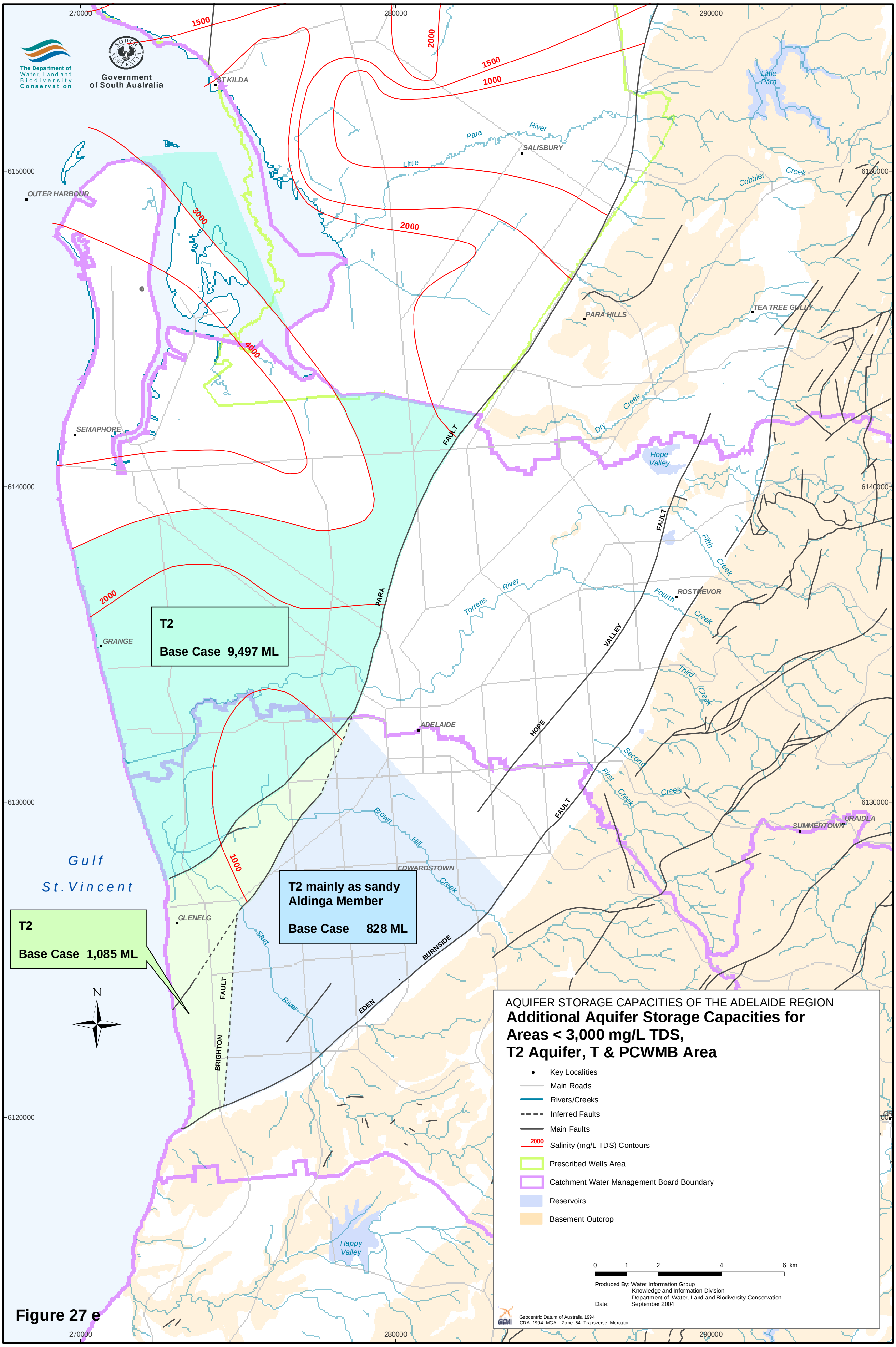
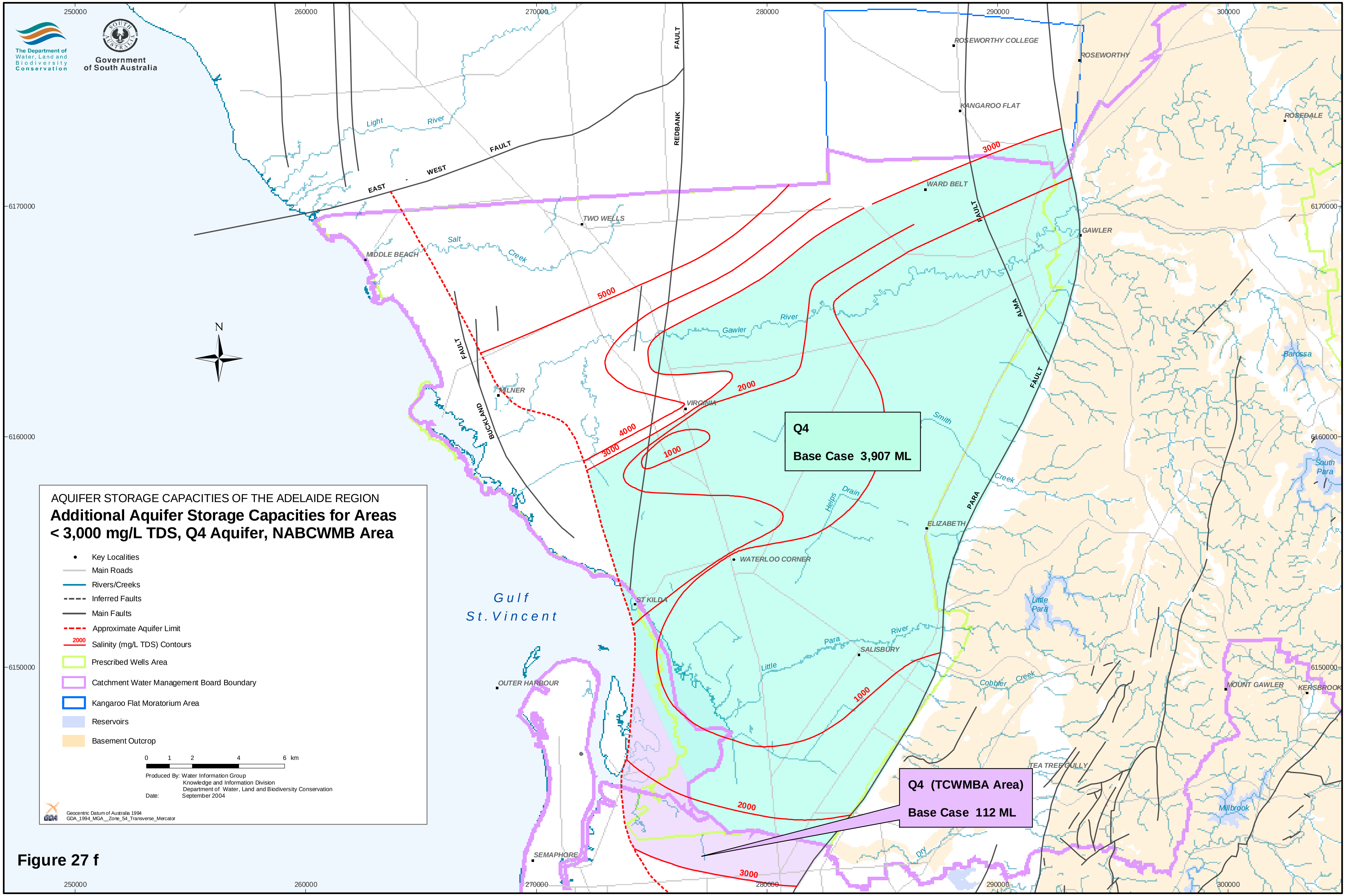

AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Aquifer Storage Capacities for
Areas < 3,000 mg/L TDS,
T1B Sub-aquifer, T & PCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Salinity (mg/L TDS) Contours
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
T1B
Base Case 2,480 ML
T1B
Base Case 133 ML
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
Little Para River
Torrens River
Hope Valley
Happy Valley
Sturt River
Brown Hill Creek
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 27 d



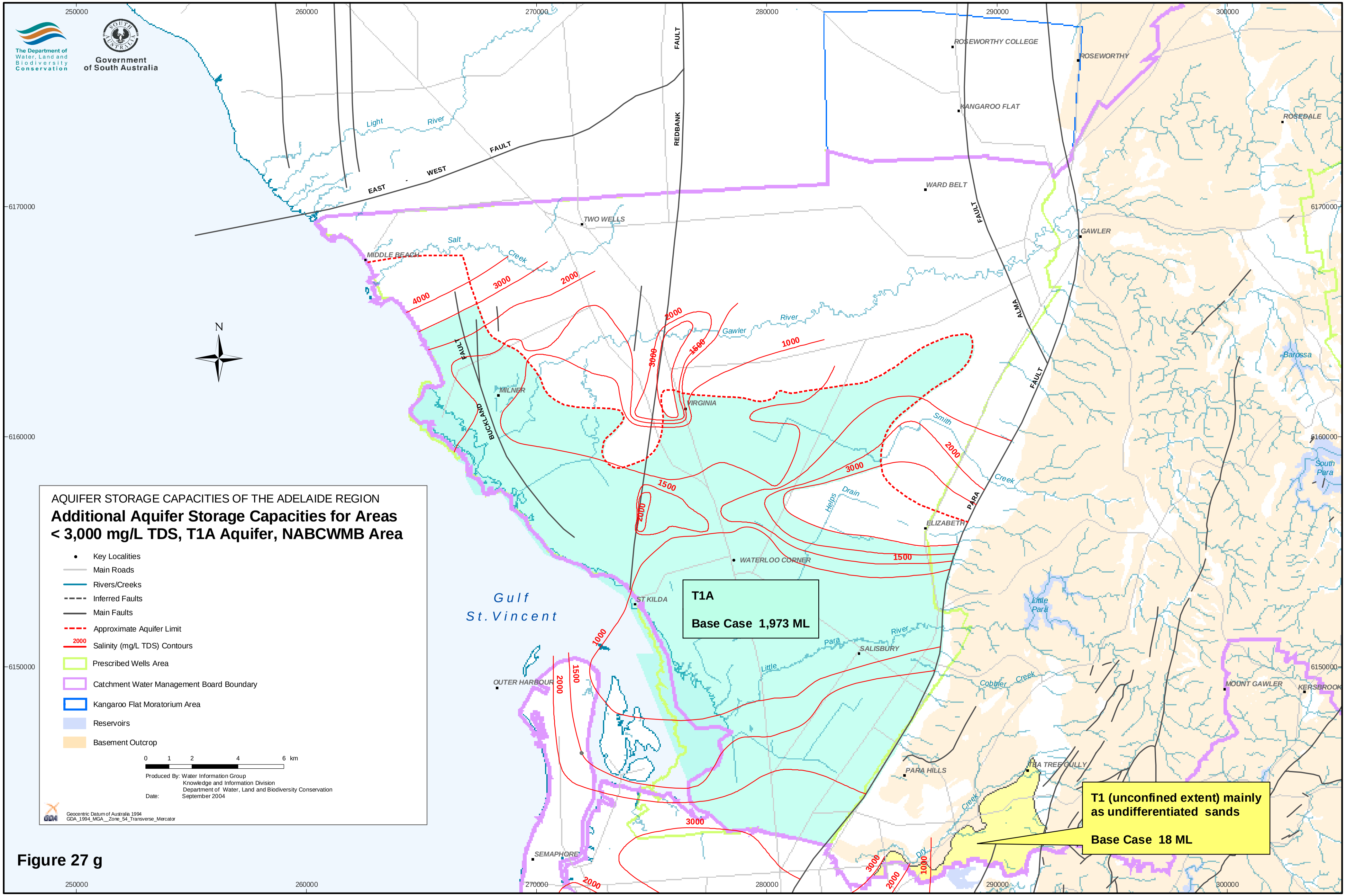
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities for Areas < 3,000 mg/L TDS, T2 Aquifer, T & PCWMB Area
T2
Base Case 9,497 ML
T2 mainly as sandy Aldinga Member
Base Case 828 ML
T2
Base Case 1,085 ML
Gulf St.Vincent
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
GRANGE
ADELAIDE
ROSTREVOR
GLENELG
EDWARDSTOWN
SUMMERTOWN
URAIDLA
Hope Valley
Happy Valley
Little Para
Little Para River
Cobbler Creek
Dry Creek
Torrens River
Fifth Creek
Fourth Creek
Third Creek
Second Creek
First Creek
Brown Hill Creek
Sturt River
PARA FAULT
HOPE VALLEY FAULT
EDEN BURNSIDE FAULT
BRIGHTON FAULT
1500
1000
2000
3000
4000
270000
280000
290000
6150000
6140000
6130000
6120000
N
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Salinity (mg/L TDS) Contours
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 27 e



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities for Areas
< 3,000 mg/L TDS, Q4 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Salinity (mg/L TDS) Contours
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
Q4
Base Case 3,907 ML
Q4 (TCWMBA Area)
Base Case 112 ML
Gulf
St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
WATERLOO CORNER
ELIZABETH
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
MOUNT GAWLER
KERSBROOK
TEA TREE GULLY
EAST - WEST FAULT
REDBANK FAULT
BUCKLAND FAULT
ALMA FAULT
PARA FAULT
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
5000
4000
3000
2000
1000

Figure 27 f



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities for Areas < 3,000 mg/L TDS, T1A Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Salinity (mg/L TDS) Contours
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
T1A
Base Case 1,973 ML
T1 (unconfined extent) mainly as undifferentiated sands
Base Case 18 ML
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
TWO WELLS
GAWLER
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT

Figure 27 g

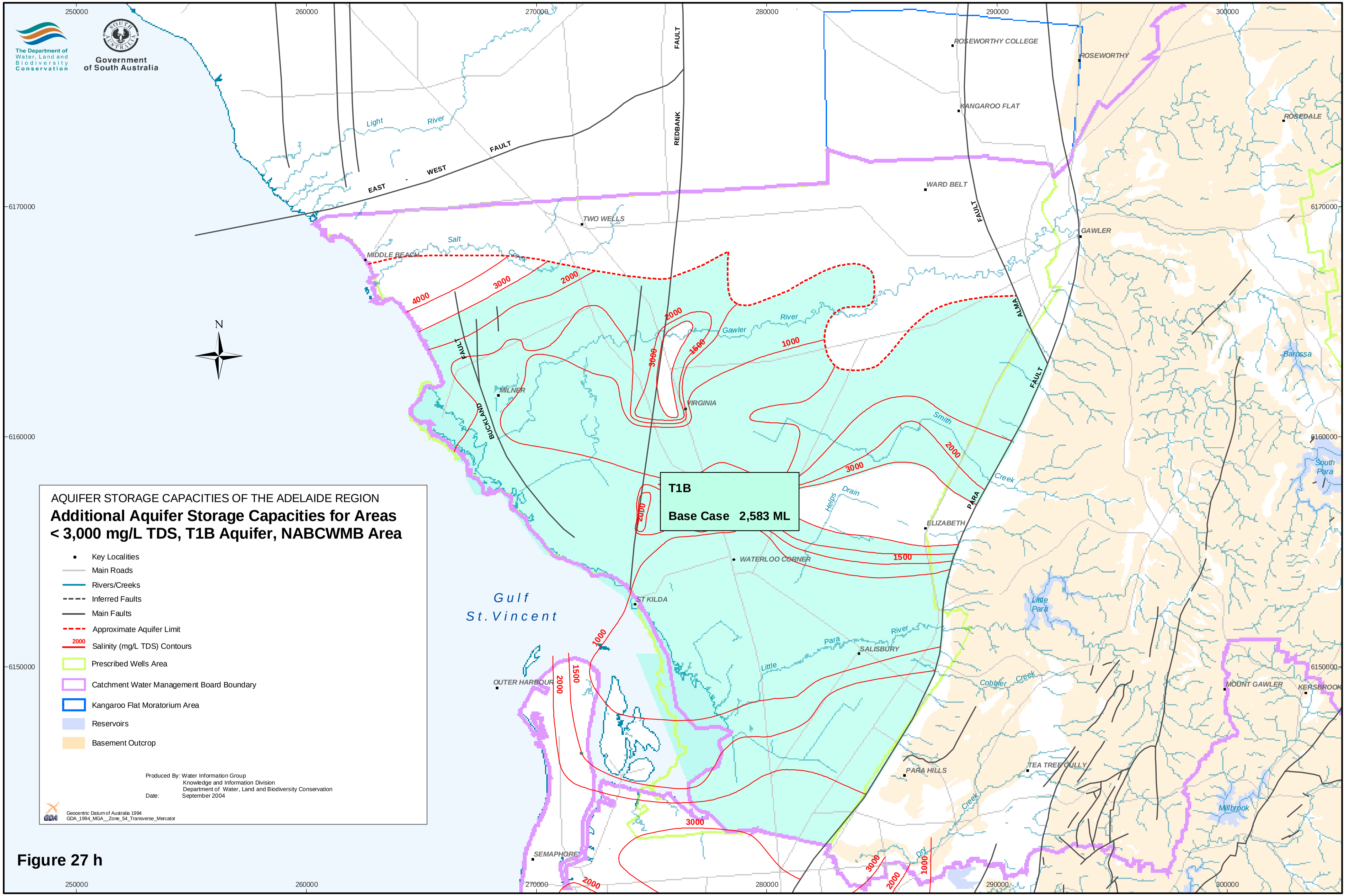

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Additional Aquifer Storage Capacities for Areas < 3,000 mg/L TDS, T1B Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
Approximate Aquifer Limit
Salinity (mg/L TDS) Contours
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
T1B
Base Case 2,583 ML
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
SEMAPHORE
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Gawler River
Salt Creek
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
N
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 27 h

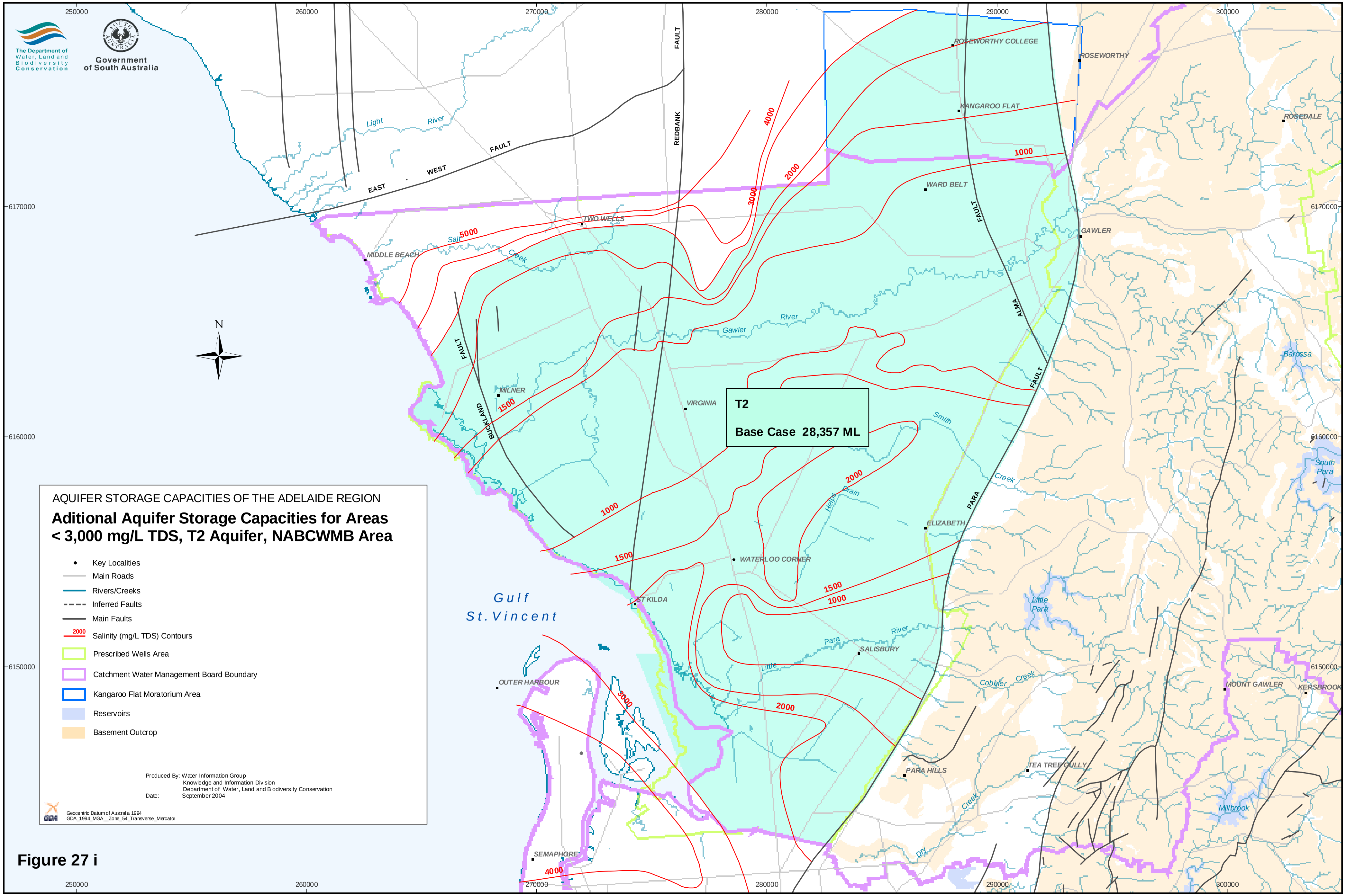
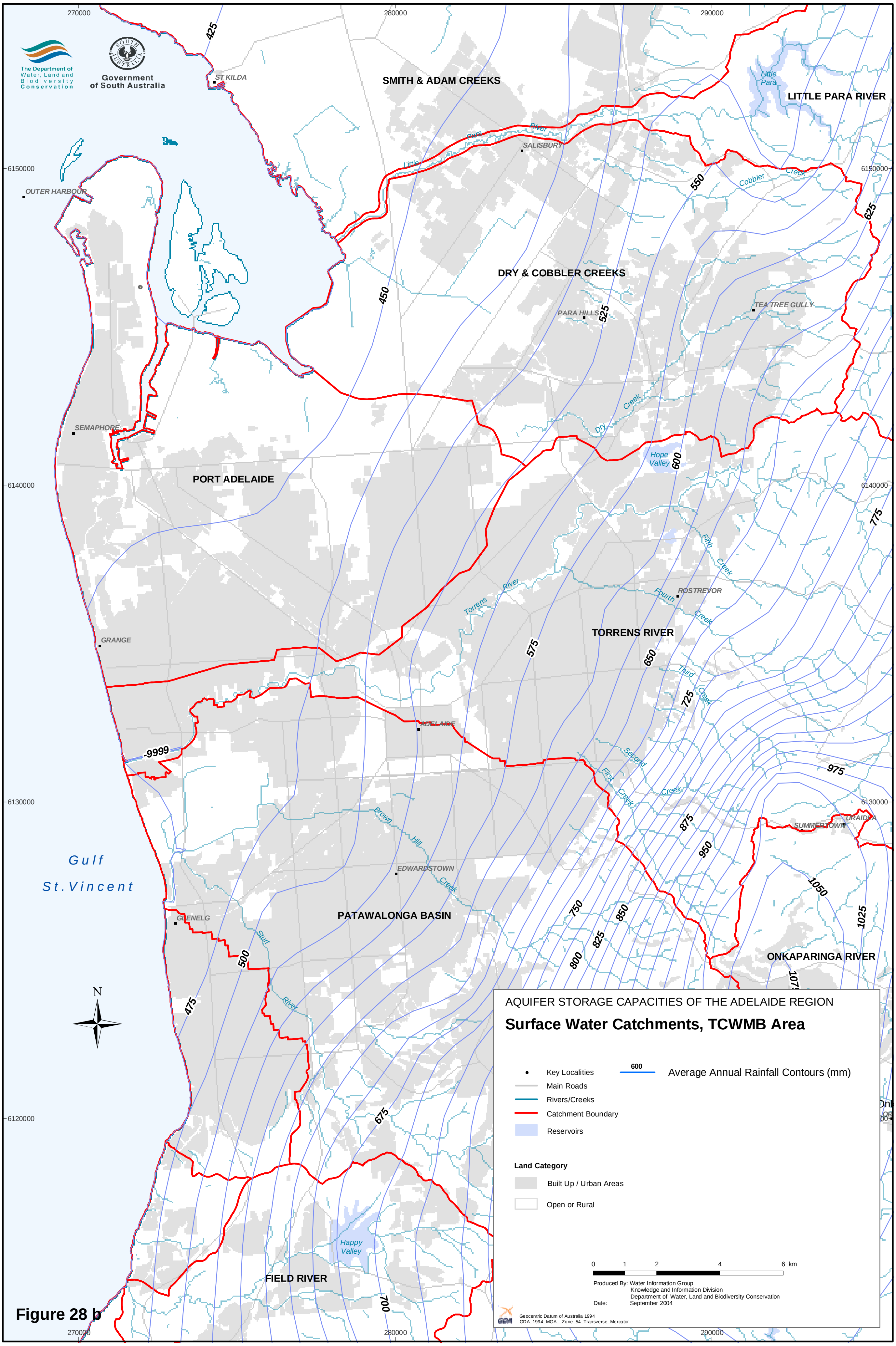

AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Aditional Aquifer Storage Capacities for Areas
< 3,000 mg/L TDS, T2 Aquifer, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Inferred Faults
Main Faults
2000
Salinity (mg/L TDS) Contours
Prescribed Wells Area
Catchment Water Management Board Boundary
Kangaroo Flat Moratorium Area
Reservoirs
Basement Outcrop
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
T2
Base Case 28,357 ML
Gulf St. Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
SEMAPHORE
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
EAST WEST FAULT
REDBANK FAULT
ALMA FAULT
PARA FAULT
BUCKLAND FAULT
Light River
Gawler River
Salt Creek
Smith Creek
Helps Drain
Little Para River
Cobbler Creek
Dry Creek
Barossa
South Para
Little Para
Millbrook
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000
1000
1500
2000
3000
4000
5000

Figure 27 i

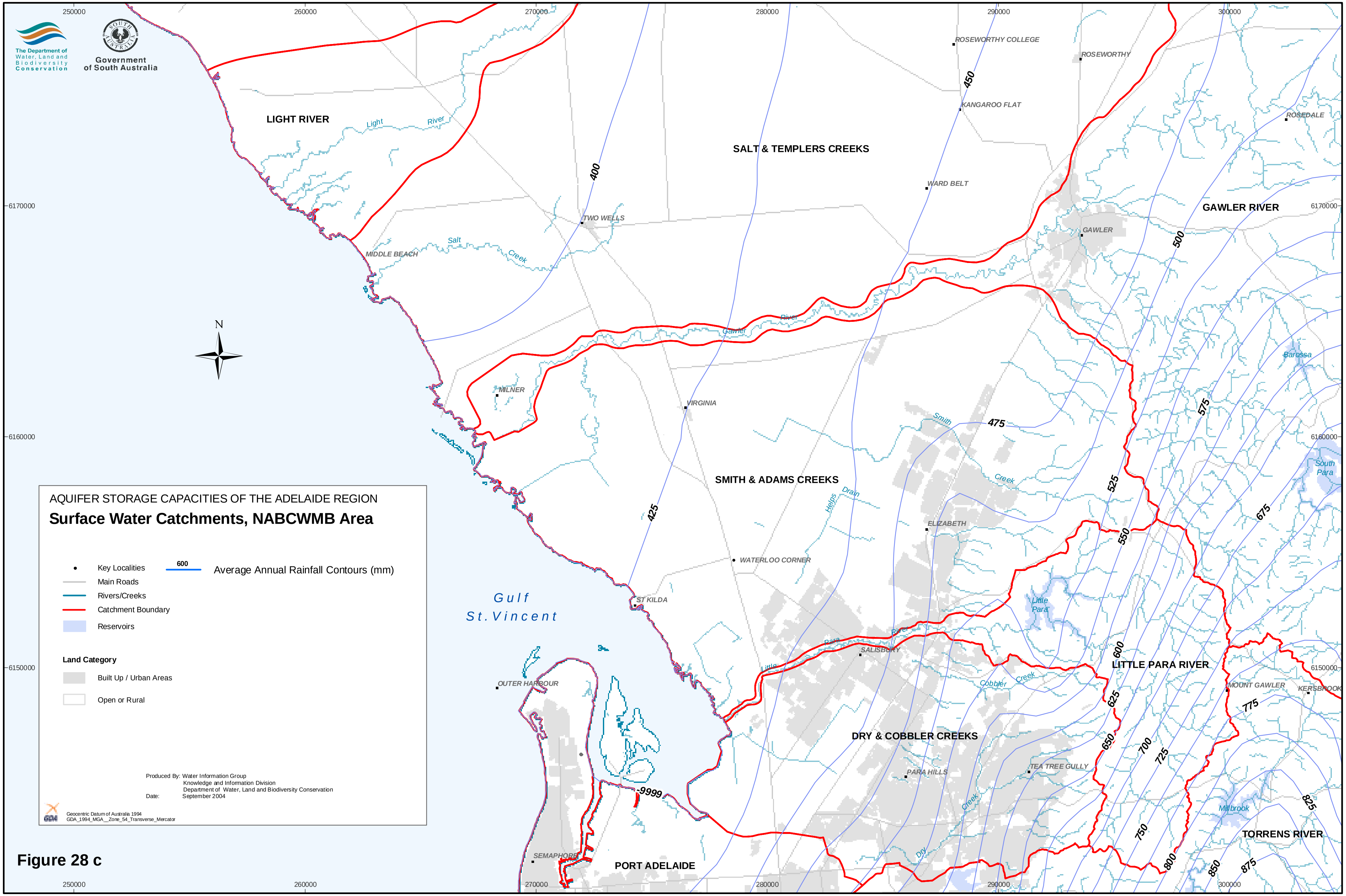
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Surface Water Catchments, OCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Catchment Boundary
Reservoirs
600
Average Annual Rainfall Contours (mm)
Land Category
Built Up / Urban Areas
Open or Rural
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf
St.Vincent
N
PATAWALONGA BASIN
FIELD RIVER
CHRISTIE CREEK
ONKAPARINGA RIVER
PEDLER CREEK
MASLIN
FINNISS RIVER
WILLUNGA
ALDINGA
SELLICKS
MYPONGA RIVER
Happy Valley
Mt. Bold
Field River
Christie Creek
Onkaparinga River
Pedler Creek
Maslin Creek
Willunga Creek
Myponga River
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
BLEWITT SPRINGS
KANGARILLA
MOUNT WILSON
MCLAREN VALE
MASLIN BEACH
PORT WILLUNGA
ALDINGA
WILLUNGA
SILVER SANDS
ALDINGA BAY
MOUNT TERRIBLE
SELLICKS BEACH
MYPONGA
270000
280000
290000
6120000
6110000
6100000
6090000
500
525
550
575
600
625
650
675
700
725
750
800
825
850
875
900
925
950
975
1000
1025

Figure 28 a



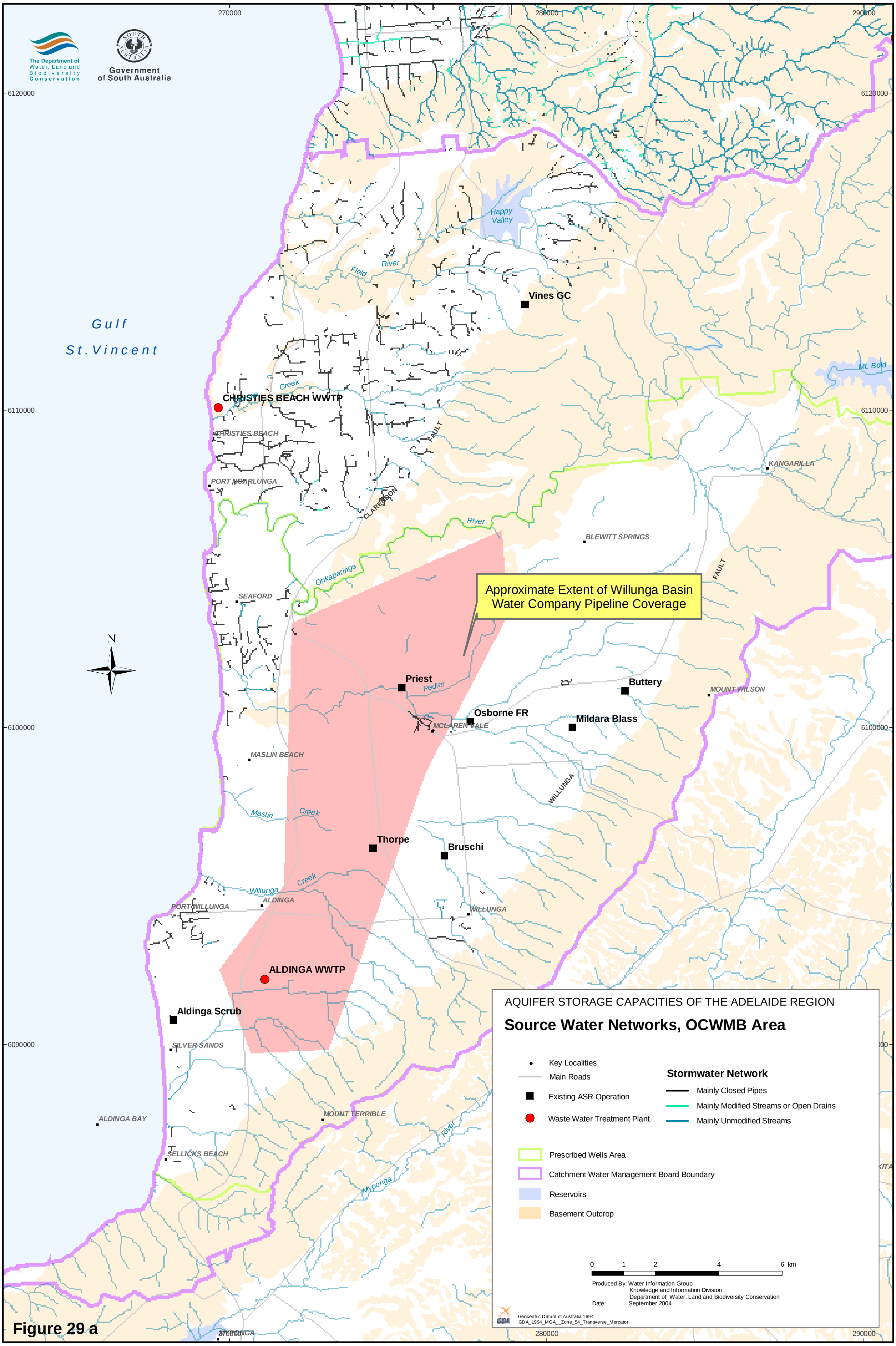
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Surface Water Catchments, TCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Catchment Boundary
Reservoirs
600
Average Annual Rainfall Contours (mm)
Land Category
Built Up / Urban Areas
Open or Rural
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
SMITH & ADAM CREEKS
LITTLE PARA RIVER
DRY & COBBLER CREEKS
PORT ADELAIDE
TORRENS RIVER
PATAWALONGA BASIN
ONKAPARINGA RIVER
FIELD RIVER
Gulf
St.Vincent
ST KILDA
OUTER HARBOUR
SALISBURY
PARA HILLS
TEA TREE GULLY
SEMAPHORE
ROSTREVOR
GRANGE
ADELAIDE
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Hope Valley
Happy Valley
Little Para
N

Figure 28 b



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Surface Water Catchments, NABCWMB Area
Key Localities
Main Roads
Rivers/Creeks
Catchment Boundary
Reservoirs
600
Average Annual Rainfall Contours (mm)
Land Category
Built Up / Urban Areas
Open or Rural
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
LIGHT RIVER
SALT & TEMPLERS CREEKS
GAWLER RIVER
SMITH & ADAMS CREEKS
LITTLE PARA RIVER
DRY & COBBLER CREEKS
TORRENS RIVER
PORT ADELAIDE
Gulf St.Vincent
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
TWO WELLS
GAWLER
MIDDLE BEACH
MILNER
VIRGINIA
ELIZABETH
WATERLOO CORNER
ST KILDA
SALISBURY
OUTER HARBOUR
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
SEMAPHORE
Light River
Salt Creek
Gawler River
Smith Creek
Helps Drain
Little Para
Cobbler Creek
Dry Creek
Barossa
South Para
Millbrook
400
425
450
475
500
525
550
575
600
625
650
675
700
725
750
775
800
825
850
875
-9999
N
250000
260000
270000
280000
290000
300000
6150000
6160000
6170000

Figure 28 c



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf
St.Vincent
N
CHRISTIES BEACH WWTP
CHRISTIES BEACH
PORT NOARLUNGA
SEAFORD
MASLIN BEACH
PORT WILLUNGA
ALDINGA
ALDINGA WWTP
Aldinga Scrub
SILVER SANDS
ALDINGA BAY
SELLICKS BEACH
MOUNT TERRIBLE
Happy Valley
Field River
Vines GC
Onkaparinga River
CLARENDON
FAULT
BLEWITT SPRINGS
KANGARILLA
Mt. Bold
Approximate Extent of Willunga Basin Water Company Pipeline Coverage
Priest
Pedler
Osborne FR
MCLAREN VALE
Mildara Blass
Buttery
MOUNT WILSON
WILLUNGA
Maslin Creek
Thorpe
Bruschi
Willunga Creek
Myponga River
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Source Water Networks, OCWMB Area
Key Localities
Main Roads
Existing ASR Operation
Waste Water Treatment Plant
Stormwater Network
Mainly Closed Pipes
Mainly Modified Streams or Open Drains
Mainly Unmodified Streams
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
270000
280000
290000
6120000
6110000
6100000
6090000

Figure 29 a

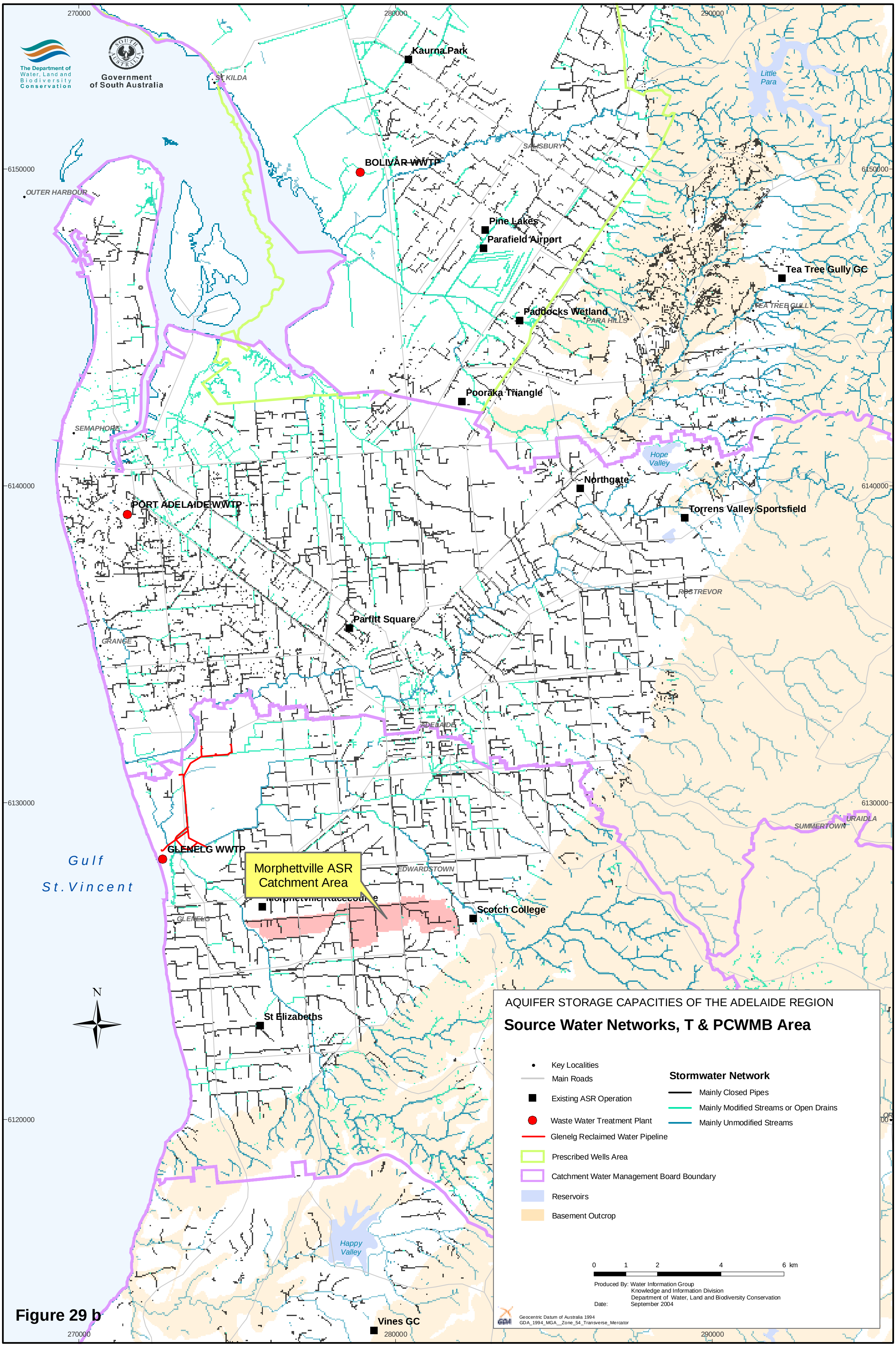

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Source Water Networks, T & PCWMB Area
Key Localities
Main Roads
Existing ASR Operation
Waste Water Treatment Plant
Glenelg Reclaimed Water Pipeline
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Stormwater Network
Mainly Closed Pipes
Mainly Modified Streams or Open Drains
Mainly Unmodified Streams
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Kaurna Park
BOLIVAR WWTP
Pine Lakes
Parafield Airport
Tea Tree Gully GC
Paddocks Wetland
Pooraka Triangle
Northgate
Torrens Valley Sportsfield
PORT ADELAIDE WWTP
Parfitt Square
GLENELG WWTP
Morphettville ASR Catchment Area
Scotch College
St Elizabeths
Vines GC
ST KILDA
SALISBURY
OUTER HARBOUR
TEA TREE GULLY
PARA HILLS
SEMAPHORE
ROSTREVOR
GRANGE
ADELAIDE
EDWARDSTOWN
GLENELG
SUMMERTOWN
URAIDLA
Little Para
Hope Valley
Happy Valley
Gulf St.Vincent
N
270000
280000
290000
6150000
6140000
6130000
6120000

Figure 29 b

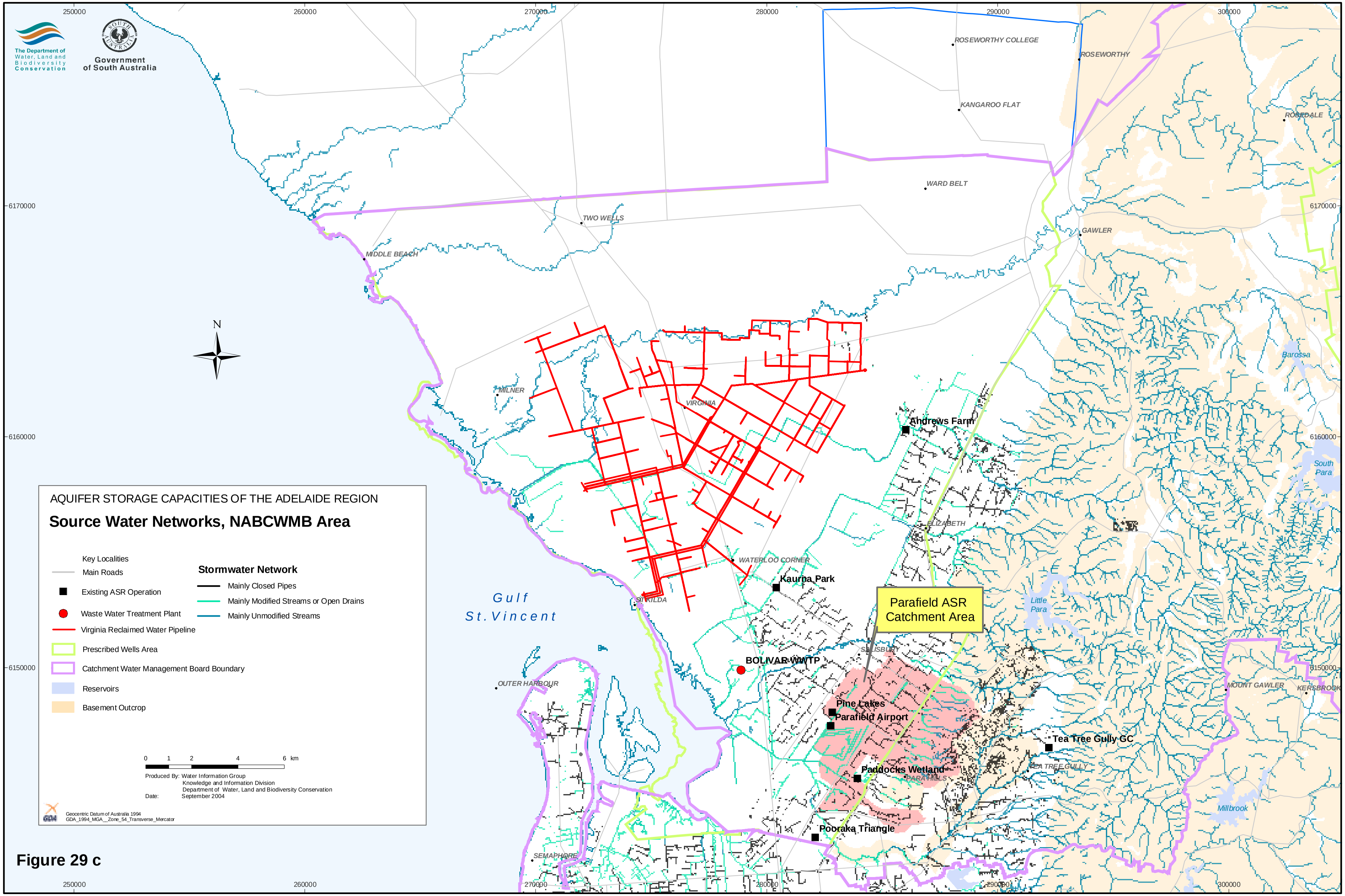
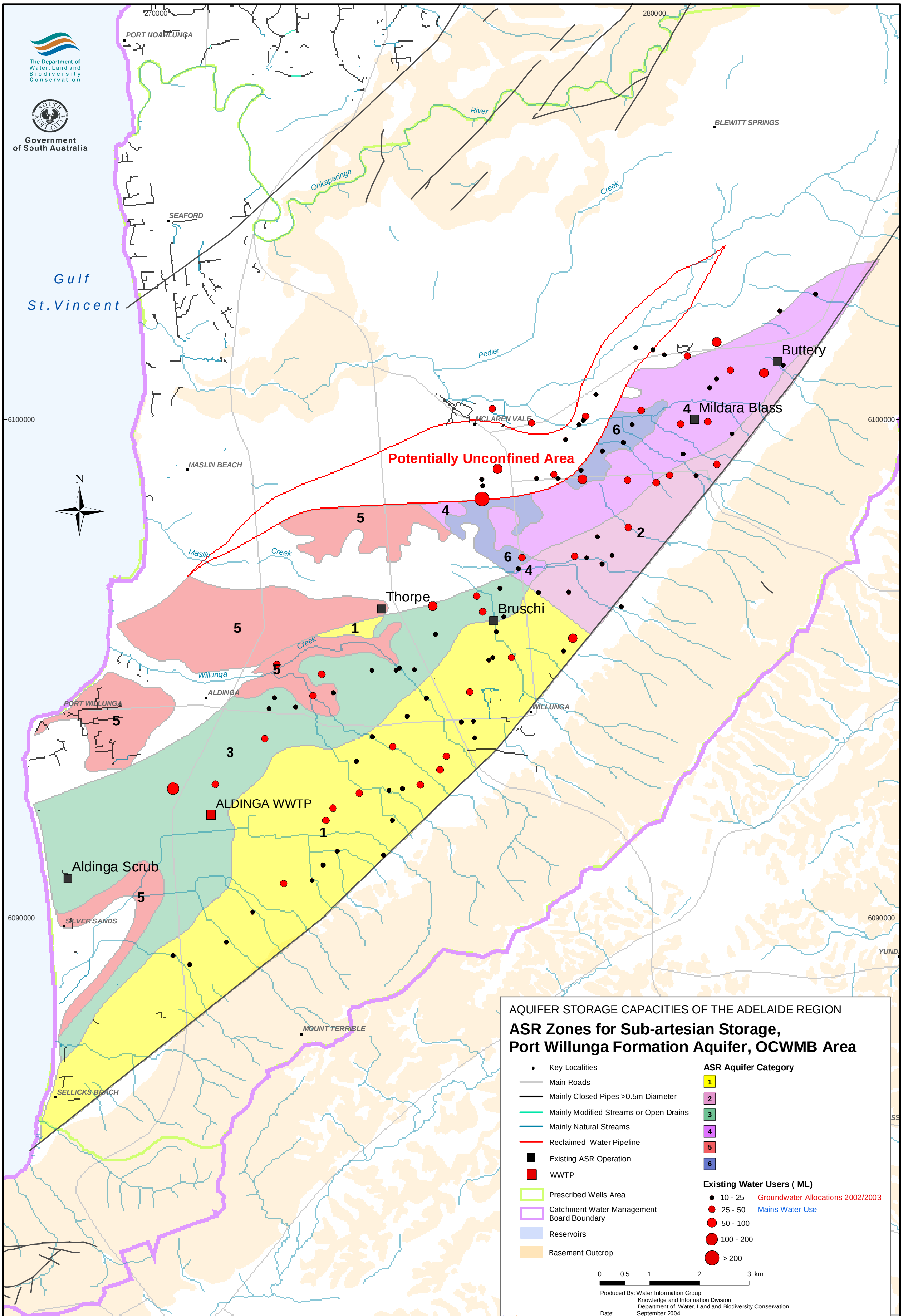

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
Source Water Networks, NABCWMB Area
Key Localities
Main Roads
Existing ASR Operation
Waste Water Treatment Plant
Virginia Reclaimed Water Pipeline
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
Stormwater Network
Mainly Closed Pipes
Mainly Modified Streams or Open Drains
Mainly Unmodified Streams
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf
St. Vincent
Parafield ASR
Catchment Area
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
WARD BELT
TWO WELLS
GAWLER
MIDDLE BEACH
MILNER
VIRGINIA
Andrews Farm
ELIZABETH
WATERLOO CORNER
Kaurna Park
ST KILDA
BOLIVAR WWTP
OUTER HARBOUR
Pine Lakes
Parafield Airport
Tea Tree Gully GC
TEA TREE GULLY
Paddocks Wetland
PARA HILLS
Pooraka Triangle
SEMAPHORE
MOUNT GAWLER
KERSBROOK
Barossa
South Para
Little Para
Millbrook
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 29 c



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
PORT NOARLUNGA
SEAFORD
MASLIN BEACH
PORT WILLUNGA
ALDINGA
SILVER SANDS
SELLICKS BEACH
MOUNT TERRIBLE
MCLAREN VALE
WILLUNGA
BLEWITT SPRINGS
Onkaparinga River
Pedler Creek
Maslin Creek
Willunga Creek
Potentially Unconfined Area
Buttery
Mildara Blass
Thorpe
Bruschi
ALDINGA WWTP
Aldinga Scrub
N
270000
280000
6100000
6090000
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Sub-artesian Storage, Port Willunga Formation Aquifer, OCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes >0.5m Diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1
2
3
4
5
6
Existing Water Users (ML)
10 - 25
25 - 50
50 - 100
100 - 200
> 200
Groundwater Allocations 2002/2003
Mains Water Use
0 0.5 1 2 3 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 30 a

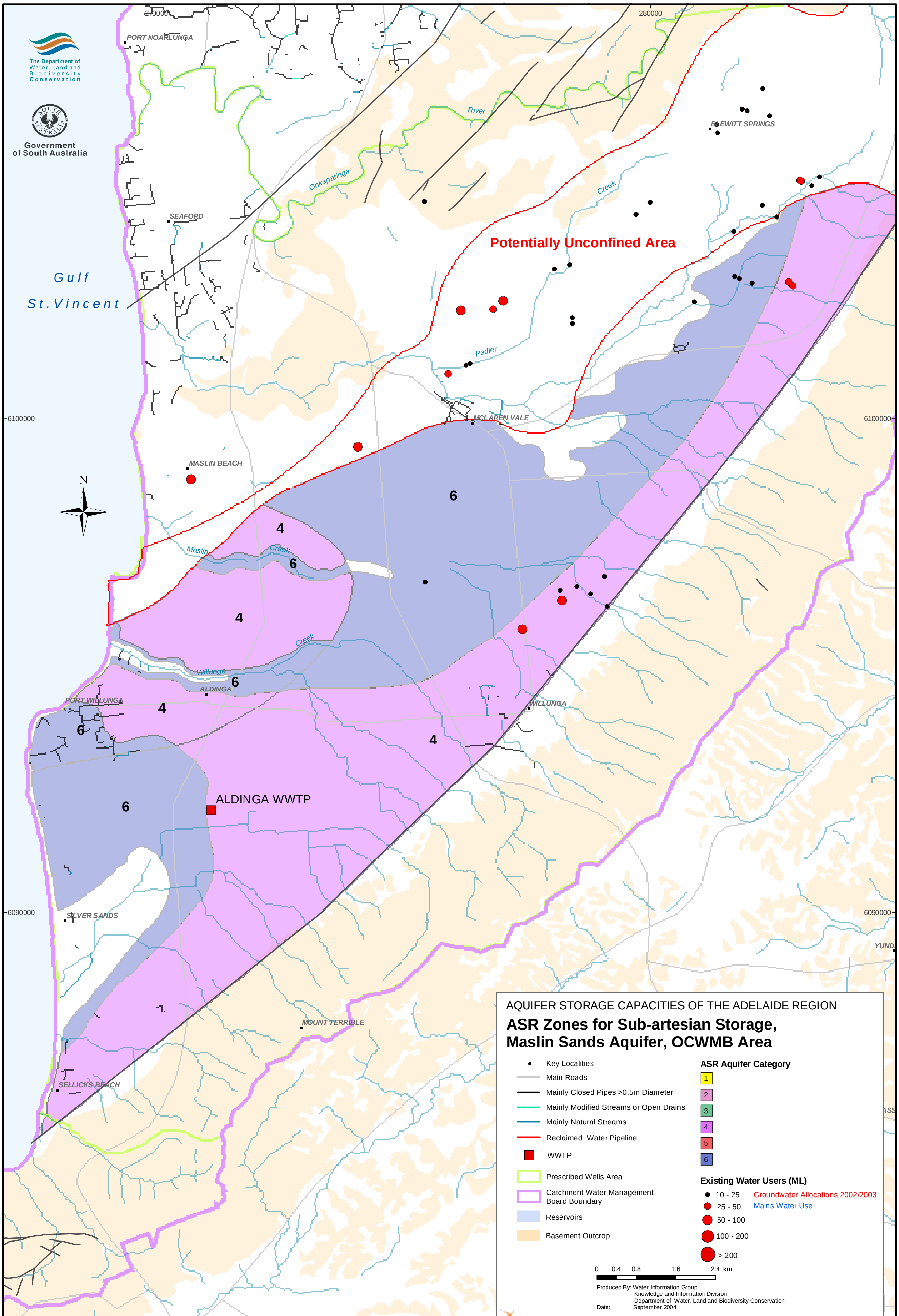
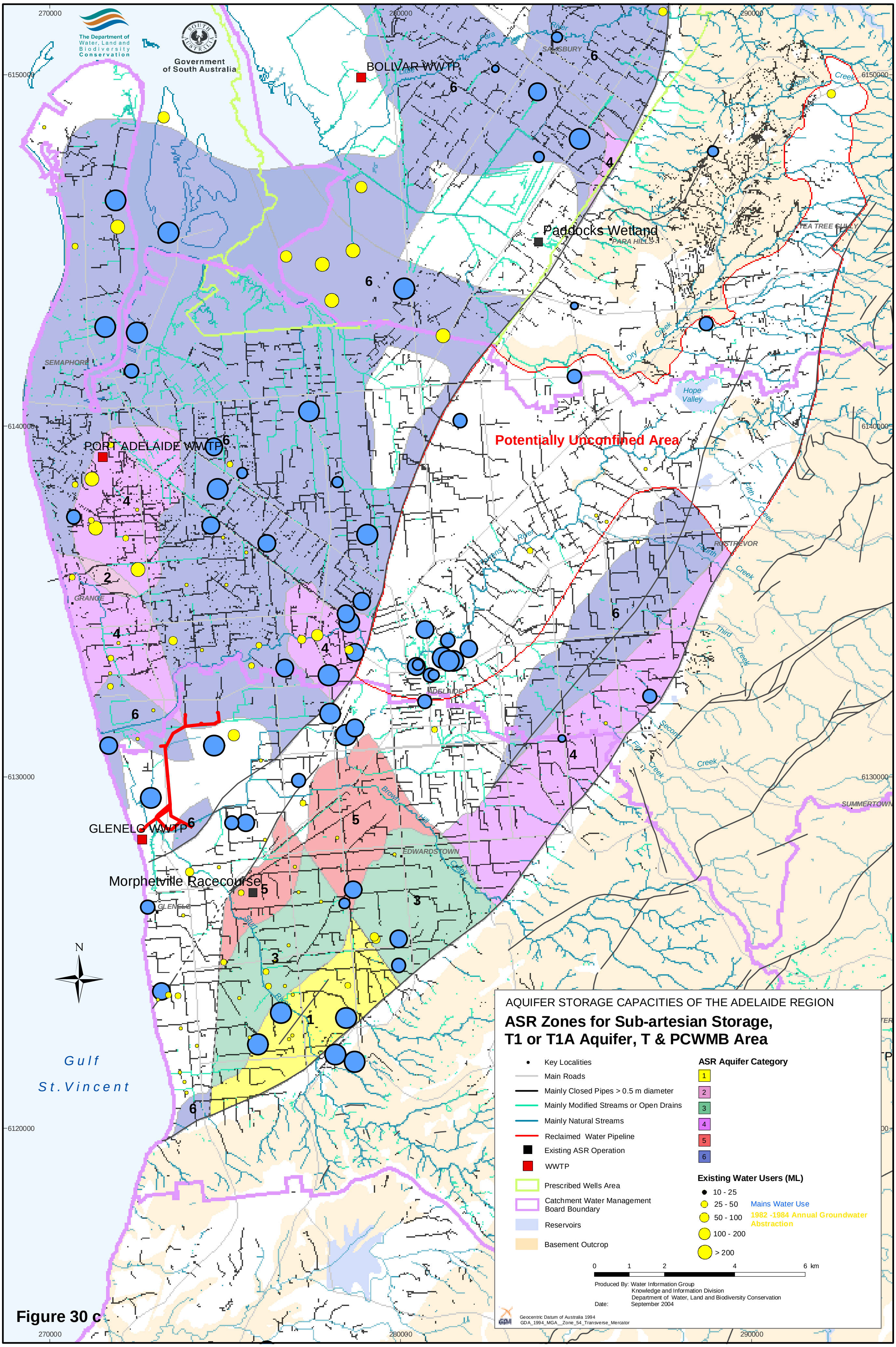
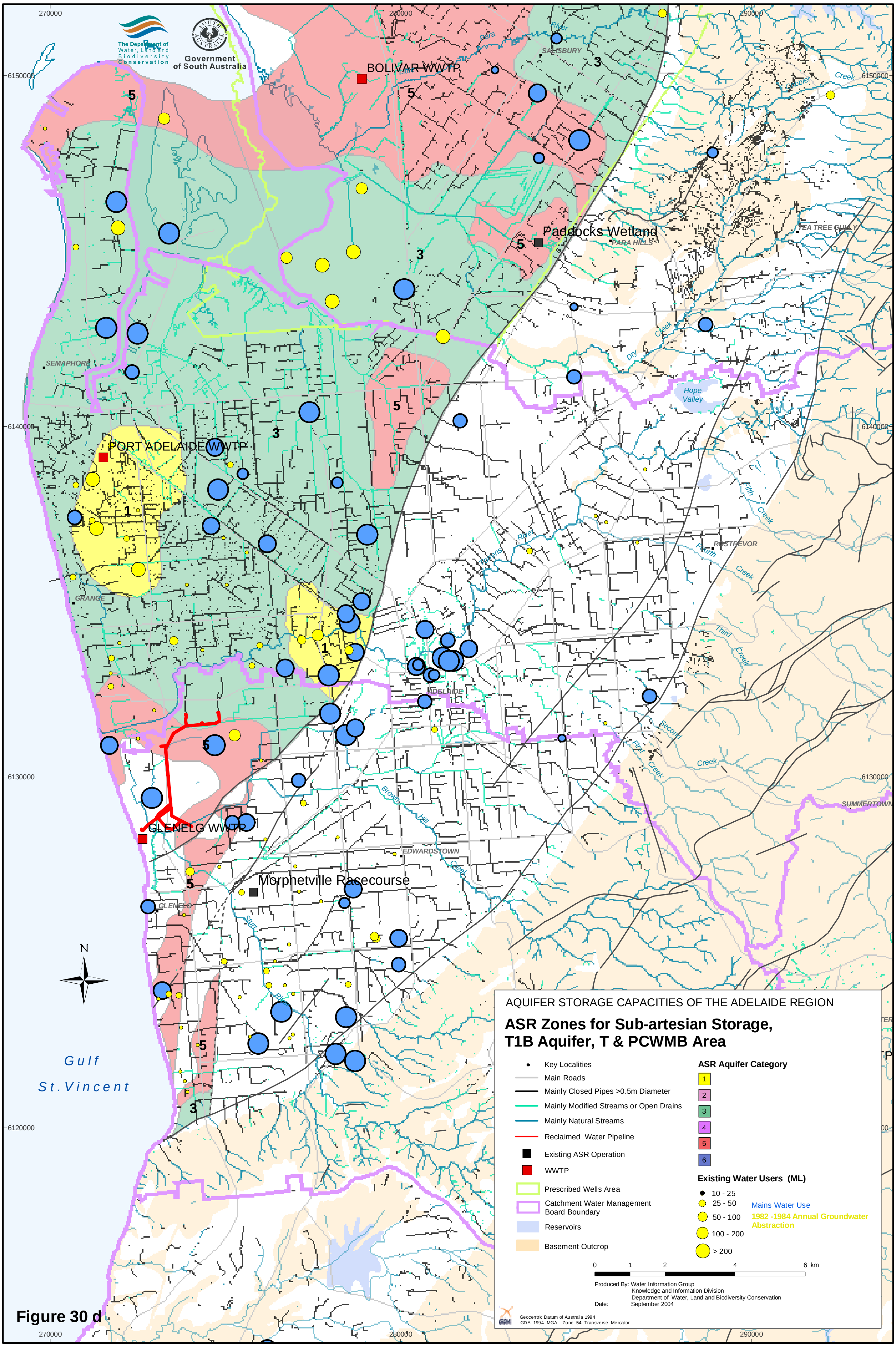

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
N
PORT NOARLUNGA
SEAFORD
River
Onkaparinga
Creek
BLEWITT SPRINGS
Potentially Unconfined Area
Pedler
MCLAREN VALE
MASLIN BEACH
Maslin
Creek
Willunga
Creek
ALDINGA
PORT WILLUNGA
WILLUNGA
ALDINGA WWTP
SILVER SANDS
MOUNT TERRIBLE
SELLICKS BEACH
YUND
270000
280000
6100000
6090000
4
6
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Sub-artesian Storage, Maslin Sands Aquifer, OCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes >0.5m Diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1
2
3
4
5
6
Existing Water Users (ML)
10 - 25
25 - 50
50 - 100
100 - 200
> 200
Groundwater Allocations 2002/2003
Mains Water Use
0 0.4 0.8 1.6 2.4 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 30 b



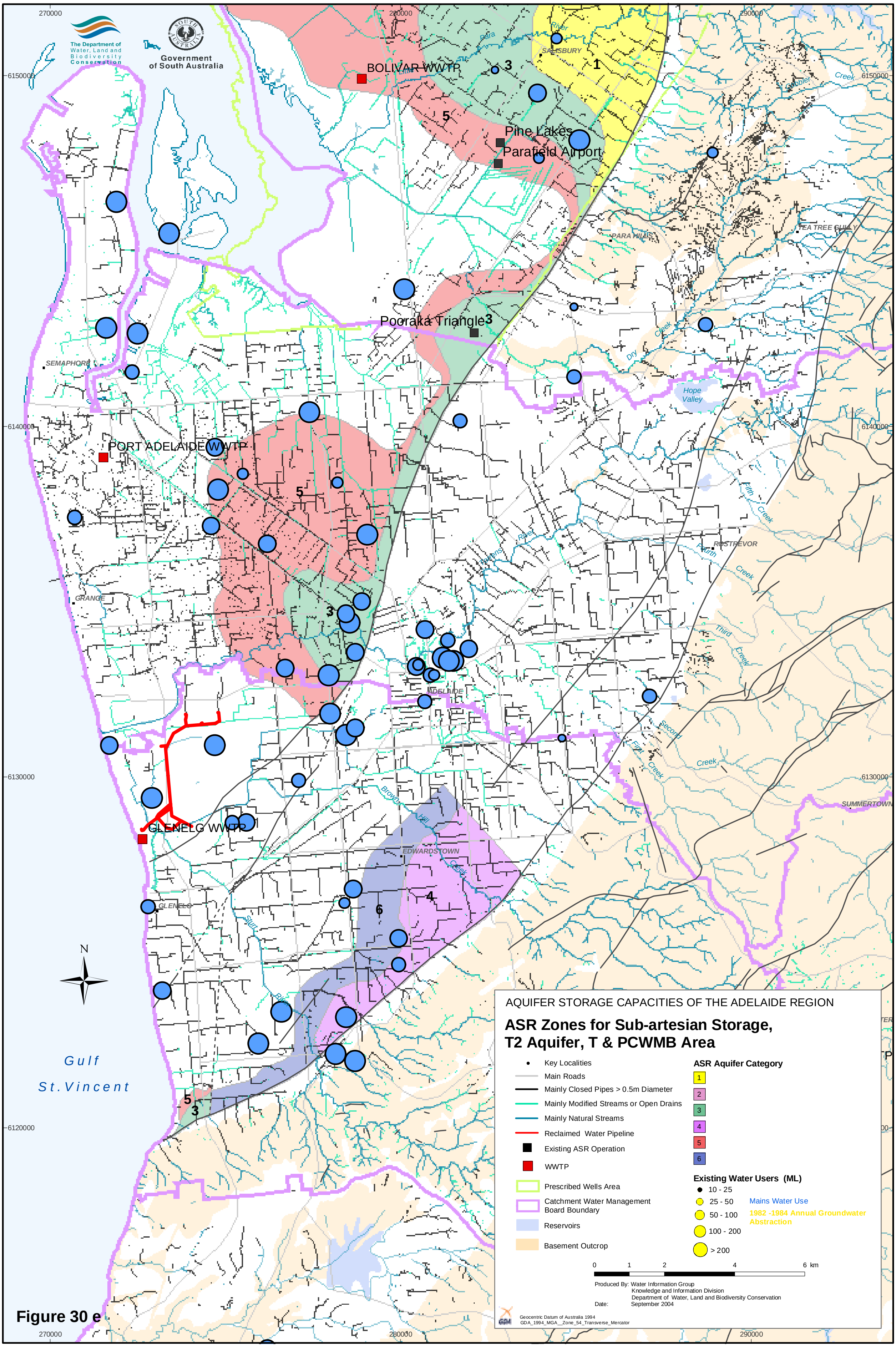
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
BOLIVAR WWTP
Paddocks Wetland
PORT ADELAIDE WWTP
GLENELG WWTP
Morphetville Racecourse
Potentially Unconfined Area
Gulf St.Vincent
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Sub-artesian Storage, T1 or T1A Aquifer, T & PCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes > 0.5 m diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
Existing Water Users (ML)
10 - 25
25 - 50
50 - 100
100 - 200
> 200
Mains Water Use
1982 -1984 Annual Groundwater Abstraction
Produced By: Water Information Group Knowledge and Information Division Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994 GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 30 c



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
BOLIVAR WWTP
SALISBURY
Paddocks Wetland
PARA HILLS
TEA TREE GULLY
SEMAPHORE
Hope Valley
PORT ADELAIDE WWTP
ROSTREVOR
GRANGE
ADELAIDE
GLENELG WWTP
Morphetville Racecourse
EDWARDSTOWN
GLENELG
SUMMERTOWN
Gulf St.Vincent
N
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Sub-artesian Storage, T1B Aquifer, T & PCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes >0.5m Diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1
2
3
4
5
6
Existing Water Users (ML)
10 - 25
25 - 50
50 - 100
100 - 200
> 200
Mains Water Use
1982 -1984 Annual Groundwater Abstraction
0 1 2 4 6 km
Produced By: Water Information Group Knowledge and Information Division Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994 GDA_1994_MGA_Zone_54_Transverse_Mercator

Figure 30 d



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
BOLIVAR WWTP
SALISBURY
Pine Lakes
Parafield Airport
PARA HILLS
TEA TREE GULLY
Pooraka Triangle
SEMAPHORE
Hope Valley
PORT ADELAIDE WWTP
ROSTREVOR
GRANGE
ADELAIDE
GLENELG WWTP
EDWARDSTOWN
SUMMERTOWN
GLENELG
Gulf St.Vincent
N
270000
280000
290000
6150000
6140000
6130000
6120000
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Sub-artesian Storage,
T2 Aquifer, T & PCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes > 0.5m Diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1
2
3
4
5
6
Existing Water Users (ML)
10 - 25
25 - 50
50 - 100
100 - 200
> 200
Mains Water Use
1982 -1984 Annual Groundwater Abstraction
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 30 e

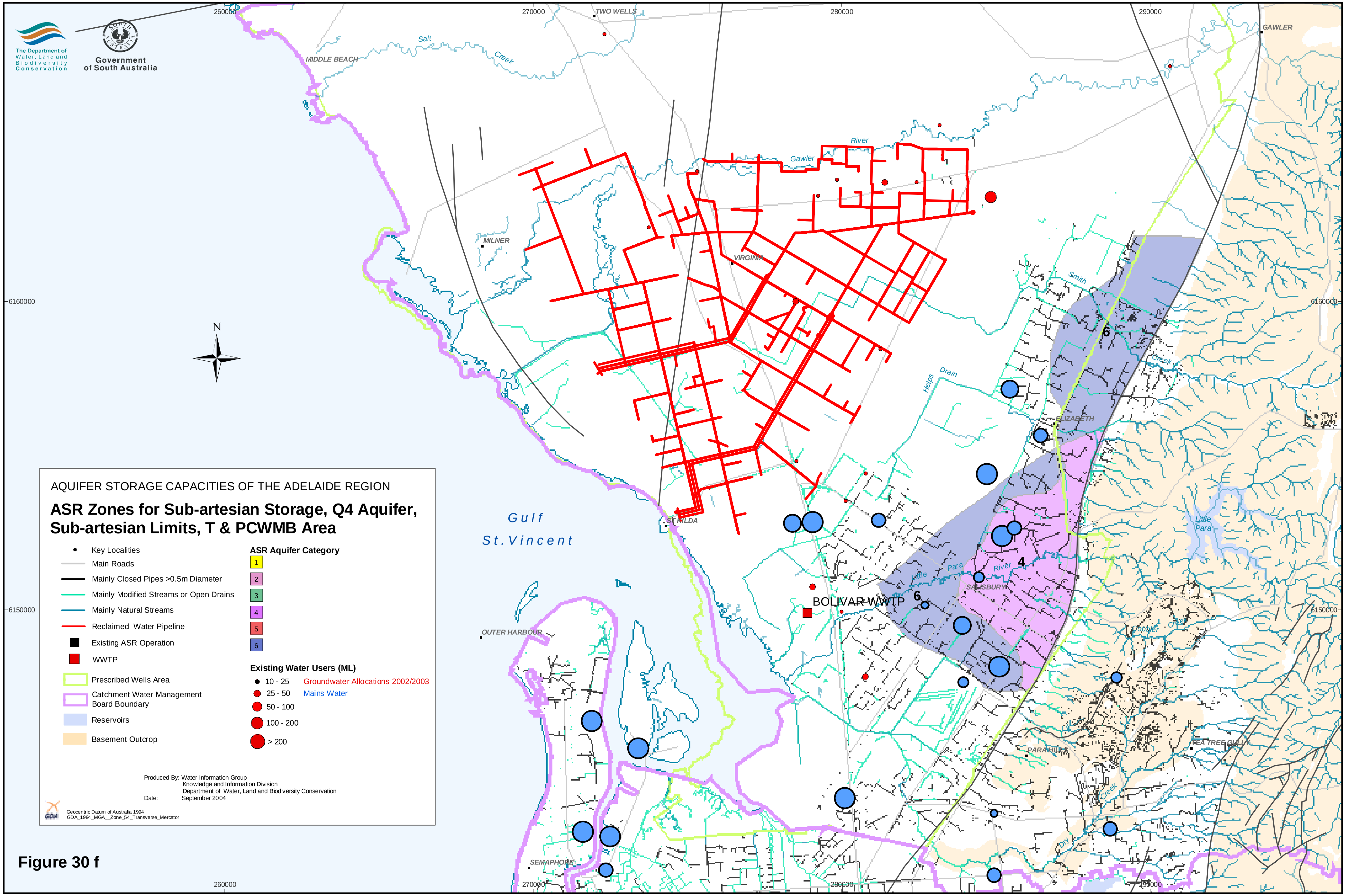
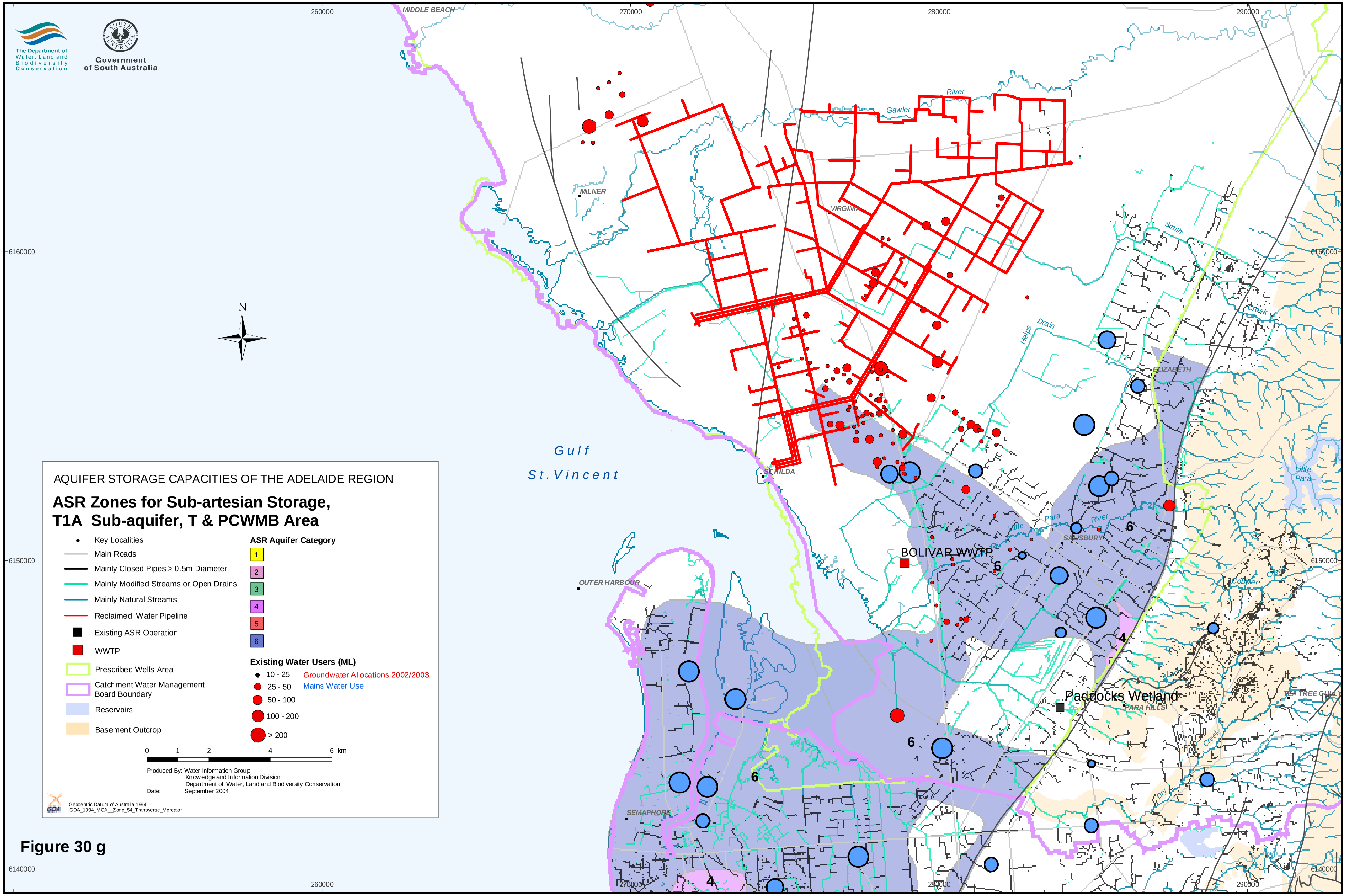

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Sub-artesian Storage, Q4 Aquifer, Sub-artesian Limits, T & PCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes >0.5m Diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1
2
3
4
5
6
Existing Water Users (ML)
10 - 25
25 - 50
50 - 100
100 - 200
> 200
Groundwater Allocations 2002/2003
Mains Water
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf St.Vincent
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ST KILDA
OUTER HARBOUR
SEMAPHORE
BOLIVAR WWTP
SALISBURY
ELIZABETH
PARAHILLS
TEA TREE GULLY
GAWLER
Salt Creek
Gawler River
Helps Drain
Smith Creek
Little Para River
Little Para
Dry Creek
260000
270000
280000
290000
6160000
6150000

Figure 30 f



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Sub-artesian Storage,
T1A Sub-aquifer, T & PCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes > 0.5m Diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1
2
3
4
5
6
Existing Water Users (ML)
10 - 25
25 - 50
50 - 100
100 - 200
> 200
Groundwater Allocations 2002/2003
Mains Water Use
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf
St.Vincent
MIDDLE BEACH
MILNER
VIRGINIA
ST KILDA
OUTER HARBOUR
SEMAPHORE
ELIZABETH
SALISBURY
PARA HILLS
TEA TREE GULLY
BOLIVAR WWTP
Paddocks Wetland
Gawler
River
Smith
Creek
Helps
Drain
Little
Para
River
Cobbler
Dry
260000
270000
280000
290000
6160000
6150000
6140000

Figure 30 g

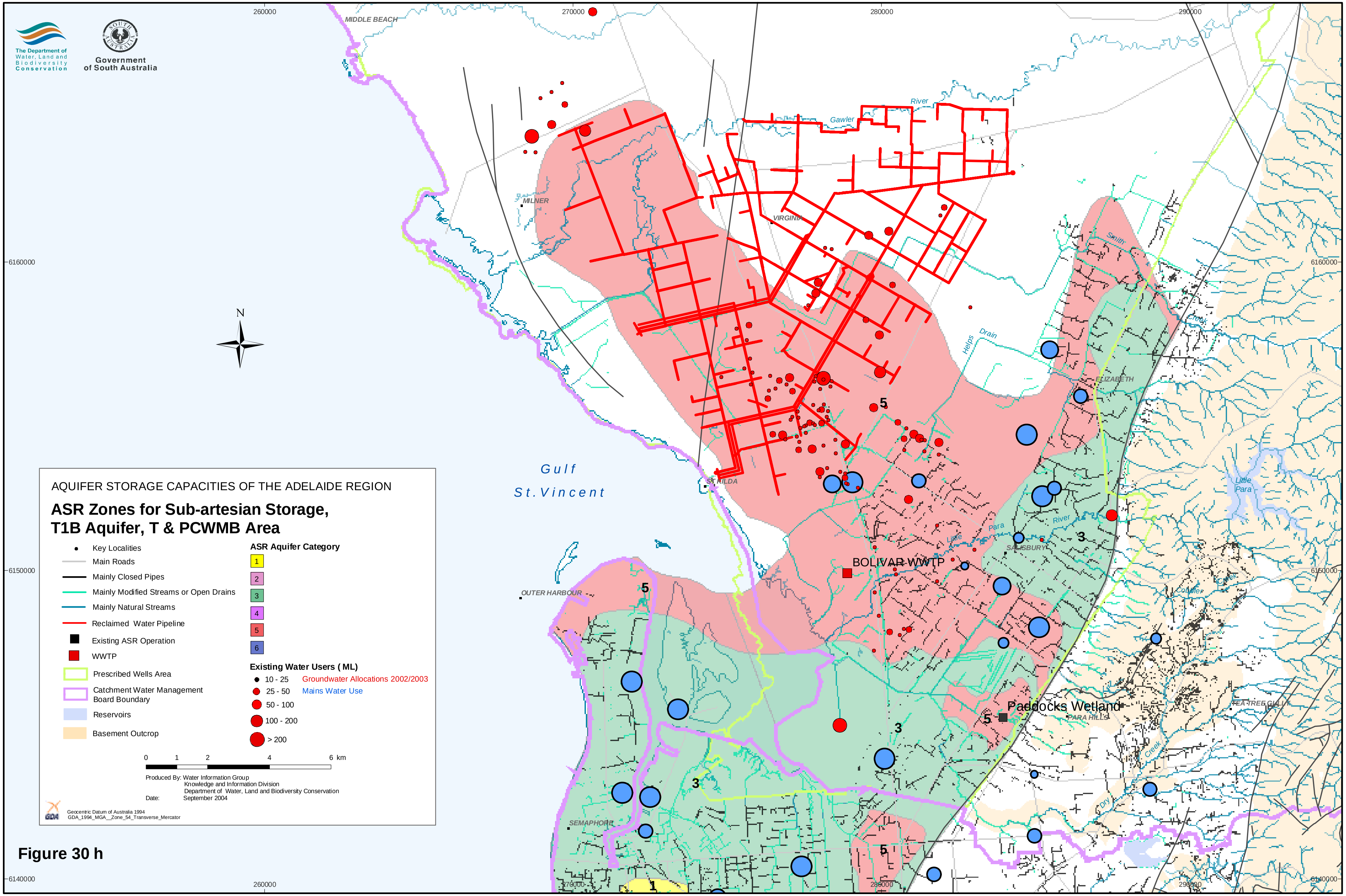

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Sub-artesian Storage, T1B Aquifer, T & PCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1
2
3
4
5
6
Existing Water Users (ML)
10 - 25
25 - 50
50 - 100
100 - 200
> 200
Groundwater Allocations 2002/2003
Mains Water Use
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf St. Vincent
MIDDLE BEACH
MILNER
VIRGINIA
ST KILDA
OUTER HARBOUR
SEMAPHORE
ELIZABETH
SALISBURY
PARA HILLS
TEA TREE GULLY
BOLIVAR WWTP
Paddocks Wetland
Gawler River
Helps Drain
Smith Creek
Little Para River
Dry Creek
Cobbler Creek
Little Para
260000
270000
280000
290000
6160000
6150000
6140000

Figure 30 h

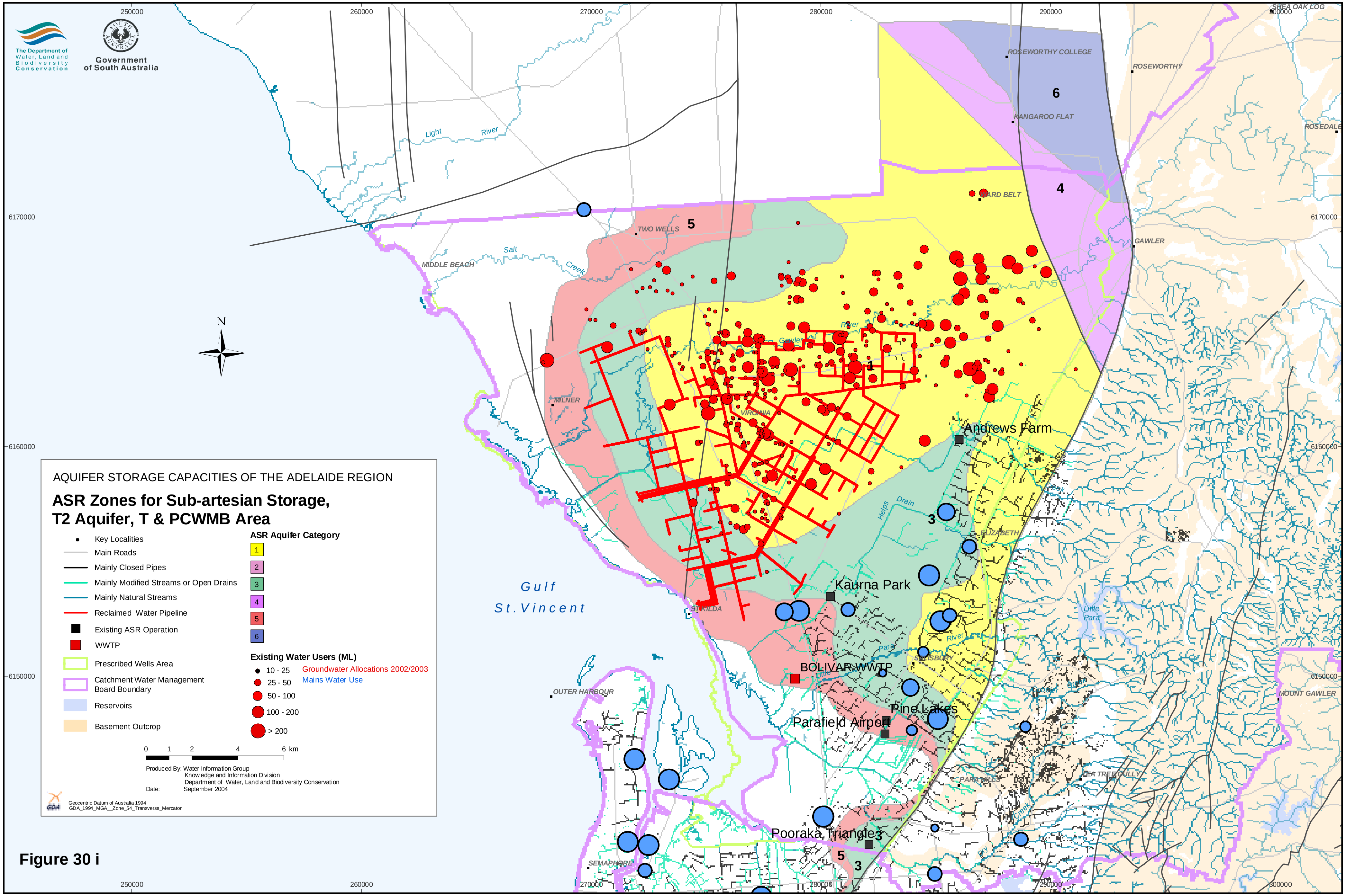
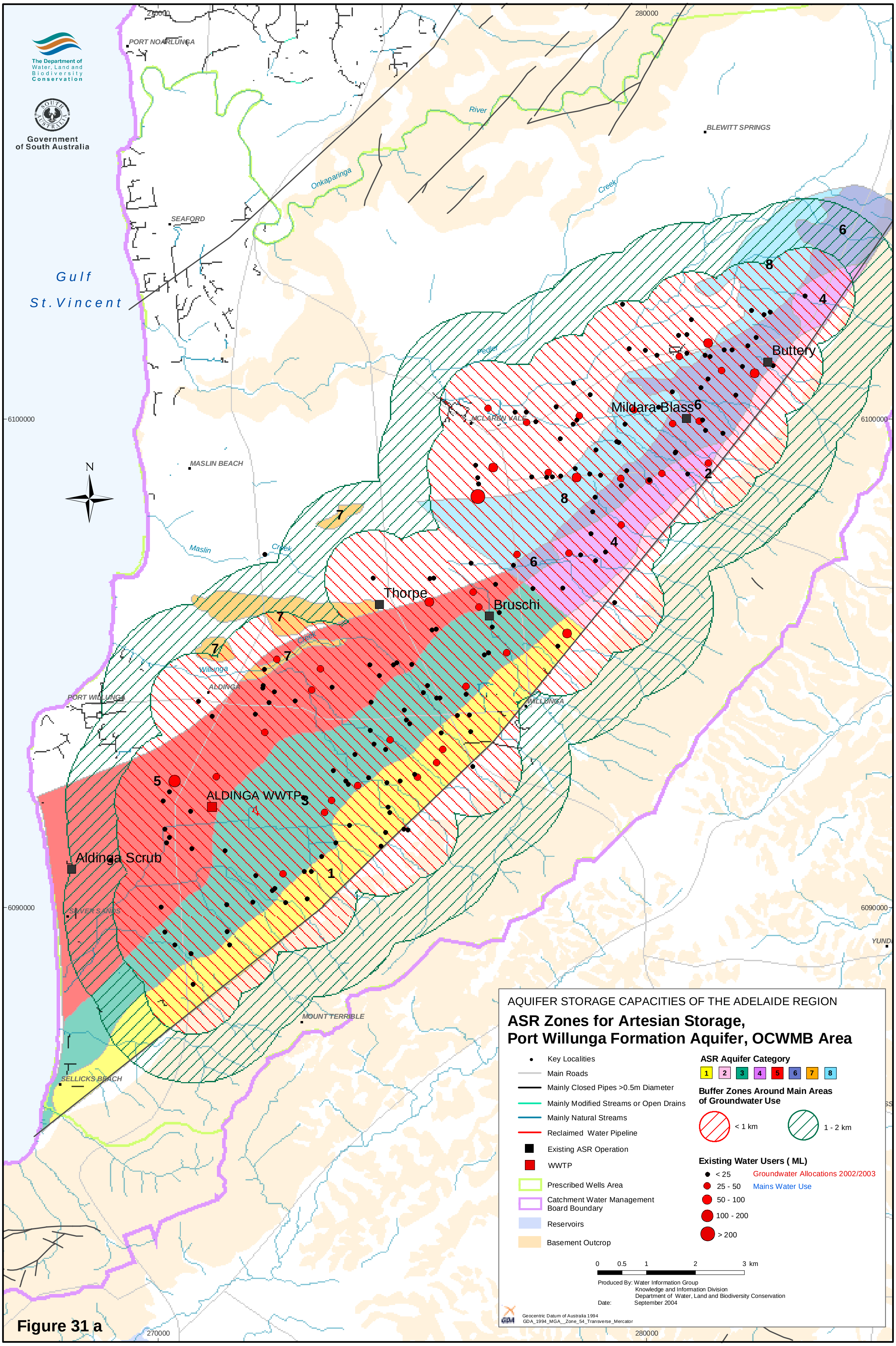

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Sub-artesian Storage, T2 Aquifer, T & PCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1
2
3
4
5
6
Existing Water Users (ML)
10 - 25
25 - 50
50 - 100
100 - 200
> 200
Groundwater Allocations 2002/2003
Mains Water Use
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
N
Gulf
St. Vincent
Andrews Farm
Kaurna Park
BOLIVAR WWTP
Pine Lakes
Parafield Airport
Pooraka Triangle
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
ROSEDALE
GAWLER
TWO WELLS
MIDDLE BEACH
MILNER
VIRGINIA
ST KILDA
OUTER HARBOUR
SEMAPHORE
ELIZABETH
MOUNT GAWLER
SHEA OAK LOG
Light River
Salt Creek
Gawler River
Helps Drain
Little Para
250000
260000
270000
280000
290000
300000
6150000
6160000
6170000

Figure 30 i



AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Artesian Storage, Port Willunga Formation Aquifer, OCWMB Area
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
Gulf St.Vincent
N
PORT NOARLUNGA
SEAFORD
MASLIN BEACH
PORT WILLUNGA
ALDINGA
SILVER SANDS
SELLICKS BEACH
MOUNT TERRIBLE
McLAREN VALE
WILLUNGA
BLEWITT SPRINGS
YUNDI
Onkaparinga
River
Creek
Pedler
Maslin
Willunga
Thorpe
Bruschi
Buttery
Mildara Blass
ALDINGA WWTP
Aldinga Scrub
270000
280000
6100000
6090000
Key Localities
Main Roads
Mainly Closed Pipes >0.5m Diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1 2 3 4 5 6 7 8
Buffer Zones Around Main Areas of Groundwater Use
< 1 km
1 - 2 km
Existing Water Users (ML)
< 25
25 - 50
50 - 100
100 - 200
> 200
Groundwater Allocations 2002/2003
Mains Water Use
0 0.5 1 2 3 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 31 a

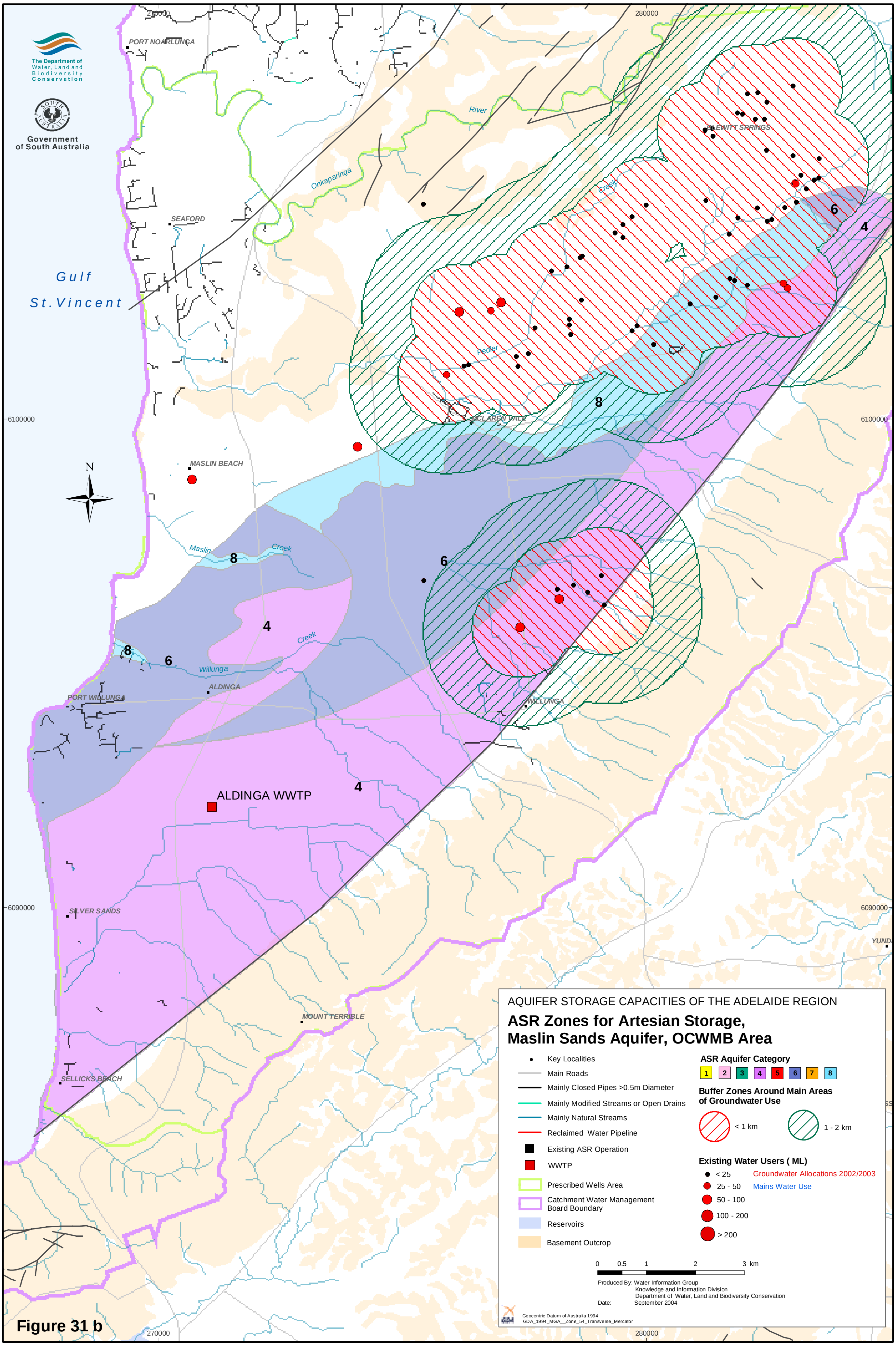

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
PORT NOARLUNGA
SEAFORD
MASLIN BEACH
PORT WILLUNGA
ALDINGA
SILVER SANDS
SELLICKS BEACH
MOUNT TERRIBLE
McLAREN VALE
WILLUNGA
BLEWITT SPRINGS
Gulf St.Vincent
Onkaparinga River
Pedler Creek
Maslin Creek
Willunga Creek
ALDINGA WWTP
N
270000
280000
6100000
6090000
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Artesian Storage, Maslin Sands Aquifer, OCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes >0.5m Diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1 2 3 4 5 6 7 8
Buffer Zones Around Main Areas of Groundwater Use
< 1 km
1 - 2 km
Existing Water Users (ML)
< 25
25 - 50
50 - 100
100 - 200
> 200
Groundwater Allocations 2002/2003
Mains Water Use
0 0.5 1 2 3 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 31 b

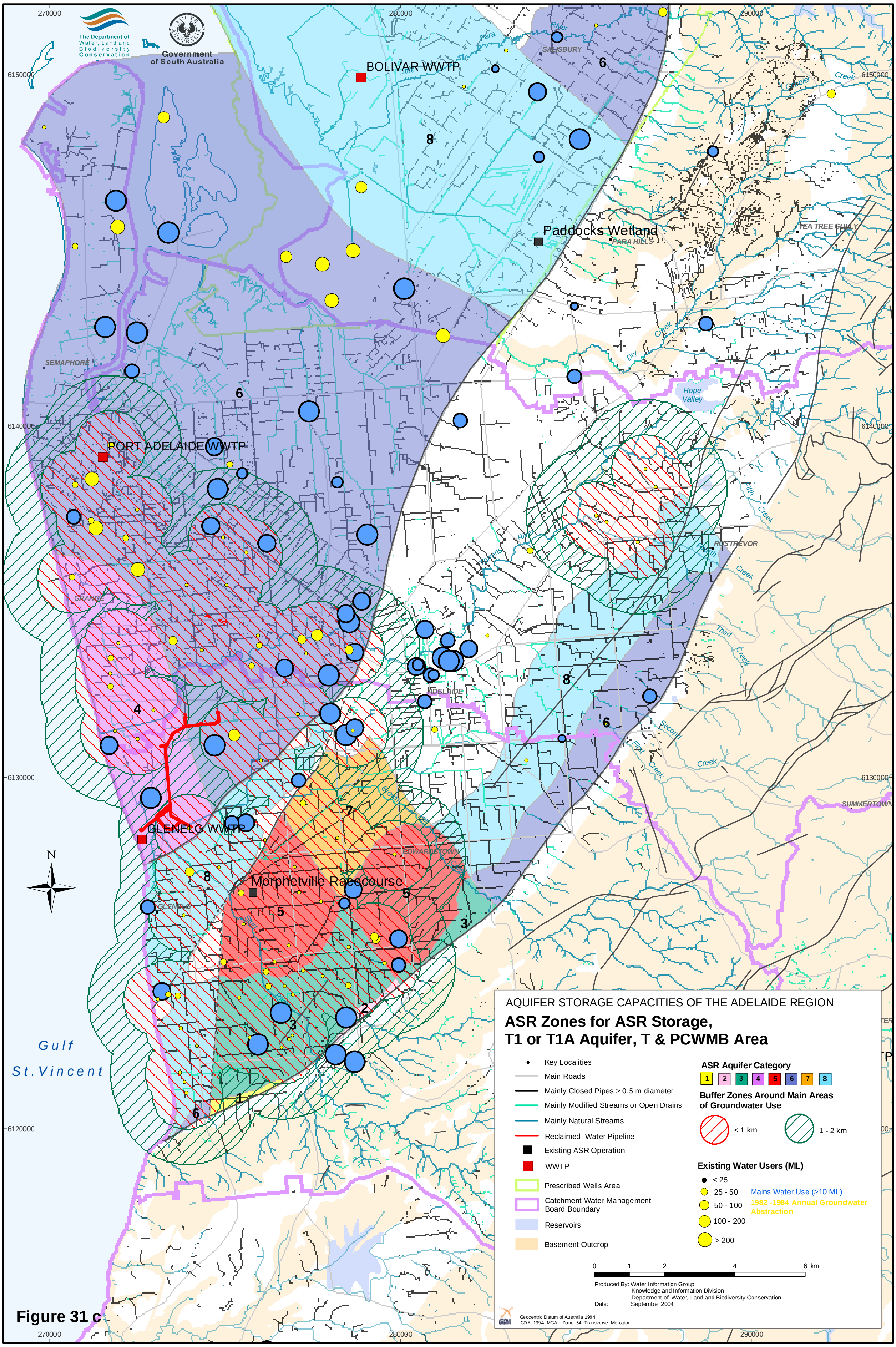
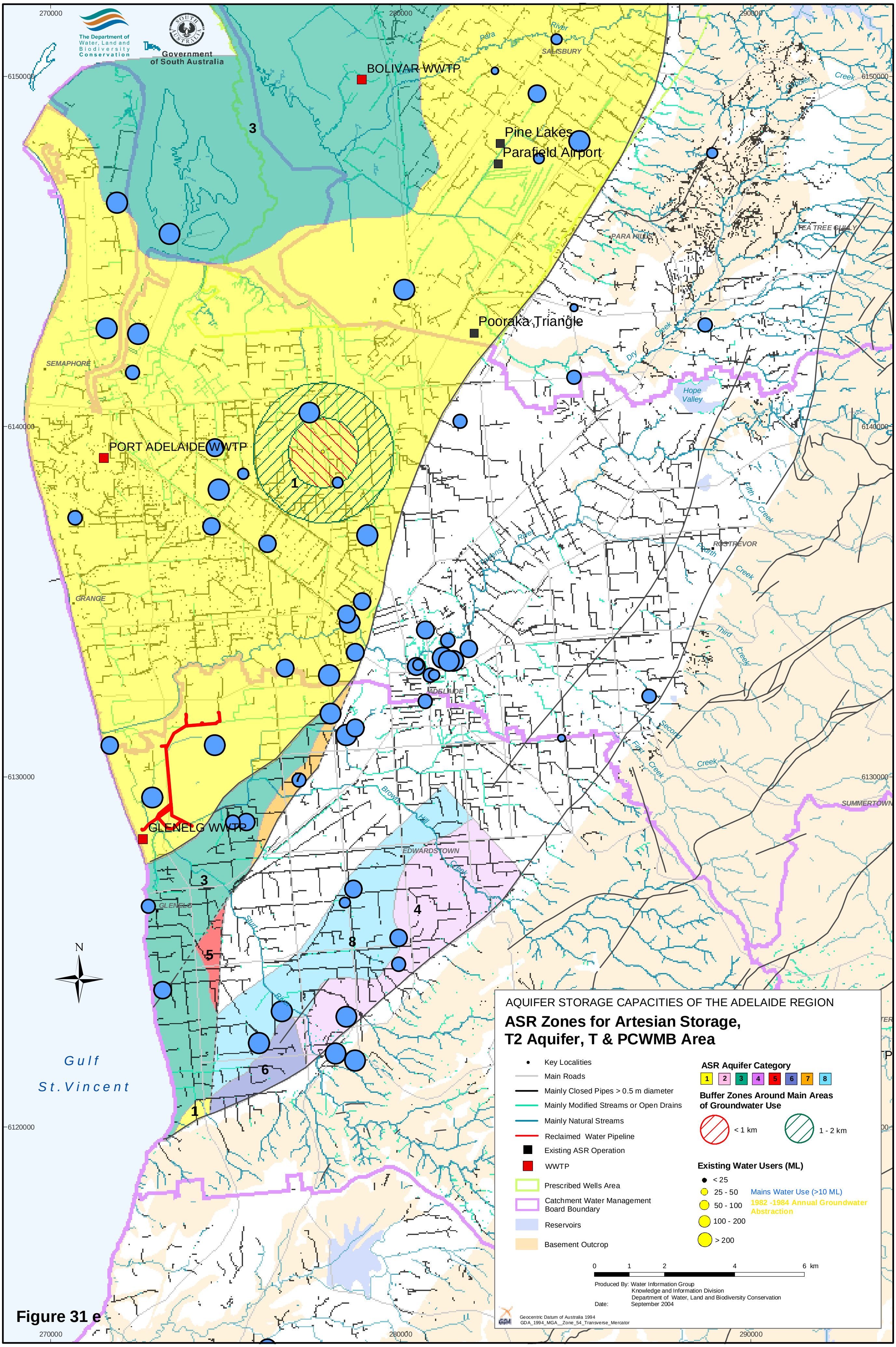

AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for ASR Storage,
T1 or T1A Aquifer, T & PCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes > 0.5 m diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1 2 3 4 5 6 7 8
Buffer Zones Around Main Areas of Groundwater Use
< 1 km
1 - 2 km
Existing Water Users (ML)
< 25
25 - 50
50 - 100
100 - 200
> 200
Mains Water Use (>10 ML)
1982 -1984 Annual Groundwater Abstraction
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
BOLIVAR WWTP
Paddocks Wetland
PORT ADELAIDE WWTP
GLENELG WWTP
Morphetville Racecourse
SALISBURY
PARA HILLS
SEMAPHORE
GRANGE
ADELAIDE
GLENELG
EDWARDSTOWN
ROSTREVOR
SUMMERTOWN
TEA TREE GULLY
Hope Valley
Gulf St.Vincent
N
270000
280000
290000
6150000
6140000
6130000
6120000

Figure 31 c



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
270000
280000
290000
6150000
6140000
6130000
6120000
BOLIVAR WWTP
SALISBURY
Pine Lakes
Parafield Airport
PARA HILLS
TEA TREE GULLY
Pooraka Triangle
SEMAPHORE
PORT ADELAIDE WWTP
Hope Valley
ROSTREVOR
GRANGE
ADELAIDE
GLENELG WWTP
EDWARDSTOWN
GLENELG
SUMMERTOWN
Gulf St.Vincent
N
1
3
4
5
6
7
8
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Artesian Storage, T2 Aquifer, T & PCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes > 0.5 m diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1 2 3 4 5 6 7 8
Buffer Zones Around Main Areas of Groundwater Use
< 1 km
1 - 2 km
Existing Water Users (ML)
< 25
25 - 50
50 - 100
100 - 200
> 200
Mains Water Use (>10 ML)
1982 -1984 Annual Groundwater Abstraction
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator

Figure 31 e

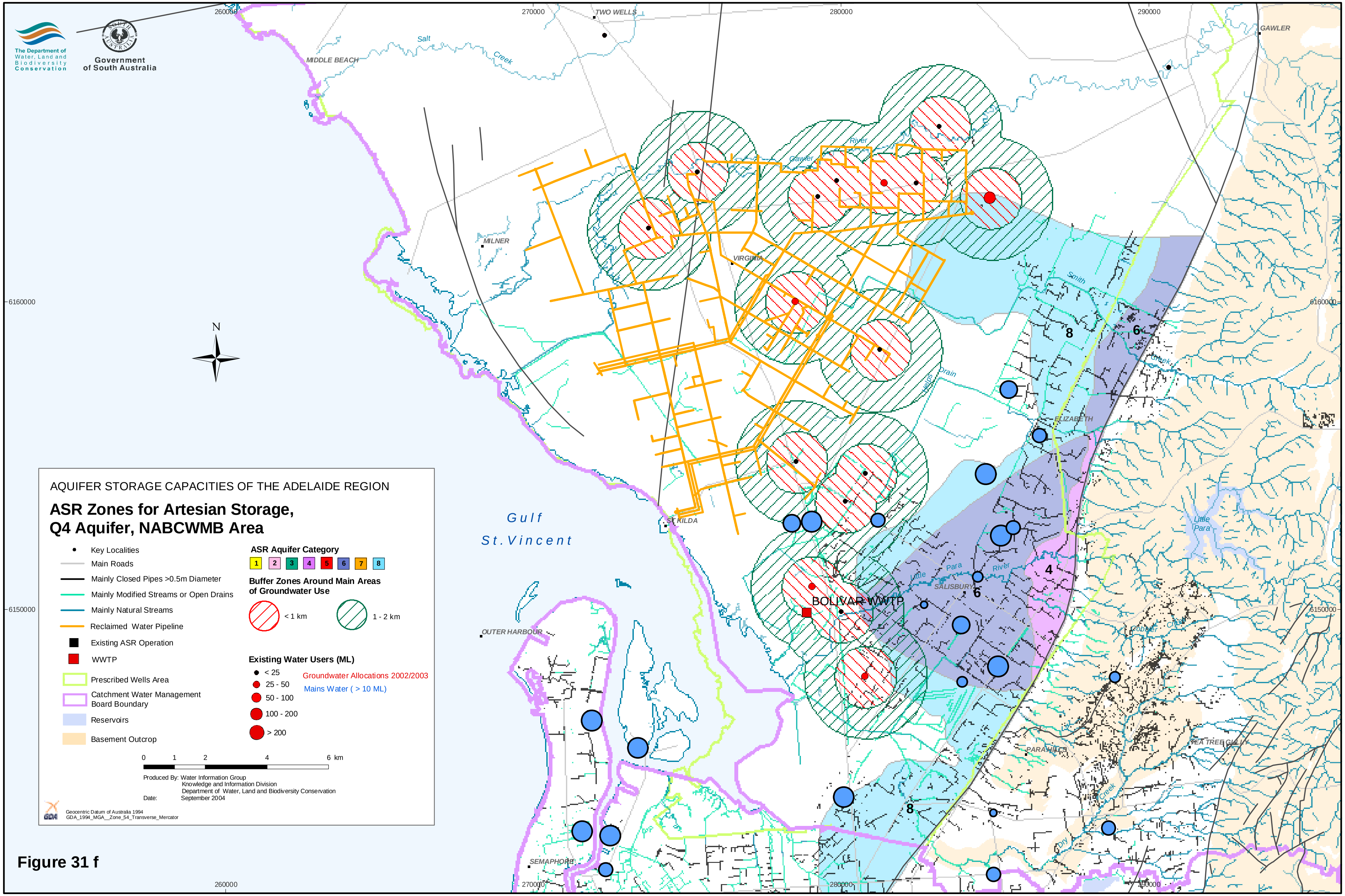
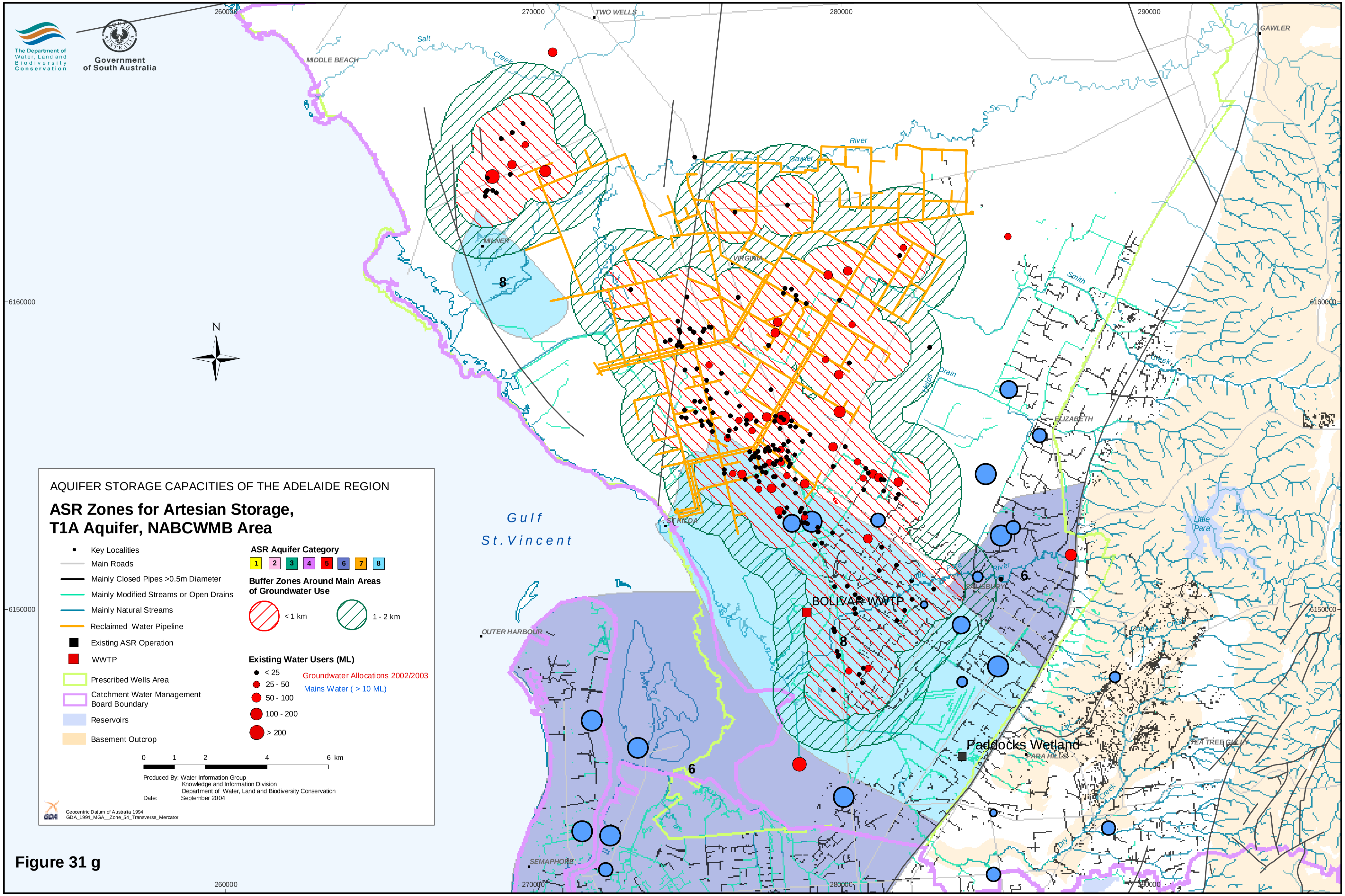
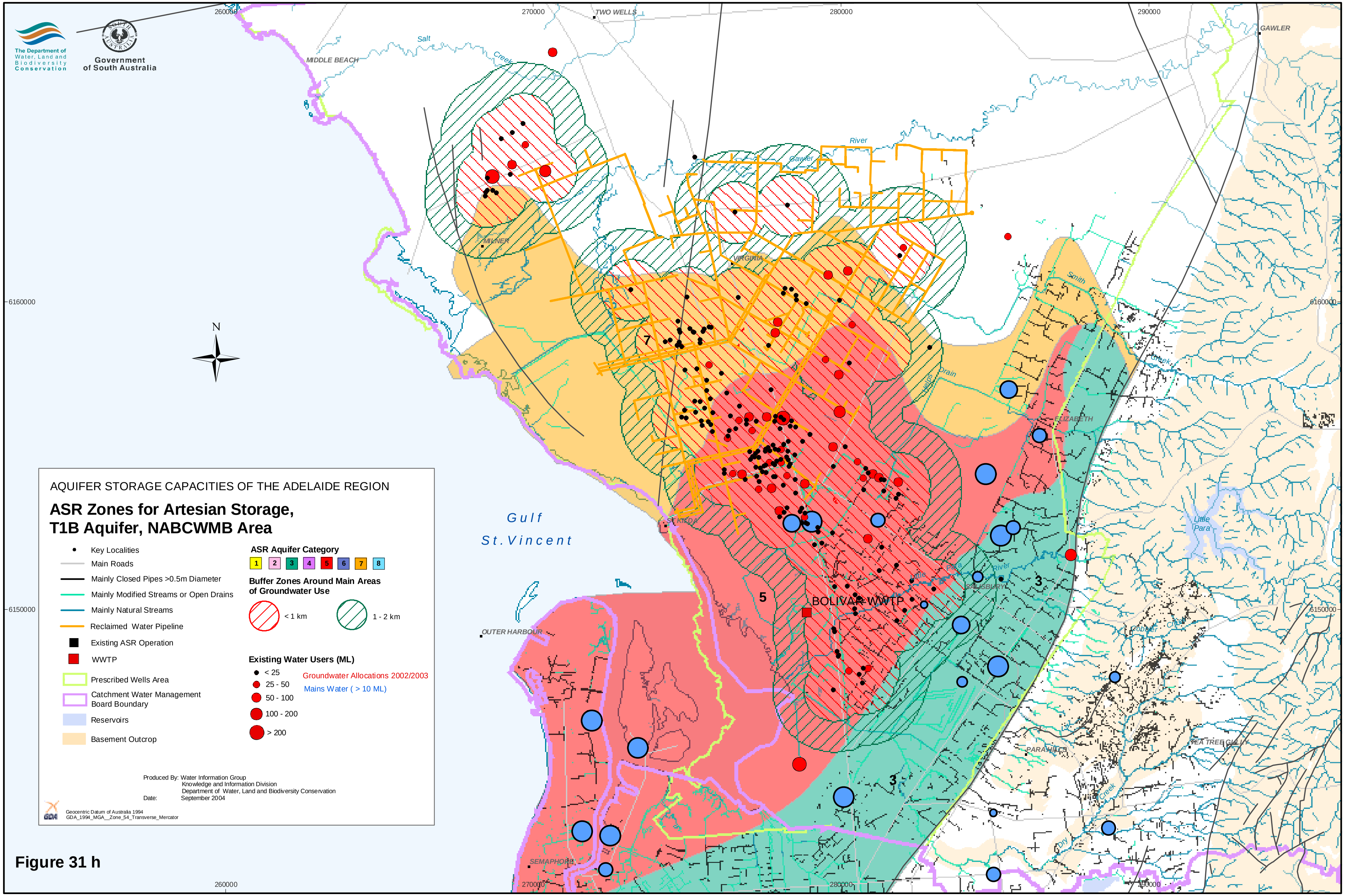

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Artesian Storage, Q4 Aquifer, NABCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes >0.5m Diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1 2 3 4 5 6 7 8
Buffer Zones Around Main Areas of Groundwater Use
< 1 km
1 - 2 km
Existing Water Users (ML)
< 25
25 - 50
50 - 100
100 - 200
> 200
Groundwater Allocations 2002/2003
Mains Water (> 10 ML)
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
N
Gulf St. Vincent
TWO WELLS
GAWLER
MIDDLE BEACH
MILNER
VIRGINIA
ST KILDA
OUTER HARBOUR
SEMAPHORE
ELIZABETH
SALISBURY
PARAHILLS
TEA TREE GULLY
BOLIVAR WWTP
Salt Creek
Gawler River
Smith Creek
Little Para River
Little Para
Dry Creek
Cobbler Creek
Drain
260000
270000
280000
290000
6160000
6150000

Figure 31 f



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Artesian Storage,
T1A Aquifer, NABCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes >0.5m Diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1 2 3 4 5 6 7 8
Buffer Zones Around Main Areas of Groundwater Use
< 1 km
1 - 2 km
Existing Water Users (ML)
< 25
25 - 50
50 - 100
100 - 200
> 200
Groundwater Allocations 2002/2003
Mains Water (> 10 ML)
0 1 2 4 6 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
N
Gulf
St.Vincent
TWO WELLS
GAWLER
MIDDLE BEACH
MILNER
VIRGINIA
ST KILDA
ELIZABETH
SALISBURY
PARA HILLS
TEA TREE GULLY
OUTER HARBOUR
SEMAPHORE
BOLIVAR WWTP
Paddocks Wetland
Salt
Creek
Gawler
River
Smith
Drain
Little
Para
Dry
Creek
Cobbler
8
6
260000
270000
280000
290000
6160000
6150000

Figure 31 g


The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Artesian Storage, T1B Aquifer, NABCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes >0.5m Diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1 2 3 4 5 6 7 8
Buffer Zones Around Main Areas of Groundwater Use
< 1 km
1 - 2 km
Existing Water Users (ML)
< 25
25 - 50
50 - 100
100 - 200
> 200
Groundwater Allocations 2002/2003
Mains Water (> 10 ML)
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA__Zone_54_Transverse_Mercator
Gulf St.Vincent
TWO WELLS
GAWLER
MIDDLE BEACH
MILNER
VIRGINIA
ST KILDA
OUTER HARBOUR
SEMAPHORE
ELIZABETH
SALISBURY
PARAHILLS
TEA TREE GULLY
BOLIVAR WWTP
Salt Creek
Gawler River
Smith
Drain
Little Para
Dry Creek
Cobbler Creek
7
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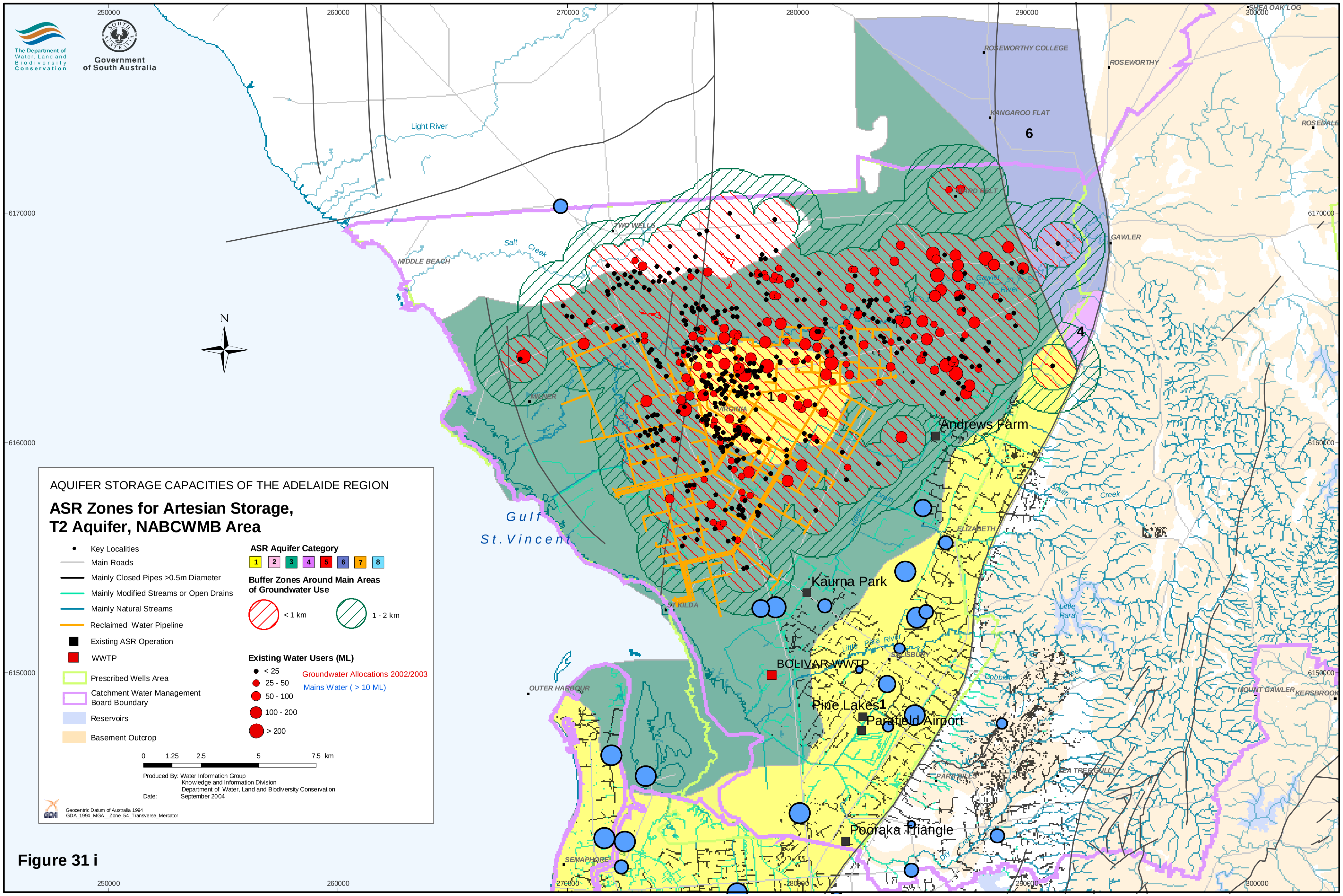
260000
270000
280000
290000
6160000
6150000

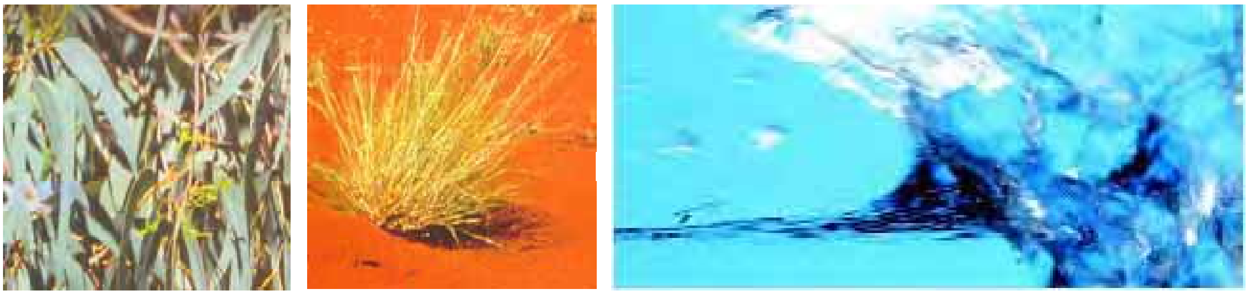
Figure 31 h



The Department of Water, Land and Biodiversity Conservation
Government of South Australia
AQUIFER STORAGE CAPACITIES OF THE ADELAIDE REGION
ASR Zones for Artesian Storage, T2 Aquifer, NABCWMB Area
Key Localities
Main Roads
Mainly Closed Pipes >0.5m Diameter
Mainly Modified Streams or Open Drains
Mainly Natural Streams
Reclaimed Water Pipeline
Existing ASR Operation
WWTP
Prescribed Wells Area
Catchment Water Management Board Boundary
Reservoirs
Basement Outcrop
ASR Aquifer Category
1 2 3 4 5 6 7 8
Buffer Zones Around Main Areas of Groundwater Use
< 1 km
1 - 2 km
Existing Water Users (ML)
< 25
25 - 50
50 - 100
100 - 200
> 200
Groundwater Allocations 2002/2003
Mains Water (> 10 ML)
0 1.25 2.5 5 7.5 km
Produced By: Water Information Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Date: September 2004
Geocentric Datum of Australia 1994
GDA_1994_MGA_Zone_54_Transverse_Mercator
N
Light River
Salt Creek
MIDDLE BEACH
TWO WELLS
Gulf St. Vincent
MILNER
VIRGINIA
ST KILDA
OUTER HARBOUR
SEMAPHORE
ROSEWORTHY COLLEGE
ROSEWORTHY
KANGAROO FLAT
GAWLER
ROSEDALE
SHEA OAK LOG
Andrews Farm
Kaurna Park
BOLIVAR WWTP
Pine Lakes1
Parafield Airport
Pooraka Triangle
ELIZABETH
SALISBURY
PARA HILLS
TEA TREE GULLY
MOUNT GAWLER
KERSBROOK
Little Para
1
3
4
6
250000
260000
270000
280000
290000
300000
6170000
6160000
6150000

Figure 31 i

12 APPENDIX A



SUMMARY DETAILS OF PAST AND CURRENT ASR PROJECTS IN THE ADELAIDE REGION

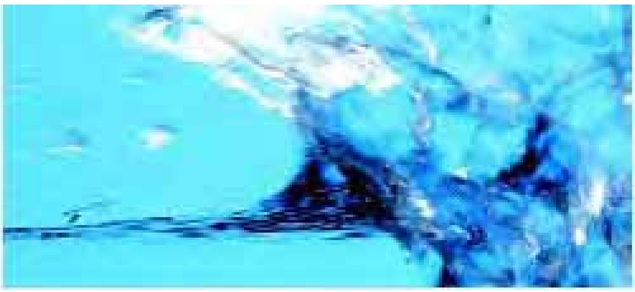
Project or Applicant Name	Project Level Attained	Project Status at July 2004	Key Well Unit Number	MGA Easting	MGA Northing	Prescribed Well Area	ASR Operations Licensed By	Aquifer	Year Operations or Investigations Commenced	Typical Injection Volume[1] (ML/year)
Onkaparinga Catchment Water Management Board										
Aldinga Arts Eco Village	pre-feasibility	inactive	n/a	270,500.0	6,094,250.0	McLaren Vale	n/a	Port Willunga Formation	2001	n/a
Aldinga Scrub	operation	active	652701246	268,237.0	6,090,786.0	McLaren Vale	EPA	Port Willunga Formation	2000	5
Ashmans Pty Ltd	investigation	active	662707218	277,402.0	6,095,939.0	McLaren Vale	n/a	Port Willunga Formation		n/a
Ballast Stone Estate Wines	investigation	inactive	662710507	281,894.0	6,100,729.0	McLaren Vale	n/a	Port Willunga Formation	2001	n/a
Bruschi	operation	active	662709920	276,778.0	6,095,964.0	McLaren Vale	DWLBC (pending)	Port Willunga Formation	1999	60
Buttery (old Gemtree project)	operation	active	662709719	282,470.0	6,101,159.0	McLaren Vale	DWLBC	Port Willunga Formation	1998	9
Christies Beach WWTP	investigation	active	662710489	273,001.0	6,092,236.0	McLaren Vale	n/a	Port Willunga Formation	2000	n/a
CIC, Aldinga	pre-feasibility	active	n/a	268,460.0	6,092,267.0	McLaren Vale	n/a	Port Willunga Formation	2003	n/a
Curtis Chalk Hill Rd	investigation	active	n/a	275,520.0	6,101,180.0	McLaren Vale	n/a	Fractured Rock	2002	n/a
Dalkeith Rd	pre-feasibility	inactive	n/a	270,610.0	6,101,690.0	McLaren Vale	n/a	none suitable	2002	n/a
Eberhard	investigation	active	662709268	278,681.0	6,103,329.0	McLaren Vale	DWLBC	Maslin Sands		n/a
Flagstaff Hill Golf Course	investigation	active	662710845	279,657.0	6,117,805.0	n/a	n/a	Fractured Rock	2002	n/a
Fox Creek Winery, McLaren Vale	pre-feasibility	inactive	n/a	276,420.0	6,096,450.0	McLaren Vale	n/a			n/a
Leask & Hardy (Pertaringa Vineyard)	investigation	active	662707776	280,047.9	6,098,727.0	McLaren Vale	DWLBC	Port Willunga Formation		n/a
Leask (Breakneck Creek Vineyard)	investigation	active	662708749	281,880.0	6,099,750.0	McLaren Vale	DWLBC	Port Willunga Formation		n/a
Leask (Home Vineyard)	investigation	active	662708192	281,138.0	6,099,975.0	McLaren Vale	DWLBC	Port Willunga Formation		n/a
Ledson	investigation	active	662707708	278,638.0	6,103,296.0	McLaren Vale	EPA	Maslin Sands		n/a
Maglieri	investigation	inactive	662710066	273,516.9	6,095,223.2	McLaren Vale	n/a	Port Willunga Formation	1999	n/a
McLaren Flat	pre-feasibility	active	n/a	279,900.0	6,101,400.0	McLaren Vale	n/a	Fractured Rock	2002	n/a
Melltine	investigation	inactive	n/a				n/a			n/a
Mildara Blass	operation	active	662707412	280,808.0	6,100,000.0	McLaren Vale	DWLBC (pending)	Port Willunga Formation	2001	4
Noarlunga Centre/South Adelaide Football Club	desktop	inactive	n/a	271,600.0	6,107,900.0	n/a	n/a	Fractured Rock	2002	n/a
Osborne FR	operation	active	662709651	277,591.0	6,100,187.0	McLaren Vale	DWLBC (pending)	Fractured Rock	1998	12
Osborne MS	investigation	active	662710075	277,035.0	6,102,381.0	McLaren Vale	DWLBC (pending)	Maslin Sands	1998	n/a
Parkinson	investigation	inactive	662707945	281,277.0	6,099,105.0	McLaren Vale	n/a	Port Willunga Formation	1999	n/a
Petrucci	investigation	inactive	662707209	278,227.0	6,099,597.0	McLaren Vale	n/a	Port Willunga Formation	1999	n/a
Pridham Boulevard	pre-feasibility	active	n/a	269,300.0	6,093,175.0	McLaren Vale	n/a	Port Willunga Formation or Semaphore Sands	2002	n/a
Priest	operation	active	662707080	275,438.0	6,101,262.0	McLaren Vale	n/a	Fractured Rock	1998	20
Pt Stanvac	pre-feasibility	inactive	n/a	270,500.0	6,111,500.0	n/a	n/a	Fractured Rock	2002	n/a
Sharpe Vineyard	pre-feasibility	active	662709796	274,500.0	6,095,000.0	McLaren Vale	n/a	Port Willunga Formation	2002	n/a
Simpsons Vineyard	investigation	active	662702087	280,908.0	6,098,941.0	McLaren Vale	DWLBC			n/a
Tatachilla Lutheran College	pre-feasibility	inactive	n/a	274,250.0	6,099,250.0	McLaren Vale	n/a		2003	n/a
Thorpe	operation	active	662710663	274,530.0	6,096,198.0	McLaren Vale	DWLBC	Port Willunga Formation	2001	1
Tyrrells Vineyards	investigation	inactive	n/a	278,000.0	6,095,000.0	McLaren Vale	n/a			n/a
Vines Golf Course	operation	active	662704704	279,321.0	6,113,335.0	n/a	EPA	Fractured Rock	2002	5
Waters	investigation	active	652701110	270,678.0	6,089,064.0	McLaren Vale	n/a	Port Willunga Formation		n/a

Project or Applicant Name	Project Level Attained	Project Status at July 2004	Key Well Unit Number	MGA Easting	MGA Northing	Prescribed Well Area	ASR Operations Licensed By	Aquifer	Year Operations or Investigations Commenced	Typical Injection Volume[1] (ML/year)
Torrens and Patawalomga Catchment Water Management Boards										
Barker Inlet Wetlands	investigation	active	n/a	277,538.9	6,143,216.6	Northern Adelaide Plains	n/a	T2	2004	n/a
Cheltenham Racecourse	pre-feasibility	inactive	662813368	274,410.0	6,138,719.0	n/a	n/a	T1	2000	n/a
Glenelg Golf Club	pre-feasibility	active	n/a	274,270.2	6,128,465.7	n/a	n/a	T1	2003	n/a
Grange Golf Club	pre-feasibility	active	n/a	271,397.3	6,136,780.2	n/a	n/a	T1	2002	n/a
Kooyonga Golf Course	pre-feasibility	active	n/a	274,326.1	6,131,902.0	n/a	n/a		2004	n/a
Morphetville Racecourse	operation	active	662821045	275,788.0	6,126,711.0	n/a	EPA	T1	2003	*640*
New Brompton Estate	operation	active	662815933	278,545.0	6,136,110.0	n/a	EPA	Quaternary	1996	0.75
North Parklands	investigation	active	n/a	280,120.0	6,133,430.0	n/a	n/a	Fractured Rock	2004	n/a
Northgate	operation	active	662819941	285,836.0	6,139,920.0	n/a	EPA	Fractured Rock	2001	75
Oaklands Park	investigation	active	n/a	276,225.8	6,124,107.5	n/a	EPA	T1	2004	n/a
Parfitt Square	operation	active	662817837	278,544.6	6,135,505.9	n/a	EPA	Quaternary	1997	1.5
Regent Gardens	operation	active	662816486	284,707.0	6,140,538.0	n/a	EPA	Fractured Rock	1998	60
Royal Adelaide Golf Club	investigation	active	n/a	272,454.3	6,135,729.4	n/a	n/a		2004	n/a
Scotch College, Brownhill Creek	operation	active	n/a	282,455.8	6,126,342.5	n/a		Fractured Rock	1989	40
South Parklands	investigation	inactive	n/a	280,250.0	6,131,000.0	n/a	n/a	T1	1997	n/a
St Elizabeths Anglican Church	operation	active	662709437	275,723.0	6,122,962.1	n/a	n/a	Quaternary	1997	1
St Ignatius Senior School	investigation	active	n/a	289,607.7	6,138,132.0	n/a	n/a	Fractured Rock		n/a
Torrens Valley Sportsfield	operation	active	662818613	289,132.8	6,138,998.0	n/a	EPA	Fractured Rock	2003	*40*
Urrbrae	investigation	active	n/a	282,846.9	6,127,962.9	n/a	EPA	Quaternary		n/a
Victoria Park Racecourse	investigation	active	n/a	282,735.2	6,131,510.9	n/a	n/a	Fractured Rock	2004	n/a
Northern Adelaide and Barossa Catchment Water Management Board										
Andrews Farm (Stebonheath)	operation	active	662816255	286,012.0	6,160,298.0	Northern Adelaide Plains	EPA	T2	1993	100
Bolivar WWTP	investigation	active	662818777	276,553.0	6,154,021.0	Northern Adelaide Plains	n/a	T2	1997	n/a
Burton West Wetlands	pre-feasibility	active	n/a	279,600.0	6,152,700.0	Northern Adelaide Plains	n/a		2003	n/a
Civic Park	investigation	active								*20*
Edinburgh Parks	investigation	active	662821324	282,499.0	6,154,677.0	Northern Adelaide Plains	EPA (pending)	T2	2003	n/a
Fremont Park	investigation	active	n/a	287,000.0	6,155,500.0	Northern Adelaide Plains	n/a		2003	n/a
Greenfields Railway Station	investigation	active	662820328	282,065.1	6,146,759.0	Northern Adelaide Plains	n/a	T2	2004	n/a
Greenfields Wetland	investigation	active	662816255	282,092.0	6,146,243.0	Northern Adelaide Plains	EPA	T1	1995	n/a
Kaurna Park	operation	active	662818545	280,406.9	6,153,468.3	Northern Adelaide Plains	EPA	T2	1999	150
Paddocks Wetland	operation	active	662816623	283,926.8	6,145,223.3	Northern Adelaide Plains	EPA	T1	1998	75
Parafield Airport	operation	active	662820743	282,779.0	6,147,496.0	Northern Adelaide Plains	EPA	T2	2003	*550*
Pine Lakes	operation	active	662818546	282,837.0	6,148,078.0	Northern Adelaide Plains	EPA	T2	2004	*45*
Pooraka Triangle	operation	active	662820765	282,093.0	6,142,663.0	Northern Adelaide Plains	EPA (pending)	T2	2004	*100*
Solandra Reserve	investigation	active	662821671	288,339.0	6,143,601.0	n/a	EPA (pending)	Fractured Rock	2003	n/a
Tea Tree Gully Golf Course	operation	active	662820853	292,206.0	6,146,552.0	n/a	EPA (pending)	Fractured Rock	2001	*50*

Note 1. Figures in italics represent design volume for those projects only recently commenced

13 APPENDIX B





1982/83 AND 1983/84 AVERAGE ANNUAL GROUNDWATER ABSTRACTIONS (AFTER EDWARDS ET AL, 1987)

Well Unit Number	MGA Easting	MGA Northing	Aquifer	Total Well Depth (m)	Average Annual Abstraction (kL)	Operator / Comment
662811758	283,586.00	6,130,473.00	T1	250.0	301	Glenside Hospital
662800104	282,474.73	6,134,025.23	T1	47.5	590	St Peters Boys College, Hackney
662807759	278,634.69	6,131,316.28	T1	103.0	680	SA Cold Stores
662809817	284,747.72	6,137,482.22	Fractured Rock	73.2	730	Mt L Heading, Klemzig (agricultural)
662807746	277,080.70	6,131,793.26	T1	118.9	1,620	Fulham Gardens Old Folks Home (St Josephs)
662807965	278,536.69	6,125,166.28	T1	67.1	2,140	Lois Jeans Aust, Edwardstown
662811721	289,136.78	6,139,813.26	Fractured Rock	31.6	2,180	NV Emergy, Athelstone (agricultural)
662811989	290,206.78	6,137,376.22	Fractured Rock	114.0	2,270	Black Hill Conservation Park
662810025	286,937.78	6,130,422.20	Fractured Rock	22.0	2,270	RG Pank, Burnside
662807717	277,317.71	6,133,518.26	T1	143.3	3,200	Thebarton Boys Tech High School PBD
662812044	291,788.73	6,139,835.24	Fractured Rock	22.0	3,440	Creative Landscaping
662805028	283,010.79	6,150,667.29	T1	137.7	3,885	Agricultural
662805103	285,578.80	6,151,385.29	T1	204.2	4,910	Salisbury Reserve
662811722	286,398.74	6,129,971.30	Fractured Rock	90.0	5,455	Beaumont house (National Trust)
662807852	273,981.70	6,128,542.24	T1	153.3	5,455	Glenelg Golf Club
662809762	289,103.79	6,139,764.22	Fractured Rock	93.0	5,455	P Mercorella, Athelstone (agricultural)
662812020	284,258.76	6,128,027.22	Fractured Rock	62.0	6,240	Waite research Unit
662809756	289,418.74	6,140,114.30	Fractured Rock	24.4	6,545	Mr Fractured Rocky (agricultural)
662809723	287,267.71	6,138,258.26	T1	90.8	7,000	Campbelltown Primary School
662810028	288,138.79	6,130,437.29	Fractured Rock	390.0	7,270	Pioneer Concrete, Greenhill
662808899	277,780.75	6,139,285.29	T2	219.0	7,730	Regency Park Golf Course
662706234	276,625.71	6,122,300.25	T1	71.0	7,730	Sturt Oval
662811643	284,827.73	6,128,548.22	Fractured Rock	21.3	8,180	Carmellite Cement
662807504	275,941.73	6,134,025.28	T1	140.2	8,300	Flinders Park Primary School PBD
662807955	277,237.73	6,124,493.26	T1	49.0	8,700	Mitchell Park Boys Tech PBD
662701710	277,784.00	6,124,331.00	T1	64.6	8,700	Mitchell Park Primary School PBD
662807926	275,549.76	6,125,808.22	T1	94.5	8,700	Morphetville Park Primary School PBD
662811591	279,551.74	6,124,697.26	T1	62.0	9,090	Centenial Park Cemetery
662807750	271,879.75	6,131,313.23	T1	123.0	9,800	Cowandilla Primary School PBD

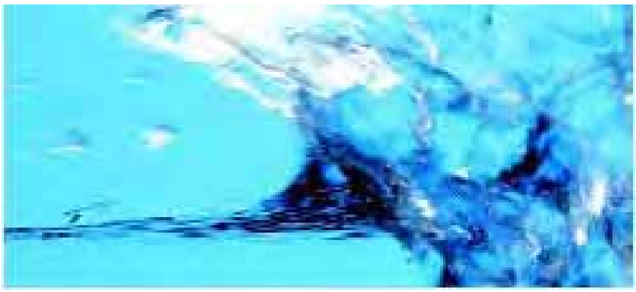
Well Unit Number	MGA Easting	MGA Northing	Aquifer	Total Well Depth (m)	Average Annual Abstraction (kL)	Operator / Comment
662805016	281,806.73	6,149,645.31	T1	124.4	9,820	A Bevone
662811907	289,081.77	6,132,407.28	Fractured Rock	318.0	10,150	BM Dolling, Skye
662809915	286,755.79	6,136,681.21	T1	89.9	10,780	Newton Primary School PBD
662809874	285,868.73	6,137,263.25	T1	48.0	10,910	St Bernards Recreation Centre
662701684	276,926.71	6,122,645.29	T1	73.2	11,000	Sturt Primary School PBD
662811905	289,410.78	6,133,206.20	Fractured Rock	266.0	11,200	Ridge Supply, Skye
662808143	278,204.76	6,128,274.21	T1	30.5	11,820	Glandore Oval
662807944	276,422.74	6,124,746.23	T1		11,820	Marion Swimming Centre
662812058	287,200.81	6,132,297.30	Fractured Rock	287.0	11,820	St Peters Girl School, Wattle Park
662701681	276,837.73	6,122,546.21	T1	68.6	11,820	Sturt Oval
662701668	275,414.72	6,123,716.22	T1	64.6	12,540	Warradale Primary School PBD
662808102	277,000.72	6,127,445.21	T1	83.5	12,700	Vermont girls High School PBD
662811908	289,014.77	6,132,688.30	Fractured Rock	182.0	12,800	WA Lavers (Knoxstead PL), Skye
662808112	277,110.73	6,126,720.21	T1	47.2	13,000	Forbes Primary School PBD
662809872	285,572.75	6,137,436.23	T1	45.7	13,370	East Marden Primary School PBD
662811160	285,846.81	6,131,529.36	T1	133.3	13,640	Hazelwood Park Reserve
662806882	290,411.72	6,137,101.24	Fractured Rock	29.0	13,640	Mary Banks Estate
652800376	269,862.79	6,148,483.29	T1	144.5	13,820	North Haven Golf Course
662807791	276,024.76	6,130,466.30	T1	141.7	14,090	Central Bottle Co-Op, West Beach Rd
662808766	275,619.73	6,136,393.28	T1	137.8	14,100	Croydon Tech High School PBD
662808759	275,047.75	6,135,468.26	T1	128.0	14,200	Findon Primary School PBD
662701678	275,706.71	6,122,589.22	T1	57.0	14,300	Oaklands Primary School PBD
662701646	274,213.69	6,122,351.28	T1	85.3	14,400	Brighton Primary School PBD
662807384	271,976.69	6,133,815.29	T1	106.7	14,400	Fulham Gardens Primary School PBD
662807576	272,970.73	6,131,893.33	T1	131.7	14,700	Fulham Primary School PBD
662808115	277,739.72	6,126,447.31	T1		14,770	Edwardstown Oval, Aquifer B
662808635	272,508.75	6,137,600.33	T1	128.9	14,850	Hendon Primary School PBD
662810126	288,708.76	6,133,007.30	Fractured Rock	91.4	15,000	Foothills Water Co., Skye
662701706	276,709.75	6,124,052.21	T1	59.7	15,454	Westminster School

Well Unit Number	MGA Easting	MGA Northing	Aquifer	Total Well Depth (m)	Average Annual Abstraction (kL)	Operator / Comment
662805471	290,587.76	6,141,454.27	Fractured Rock	75.6	15,840	Highbury Primary School PBD
662807461	274,346.76	6,133,607.30	T1	137.2	17,900	Kidman Park High School PBD
662807939	276,825.70	6,125,213.20	T1	53.7	18,400	Ascot Park Primary School PBD
662808754	274,955.75	6,136,813.29	T1	131.4	18,630	Woodville Oval
662807625	272,515.75	6,131,088.25	T1	128.0	18,700	West Beach Primary School
662811932	289,072.79	6,132,875.21	Fractured Rock	182.0	19,200	AA Sheperd, Skye
662701873	273,725.70	6,121,598.22	T1	120.0	21,600	Marion Park Golf Course
662701875	273,851.69	6,121,323.30	T1	101.9	21,600	Marion Park Golf Course
662706214	273,917.74	6,121,013.25	T1	104.5	21,600	Marion Park Golf Course
662808010	279,831.72	6,127,798.29	T1	61.0	21,820	Cabra Convent
662807869	273,825.71	6,126,064.29	T1	88.0	21,820	Glenelg Oval
662706490	273,098.73	6,123,670.27	T1	77.0	21,820	Minda Home (also have 2 Quaternary wells)
652800405	271,737.00	6,132,955.00	T1	153.0	22,550	Henley Oval
662809702	286,984.78	6,138,766.21	T1	63.1	22,730	Campbelltown Oval Daly Rd
662808045	274,832.68	6,127,430.21	T1	106.7	22,730	Immanuel college
662701642	273,748.69	6,122,851.23	T1	89.3	22,900	Mawson High School (Brighton Boys Tech) PBD
662808679	273,911.75	6,135,469.32	T1	115.7	23,000	Findon High School PBD
662808084	276,150.72	6,128,216.24	T1	50.9	23,700	Plympton High School PBD
652800408	271,737.00	6,132,578.00	T1	139.3	26,700	Henley High School PBD
662807945	276,167.75	6,124,466.24	T1	73.0	27,270	Road Safety Council
652800776	270,652.70	6,135,692.27	T1	201.0	28,050	Grange Recreation Reserve
662701631	273,671.73	6,123,778.27	T1	92.0	28,600	Brighton High School PBD
662807538	275,976.74	6,133,753.31	T1	182.9	28,640	Torrens College TAFE
662701721	278,504.69	6,124,082.28	T1	58.8	28,700	Marion High School PBD
662807693	275,756.76	6,133,176.28	T1	143.0	30,300	Underdale High school
662807928	274,961.71	6,124,744.21	T1		31,100	Glengowrie High School PBD
662701632	273,393.75	6,123,811.22	T1	90.2	32,730	Minda Home
662808617	271,747.77	6,139,453.28	T1	116.0	33,000	Royal Park High School PBD
662808093	277,222.74	6,129,259.23	T1	50.6	33,090	Weigall Oval (Kumulta Park)
662811693	275,458.71	6,126,715.28	T1	52.0	34,770	Morphettville Racecourse (SAJC), total from 2? wells
662800555	280,972.74	6,131,351.26	T1	29.3	36,000	Pulteney St Grammar School
662808847	275,140.71	6,138,907.25	T1	102.1	39,770	Birrel & Co, Electroplaters, Woodville North
662809570	283,683.73	6,136,448.22	T1	50.3	39,900	Marden High School PBD
662808655	272,180.74	6,136,803.29	T1	199.8	42,000	Seaton North Primary School and Seaton Tech High School

Well Unit Number	MGA Easting	MGA Northing	Aquifer	Total Well Depth (m)	Average Annual Abstraction (kL)	Operator / Comment
662807385	271,751.74	6,133,384.31	T1	205.7	45,450	St Michaels College
652800526	271,196.71	6,137,313.31	T1	189.0	46,360	Football Park
652800645	270,736.74	6,145,105.24	T1	155.0	48,360	Police Academy
662701707	276,244.73	6,124,054.22	T1	86.9	48,730	Oaklands Reserve
652800511	270,738.71	6,138,321.27	T1	124.0	49,090	Delfin Island
662809786	289,774.74	6,138,101.24	Fractured Rock	140.0	50,455	St Ignatius College
662811199	277,183.71	6,133,914.25	T1	170.0	57,270	CARBA (Liquid Air Australia)
662811153	273,527.30	6,133,887.80	T1	220.0	62,350	Collins Reserve
662807860	273,995.72	6,127,298.28	T1	109.7	65,450	Fordham Reserve, David Av
662807974	279,296.70	6,125,390.29	T1	73.2	68,180	Palm Beach Towel Co
662808981	279,253.73	6,125,456.29	T1	66.0	68,180	Palm Beach Towel Co
662804995	287,469.81	6,151,776.27	T1	171.6	88,100	Old Spot
662803612	292,261.78	6,149,442.29	T1	106.7	90,910	Hallet Bricks Golden Grove? (Maslin Sands), total of 2 wells
662807725	278,529.69	6,133,618.21	T1	127.0	91,950	Coca Cola,total from 3? wells
662807267	285,704.73	6,128,861.22	Fractured Rock	121.9	98,180	Mt Osmond Golf Club, total from 2? wells
662807555	277,636.76	6,134,041.28	T1	141.6	109,350	Onkaparinga Wool Mills, Thebarton, total from 2? wells
662807661	275,267.71	6,131,190.26	T1	213.4	125,450	Adelaide Airport, total Fractured Rockom 3? wells
662812212	291,805.75	6,146,274.23	Fractured Rock	161.0	136,360	Tea Tree Gully Golf Course, total from 3? wells
662803438	278,889.12	6,146,782.03	T1	140.2	145,380	ICI Australia (Dry Creek)
662804371	276,751.14	6,144,805.99	T1	128.0	154,140	ICI Australia (Dry Creek)
662812311	284,690.75	6,136,068.21	Fractured Rock	152.0	159,105	Schweppes Co.
662803356	273,262.76	6,148,770.31	T1	111.6	169,455	Torrens Island Quarantine
652800507	271,221.76	6,138,477.33	T1	121.9	230,000	Riverside Golf Club, total from 2? wells
662804372	278,050.76	6,143,560.24	T1	121.9	277,660	ICI Australia (Dry Creek)
662804356	278,655.79	6,144,972.27	T1	118.2	305,280	ICI Australia (Dry Creek)
662804370	277,775.75	6,144,586.26	T1	120.0	305,900	ICI Australia (Dry Creek)
662808667	272,528.76	6,135,906.31	T1	134.7	355,455	Royal Adelaide Golf Course, total from 3? wells
652800525	271,333.72	6,137,087.29	T1	188.9	433,180	Grange Golf Club, total of several wells
662803402	271,949.74	6,145,654.30	T1	132.5	545,800	ICI Osborne, total wells from 2? wells
662806905	281,220.73	6,142,558.29	T1	141.7	784,860	Samcor Gepps Cross, total from 4? wells

14 APPENDIX C





SUMMARY DETAILS OF AQUIFER TESTS REVIEWED

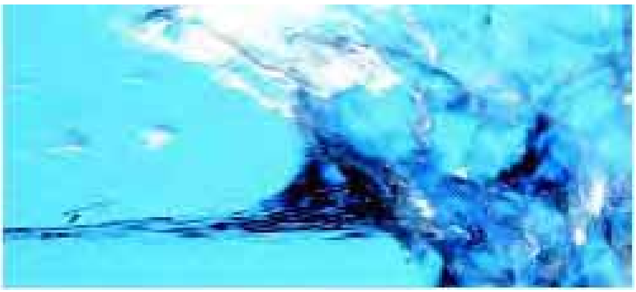
Project	Well Unit Number	Plan Code	Number	Easting	Northing	Ground Level (mAHD)	ORIG_ DRILLED_ DEPTH	PZONE_ FR	PZONE_ TO	PZONE_ TYPE	WELL_ YIELD	AQ_ SUBAQ	AQ_ NAME	AQ_ STRAT	Strat	Analysis by	T_ effec	S	MAX_B	SCREEN_L	Tmin	Tmax	Smin	Smax	k_screen	k_aquifer	Ss_screen	Ss_aquifer
Aldinga Scrub ASR	652701246			268,237	6,090,786	13	40	30	40	OH	19	Tow	T1	Tow	Port Willunga Formation	S Howles et al	403		105	10		403			40.3	3.838		
Allenby Gardens	662811477	YAT	67	276,503	6,135,636	12.981	620.16	554		S	1	T(T4)	T4	Te2	Maslin Sands	T Hodgkin	66		40		27	66				1.65		
Andrews Farm	662816255	MPA	138	286,012	6,160,298	27.5	179	107	126	OH	20	T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	T Hodgkin	175		62	19	152	209			9.211	2.823		
Bailey Reserve	662812928			278,864	6,127,223	32	151.4	98	151.4	UKN	0.5	T(T2)	T2	Towa	Aldinga Member	T Hodgkin	222		25	53.4	142	367	6E-04	0.001	4.157	8.88	1.05E-05	1.20E-06
Black Hill Flora Park	662811989	ADE	147	290,207	6,137,376	145.857	114	110	114	UKN	12.5	NE	FR	NE	Undifferentiated Proterozoic rocks	T Hodgkin	193		4	4		193			48.25	48.25		
Bolivar	662818777			276,553	6,154,021	4.98	170.4	100	170	OH		T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	N Gerges	184		82	70	183	185			2.629	2.244		
Botanic Gardens	662813307	ADE	185	281,498	6,133,620	30.005	19	12.4	16.5	S	3	Q(Q1)	Q1	Qpah	Hindmarsh Clay	T Hodgkin	53	6E-04	4	4.1	13	53	4E-06	0.002	12.93	13.25	1.36E-04	1.39E-04
Brighton Oval	662707723			274,290	6,122,570	14	98	72	98	S		T(T1)	T1A	Tpd, Tph, Tow	Dry Creek Sands, Hallet Cove Sandstone, Port Willunga Formation	T Hodgkin	56		15	26	11.2	75			2.154	3.733		
Brompton	662815933			278,545	6,136,110	13	35	30	35	S		Q(Q)	Q2	Qpah	Hindmarsh Clay	T Hodgkin	107		5	5		107			21.4	21.4		
Bruschi ASR	662709920			276,778	6,095,964	70	56	40	44.5	OH	7.5	Tow	T1	Tow	Port Willunga Formation	S Howles et al	800		120	4.5					177.8	6.667		
Campbelltown	662818613			289,197	6,139,068	85	91.5	44	91.5	OH	6.25	Nds	FR	Nds	Saddleworth Formation	T Hodgkin	71		48	47.5	71				1.495	1.479		
Carisbrook Park	662804995	MPA	92	287,470	6,151,776	50	187.5	124.9	145	SC	25.26	T(T1)	T1A	Tph	Hallet Cove Sandstone	T Hodgkin	91		8	20.1	75	107			4.527	11.38		
Centennial Park Cemetry	662811591	ADE	62	279,552	6,124,697	41.5	66.3	55	66.3	S	3	T(T1)	T1	Tow	Port Willunga Formation (lower limestones)	T Hodgkin	17		30	11.3		17			1.504	0.567		
Christies Beach WWTP trial	662710489			273,001	6,092,236	47.5	87	55.5	73	OH	7	Tow	T1	Tow	Port Willunga Formation	AGT	75		130	17.5					4.286	0.577		
Coca Cola	662800516	ADE	87	278,604	6,133,525	18.1	137.77	117.08	123	UKN	12.5	T(T1)	T1A	Tpd	Dry Creek Sands	T Hodgkin	52		35	5.92	19	52			8.784	1.486		
Coca Cola	662812516			278,551	6,133,577	20	210	164	200	UKN	18.75	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	56	3E-04	43	36	42	63	2E-04	4E-04	1.556	1.302	8.33E-06	6.98E-06
Collins Reserve	662811153	YAT	132	273,527	6,133,888	6.868	220	232	244	OH	2	T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	T Hodgkin	51		100	12	12	51			4.25	0.51		
Coopers	662820250			278,043	6,138,275	9	230	210	230	OH	10	T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	T Hodgkin	97	3E-05	100	20	97	206	3E-05	5E-04	4.85	0.97	1.42E-06	2.84E-07
De Ruvo	662818881			278,098	6,155,718	9.95	89	70	89	SB+SC	5	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	30	7E-05	27	19	17	50	6E-05	9E-05	1.579	1.111	3.84E-06	2.70E-06
Findon High School	662812149			274,100	6,135,849	6.5	202	175	202	OH	31.6	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	77		30	27	71	83			2.852	2.567		
Flinders Park Oval	662812556			274,951	6,134,034	10	221.5	189.26	221.5	UKN	5	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	N Gerges	75		37	32.24	52	97			2.326	2.027		
Fort Largs	652800315	PTA	60	270,727	6,145,038	6.6	127.5	111.5	126	OH	5	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	N Gerges	97	0.002	22	14.5	70	123			6.69	4.409	1.24E-04	8.18E-05
Gemtree ASR	662707061			282,586	6,101,085	145	123	103	106	S	2.13	Tow	T1	Tow	Port Willunga Formation	S Howles et al	450		70	3	450				150	6.429		
Glengowrie High School	662814251			275,145	6,124,699	14	94	69	94	UKN	2.5	T(T1)	T1	Tow	Port Willunga Formation ? Not sure what litho	T Hodgkin	52		70	25	47	57			2.08	0.743		
Glenside Hospital	662811758	ADE	90	283,586	6,130,473	65.994	253.4			S	13.4	T(T2)	T2	Te2	Maslin Sands	N Gerges	38		8		26	49				4.75		
Grange Golf Club	652800436			271,158	6,136,392	4.5	131	109	131	S	16.42	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	89	5E-04	30	22	71	107	3E-04	8E-04	4.045	2.967	2.41E-05	1.77E-05
Grange Golf Club	652800893			271,278	6,136,592	5	200	176	200	UKN	10	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	N Gerges	85	3E-04	30	24	67	100	2E-04	5E-04	3.542	2.833	1.42E-05	1.13E-05
Greenfields	662816624			280,372	6,146,188	4	148.3	102	148	OH	8.9	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	101	2E-04	49	46	33	103	1E-04	2E-04	2.196	2.061	3.37E-06	3.16E-06
Hawkesbury Reserve	652800955	YAT	117	270,130	6,139,114	2.22	197	176.5	194	UKN	3	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	43		21	17.5	43	95			2.457	2.048		
Heynes Nursery (Kaurna ASR)	662818545			280,407	6,153,468	11	180	120	180	OH	15	T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	N Gerges	224		85	60		224			3.733	2.635		
Immanuel College	662808045	ADE	148	274,833	6,127,430	6.2	106.68	84.23	106.7	UKN	15.16	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	63		18	22.45	24	63			2.806	3.5		

Project	Well Unit Number	Plan Code	Number	Easting	Northing	Ground Level (mAHD)	ORIG_ DRILLED_ DEPTH	PZONE_ FR	PZONE_ TO	PZONE_ TYPE	WELL_ YIELD	AQ_ SUBAQ	AQ_ NAME	AQ_ STRAT	Strat	Analysis by	T_ effec	S	MAX_B	SCREEN_L	Tmin	Tmax	Smin	Smax	k_screen	k_aquifer	Ss_screen	Ss_aquifer
Kangaroo Flat Hydro Investigation	662819388			284,087	6,172,113	36	58	45	58	OH	25	T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	J. James-Smith	142	0.001	42	13	142	323	8E-04	0.001	10.92	3.381	8.68E-05	2.69E-05
Kidman Park Test 1	662813378			273,835	6,133,966	6.6	221	189	221	UKN	10	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	56	4E-04	35	32	20	79	2E-04	5E-04	1.75	1.6	1.13E-05	1.03E-05
Kings Road	662804889	MPA	53	281,103	6,150,204	14.61	136.25	107.29	136.3	UKN	5.05	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	N Gerges	62		25	28.96	44	63			2.141	2.48		
Kings Road	662804900	MPA	54	280,997	6,150,116	14.395	135.64	105.77	134.7	SC	12.63	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	N Gerges	50		25	28.95	49	68			1.727	2		
Kooyonga Golf Course	662807658			274,428	6,132,221	5.5	216.71	100.97	216.7	UKN	12.63	T(T1)	T1	Tpd, Tph, Tow	Dry Creek Sands, Hallet Cove Sandstone, Port Willunga Formation	T Hodgkin	39		70	115.7	35	442			0.337	0.557		
Maglieri ASR	662710066			273,517	6,095,223	42	60	31	45.5	OH	10	Tow	T1	Tow	Port Willunga Formation	S Howles et al	338		70	14.5	324	351			23.31	4.829		
Marineland West Beach	662814214			272,256	6,129,076	5	228	198	228	UKN	6	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	47		33	30	6.2	47			1.567	1.424		
Marion Golf Course	662701875	NOA	19	273,852	6,121,323	8	120	91.9	105	S	6.33	T(T2)	T2	Tow	Port Willunga Formation(possibly lower)	T Hodgkin	96	3E-04	10	13.05	35	114	7E-05	5E-04	7.356	9.6	2.15E-05	2.80E-05
Marion Golf Course	662706214	NOA	14	273,918	6,121,013	15.346	104.5	97.5	104.5	S		T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	T Hodgkin	37		20	7	11	71			5.286	1.85		
Mawson Lakes ASR (MFP)	662817760			281,705	6,145,330	7	212	164	212	OH	4	T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	T Hodgkin	192	2E-04	95	48	151	199	1E-06	0.003	4	2.021	3.33E-06	1.68E-06
Michells	662805253	YAT	68	284,723	6,148,083	21.899	525	506	512	WS	12.5	T	T3	Te2	Maslin Sands	T Hodgkin	0.5		6	6	0.28	0.73			0.083	0.083		
Millswood Bowling Club	662808004	ADE	150	279,716	6,129,065	36.307	15.24	8	15		1.25	Q(Q1)	Q1	Qpah	Hindmarsh Clay	T Hodgkin	12		7	7	12	55			1.714	1.714		
Mitchell Park School	662701738	ADE	84	279,135	6,122,954	69.7	60.35	17.48	60.35	UKN	7.77	NE	FR	NE	Undifferentiated Proterozoic rocks	T Hodgkin	139		43	42.87	59	139			3.242	3.233		
Morphetville	662818567			275,622	6,127,033	11	82	37	82	OH	40	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	842	9E-05	45	45	826	859	8E-05	9E-05	18.71	18.71	1.96E-06	1.96E-06
Northfield	662819498			283,697	6,140,288	80	81	45	81	OH	4	Nds	FR	Nds	Saddleworth Formation	T Hodgkin	50		36	36	7.5	51			1.389	1.389		
Oaklands Park	662807945	ADE	41	276,168	6,124,466	18.3	73.15	59	73.15	S	3.75	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	51	1E-04	50	14.15	33	51			3.604	1.02	9.19E-06	2.60E-06
Osborne ASR	662709651			277,591	6,100,187	63	160	103	160	OH	7.58	NE	FR	NE	Undifferentiated Proterozoic rocks	S Howles et al	30		57	57		30			0.526	0.526		
Osborne ASR	662710075			277,035	6,102,381	115	88	74.5	83.5	S	6	Te2	T2	Te2	Maslin Sands	S Howles et al	180		32	9		180			20	5.625		
Paddocks ASR	662816623			283,928	6,145,223	12.5	180	134	164	OH		T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	104		59	30	101	108			3.467	1.763		
Parafield Airport ASR	662820328	YAT	129	282,065	6,146,759	7.407	212	166	191	OH	10	T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	T Hodgkin	177		90	25	169	185			7.08	1.967		
Parafield Airport ASR	662820742			282,751	6,147,527	11	150	126.6	150	OH		T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	?	40		35	23.4					1.709	1.143		
Penrice Osborne	662815205			272,032	6,145,807	3	243	156	243	OH	25.3	T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	N Gerges	130		90	87					1.494	1.444		
Petrucci ASR	662707209			278,227	6,099,597	70	50	30.94	42	WS	12.5	Tow	T1	Tow	Port Willunga Formation	S Howles et al	59		25	11.06		59			5.335	2.36		
Port Gawler	662801066	PTG	53	279,774	6,165,024	24.5	118.87	95	118.9	SC	25.26	T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	T Hodgkin	82		75	23.87	76	89			3.435	1.093		
Priest ASR	662707080			275,438	6,101,262	45	50	13	50	OH+WS	8.4	NE	FR	NE	Undifferentiated Proterozoic rocks	S Howles et al	7.8		37	37		6.3			0.211	0.211		
PTG66	662800016			281,665	6,133,255	36	12.57	4	12	S		Q(Q)	Q1	Qpah	Hindmarsh Clay	T Hodgkin	50	7E-04	5	8	36	87	3E-04	7E-04	6.25	10	8.13E-05	1.30E-04
R. M. Herriot	662804239	MPA	114	295,095	6,156,166	238.38	157.9	25.6	157.9	OH	7.6	NE	FR	NE	Undifferentiated Proterozoic rocks	T Hodgkin	14.2		132	132.3					0.107	0.108		
Regency Park Golf Course	662813634			277,786	6,139,411	8	216	204	216	UKN	6	T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	T Hodgkin	188	1E-04	105	12	28	188			15.67	1.79		
Regent Gardens	662816185			285,052	6,140,538	79	80.5	45.5	80.5	OH			FR	NE		S Howles et al	70	2E-05	35	35	156	171		2E-05	2	2	6.77E-07	6.77E-07
Royal Adelaide Golf Club	662808667			272,529	6,135,906	8	134.72	108.2	134.7	UKN	11.37	T(T1)	T1A	Tpd, Tph	Dry Creek Sands, Hallet Cove Sandstone	T Hodgkin	79		65	26.52		79			2.979	1.215		

Project	Well Unit Number	Plan Code	Number	Easting	Northing	Ground Level (mAHD)	ORIG_ DRILLED_ DEPTH	PZONE_ FR	PZONE_ TO	PZONE_ TYPE	WELL_ YIELD	AQ_ SUBAQ	AQ_ NAME	AQ_ STRAT	Strat	Analysis by	T_ effec	S	MAX_B	SCREEN_L	Tmin	Tmax	Smin	Smax	k_screen	k_aquifer	Ss_screen	Ss_aquifer
SA Farmers Union	662800719	ADE	151	278,621	6,131,117	19.231	156.97	83	156	S	12.63	T(T1)	T1	Te3	Blanche Point Formation	T Hodgkin	227		35	73	73	227			3.11	6.486		
Salisbury Golf Course	662816544			282,742	6,150,748	23	145	122	145	OH	12	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	60		27	23	41	139			2.609	2.222		
Samcor 1973	662804332	YAT	59	280,549	6,142,232	9.5	183	160.57	183	UKN	12.5	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	N Gerges	91		40	22.43					4.057	2.275		
Samcor 1974	662806920			280,910	6,141,941	14.5	175	168	175	S		T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	79	3E-04	40	7	51	167	3E-04	4E-04	11.29	1.975	4.71E-05	8.25E-06
South Parklands	662800732	ADE	33	280,839	6,130,956	39.502	123	4	30	S		T(T1)	T1	Towr	Ruwarung Member	N Gerges	55		20	26	55	56			2.115	2.75		
St Ignatius College	662809786	ADE	134	289,775	6,138,101	111.5	140	77	140	OH	15	NE	FR	NE	Undifferentiated Proterozoic rocks	T Hodgkin	134		63	63	44	134			2.127	2.127		
Thorndon High School	662809726	ADE	31	287,530	6,138,449	70	77.72	52.43	76.2	UKN		T(T1)	T1	Towa	Aldinga Member	T Hodgkin	3		20	23.77		3			0.126	0.15		
Torrens College	662807691	ADE	32	275,998	6,133,306	12.084	204			S	12.5	T(T1)	T1	Tpd, Tph, Tow	Dry Creek Sands, Hallet Cove Sandstone, Port Willunga Formation	T Hodgkin	71		60			71				1.183		
Torrens College	662812979			275,942	6,133,800	11	226	192	226	UKN	10	T(T1)	T1A	Tpd, Tph	Dry Creek Sands, Hallet Cove Sandstone	N Gerges	98	6E-04	77	34	69	231	3E-04	7E-04	2.882	1.273	1.64E-05	7.22E-06
Torrens College	662812979			275,942	6,133,800	11	226	192	226	UKN	10	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	N Gerges	137	5E-04	34	34	99	385	4E-04	7E-04	4.029	4.029	1.57E-05	1.57E-05
Torrens Island Quarantine Station	662803356	PTA	72	273,263	6,148,770	2.011	111.56	94.5	111.6	OH	15.15	T(T1)	T1A	Tpd	Dry Creek Sands	T Hodgkin	189		35	17.06		189			11.08	5.4		
Virginia	662816257	PTA	91	276,330	6,161,309	12.806	133	71.5	133	OH	2	T(T2)	T2	Tow	Port Willunga Formation (lower limestones)	T Hodgkin	88	2E-04	70	61.5	88	113	2E-04	2E-04	1.431	1.257	3.25E-06	2.86E-06
Willunga Basin SADME Investigations	652700998			270,065	6,090,019	15	44	38.5	44	OH	12.5	Tow	T1	Tow	Port Willunga Formation	R Aldam	790	8E-04	150	5.5	731	1734	8E-04	0.009	143.6	5.267	1.40E-04	5.13E-06
Willunga Basin SADME Investigations	652701066			270,351	6,089,243	38	76.2	72.2	76.2	OH	11.25	Tow	T1	Tow	Port Willunga Formation	R Aldam	391		155	4	391	2128			97.75	2.523		
Willunga Basin SADME Investigations	662706505			278,280	6,096,540	85	129	115	124	S	15	Tow	T1	Tow	Port Willunga Formation	R Aldam	51	3E-04	130	9	46	119	4E-04	0.001	5.667	0.392	3.33E-05	2.31E-06
Willunga Basin SADME Investigations	662706647			280,029	6,098,707	100	120	96	110	WS	15	Tow(PW-Fm-PIRR)	T1	Tow	Pirramimma Sand Member	R Aldam	390	5E-05	85	14	208	463	5E-04	5E-04	27.86	4.588	3.71E-06	6.12E-07
Willunga Basin SADME Investigations	662706875			274,754	6,093,437	65	84	61	84	SC	12.5	Towa+Tow	T1	Tow	Port Willunga Formation	R Aldam	160	0.001	130	23	130	190	9E-04	0.002	6.957	1.231	5.65E-05	1.00E-05
Willunga Basin SADME Investigations	662707037			276,865	6,095,200	80	80	63	80	OH	15	Tow	T1	Tow	Port Willunga Formation	R Aldam	1100	0.002	140	17	976	5560	0.002	0.011	64.71	7.857	1.00E-04	1.21E-05
Willunga Basin SADME Investigations	662707241	WLG	62	278,421	6,102,041	90.8	82	66.5	71.5	S	4.38	Te2	T2	Te2	Maslin Sands	R Aldam	35		21	5		35			7	1.667		
Willunga Basin SADME Investigations	662707387	WLG	72	275,953	6,099,037	61.18	110	97.8	102.4	S	3.37	Te2	T2	Te2	Maslin Sands	R Aldam	16		28	4.6	15.5	16.5			3.478	0.571		
Willunga Basin SADME Investigations	662707656	WLG	50	279,352	6,103,801	136.33	84	78	80.5	S	0.88	Te2	T2	Te2	Maslin Sands	R Aldam	35		40	2.5		35			14	0.875		
Willunga Basin SADME Investigations	662707805	WLG	61	283,239	6,102,518	159.57	112	73.5	83.5	WS	2	Tow(PW-Fm-PIRR)	T1	Tow	Port Willunga Formation	R Aldam	156		40	10		156			15.6			
Willunga Basin SADME Investigations	662707949			281,703	6,102,875	115	108	95.2	102.8	S	12.5	Te2	T2	Te2	Maslin Sands	R Aldam	25	6E-05	35	7.6	25	49	3E-05	9E-05	3.289	0.714	7.30E-06	1.59E-06
Willunga Basin SADME Investigations	662708013			282,822	6,104,308	131	80	69	75	WS	13	Te2	T2	Te2	Maslin Sands	R Aldam	39	7E-05	45	6	29	48	7E-05	9E-05	6.5	0.867	1.17E-05	1.56E-06
Willunga Fault - Sauerbier	662709896			284,208	6,102,331	160	96	51	57	SC	7.5	Nds	FR	Nds	Saddleworth Formation	T Hodgkin	39		6	6		39			6.5	6.5		
Wilsford Winery	662814425			305,442	6,170,558	162.5	42.67	13.3	42.66	OH	18.75	Nds	FR	Nds	Saddleworth Formation	T Hodgkin	262		29	29.36					8.924	9.034		
WLG70	662707364	WLG	70	275,570	6,096,736	63.51	88	69	77	WS	4.8	Tow	T1	Tow	Port Willunga Formation	T Hodgkin	44	3E-04	85	8	44	68	3E-04	3E-04	5.5	0.518	3.38E-05	3.18E-06
Woodville Council, St Clair	662813368			274,952	6,138,160	8	198	179	198	UKN	8	T(T1)	T1B	Tow	Port Willunga Formation (upper limestones)	T Hodgkin	92		30	19		92			4.842	3.067		

15 APPENDIX D





ENVIRONMENT PROTECTION (WATER QUALITY) POLICY - SCHEDULE 2 (WATER QUALITY CRITERIA)

Schedule 2—Water quality criteria (cl. 9 and 13)

Table 1

General Criteria

NOTE: · All pollutant quantities listed below are in milligrams per litre (mg/L) unless otherwise indicated and are maxima.

	Protected environmental values									
POLLUTANTS (Clause 13(1)*(a)*)	**Aquatic ecosystem**		**Potable**	**Recreation & aesthetics**			**Agriculture/aquaculture**			**Industrial**
	fresh	marine		primary contact	secondary contact	aesthetics	irrigation	livestock	aquaculture	
Metal pollutants:										
aluminium (soluble *)	0.1						1	5		
antimony (total)	0.03	0.5	0.003							
arsenic (total)	0.05	0.05	0.007				0.1	0.5	0.02	
barium			0.7							
beryllium (total)	0.004						0.1	0.1	0.0001	
boron (total)			0.3				1	5		
cadmium (total)	0.002	0.002	0.002				0.01	0.01		
chromium (total)							1	1	0.02	
chromium VI	0.001	0.0044	0.05							
cobalt (total)							0.05	1		
copper (total)	0.01	0.01	2				0.2	0.5		
iron (total)	1						1			
lead (total)	0.005	0.005	0.01				0.2	0.1		
lithium (total)							2.5			
manganese (total)			0.5				2		0.1	
mercury (total)	0.0001	0.0001	0.001				0.002	0.002	0.0005	
molybdenum (total)			0.05				0.01	0.01		
nickel (total)	0.15	0.015	0.02				0.2	1	0.1	
selenium (total)	0.005	0.07	0.01				0.02	0.02		
silver (total)	0.0001	0.001	0.1							
thallium (total)	0.004	0.02								
uranium (total)			0.02				0.01	0.2		
vanadium (total)							0.1	0.1		
zinc (total)	0.05	0.05					2	20	0.005	
Inorganic pollutants:										
ammonia (total as nitrogen)	0.5	0.2								
ammonia (NH_3 as nitrogen)	0.01	0.05								
Biochemical Oxygen Demand (5-day test)	10	10								
chlorine (total)	0.003	0.0075								
colour (Hazen units)	30	15								
cyanide (total)			0.08							
iodide			0.1							
fluoride			1.5				1	2		
nitrate (as nitrogen)			10					30		
nitrite (as nitrogen)			1					10		

	Protected environmental values									
POLLUTANTS (Clause 13(1)*(a)*)	**Aquatic ecosystem**		**Potable**	**Recreation & aesthetics**			**Agriculture/aquaculture**			**Industrial**
	fresh	marine		primary contact	secondary contact	aesthetics	irrigation	livestock	aquaculture	
oxidised nitrogen (as nitrogen)	0.5	0.2								
phosphorus (total as phosphorus)	0.5	0.5								
phosphorus (soluble as phosphorus)	0.1	0.1								
salinity (percentage variation)	10									
sulfate			500					1000		
sulfide	0.002	0.002								
suspended sediment	20	10								
total nitrogen (as nitrogen)	5	5								
total organic carbon	15	10								
turbidity (Nephelometric Turbidity units (NTU))	20	10	5	20						
Organic pollutants:										
<u>Chlorinated phenols</u>										
monochlorophenol	0.007		0.0001							
2,4-dichlorophenol	0.0002		0.0003							
trichlorophenol (total)	0.018		0.002							
2,4,5-trichlorophenol		0.008	0.002							
tetrachlorophenol	0.001									
oil and grease	10	10				10				
pentachlorophenol	0.00005	0.0002	0.00001							
<u>Chlorobenzenes</u>										
1,2-dichlorobenzene	0.0025		1.5							
1,3-dichlorobenzene	0.0025									
1,4-dichlorobenzene	0.004		0.04							
monochlorobenzene	0.015									
trichlorobenzenes (total)			0.03							
1,2,3-trichlorobenzene	0.0009									
1,2,4-trichlorobenzene	0.0005									
1,3,5-trichlorobenzene	0.0007									
1,2,3,4-tetrachlorobenzene	0.0001									
1,2,3,5-tetrachlorobenzene	0.0001									
1,2,4,5-tetrachlorobenzene	0.0002									
pentachlorobenzene	0.00003									
hexachlorobenzene	0.000007									

	Protected environmental values									
POLLUTANTS (Clause 13(1)*(a)*)	**Aquatic ecosystem**		**Potable**	**Recreation & aesthetics**			**Agriculture/aquaculture**			**Industrial**
	fresh	marine		primary contact	secondary contact	aesthetics	irrigation	livestock	aquaculture	
Organotins										
tributyltins	0.00008	0.00002	0.001							
Plasticisers										
di(2-ethylhexyl) phthalate			0.01							
Other organic pollutants										
acrlyamide			0.0002							
benzene	0.3	0.3	0.001						0.04	
carbon tetrachloride			0.003							
1,2-dichloroethane			0.003							
1,1-dichloroethene			0.03							
1,2-dichloroethene			0.06							
dichloromethane			0.004							
epichlorohydrin			0.0005							
ethylbenzene			0.3							
ethylenediamine tetraacetic acid			0.25							
hexachlorobutadiene			0.0007							
nitrilotriacetic acid			0.2							
pesticides	0	0	0							
polyaromatic hydrocarbons (PAHs)	0.003	0.003	0.00001							
phenol	0.05	0.05								
polychlorinated biphenyls (PCBs)	0.000001	0.000004							0.0005	
styrene			0.03							
2,3,7,8 tetra-chlorodibenzodioxin (2378 TCDD)	0	0	0							
tetrachloroethene			0.04							
toluene	0.3		0.8							
vinyl chloride			0.0003							
xylene			0.6							
Microbiological pollutants (organisms per 100 millilitres):										
faecal coliforms or *E.coli*			0	150	1000		1000	1000	0	
Enterococci				33						

	Protected environmental values									
POLLUTANTS (Clause 13(1)*(a)*)	**Aquatic ecosystem**		**Potable**	**Recreation & aesthetics**			**Agriculture/aquaculture**			**Industrial**
	fresh	marine		primary contact	secondary contact	aesthetics	irrigation	livestock	aquaculture	
CHARACTERISTICS (Clause 13(1)*(b)*)										
oxygen (dissolved)	>6	>6								
pH (pH units)	between 6.5-9		between 6.5-8.5				between 4.5-9			

* Soluble means fully dissolved or filterable through a 0.1 micron filter.
* Zero means that the pollutant must not be detectable when measured by a method approved by the Authority.