GROUNDWATER (BORDER AGREEMENT) ACT MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

DWLBC
Report

2003/11

The Department of Water, Land and Biodiversity Conservation

Government of South Australia

The Department of
Water, Land and
Biodiversity
Conservation

Groundwater (Border Agreement) Act March 2002 Full Chemical Analysis Sampling Program

Daniel Wohling

Water Policy
Department of Water, Land and Biodiversity Conservation

January 2003

Report DWLBC 2003/11

Government
of South Australia

Water Policy Division
Department of Water, Land and Biodiversity Conservation
101 Cedar Avenue, Naracoorte

Telephone	National	(08) 87621511
	International	+61 8 87621511
Fax	National	(08) 87623397
	International	+61 8 87623397
Website	www.dwlbc.sa.gov.au	

Daniel Wohling 2002. Groundwater (Border Agreement) Act March 2002 Full Chemical Analysis. South Australia. *Department of Water, Land and Biodiversity Conservation. Report,* DWLBC 2003/11.

Foreword

South Australia's natural resources are fundamental to the economic and social wellbeing 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 a 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, Resource Assessment Division
Department of Water, Land and Biodiversity Conservation

CONTENTS

FOREWORD.......... I

CONTENTS.......... II

ABSTRACT.......... 1

INTRODUCTION.......... 2

OBJECTIVES.......... 5

HYDROGEOLOGY.......... 6

METHODOLOGY.......... 9

RESULTS.......... 11

Spatial Groundwater Quality Distributions.......... 11

TERTIARY LIMESTONE AQUIFER (TLA).......... 11

TERTIARY CONFINED SAND AQUIFER (TCSA).......... 21

TEMPORAL GROUNDWATER QUALITY TRENDS - TLA.......... 28

DISCUSSION.......... 31

CONCLUSIONS AND RECOMMENDATIONS.......... 33

REFERENCES.......... 34

List of Tables

Table 1. Electrical Conductivity Water Quality Guidelines.......... 11
Table 2. Chloride Water Quality Guidelines.......... 13
Table 3. Fluoride Water Quality Guidelines.......... 15
Table 4. Iron Water Quality Guidelines.......... 15
Table 5. Sodium Adsorption Ratio Water Quality Guidelines.......... 18
Table 6. Nitrate + nitrite as nitrogen Water Quality Guidelines.......... 21

List of Figures

Figure 1. Locality plan and geological province.......... 3
Figure 2. Hydrostratigraphic Units of the Otway and Murray Basins.......... 4
Figure 3. Hydrogeological Provinces of the Designated Area.......... 7
Figure 4. Monitoring well locations.......... 10
Figure 5. TLA - Electrical conductivity - March 2002.......... 12
Figure 6. TLA - Chloride concentration - March 2002.......... 14
Figure 7. TLA - Fluoride concentration - March 2002.......... 16
Figure 8. TLA - Iron concentration - March 2002.......... 17

Figure 9. TLA - Sodium Adsorption Ratio - March 2002 19
Figure 10. TLA - Nitrate + nitrite as nitrogen concentration - March 2002 20
Figure 11. TCSA - Electrical conductivity - March 2002 22
Figure 12. TCSA - Chloride concentration - March 2002 24
Figure 13. TCSA - Fluoride concentration - March 2002 25
Figure 14. TCSA - Iron concentration - March 2002 26
Figure 15. TCSA - Nitrate + nitrite as nitrogen concentration - March 2002 27
Figure 16. TLA - Annual electrical conductivity trend 29
Figure 17. TLA - Annual chloride concentration trend 30

List of Appendixes

Appendix A. Results/Parameters 35
Appendix B. NO_3 (as NO_3) and NO_2 (as NO_2) to NO_X (as N) derivation 38

ABSTRACT

The Groundwater (Border Agreement) Act 1985 was introduced to protect the groundwater resources along a 40 km wide strip of the South Australian and Victorian State border. The Border Groundwater Agreement Review Committee (BGARC) uses this legislation as a framework for the management of 22 zones of this region. These 22 zones along the State border are referred to as the Designated Area. The BGARC recommends that in addition to the regular 3 monthly water level and salinity groundwater monitoring program, sampling for full chemical analysis be undertaken every six years.

Groundwater samples analysed for a range of chemical parameters were taken from a network of monitoring wells in March 2002 from two separate aquifer systems, namely, the Tertiary Limestone Aquifer (TLA) and the Tertiary Confined Sand Aquifer (TCSA) within the Designated Area.

This report presents the result of the sampling and full chemical analysis program undertaken in March 2002 throughout the Designated Area in both South Australia and Victoria.

A strong correlation between electrical conductivity and chloride concentration annual trends exists in the Designated Area. This relationship is expected, as chloride is the dominant anion in groundwater chemistry.

Vegetation clearance and irrigation impacts, such as the recycling of salts and the mobilisation of historic salt stored in the soil profile, are thought to be the primary reasons for the long term increase in electrical conductivity of groundwater in parts of the Designated Area. The affect of below average rainfall for the past 8-10 years may also be a contributing factor for the increasing electrical conductivity levels in areas of the Designated Area, for example, where runaway holes and drainage wells are present. Decreasing electrical conductivity trends in the Designated Area are thought to be from the migration of zones of better quality water.

It is recommended that a comprehensive land use map be compiled for the entire Designated Area to attain a thorough understanding of the relationships between land use and groundwater quality. It is also recommended that a review of the adequacy of the current networks and an associated salinity risk assessment be undertaken.

INTRODUCTION

The groundwater resources within a 40 km wide strip of land along the State border of South Australia and Victoria are jointly managed by the authorities in each State under the Groundwater (Border Agreement) Act 1985. This area is referred to as the Designated Area and comprises 22 management zones, as shown in Figure 1.

There is almost total reliance on the groundwater resources within the Designated Area for irrigation, stock, domestic, industrial and municipal supplies, which are sourced from two main aquifer systems. The upper Tertiary Limestone Aquifer (TLA) is the principal aquifer used for groundwater extraction in the Designated Area, while the deeper Tertiary Confined Sand Aquifer (TCSA) has limited groundwater extraction and is used primarily for municipal supplies. The relationship between these two aquifers is illustrated in Figure 2.

A good understanding of the chemical nature of the groundwater contained in the TLA and the TCSA is an important aspect of management of these groundwater resources, particularly in relation to spatial variability and any temporal water quality changes.

Regular three monthly monitoring of the groundwater resources is undertaken within the Designated Area for total dissolved salts, and on a six yearly basis for a full range of chemical parameters (i.e. major cations, anions and nutrients).

The previous full chemical analysis sampling program undertaken in March 1996 within the Designated Area was reported by Brown and Sinclair Knight Merz (1998) and provided details for spatial and temporal water quality trends, groundwater chemistry types and relationships between land use and possible water quality impacts.

This report presents the result of the sampling and full chemical analysis program undertaken in March 2002 throughout the Designated Area in both South Australia and Victoria.

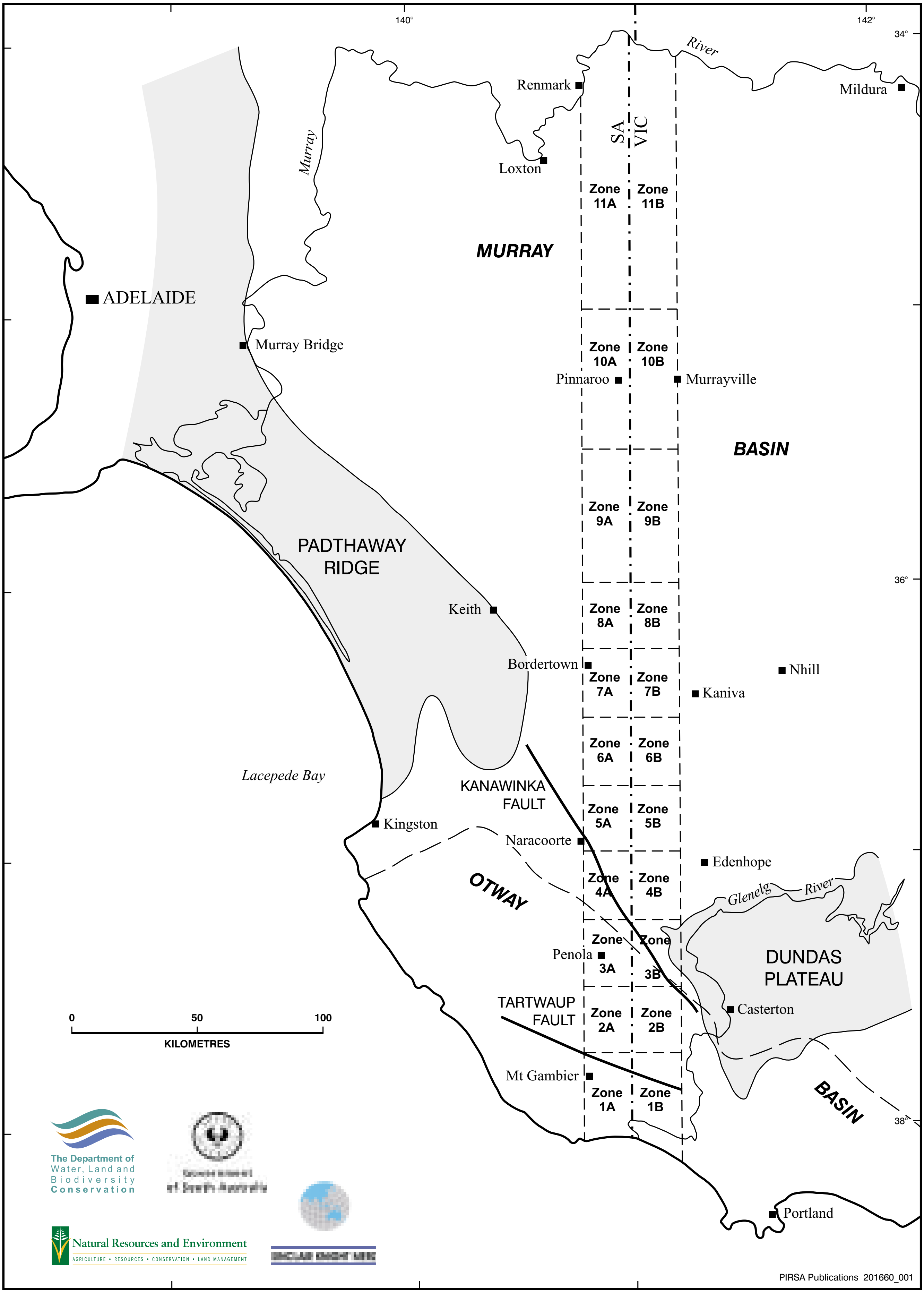


Figure 1 *Locality plan (underlying hydrogeology).*

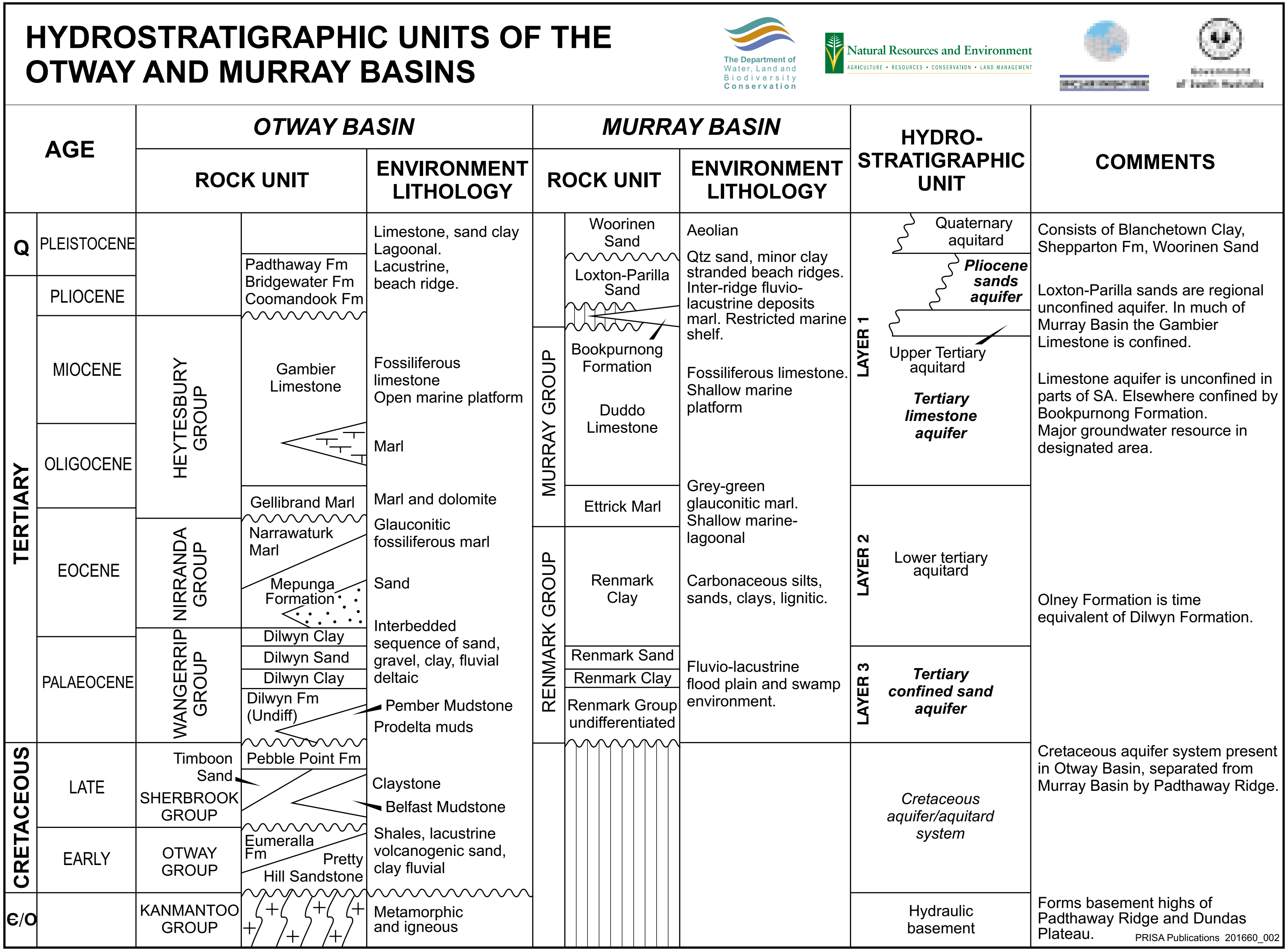


Figure 2 *Hydrostratigraphic units of the Otway and Murray Basins.*

OBJECTIVES

The main objectives of the full chemical analysis sampling program were to:

- Monitor and review in detail the groundwater quality data from the Designated Area, and together with available preceding data for the two aquifer systems determine any impacts affecting the groundwater resources.
- Identify knowledge gaps delineated by the spatial and temporal water quality trends in the TLA and by the spatial water quality relationships in the TCSA.
- Identify any groundwater management concerns for the aquifers in the Designated Area.
- Update the groundwater quality databases in both states to maintain a record of the results and to add to the temporal water quality records for the individual monitoring wells.

HYDROGEOLOGY

Two sedimentary basins, as shown in Figure 1, form the underlying hydrogeology in the Designated Area. The Otway Basin occurs to the south and Murray Basin to the north, both being formed during the Cainozoic period. The sediments occurring in these two basins are similar in character, but are separated by an axial high extending from the Dundas Plateau in the east to the Padthaway Ridge to the west (Walker *et al*., 2001).

There are 3 main aquifer systems, as shown in Figure 2, in the Designated Area:

1) The Tertiary Limestone Aquifer (TLA), comprising mainly cemented limestone ranging from clayey marl to karstic limestone. This is called the Gambier Limestone in the Otway Basin and is overlain by the Bridgewater, Coomandook and Padthaway Formations. The equivalent of the Gambier Limestone in the Murray Basin is called the Murray Group Limestone.

2) The Tertiary Confined Sand Aquifer (TCSA), comprising of a series of sand and gravel called the Dilwyn Formation in the Otway Basin and the Renmark Group in the Murray Basin. The depth to the confining bed that overlies the TCSA ranges from less than 30 m to in excess of 240 m along the Designated Area, and

3) The Pliocene Sands Aquifer (PSA), consisting mainly of the Loxton-Parilla Sands. This aquifer is not found extensively through the Designated Area and is restricted in occurrence, mainly in the northern part of the Designated Area, due to the Loxton-Parilla Sands being unsaturated through most of the Designated Area.

There are two distinct aquitards that occur within the hydrogeological sequence in the Designated Area (Fig. 2):

1) The Lower Tertiary Aquitard, consisting of clay and marl, is the confining bed overlying the TCSA and allows limited groundwater leakage between the TLA and TCSA.

2) The Upper Tertiary Aquitard, consisting of the Bookpurnong Beds, a calcareous clay and silty sand deposition, occurs largely to the north and north eastern parts of the Murray Basin, (Walker *et al*., 2001). The Upper Tertiary Aquitard is the confining bed that overlies the TLA in Hydrogeological Province 3, discussed below, above which lies the PSA.

The Designated Area has been divided into 3 hydrogeological provinces to describe the varying hydraulic nature of the TLA (Fig. 3).

Province 1 is located to the south of the Kanawinka Fault, therefore occurring mainly in the Otway Basin. Here, the TLA is characterized as an unconfined aquifer having the Gambier Limestone overlain by the Bridgewater, Coomandook and Padthaway Formations.

Province 2 is to the north of the Kanawinka Fault, occurring in the Murray Basin. Here, the TLA is unconfined with the Murray Group Limestone at the surface or overlain by the Loxton-Parilla Sands.

Province 3 is the region of the Murray Basin where the Murray Group Limestone is confined. This is due to the presence of the Upper Tertiary Aquitard that separates the TLA and PSA and allows limited vertical leakage between the two aquifers. Confinement of the TLA can also occur due to cementation of the Upper Parilla Sands.

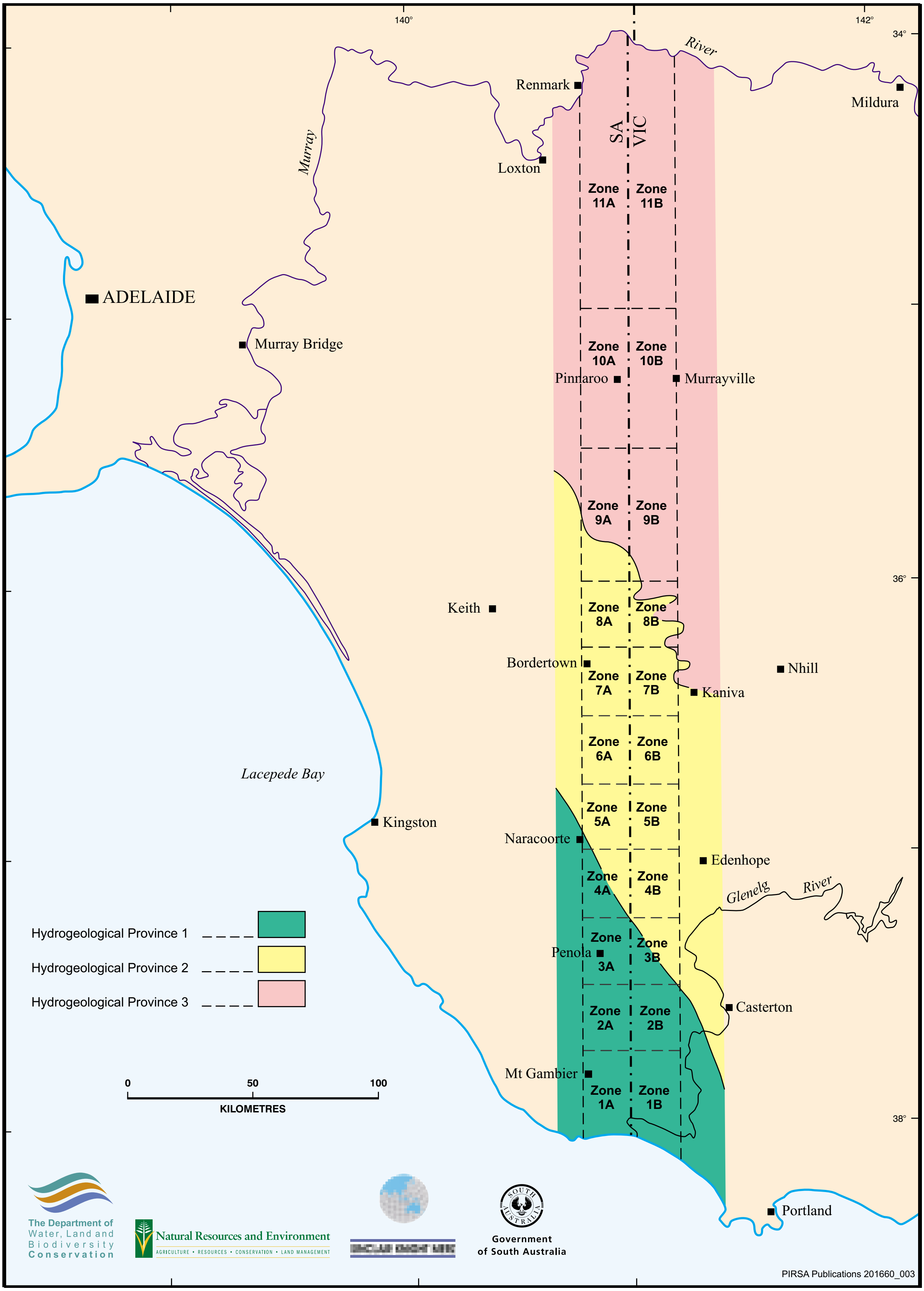


Figure 3 *Hydrogeological provinces of the Designated Area.*

Groundwater flow direction in the TLA can be generalized into:

a) a northeast to southwest flow in the south of the Designated Area,

b) an east to west flow in the central regions and

c) a southeast to northwest flow in the north of the Designated Area (Walker *et al*., 2001).

For the TCSA, the primary recharge area is the Dundas Plateau and from there, the groundwater flows to the south, west, and north in a radial manner (Walker *et al*., 2001). There is the potential for leakage or mixing of groundwater between the TLA and TCSA within the Designated Area. In the area south of Mount Gambier, there is a potential for upward leakage from the TCSA to the TLA as there is a positive head difference between the two aquifers. Hence there is potential for the TCSA to recharge the TLA. North of Mount Gambier, the potential leakage is downward as there is a negative head difference between the two aquifers. Therefore there is the potential for groundwater from the TLA to recharge the TCSA in this area.

A key knowledge gap for the Designated Area is the hydraulic interconnectivity between the two main aquifer systems. Potentiometric head differences between the confined and unconfined aquifers are known, however the hydraulic and spatial nature of the confining bed are not fully understood.

METHODOLOGY

A total of 171 wells were sampled during the March 2002 sampling period, including wells in both the TLA (147 wells) and TCSA (24 wells) (Fig. 4). The wells sampled were sought from a combination of both South Australian and Victorian locations to give a snapshot of the groundwater quality in the Designated Area.

All South Australian wells were sampled by pumping and followed the Australian sampling protocol (W.R.M.C 1991) to ensure the samples were representative of the aquifer. Sampling in Victoria was undertaken using a combination of pumped, bailed, tank and tap samples.

All groundwater samples from South Australia and Victoria were analysed for a range of parameters, as shown in Appendix A, at Australian Laboratory Services therefore ensuring consistent analytical methods. The analytical data was then used to determine spatial distributions in the Designated Area in both the TLA and TCSA systems. Through comparison with historical data from the Designated Area, temporal trends were also analysed. Land use patterns were studied in conjunction with the results found in spatial and temporal trends in groundwater quality to determine those practices, if any, impacting on the groundwater system.

The spatial and temporal analysis of the data involved entering the data into ArcView 3.2, a GIS software package. For use in ArcView 3.2, concentrations less than their minimum reportable analytical concentration were assumed to be zero.

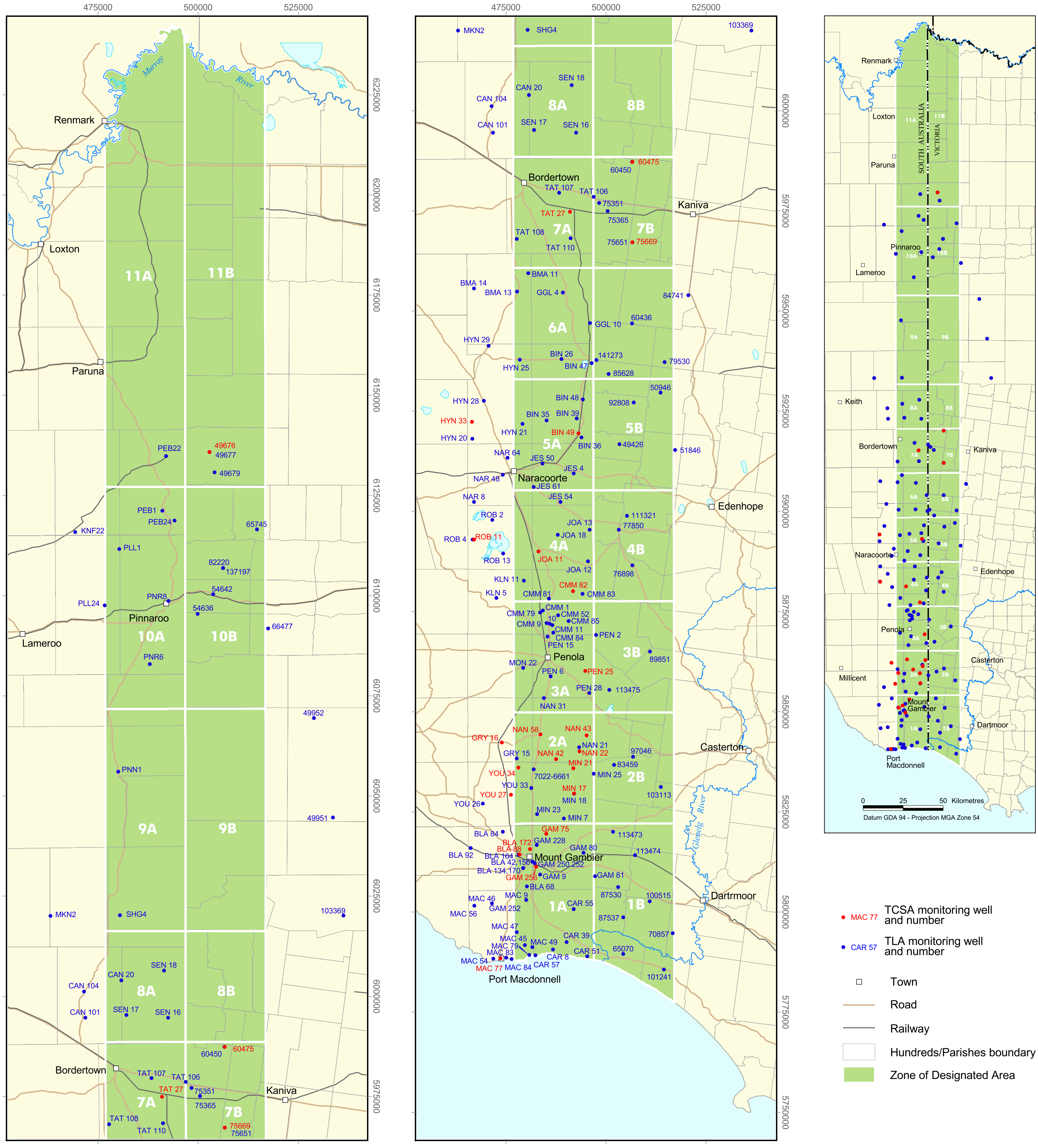
SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

Monitoring well locations

The Department of Water, Land and Biodiversity Conservation

SINCLAIR KNIGHT MERZ

Natural Resources and Environment
AGRICULTURE • RESOURCES • CONSERVATION • LAND MANAGEMENT



MAC 77 TCSA monitoring well and number

CAR 57 TLA monitoring well and number

Town

Road

Railway

Hundreds/Parishes boundary

Zone of Designated Area

0 10 20 30 40 50 Kilometres

Datum GDA 94 - Projection UTM MGA Zone 54

Government of South Australia

Figure 4

PIRSA Publications 201660_004

Disclaimer

The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details

Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

RESULTS

Spatial Groundwater Quality Distributions

TERTIARY LIMESTONE AQUIFER (TLA)

1) Electrical Conductivity (EC)

Electrical conductivity (EC) is a measure of the ability of water to conduct an electrical current. This increases with increasing salinity or Total Dissolved Solids (TDS) content of the water.

Figure 5 gives an electrical conductivity range for each well sampled in the TLA for the Designated Area along with contours of electrical conductivity.

Generally Zones 1A and 1B have an EC below 1000 µS/cm, while Zones 2A, 2B, 3A and 3B have an increased EC ranging from 1000 µS/cm to 2000 µS/cm. The increasing trend continues through Zones 4A and 4B over a sharp salinity gradient with several wells recording salinities up to 5000 µS/cm. Hydrogeological Province 1 corresponds to the area of lowest salinity groundwater of the Designated Area. The sharp salinity gradient that occurs through Zones 4A and 4B, as described above, also closely aligns with the Kanawinka Fault and Hydrogeological Province 2 to the north of this fault.

From Zones 5A and 5B through to the middle of Zone 8A, the EC varies from areas higher than 5000 µS/cm to less than 2000 µS/cm. Hydrogeological Province 2 is located in this highly variable environment. Between Zones 8A and 8B to the middle of Zones 10A and 10B, the EC value for the groundwater remains within 1000 to 2000 µS/cm, however the number of wells sampled in this region of the Designated Area gives insufficient data to allow accurate interpretation. From the middle of Zones 10A and 10B to the start of Zones 11A and 11B, the EC again rises with one well having an EC of 6870 µS/cm. Hydrogeological Province 3 is located above Zones 8A and 8B and as described above, the TLA is confined and overlain by the PSA.

Table 1 shows the electrical conductivity water quality guidelines for human drinking water, irrigation purposes and ideal livestock conditions. Of the wells sampled in the Designated Area, approximately half are of an acceptable EC concentration for human drinking water (less than 1820 EC units).

Table 1. Electrical Conductivity Water Quality Guidelines

EC Water Quality Guidelines (units=mS/cm)			
Drinking	*Irrigation*	*Livestock (ideal)*	
< 910 (good) 910-1820 (acceptable) > 1820 (poor)	Varies according to crop type and other factors	Sheep	10 510
		Beef cattle	7 100
		Dairy cattle	5 360
		Horses	7 000
		Pigs	3 600

Source: NHMRC 1996 and ANZECC Nov 1992.

SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

TLA – Electrical conductivity March 2002

The Department of Water, Land and Biodiversity Conservation
SINCLAIR KNIGHT MERZ
Natural Resources and Environment
AGRICULTURE • RESOURCES • CONSERVATION • LAND MANAGEMENT

Electrical conductivity (µS/cm)

- 0 to 1000
- 1000 to 2000
- Greater than 2000
- Electrical conductivity contours
- Town
- Road
- Railway
- Hundreds/Parishes boundary
- Zone of Designated Area

GDA

0 10 20 30 40 50 Kilometres

Datum GDA 94 - Projection UTM MGA Zone 54

Government of South Australia

Figure 5

PIRSA Publications 201660_005

Disclaimer

The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details

Produced by:	Resource Assessment Division Department of Water, Land and Biodiversity Conservation
Projection:	UTM MGA Zone 54
Datum:	Geocentric Datum of Australia 1994
Date:	November 2002

The EC is an important consideration for irrigation waters. Increased EC causes the osmotic pressure of the soil solution to increase causing reduced accessibility to water by the plants possibly leading to slowing of plant growth. The guideline values for EC that are provided vary for different irrigation regimes, crop types and tolerance, soil types and climatic conditions (ANZECC 1992).

For the land in Zones 1A and 1B, the EC is quite low and therefore should be quite suitable for most irrigation practices on the soils found in the region. For the remainder of the Designated Area, the groundwater quality varies from areas requiring minor salinity management to isolated areas where irrigation salinity limits are exceeded and would not be possible even for quite salt tolerant crops.

The livestock water quality guidelines vary over a large range of values, being dependent on the type of livestock involved, condition of the livestock and time the livestock be subjected to the water. For much of the Designated Area, except in the northern most part of the area, the EC concentration should be suitable for most types of stock.

2) Chloride (Cl)

Figure 6 gives a chloride concentration range for each well sampled in the TLA for the Designated Area along with chloride concentration contours for the entire area.

Generally, the chloride concentration is below 500 mg/L in Zones 1A, 1B, 2A, 2B and 3A, with the majority of wells in this region of the Designated Area having a chloride level below the aesthetic drinking water quality guideline of 250 mg/L (Table 2). This region of low chloride concentration aligns with Hydrogeological Province 1 and, similarly to EC, a sharp chloride gradient occurs across the Kanawinka Fault.

Table 2. Chloride Water Quality Guidelines

Chloride Water Quality Guidelines		
Drinking	*Irrigation*	*Livestock*
250 mg/L (Aesthetic)	30–700 mg/L	Not Available

Source: NHMRC 1996 and ANZECC Nov 1992.

North of the Kanawinka Fault in Hydrogeological Province 2, the chloride concentration rises to a concentration of 2400 mg/L in Zone 3B. This high value is however isolated with the majority of wells having concentrations ranging from less than 500 mg/L to around 1500 mg/L. There are 4 wells in Zones 4A, 5A and 5B where the chloride concentration does not exceed the drinking water quality guideline of 250 mg/L.

In Hydrogeological Province 3, where the PSA overlays the TLA, the chloride concentration decreases from around 1000 mg/L to less than 500 mg/L. However, from the middle of Zones 10A and 10B to the beginning of Zones 11A and 11B, the chloride concentration again rises with one well having a concentration of 1930 mg/L in Zone 11B.

In relation to irrigation guidelines, the chloride concentrations in the Designated Area are difficult to summarize due to the wide range of acceptable concentrations and that they are dependent on irrigation management and crop type. However towards the south of the

The Department of Water, Land and Biodiversity Conservation

SINCLAIR KNIGHT MERZ

Natural Resources and Environment
AGRICULTURE • RESOURCES • CONSERVATION • LAND MANAGEMENT

SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

TLA – Chloride concentration March 2002

GDA

0 10 20 30 40 50 Kilometres
Datum GDA 94 - Projection UTM MGA Zone 54

Government of South Australia

Figure 6

PIRSA Publications 201660_006

Disclaimer
The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details
Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

Designated Area, being Zones 1A, 1B, 2A, 2B and 3A, the concentrations are low and are suitable for most irrigation crops.

3) Fluoride (F)

Figure 7 shows the fluoride concentrations for each well sampled in the TLA within the Designated Area. There was no distinguishing spatial trend in groundwater fluoride concentrations. Six wells have fluoride concentrations exceeding the drinking water quality guideline of 1.5 mg/L, refer to Table 3. Of these six, 4 located in the region of Zones 4A and 4B and 1 in Zone 11B fall within the concentration range of 1.5 to 4 mg/L which requires caution if used for drinking water due to danger of dental fluorosis. The sixth well to exceed the 1.5 mg/L guideline is located in Zone 3B and has a concentration exceeding the 4 mg/L guideline for drinking water, above which there is a risk of skeletal fluorosis.

Table 3. Fluoride Water Quality Guidelines

Fluoride Water Quality Guidelines		
Drinking	*Irrigation*	*Livestock*
1.5 mg/L (dental) 4 mg/L (skeletal)	1 mg/L	2 mg/L

Source: NHMRC 1996 and ANZECC Nov 1992.

Most of the wells have fluoride concentrations that fall below the irrigation water quality guideline of 1 mg/L. There is one well located near Port MacDonnell in Zone 1A and there are 7 wells located in and around Zones 3B, 4A, 4B and 5A with concentrations greater than the irrigation guideline. A further 4 wells in Zones 10A, 10B, 11A and 11B (a less sampled area of the Designated Area) have high fluoride concentrations.

Four wells in the Designated Area have fluoride concentrations exceeding the livestock water quality guideline of 2 mg/L. These are located in Zones 3B, 4B, and two just outside Zone 4A. Excess fluoride has similar effects on livestock as on humans.

4) Iron (Fe)

Figure 8 provides the iron concentrations for each well sampled in the TLA within the Designated Area and shows little spatial trend. Nineteen wells have iron concentrations above the acceptable drinking water quality guideline of 0.3 mg/L, refer to Table 4. This guideline is an aesthetic value based on the taste threshold. At higher concentrations iron staining can occur, whilst iron bacteria can cause corrosion, taste and odour (NHMRC 1996).

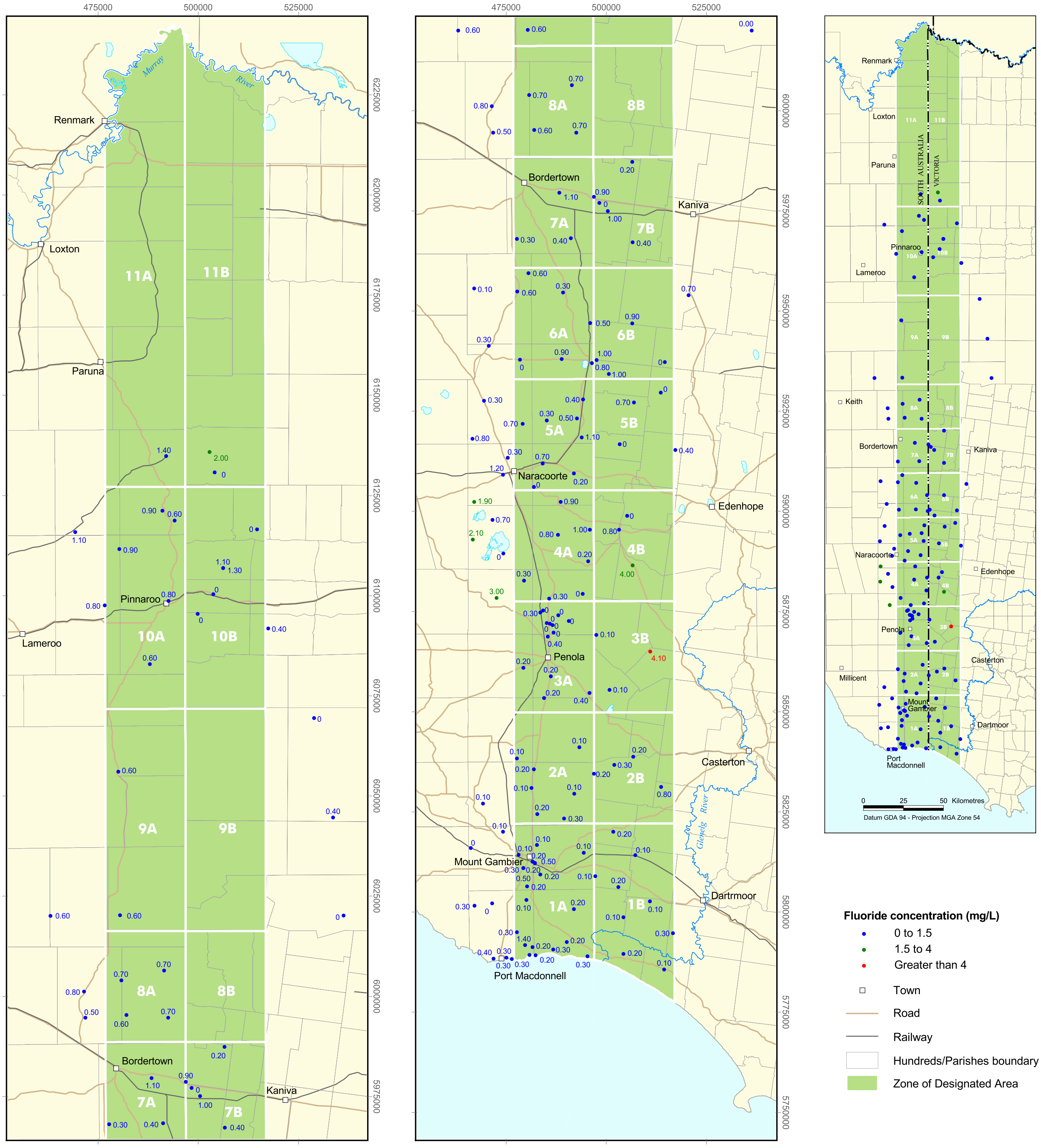
Table 4. Iron Water Quality Guidelines

Iron Water Quality Guidelines		
Drinking	*Irrigation*	*Livestock*
0.3 mg/L (Aesthetic)	1 mg/L	Not Available

Source: NHMRC 1996 and ANZECC Nov 1992.

SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

TLA – Fluoride concentration March 2002



Fluoride concentration (mg/L)

- 0 to 1.5
- 1.5 to 4
- Greater than 4
- Town
- Road
- Railway
- Hundreds/Parishes boundary
- Zone of Designated Area

0 10 20 30 40 50 Kilometres
Datum GDA 94 - Projection UTM MGA Zone 54

Figure 7

PIRSA Publications 201660_007

Disclaimer

The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details

Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

The Department of Water, Land and Biodiversity Conservation

SINCLAIR KNIGHT MERZ

Natural Resources and Environment
AGRICULTURE • RESOURCES • CONSERVATION • LAND MANAGEMENT

SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

TLA – Iron concentration March 2002

GDA

0 10 20 30 40 50 Kilometres

Datum GDA 94 - Projection UTM MGA Zone 54

Government of South Australia

Figure 8

PIRSA Publications 201660_008

Disclaimer

The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details

Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

Four wells in the Designated Area have iron concentrations above the irrigation water quality guideline of /L. These 4 wells display no spatial grouping, while the remaining wells have concentrations below the guideline and are suitable for irrigation waters. Above this guideline, the excess iron can cause blockage of irrigation equipment.

5) Sodium Adsorption Ratio (SAR)

The Sodium Adsorption Ratio is a guide used to indicate the threat of using high sodium concentrations in irrigation waters. Through a process known as cation exchange, water high in sodium concentration and low in calcium and magnesium concentrations can destroy the soil structure as clay particles are dispersed (Fetter, 1994).

The Sodium Adsorption Ratio is expressed as:

$SAR = (Na^{+}) / [(Ca^{2+}) + (Mg^{2+})/2]^{0.5}$

Table 5 shows the SAR categories, their values and the potential risk for soil structure if that water is used for irrigation purposes.

Table 5. Sodium Adsorption Ratio Water Quality Guidelines

Sodium Adsorption Ration Water Quality Guidelines		
Category	*SAR*	*Potential risk for soil dispersion*
S1	0 to 10	Low
S2	10 to 18	Medium
S3	18 to 26	High
S4	> 26	Very high

Source: Fetter, 1994.

Figure 9 shows the SAR values for each well sampled in the TLA for the Designated Area. The majority of wells sampled in the Designated Area have SAR's in the S1 category, being of low potential risk for soil structure. A group of wells in Zones 4A and 4B display SAR's in the S2 category, representing a medium hazard to soil structure. Beyond this, there are a few other wells scattered throughout the Designated Area that have a SAR in the S2 category. No wells in the Designated Area have SAR greater than a S2 category, that is, no wells have high or very high-risk soil dispersing irrigation waters.

6) Nitrate + Nitrite as Nitrogen (NO_3 + NO_2 as N)

The summation of NO_3 + NO_2 (as N) is generally referred to as NO_X (as N) and therefore for the remainder of this report the term NO_X (as N) will be used.

Figure 10 provides the NO_X (as N) concentrations for each well sampled in the TLA for the Designated Area. Generally lower concentrations occur towards the north of the Designated Area.

Table 6 shows the nitrate and nitrite (as N) water quality guidelines for drinking, irrigation and livestock uses.

The Department of Water, Land and Biodiversity Conservation

SINCLAIR KNIGHT MERZ

Natural Resources and Environment
AGRICULTURE • RESOURCES • CONSERVATION • LAND MANAGEMENT

SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

TLA – Sodium Adsorption Ratio March 2002

Figure 9

PIRSA Publications 201660_009

Disclaimer
The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details
Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

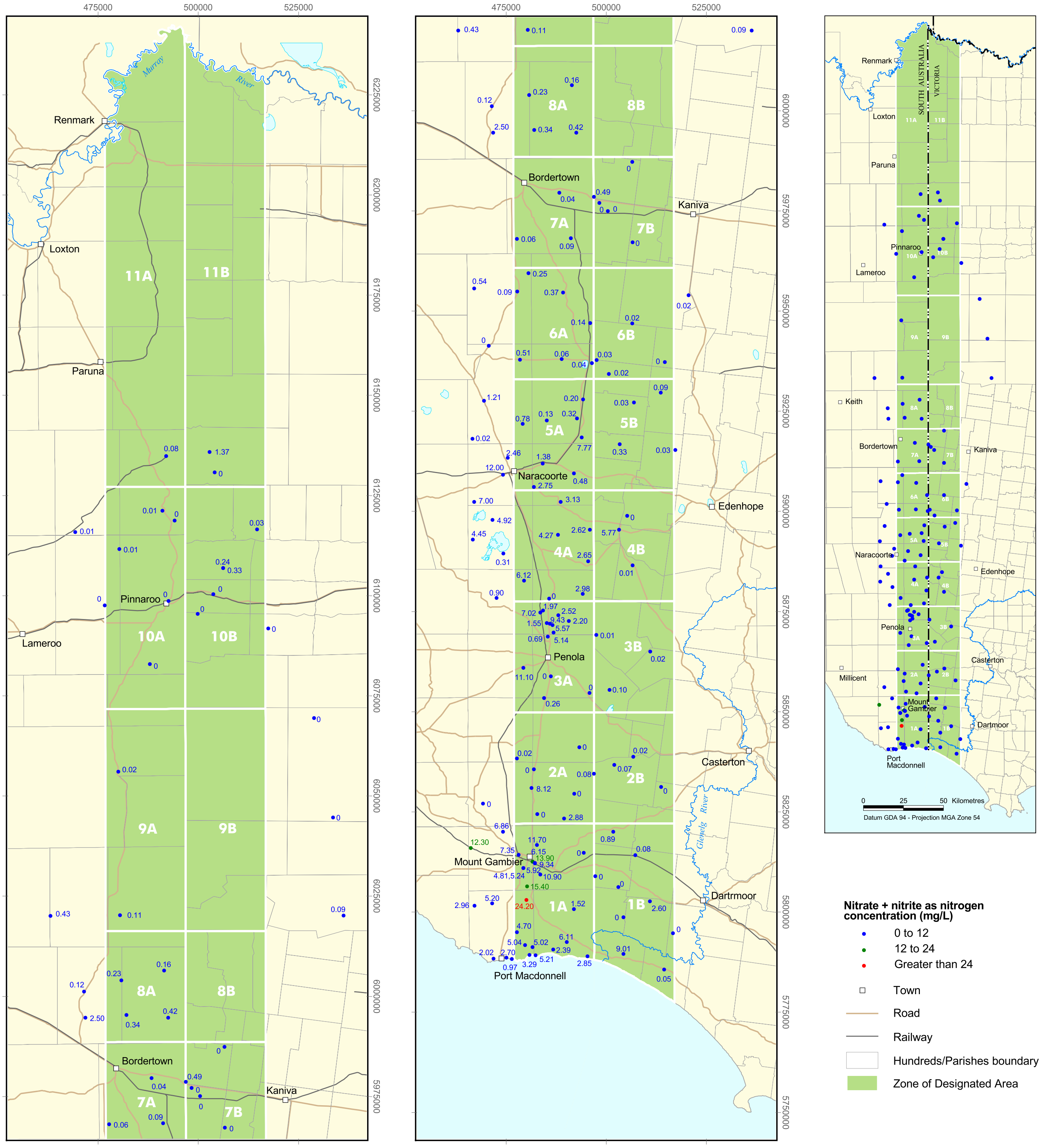
SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

TLA – Nitrate + nitrite as nitrogen concentration March 2002

The Department of Water, Land and Biodiversity Conservation

SINCLAIR KNIGHT MERZ

Natural Resources and Environment
AGRICULTURE • RESOURCES • CONSERVATION • LAND MANAGEMENT



Nitrate + nitrite as nitrogen concentration (mg/L)

- 0 to 12
- 12 to 24
- Greater than 24

- Town
- Road
- Railway
- Hundreds/Parishes boundary
- Zone of Designated Area

GDA

0 10 20 30 40 50 Kilometres

Datum GDA 94 - Projection UTM MGA Zone 54

Government of South Australia

Figure 10

PIRSA Publications 201660_010

Disclaimer

The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details

Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

Table 6. Nitrate + nitrite as nitrogen Water Quality Guidelines

Nitrate + Nitrite as nitrogen Water Quality Guidelines		
Drinking	*Irrigation*	*Livestock*
~12 mg/L (infants) ~24 mg/L (adults)	Not Available	40 mg/L

Source: NHMRC 1996 and ANZECC Nov 1992.

No specific NO_X (as N) drinking water guidelines are available. To use the NO_X (as N) analytical results for determination of drinking water quality, a determination was made using the published NO_3 and NO_2 guideline concentrations (as explained in Appendix B). It should be noted that these guidelines are somewhat arbitrary and are subject to the individual NO_3 and NO_2 concentrations that have not been analysed and reported. Future water quality testing in the Designated Area should include individual analysis for nitrate and nitrite concentrations. The guidelines assigned to the NO_X (as N) parameter are 12 mg/L for infants aged younger than 3 months and 24 mg/L for children and adults (Table 6). Above the later value, water becomes unsuitable for drinking.

Four wells have concentrations exceeding the combined drinking water quality guideline of 12 mg/L for infants, while 1 of these exceeds the guideline limit set for adults of 24 mg/L. All occur in Zone 1A to the south of Mount Gambier. This is an area where high concentrations of NO_X (as N) have previously been recorded and caution is needed if the groundwater is used as a potable supply. The elevated NO_X (as N) concentrations are attributed to a range of different causes ranging from septic tank effluent leaking into the TLA to varying industrial and agricultural land uses.

All wells in the Designated Area fall below the combined NO_X (as N) guideline of 40 mg/L for stock water.

TERTIARY CONFINED SAND AQUIFER (TCSA)

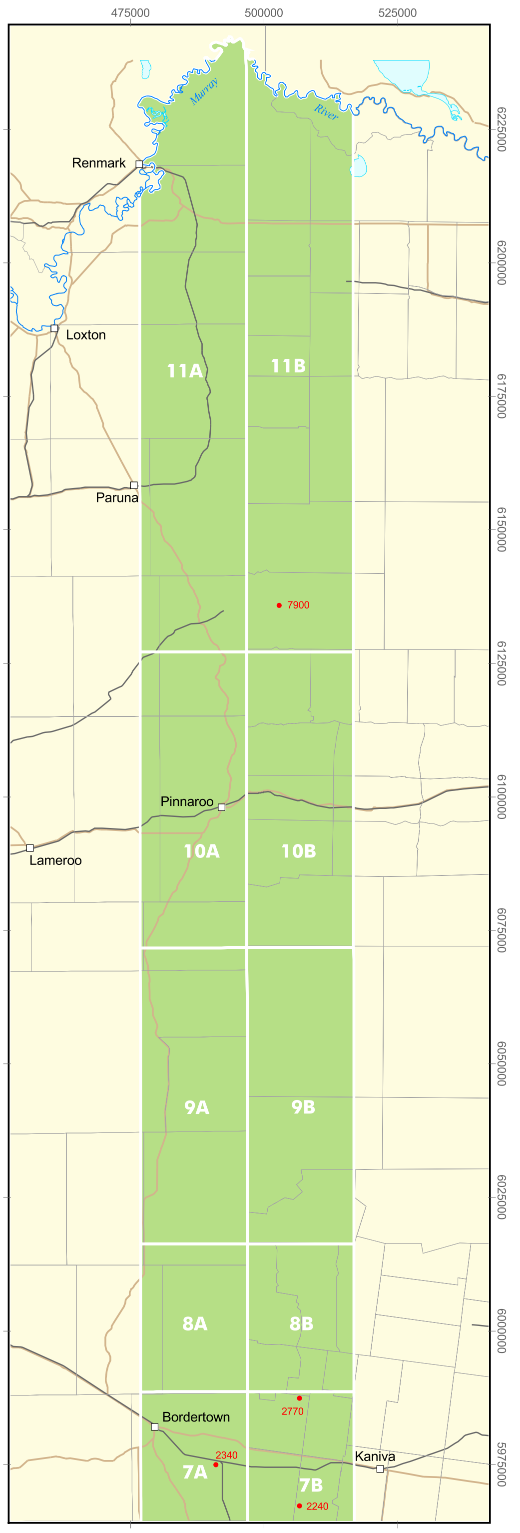
Due to the limitations of data for the TCSA, the process of a comprehensive spatial analysis could not be undertaken. The limitations of the data extends to only 3 wells in Victoria, two of which are in Zone 6B and one in Zone 11B. While in South Australia there is a concentration of wells sampled in Zones 1A and 1B with only a few wells sampled elsewhere in the Designated Area. Therefore only a brief analysis follows.

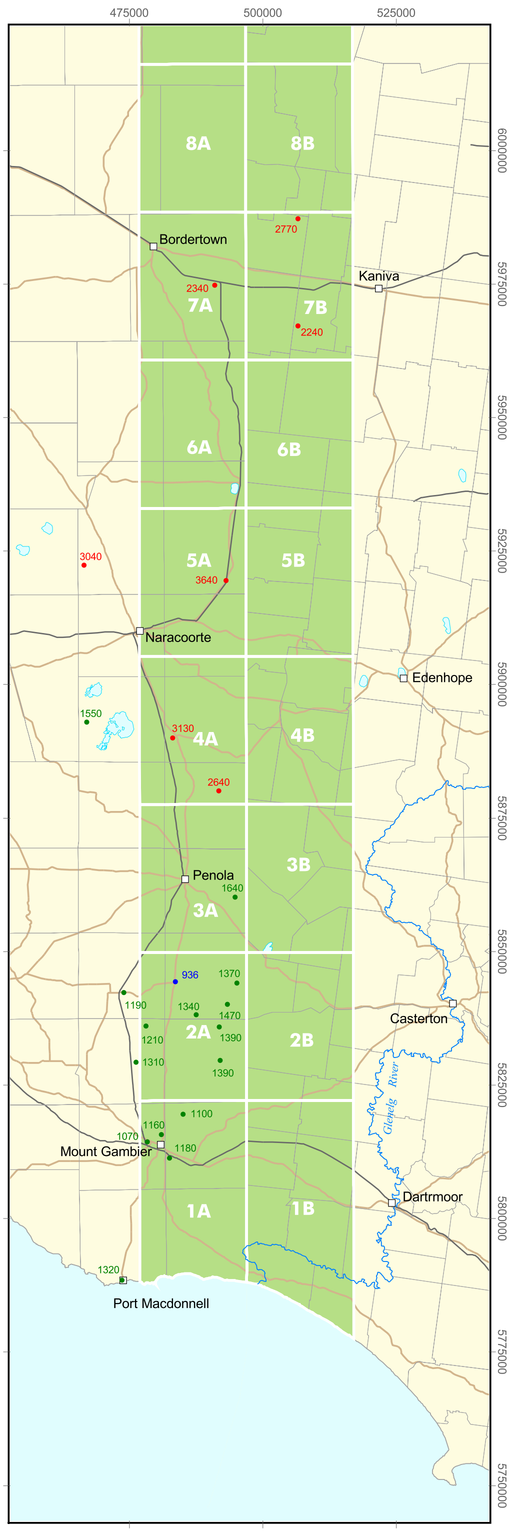
1) Electrical Conductivity (EC)

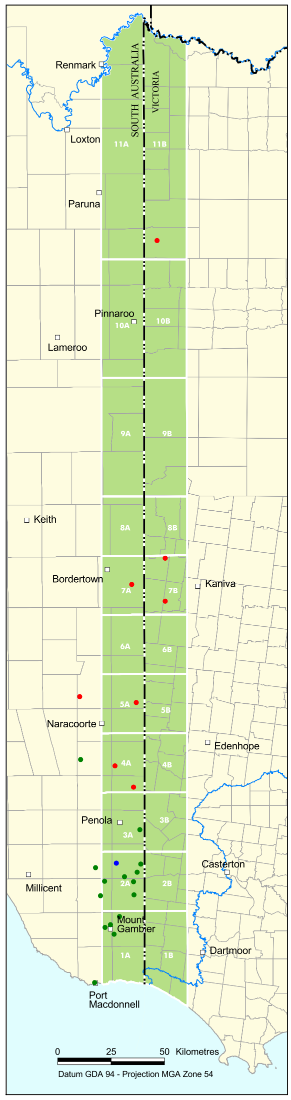
Figure 11 shows the electrical conductivity for each well sampled in the TCSA of the Designated Area. Unlike the TLA, there is only one well for the TCSA with an EC less than 1000 µS/cm, located in Zone 2A. In the south of the Designated Area, namely Zones 1A, 1B, 2A, 2B and 3A, the EC ranges between 900 and 2000 µS/cm, while towards the north the EC is greater than 2000 µS/cm with the exception of one well to the west of Zone 4A. Groundwater to the south of Zone 4A is suitable for drinking water and is used for several town water supplies.

SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

TCSA – Electrical conductivity March 2002







Electrical conductivity (µS/cm)

- 0 to 1000
- 1000 to 2000
- Greater than 2000

- Town
- Road
- Railway
- Hundreds/Parishes boundary
- Zone of Designated Area

0 10 20 30 40 50 Kilometres

Datum GDA 94 - Projection UTM MGA Zone 54

Figure 11

PIRSA Publications 201660_011

Disclaimer

The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details

Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

2) Chloride (Cl)

The chloride concentrations are shown in Figure 12 for each well sampled in the TCSA of the Designated Area. In Zones 1A and 2A, the chloride concentration is generally below 200 mg/L. From Zone 3A through to 11B, the sparse data implies that the chloride concentration increases to the north exceeding the drinking water quality guideline of 250 mg/L.

As with the analysis for the TLA, the irrigation guideline covers a wide range of acceptable concentrations that are dependent on irrigation management and crop type and therefore it is difficult to summarise groundwater of the Designated Area in relation to the guideline. However, chloride concentrations are generally low (except 1 well in 11B) and should be suitable for most irrigation practices.

3) Fluoride (F)

Figure 13 provides the fluoride concentration for each well sampled in the TCSA of the Designated Area. Of the wells sampled in the TCSA, only one well located in Zone 7B has an exceptionally high fluoride concentration (2.5 mg/L), which is above the drinking water quality guideline of 1.5 mg/L. The remaining wells show no spatial distribution pattern and range in concentration from 0.1 to 1.4 mg/L.

Four wells in the TCSA have fluoride concentrations exceeding the irrigation water quality guideline. One well is located in Zone 5A, two are located in Zones 7A and 7B, while the fourth is situated in Zone 11B and show no spatial trend.

Only one well located in Zone 7B has a fluoride concentration in excess of the livestock water quality guideline of 2 mg/L.

4) Iron (Fe)

Figure 14 shows the iron concentration for each well sampled in the TCSA within the Designated Area. Again no spatial distribution can be distinguished for iron in the TCSA due to the limited data. Three of the wells sampled in the TCSA have iron concentrations exceeding the guideline for drinking water of 0.3 mg/L. These are located in Zones 4A, 5A and 7B.

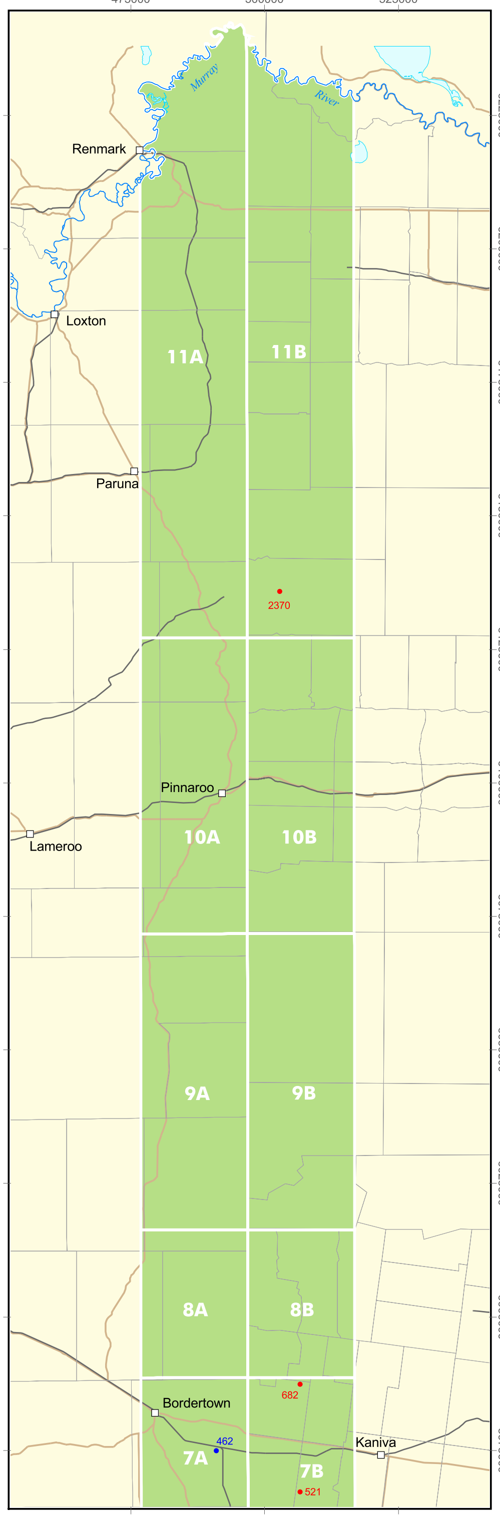
One well located in Zone 7B has a concentration marginally above the irrigation guideline of 1 mg/L for iron. The remaining wells have iron concentrations suitable for irrigation purposes.

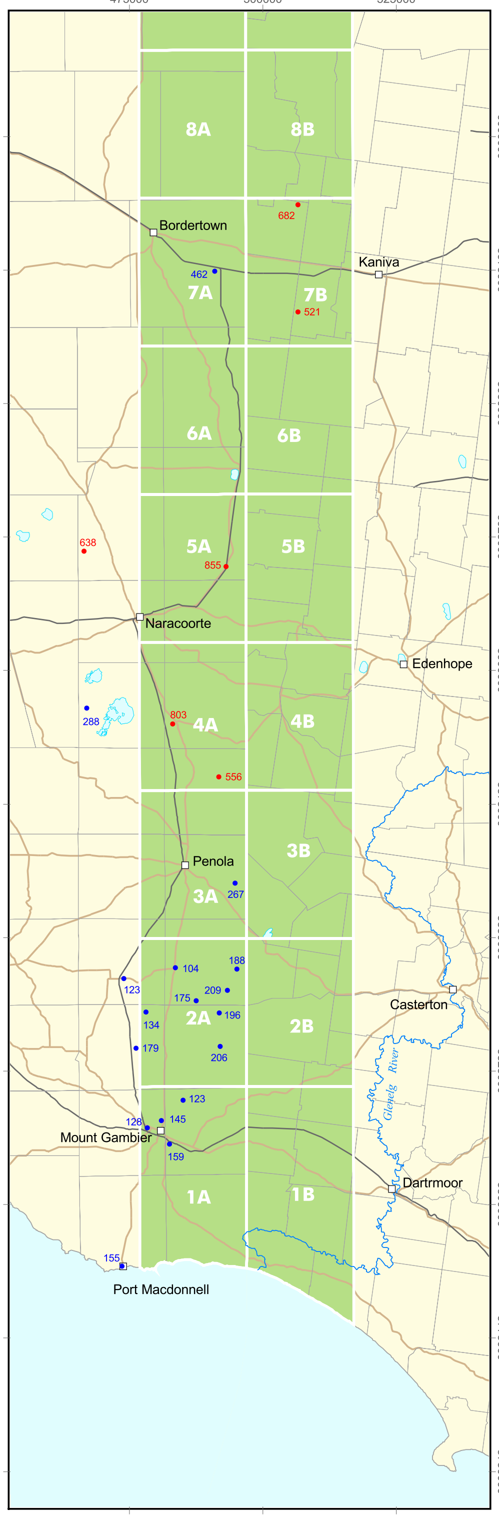
5) Nitrate + Nitrite as Nitrogen (NO_3 + NO_2 as N)

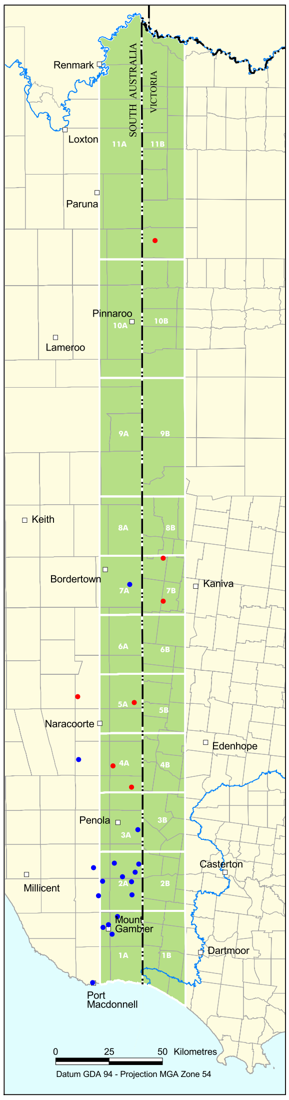
Figure 15 provides the NO_X (as N) concentration for each well sampled in the TCSA within the Designated Area. No spatial pattern is exhibited in the Designated Area for the combined concentration of NO_X (as N). Only 4 wells, 2 from South Australia in Zones 1A and 4A, and 2 from Victoria in Zones 7B and 11B have measurable concentrations and all well below both the drinking and irrigation water quality guidelines.

SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

TCSA – Chloride concentration March 2002







Chloride concentration (mg/L)

- 0 to 500
- Greater than 500
- Town
- Road
- Railway
- Hundreds/Parishes boundary
- Zone of Designated Area

0 10 20 30 40 50 Kilometres
Datum GDA 94 - Projection UTM MGA Zone 54

Government of South Australia

Figure 12

PIRSA Publications 201660_012

Disclaimer

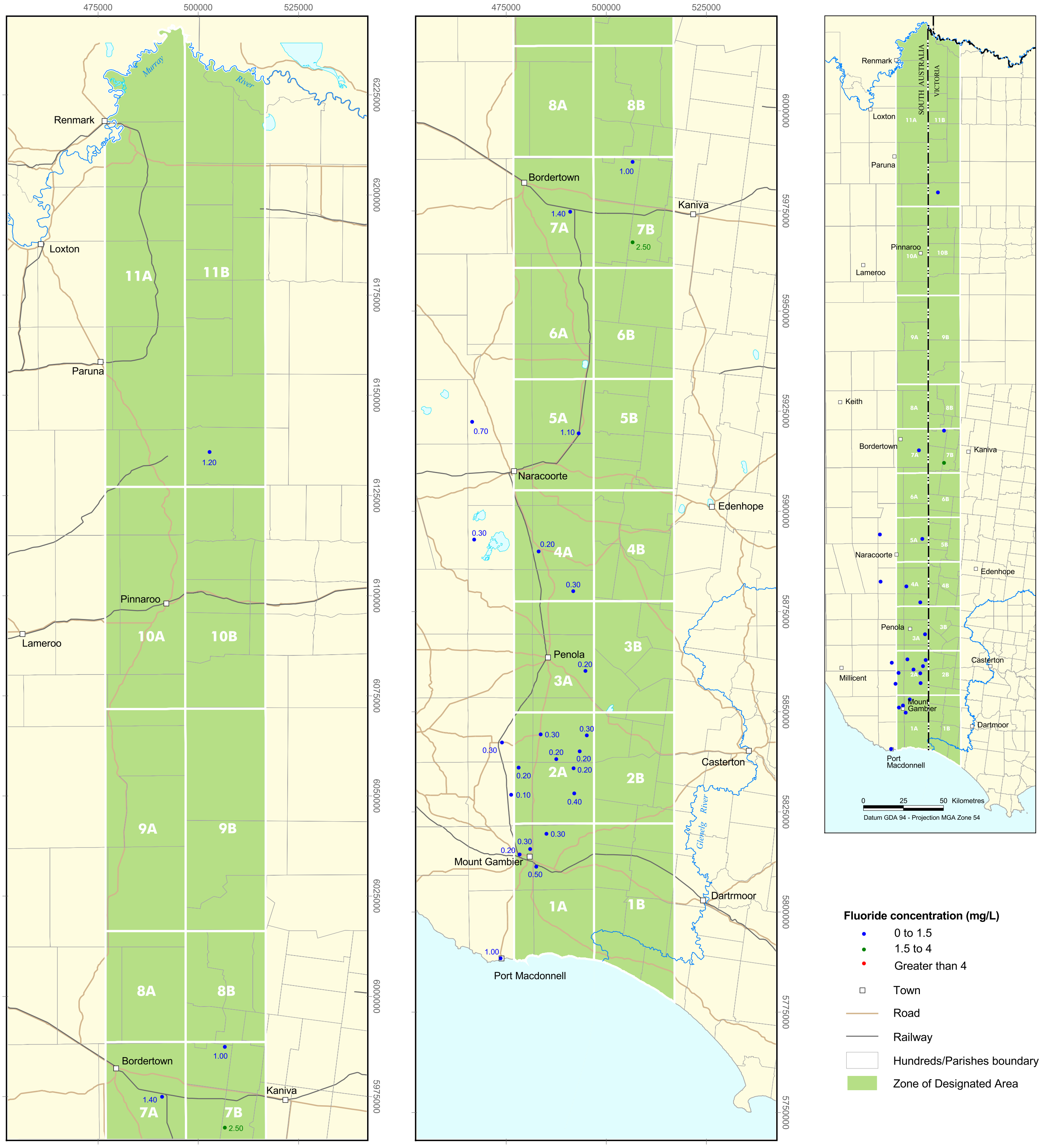
The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details

Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

TCSA – Fluoride concentration March 2002



0 10 20 30 40 50 Kilometres
Datum GDA 94 - Projection UTM MGA Zone 54

Figure 13

PIRSA Publications 201660_013

Disclaimer
The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details
Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

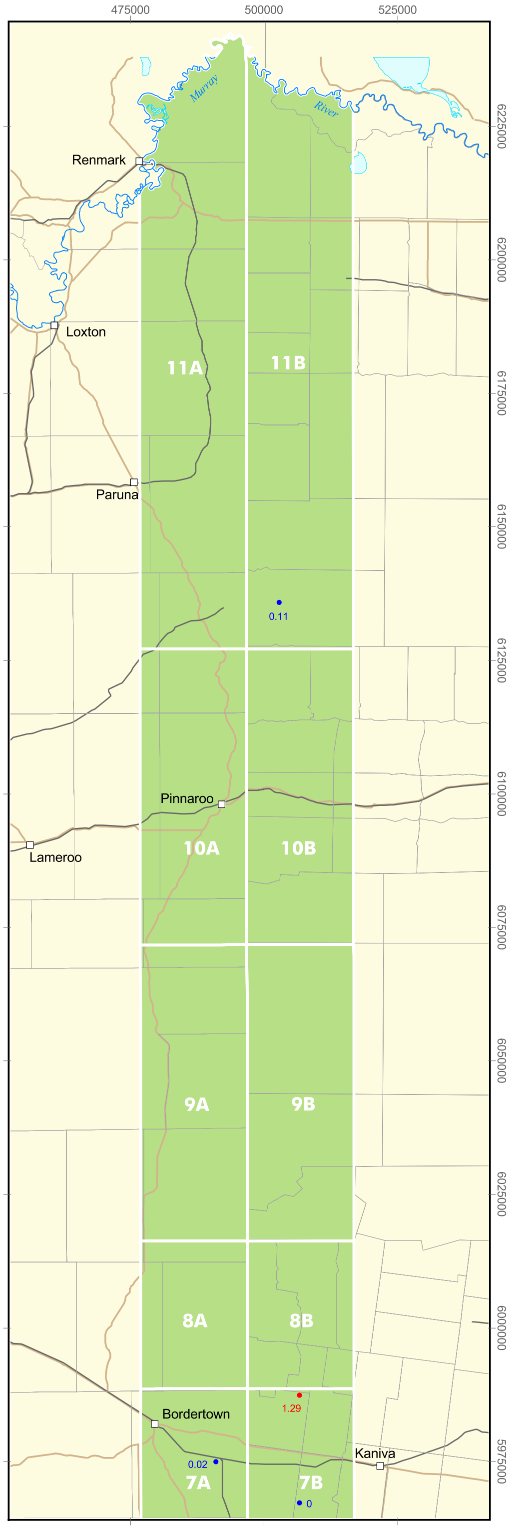
SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

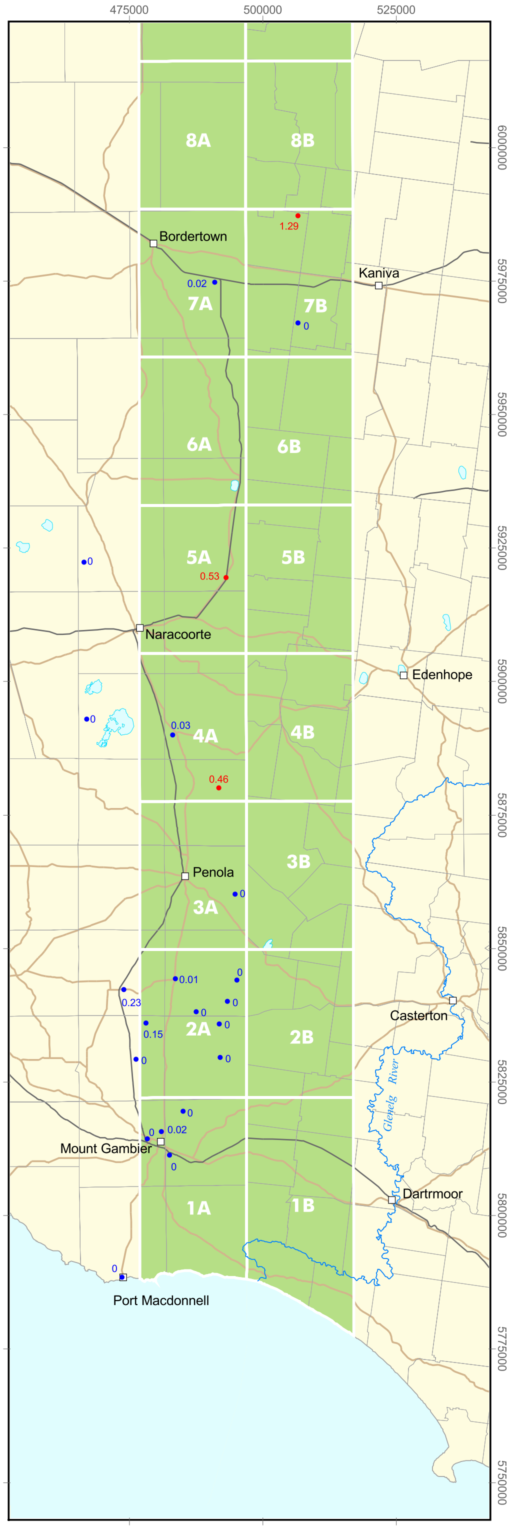
TCSA – Iron concentration March 2002

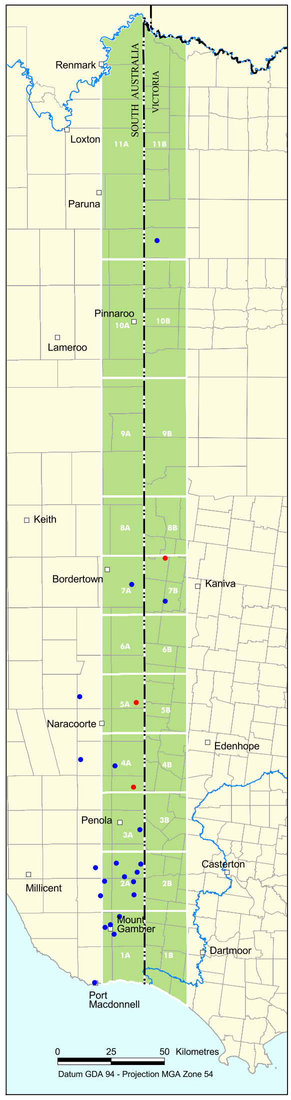
The Department of Water, Land and Biodiversity Conservation

SINCLAIR KNIGHT MERZ

Natural Resources and Environment
AGRICULTURE • RESOURCES • CONSERVATION • LAND MANAGEMENT







Iron concentration (mg/L)

- 0 to 0.3
- Greater than 0.3
- Town
- Road
- Railway
- Hundreds/Parishes boundary
- Zone of Designated Area

GDA

0 10 20 30 40 50 Kilometres
Datum GDA 94 - Projection UTM MGA Zone 54

Government of South Australia

Figure 14

PIRSA Publications 201660_014

Disclaimer

The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details

Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

TCSA – Nitrate + nitrite as nitrogen concentration March 2002

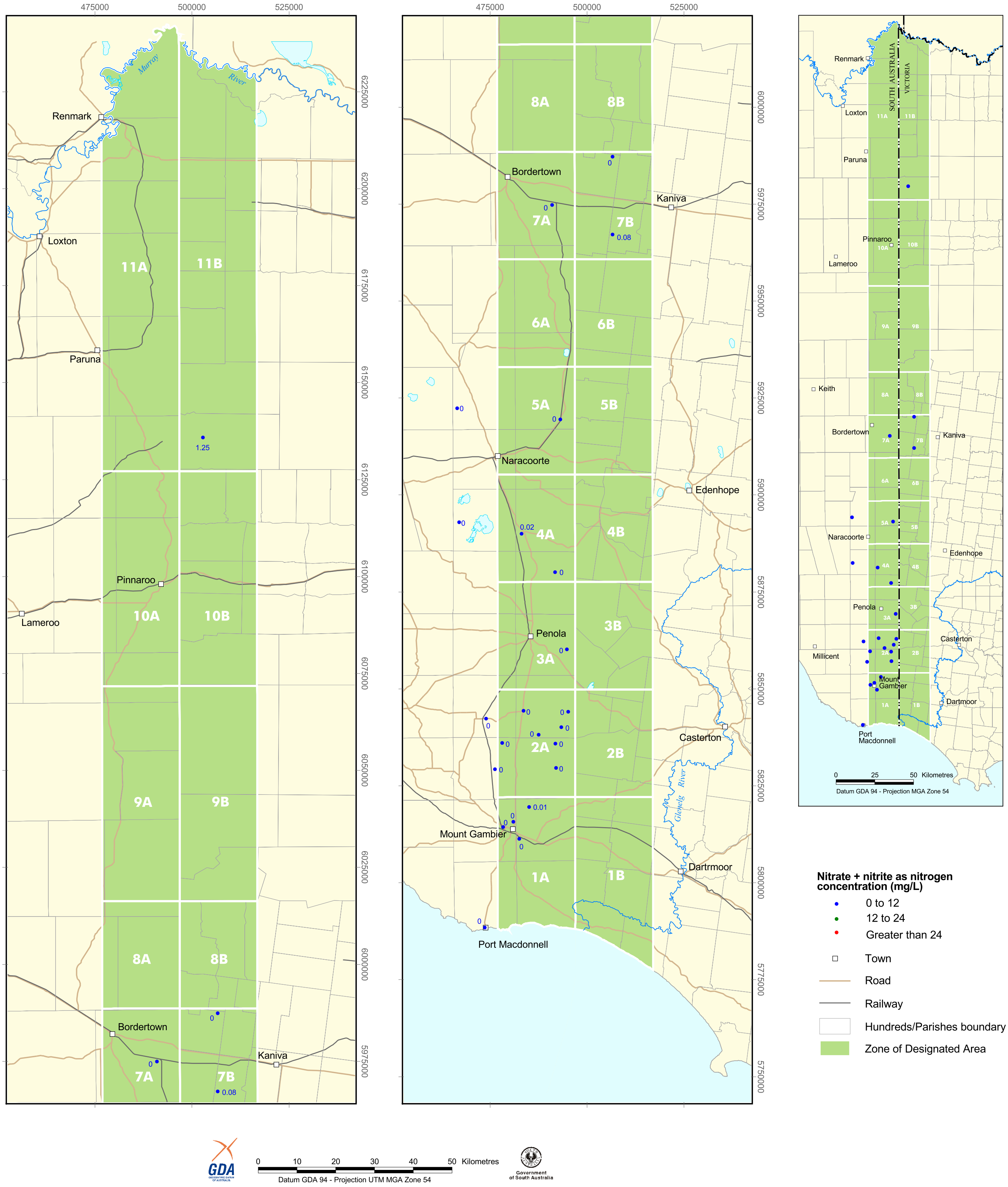


Figure 15

PIRSA Publications 201660_015

Disclaimer

The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details

Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

TEMPORAL GROUNDWATER QUALITY TRENDS - TLA

Temporal groundwater quality trends in EC and chloride concentrations were examined for the TLA. The analysis was carried out on wells having data records over a period greater than 5 years and typically with more than 4 measurements.

For the purposes of this trend analysis:

- an annual EC trend between –10 to 10 µS/cm is regarded as a negligible change, and
- a variation of –5 to 5 mg/L is regarded as negligible for chloride concentrations.

These assumptions have been made to allow for natural fluctuations and possible errors in sampling, analysis or conversion.

South Australia

Of the 106 wells sampled from the TLA in the South Australian region of the Designated Area during March 2002, 80 had sufficient historical data to be used for a temporal analysis of EC, while only 38 had sufficient historical chloride data. Two wells had historical Cl data but not historical EC data.

Figure 16 shows the annual electrical conductivity trend as at March 2002 in the TLA for the Designated Area. Forty-five of the eighty wells assessed for temporal EC trends show a negligible change over time and there is no apparent spatial distribution. An increasing trend is shown for 27 of the EC wells, with increases of up to 176 µS/cm/yr.

Figure 17 shows the annual chloride concentration trend as at March 2002 in the TLA of the Designated Area. Thirty of the thirty-eight wells used for temporal Cl analysis display a negligible annual trend. There are 4 wells located in Zones 4A, 5A and 6A that have an increasing Cl trend of up to 21 mg/L/yr, while the remaining 4 wells exhibit a decreasing Cl trend and are located in Zones 2A, 3A and 5A.

There is a strong correlation between EC trends and Cl trends across the South Australian Designated Area. As Cl is the dominant anion in the groundwater, this relationship is expected.

Victoria

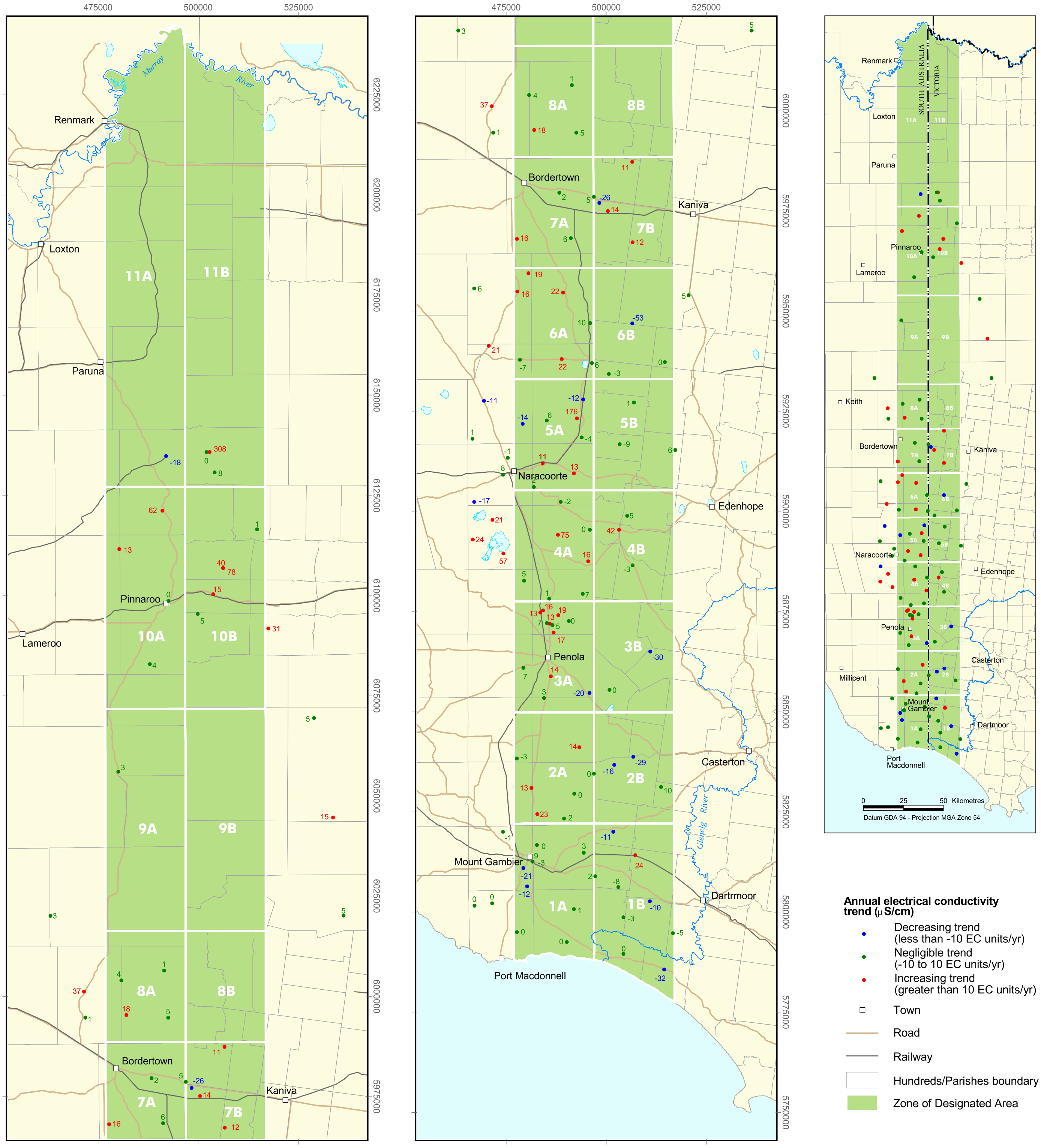
Of the 41 wells sampled from the TLA in the Victorian region of the Designated Area during March 2002, 39 had sufficient historical data to be used for a temporal analysis of EC and 25 of these wells also had historical chloride data.

Eleven of the 39 wells with historical EC records exhibit temporal increases ranging up to 308 µS/cm/yr. Eight of the 39 wells exhibit decreasing trends and the remaining 20 exhibit negligible changes in EC over the sampling period.

Three of the 25 wells with historical Cl data showed increases of up to 87 mg/L/yr. Two of the 25 wells have a decreasing Cl trend, while 20 of the wells showed negligible trends.

SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

TLA – Annual electrical conductivity trend as at March 2002



0 10 20 30 40 50 Kilometres
Datum GDA 94 - Projection UTM MGA Zone 54

Figure 16

PIRSA Publications 201660_016

Disclaimer

The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details

Produced by: Resource Assessment Division, Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

Natural Resources and Environment
AGRICULTURE • RESOURCES • CONSERVATION • LAND MANAGEMENT

The Department of Water, Land and Biodiversity Conservation

SINCLAIR KNIGHT MERZ

SA/VIC BORDER DESIGNATED AREA
MARCH 2002 FULL CHEMICAL ANALYSIS SAMPLING PROGRAM

TLA – Annual chloride concentration trend as at March 2002

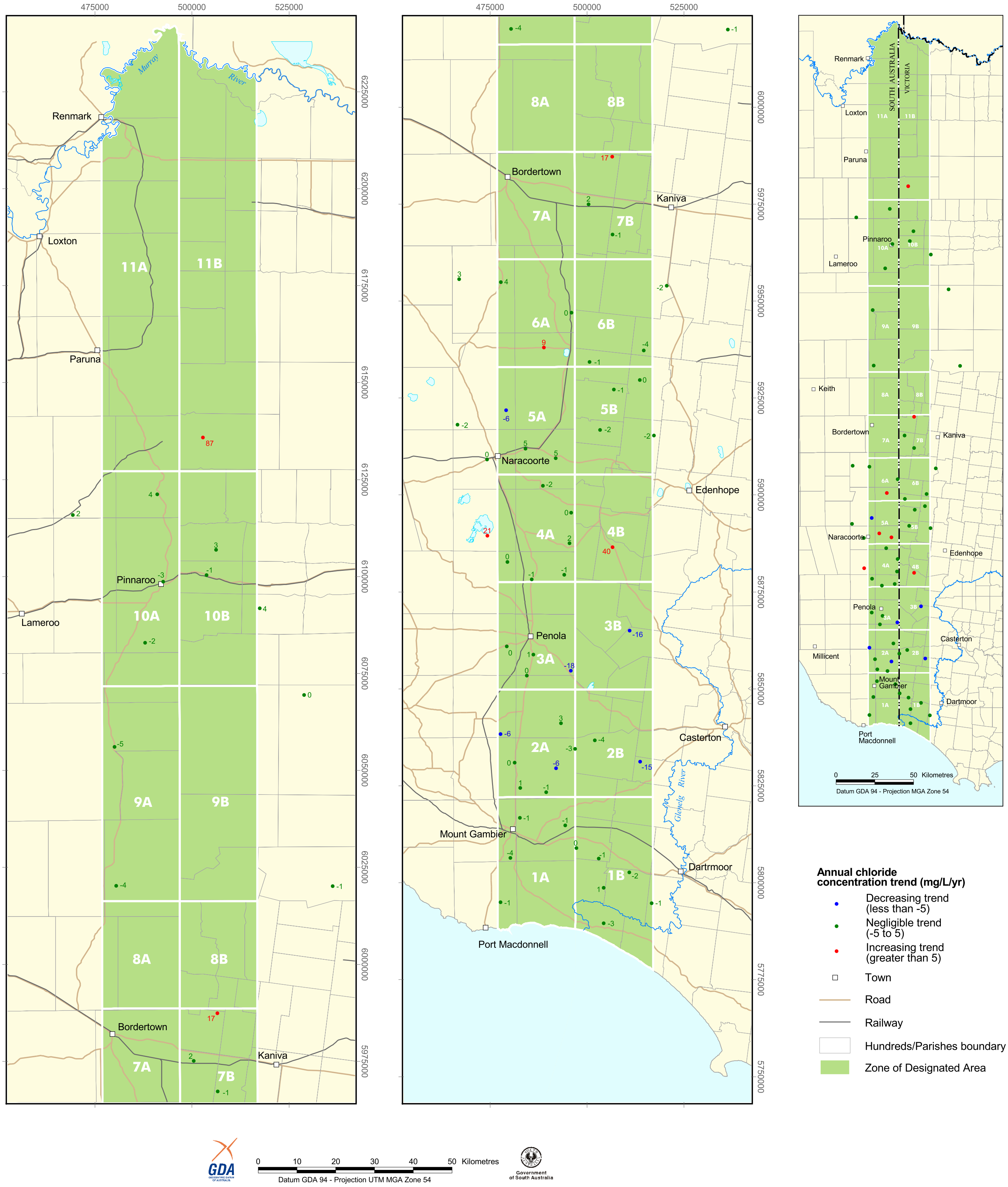


Figure 17

PIRSA Publications 201660_017

Disclaimer

The Department of Water, Land and Biodiversity Conservation, its employees and servants do not warrant or make any representation regarding the use, or results of use of the information contained herein as to its correctness, accuracy, currency or otherwise. The Department of Water, Land and Biodiversity Conservation, its employees and servants expressly disclaim all liability or responsibility to any person using the information or advice contained herein.

Production details

Produced by: Resource Assessment Division
Department of Water, Land and Biodiversity Conservation
Projection: UTM MGA Zone 54
Datum: Geocentric Datum of Australia 1994
Date: November 2002

DISCUSSION

There is a strong correlation between EC and chloride trends in the Designated Area. Chloride is a dominant anion and therefore this relationship should be expected.

The historic clearance of land is a primary cause for the annual EC increases in the Designated Area (Leaney *et al.,* 1999). Historically natural vegetation covered the land. This vegetation had a deep root system, used considerable water, kept the water table far beneath the land surface and salts were stored at and beneath the root zone. When the native vegetation was cleared and replaced by shallower rooted pastures and crops, an increased amount of soil water could recharge the groundwater system. This had the affect of flushing the salt store through to the water table, raising the water table level and dissolving salts in the profile as the water table rose, increasing the salt store in the groundwater.

The second primary cause for the annual EC increase in the Designated Area is irrigation practices. When groundwater is used for irrigation, the recycling of salts in the shallow soil profile occurs. As the crop uses water, salt is left in the profile which is then flushed into the groundwater during subsequent recharge events. The mobilisation of the historic salt store occurs as irrigation waters pass through the soil profile dissolving the salt store. The mobilised salt is then flushed through to the groundwater during subsequent recharge events. The salts concentrate in the groundwater and a recycling affect occurs as the groundwater is again drawn up for irrigation.

These two processes, the historic clearance of land and irrigation practices are considered to be the main causes of the increasing salinity in groundwater of the Designated Area. (Leaney *et al.,* 1999; Leaney and Herczeg 1999).

The southeast has also experienced a drier than average past 8 to10 years which may also be a contributing factor to an increase in groundwater salinity in localised areas of the Designated Area. For example, in periods of normal to above average rainfall, low salinity surface water is abundant in localised areas and is discharged down sinkholes and drainage refreshing the groundwater system. During the past 8 to 10 years, the abundance of fresh surface water has been low due to lower rainfall, therefore not allowing the groundwater system to be refreshed.

Around Bool Lagoon, 3 wells display increasing EC trends. Evaporation from the exposed water table could be contributing to the salinity increase in this area.

Four wells in the Designated Area have temporal increases in Cl, three of which are located in creek catchment areas and the fourth located at Bool Lagoon.

The reason for an annual EC decrease is the possible migration of zones of better quality water. A decreasing trend is apparent in two wells to the south of Mount Gambier. One of these wells is located along the southern margin of the Blue Lake while the second is located a further 4-5km south of the Blue Lake. Stormwater from Mount Gambier is channeled into drainage wells and naturally occurring sinkholes from various sites across the city. These sites act as point source recharge zones to the aquifer system, allowing fresher surface water to mix with existing groundwater.

The chemical parameters for the TLA have been examined for each of the zones and Table 7 gives an indication as to the state of each of these zones. As shown, most of the zones in the Designated Area have acceptable quality groundwater, with salinity ranging from less than 1000 μS/cm generally up to 4000 μS/cm.

The groundwater quality is generally acceptable for most drinking and agricultural purposes in the areas south of Zones 4A and 3B, the groundwater then rises in salinity above Zones 4A and 3B to Zones 8A and 8B and is unsuitable in regions for a potable supply. Between Zones 8A and 8B and Zones 10A and 10B the groundwater becomes less saline and again suitable for most purposes including potable supplies. North of Zones 10A and 10B the groundwater becomes very saline.

CONCLUSIONS AND RECOMMENDATIONS

The groundwater quality distribution the Designated Area is related to climatic conditions, regional and local hydrogeology as seen with the sharp change in salinity across the hydrogeological boundaries and localized land use impacts.

Some increasing groundwater trends are evident in the Designated Area and need to be monitored. It is not clear whether these increasing trends are due to natural vegetation clearance or irrigation induced impacts.

The current 6 yearly full chemical analysis program should be continued to monitor longer term water quality change. The regular 3 monthly EC water quality monitoring program also needs to be maintained as EC changes are evident and need to be monitored and regularly reviewed.

A more comprehensive land use plan for the Designated Area is required to attain a better understanding of the processes and relationships between land use and groundwater condition.

There is a need to strategically improve the TCSA network to give an increased data set that provides for an improved knowledge of this aquifer system.

A review of the adequacy of the current network and associated salinity risk assessment needs to be undertaken.

It is imperative that a set of standard groundwater sampling procedures be adopted in both States such that pumped groundwater samples are taken for monitoring purposes to ensure integrity and accuracy of results. The practice of taking tank, tap or bailed water samples can result in erroneous monitoring data and should be discontinued, given the importance placed on these results for groundwater management purposes.

For future analytical reporting of groundwater quality, NO_3 (as N) and NO_2 (as N) should be reported individually rather than NO_X (as N). This would allow for a direct comparison against published NO_3 (as N) and NO_2 (as N) guideline concentrations.

REFERENCES

National Health and Medical Research Council, and Agriculture and Resource Management Council of Australia and New Zealand, 1996. *National Water Quality Management Strategy, Australian Drinking Water Guidelines*.

Australian and New Zealand Environment and Conservation Council, Nov 1992.

National Water Quality Management Strategy, Australian Water Quality Guidelines for Fresh and Marine Waters.

Australian Water Resources Council, Water Resources Management Committee, Occasional Paper WRMC No. 2, September 1991. *A Preliminary Guide to the Standard Operating Procedures for Sampling Contaminated Groundwater.*

Hem J.D., Study and Interpretation of the chemical characteristics of natural water, U.S.G.S Water Supply Paper 1473.

Fetter C.W., 1994. *Applied Hydrogeology*. Third Edition. Prentice Hall, New Jersey.

Brown K. and Sinclair Knight Merz Pty Ltd, 1998. The hydrochemistry of groundwater in the South Australian-Victorian designated area – Groundwater Border Agreement Act. *PIRSA. Report Book, 98/25.*

Walker G., Nott R., King H., Barnett S., and Stadter F. SA/VIC Border Groundwater Review Committee May 2001, Five Year Technical Review 1996-2000, *South Australia Department for Water Resources, Report Book 2001/006*.

Leaney F.W.J and Herczeg A.L 1999. The origin of fresh groundwater in the SW Murray Basin and its potential for salinisation. *CSIRO L&W Technical Report 7/99*, February 1999.

Leaney F., Walker G., Knight J., Dawes W., Bradford A., Barnett S. and Stadter F. 1999. The potential for groundwater salinisation in the Tinitinara area of South Australia: Impacts of planned irrigation allocations. *CSIRO L&W Technical Report 33/99,* September 1999.

http://www.fluoridation.com/skeletal.htm

http://www.nofluoride.com/sixa.htm

APPENDIX A RESULTS/PARAMETERS

Easting	Northing	Obswell Number	Sample Date	pH Value	Sodium Adsorption Ratio	Conductivity @ 25'C	Total Dissolved Solids (TDS)	Total Dissolved Solids (Estimated)	Total Dissolved Solids (Calculated)	Total Hardness as CaCO3	Calcium Hardness as CaCO3	Magnesium Hardness as CaCO3	Langelier Index	Free Carbon Dioxide as CO2	Calcium - Filtered	Magnesium - Filtered	Sodium - Filtered	Potassium - Filtered	Carbonate as CaCO3	Bicarbonate as CaCO3	Alkalinity as CaCO3	Sulphate - Filtered	Chloride	Iron - Filtered	Manganese - Filtered	Silica - Filtered	Fluoride	Nitrite and Nitrate as N	Total Cations	Total Anions	Actual (Anion / Cation) Difference	Allowed (Anion / Cation) Difference
						uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	me/L	me/L	me/L	me/L
TLA SA																																
488861	5937986	BIN 26	18-Mar-02	7.46	8.93	3830	2080	2490	2070	641	274	367	0.3	23.3	110	89	519	17	<1	337	337	148	942	<0.01	<0.01	37.2	0.9	0.06	35.83	36.4	0.57	0.67
485154	5922656	BIN 35	18-Mar-02	7.16	2.93	1680	954	1090	909	540	403	137	0.3	59.1	161	33	157	6	<1	428	428	26	248	<0.01	<0.01	16.6	0.3	0.13	17.76	16.1	1.66	0.36
493823	5918389	BIN 36	18-Mar-02	7.53	10.9	3750	2350	2440	2300	657	316	341	0.5	21	126	83	642	12	1	357	357	194	980	<0.01	<0.01	34.9	1.1	7.77	41.35	39.44	1.91	0.72
492636	5923115	BIN 39	3-Apr-02	7.34	7.62	3100	1790	2020	1590	531	297	234	0.2	21.6	119	57	404	9	<1	306	306	95	694	<0.01	<0.01	18.1	0.5	0.32	28.41	27.7	0.71	0.54
496432	5937001	BIN 47	18-Mar-02	7.69	7.07	2950	1600	1920	1590	544	263	281	0.5	13.7	105	68	379	14	<1	337	337	104	677	<0.01	<0.01	35.7	0.8	0.04	27.72	28.01	0.3	0.54
494231	5927937	BIN 48	18-Mar-02	7.52	6.34	2540	1410	1650	1350	503	293	211	0.4	18.4	117	51	327	8	<1	306	306	71	567	0.49	0.05	18.2	0.4	0.2	24.49	23.59	0.91	0.47
479262	5810916	BLA 134	5-Mar-02	7.65	2.03	660	402	429	375	182	119	63	-0.1	5.1	48	15	63	18	<1	198	198	30	42	<0.01	<0.01	27.6	0.5	5.24	6.86	6.89	0.03	0.21
481581	5812567	BLA 156	5-Mar-02	7.45	1.36	715	392	465	371	256	195	61	0.1	8.5	78	15	50	2	<1	213	213	9	67	0.05	<0.01	12.3	0.2	6.15	7.34	7.1	0.23	0.22
478075	5814258	BLA 164	5-Mar-02	7.52	1.13	702	402	456	347	265	195	70	0.1	5.5	78	17	42	1	<1	198	198	16	57	<0.01	<0.01	7.98	0.1	7.35	7.16	6.64	0.52	0.21
479265	5810927	BLA 170	5-Mar-02	7.53	1.6	773	460	502	425	273	184	89	0.1	6	74	22	61	4	<1	229	229	17	78	<0.01	<0.01	21	0.3	4.81	8.2	8.05	0.16	0.23
481607	5812548	BLA 42	5-Mar-02	7.46	1.44	867	548	563	461	311	214	97	0.1	7.7	86	23	58	10	<1	239	239	15	74	0.05	0.02	29.3	0.5	13.9	9.02	8.96	0.06	0.25
480195	5806385	BLA 68	4-Mar-02	7.42	1.42	822	505	534	420	258	212	45	0.1	6.5	85	11	56	9	<1	208	208	8	77	<0.01	<0.01	26.8	0.2	15.4	7.81	8.31	0.5	0.24
474183	5819997	BLA 84	5-Mar-02	7.55	0.99	638	376	415	327	253	204	49	0.1	5.5	82	12	36	<1	<1	198	198	15	47	<0.01	<0.01	7.49	0.1	6.86	6.65	6.3	0.36	0.2
466118	5815924	BLA 92	8-Apr-02	7.21	1.04	844	560	849	417	298	260	38	-0.2	16.4	104	9	41	12	<1	184	184	25	74	<0.01	<0.01	7.58	<0.1	12.3	8.03	7.17	0.86	0.22
480544	5959367	BMA 11	18-Mar-02	7.15	4.61	2450	1400	1590	1300	611	375	236	0.2	57.7	150	57	262	8	<1	408	408	52	500	<0.01	<0.01	21.2	0.6	0.25	23.84	23.35	0.49	0.47
477779	5954850	BMA 13	18-Mar-02	7.82	4.83	2430	1350	1580	1300	584	329	256	0.9	12.3	132	62	268	10	<1	408	408	49	511	<0.01	<0.01	21.7	0.6	0.09	23.61	23.59	0.02	0.47
467035	5955590	BMA 14	18-Mar-02	7.42	6.4	2810	1540	1830	1500	573	402	171	0.5	26.3	161	41	352	10	<1	347	347	73	630	0.02	<0.01	16.9	0.1	0.54	26.99	26.23	0.76	0.51
471729	5994493	CAN 101	3-Apr-02	7.39	8.1	4420	2670	2870	2320	833	369	464	0.5	34	148	113	538	17	<1	459	459	170	1020	0.13	<0.01	30.1	0.5	2.5	40.46	41.5	1.04	0.75
471415	6001076	CAN 104	11-Mar-02	7.46	5.66	3000	1730	1950	1710	785	418	367	0.6	29.6	167	89	364	13	<1	428	428	103	680	<0.01	<0.01	40.4	0.8	0.12	31.86	29.92	1.93	0.57
480729	6003853	CAN 20	3-Apr-02	7.49	4.28	1970	1130	1280	1010	456	215	241	0.3	22.5	86	58	210	11	<1	357	357	71	324	<0.01	<0.01	27.4	0.7	0.23	18.52	17.79	0.73	0.38
490087	5792462	CAR 39	8-Apr-02	7.42	1.22	875	500	569	430	322	243	79	0.1	17.7	97	19	50	2	<1	245	245	16	72	<0.01	<0.01	16.3	0.2	6.11	8.66	7.7	0.96	0.23
495257	5788935	CAR 51	8-Apr-02	7.55	6.81	2750	1550	1550	1360	450	220	230	0.2	10.7	88	56	332	18	<1	235	235	92	615	<0.01	0.08	14.4	0.3	2.85	23.89	24.17	0.29	0.48
491941	5800677	CAR 55	8-Apr-02	7.63	1.17	835	448	543	408	306	215	91	0.3	11.1	86	22	47	<1	<1	255	255	8	70	<0.01	<0.01	9.97	0.2	1.52	8.15	7.36	0.79	0.22
482309	5789168	CAR 57	8-Apr-02	8.01	2.82	1160	648	754	572	288	189	99	0.5	3.7	76	24	110	8	<1	214	214	28	175	<0.01	<0.01	13.8	0.2	5.21	10.74	10.17	0.57	0.26
486724	5790563	CAR 8	8-Apr-02	7.91	8.79	1200	762	780	638	110	53	57	0.1	6.5	21	14	212	3	<1	306	306	22	137	0.05	<0.01	33.8	0.3	2.39	11.49	10.63	0.86	0.27
484174	5875193	CMM 1	18-Mar-02	7.93	3.66	1450	918	943	877	402	313	89	0.8	6.8	125	22	169	3	1	291	291	30	290	0.14	<0.01	20.3	<0.1	1.97	15.48	14.77	0.7	0.34
485866	5871942	CMM 10	18-Mar-02	7.55	3.25	1500	962	975	918	465	351	114	0.5	17.2	140	28	161	4	<1	306	306	37	278	<0.01	<0.01	33.4	<0.1	9.43	16.41	15.42	0.98	0.35
486543	5871528	CMM 11	18-Mar-02	7.3	3.91	1680	1020	1090	985	448	344	104	0.2	30.6	138	25	190	5	<1	306	306	48	326	0.04	<0.01	19.9	<0.1	5.57	17.34	16.7	0.64	0.37
487999	5874014	CMM 52	18-Mar-02	7.47	4.92	2020	1220	1310	1160	479	387	91	0.5	21.3	155	22	247	4	<1	316	316	49	427	<0.01	<0.01	16.5	<0.1	2.52	20.4	19.57	0.83	0.41
483517	5874662	CMM 79	6-Mar-02	7.39	3.59	1480	866	962	794	395	285	110	0.1	2.5	114	27	164	3	<1	224	224	20	303	0.07	0.03	17.1	0.3	7.02	15.11	14.41	0.7	0.33
485693	5878170	CMM 81	6-Mar-02	7.13	3.55	1290	744	839	718	347	275	72	-0.1	3.8	110	18	152	3	<1	312	312	21	202	0.1	0.02	19.6	0.3	<0.01	13.63	12.91	0.73	0.31
494118	5879342	CMM 83	18-Mar-02	7.45	3.91	1500	1040	975	912	454	380	74	0.4	23.1	152	18	191	3	<1	326	326	33	291	<0.01	0.03	20.1	<0.1	2.98	17.48	15.63	1.85	0.35
486822	5869703	CMM 84	18-Mar-02	7.41	5	1830	1170	1190	1060	468	368	101	0.4	24.5	147	24	249	4	<1	316	316	43	377	<0.01	<0.01	19.9	<0.1	5.14	20.27	18.21	2.06	0.39
490608	5872587	CMM 85	18-Mar-02	7.5	3.78	1300	778	845	793	357	283	74	0.4	20.5	113	18	164	2	<1	326	326	30	218	<0.01	<0.01	14.8	<0.1	2.2	14.33	13.46	0.88	0.32
485103	5872108	CMM 9	18-Mar-02	7.7	3.66	1720	996	1120	986	483	367	116	0.7	12.5	147	28	185	4	1	316	316	42	319	<0.01	<0.01	23.8	<0.1	1.55	17.79	16.3	1.49	0.36
482675	5816666	GAM 228	8-Apr-02	7.45	1.4	705	442	458	340	224	191	33	-0.1	5.3	77	8	50	<1	<1	173	173	7	59	<0.01	<0.01	18.9	0.1	11.7	6.66	6.1	0.55	0.2
482202	5812167	GAM 250	5-Mar-02	7.47	1.5	807	464	525	447	285	191	94	0.1	4.8	76	23	58	10	<1	250	250	10	78	0.03	<0.01	24.8	0.4	9.34	8.49	8.74	0.25	0.24
482182	5812117	GAM 252	5-Mar-02	7.38	1.46	708	414	460	372	254	194	61	-0.1	4.6	77	15	54	1	<1	213	213	9	67	0.09	<0.01	12.2	0.2	5.92	7.45	7.07	0.37	0.22
494404	5814749	GAM 80	4-Mar-02	7.18	1.81	850	488	552	464	296	259	37	-0.1	24.1	104	9	72	<1	<1	270	270	5	103	0.02	0.04	6.85	0.1	<0.01	9.05	8.6	0.45	0.24
497257	5808898	GAM 81	4-Mar-02	7.19	1.47	778	452	506	422	289	260	30	-0.1	17.6	104	7	57	<1	<1	260	260	<1	87	0.5	0.02	8.77	0.1	<0.01	8.29	7.9	0.39	0.23
483536	5809309	GAM 9	4-Mar-02	7.37	1.14	750	452	488	403	308	216	92	0.1	6	86	22	46	2	<1	250	250	7	57	<0.01	<0.01	17.3	0.2	10.9	8.2	8	0.2	0.23
496006	5946928	GGL 10	18-Mar-02	7.82	4.68	1870	1100	1220	1060	431	276	155	0.7	8	111	38	223	9	<1	365	365	41	387	0.06	<0.01	21.6	0.5	0.14	18.56	19.06	0.51	0.4
489197	5954568	GGL 4	18-Mar-02	7.09	4.65	2480	1450	1610	1340	641	472	169	0.2	58	189	41	271	8	<1	357	357	65	533	<0.01	<0.01	17.8	0.3	0.37	24.79	23.53	1.26	0.47
477655	5838310	GRY 15	6-Mar-02	6.98	1.15	858	544	558	473	320	287	33	-0.1	6.1	115	8	51	5	<1	354	354	3	54	2.01	0.18	8.71	0.1	0.02	8.74	8.91	0.17	0.24
466560	5918059	HYN 20	18-Mar-02	7.54	5.48	2040	1150	1330	1120	428	226	202	0.3	19.9	91	49	260	13	<1	347	347	59	398	0.63	0.01	30.9	0.8	0.02	20.21	19.39	0.82	0.41
479129	5921799	HYN 21	18-Mar-02	7.21	6.03	2860	1600	1860	1550	638	365	274	0.3	54	146	66	350	9	<1	439	439	70	618	<0.01	0.01	19.5	0.7	0.78	28.22	27.66	0.56	0.54
478423	5937769	HYN 25	11-Mar-02	7.6	4.71	1650	1120	1070	892	379	262	117	0.4	14.3	105	28	211	6	<1	286	286	54	302	<0.01	<0.01	14.1	<0.1	0.51	16.89	15.38	1.51	0.34
469438	5927549	HYN 28	11-Mar-02	7.24	3.98	1700	926	1110	900	443	280	164	0.1	14.4	112	40	193	7	<1	316	316	37	302	<0.01	<0.01	19.5	0.3	1.21	17.42	15.63	1.79	0.35
470661	5941314	HYN 29	18-Mar-02	7.4	5.04	2230	1210	1450	1180	506	328	179	0.3	25.9	131	43	261	9	<1	326	326	60	461	0.32	0.03	18	0.3	<0.01	21.69	20.77	0.92	0.43
491941	5909437	JES 4	6-Mar-02	7.02	7.2	2850	1650	1850	1560	526	363	164	-0.1	5.6	145	40	379	7	<1	328	328	101	676	<0.01	0.05	12.8	0.2	0.48	27.2	28.11	0.91	0.54
484074	5911926	JES 50	6-Mar-02	7.18	6.38	2570	1400	1670	1390	511	291	221	0.1	3.8	116	54	332	8	<1	364	364	88	545	<0.01	<0.01	24.4	0.7	1.38	24.86	25.28	0.42	0.5
488621	5902344	JES 54	18-Mar-02	7.57	10.5	3170	1800	2060	1940	544	300	245	0.6	21.9	120	59	563	10	<1	408	408	125	757	<0.01	0.01	43.2	0.9	3.13	35.64	32.38	3.26	0.61
481883	5906067	JES 61	18-Mar-02	7.62	5.13	1870	1130	1220	1110	430	287	143	0.5	14.4	115	35	245	6	<1	301	301	78	373	<0.01	<0.01	16.9	<0.1	2.75	19.41	18.35	1.05	0.39
495459	5887464	JOA 12	18-Mar-02	7.64	5.24	1810	1050	1180	1080	390	261	129	0.5	15.1	104	31	237	6	<1	332	332	60	352	<0.01	<0.01	31	0.2	2.65	18.25	18.02	0.23	0.39
495922	5895388	JOA 13	18-Mar-02	7.54	9.16	2960	1780	1920	1870	581	314	267	0.6	25.2	126	65	508	9	1	439	439	125	723	<0.01	<0.01	36.4	1	2.62	33.92	32.02	1.9	0.6
487888	5894064	JOA 18	18-Mar-02	7.39	11.8	4500	2930	2930	2850	838	487	351	0.7	39.8	195	85	784	14	1	490	490	166	1260	<0.01	<0.01	35.7	0.8	4.27	51.2	49.21	1.99	0.87
479421	5882705	KLN 11	6-Mar-02	7.28	3.7	1390	784	904	773	361	266	95	0.1	3.1	106	23	161	3	<1	270	270	31	247	0.02	0.02	26.8	0.3	6.12	14.3	14.17	0.13	0.33
472563	5878358	KLN 5	18-Mar-02	7.52	17.8	5140	3010	3340	3160	601	221	380	0.5	30.7	89	92	1000	28	<1	510	510	252	1340	<0.01	<0.01	37	3	0.9	56.26	53.41	2.85	0.93
469194	6115735	KNF22	1-Mar-02	7.72	3.72	982	578		572	220	98	123	-0.1	7.5	39	30	127	10	<1	197	197	40	165	0.34	0.02	32.7	1.1	0.01	10.16	9.48	0.68	0.25
479734	5791715	MAC 45	8-Apr-02	7.33	3.55	2130	1360	1380	1050	536	342	194	0.2	18.1	137	47	189	4	<1	245	245	62	434	<0.01	0.03	22.2	1.4	5.04	19.03	18.87	0.16	0.4
471502	5802080	MAC 46	8-Apr-02	7.71	1.05	577	328	375	281	228	204	24	0.2	5.8	82	6	30	1	<1	173	173	6	41	<0.01	<0.01	4.88	<0.1	5.2	5.89	5.11	0.77	0.19
477668	5794884	MAC 47	4-Mar-02	7.53	1.06	687	408	447	356	273	216	57	0.1	7.9	86	14	40	<1	<1	208	208	16	62	<0.01	<0.01	6.48	0.3	4.7	7.2	6.75	0.45	0.21
481531	5791147	MAC 49	8-Apr-02	7.75	1.4	773	450	502	362	252	190	62	0.3	6.7	76	15	51	1	<1	204	204	11	65	<0.01	<0.01	12.3	0.2	5.02	7.27	6.5	0.77	0.21
471822	5788298	MAC 54	8-Apr-02	7.57	2.09	935	534	607	461	270	188	82	0.1	8.9	75	20	79	2	<1	204	204	22	118	<0.01	<0.01	16.5	0.4	2.02	8.89	8.03	0.86	0.23
467092	5801477	MAC 56	4-Mar-02	7.45	1.45	772	458	502	409	284	208	75	0.1	8.9	83	18	56	1	<1	229	229	12	82	<0.01	<0.01	13.3	0.3	2.96	8.15	7.73	0.41	0.23
480804	5789261	MAC 79	8-Apr-02	8.03	11.6	3520	1980	2290	1800	498	219	279	0.6	3.9	88	68	473	21	<1	214	214	122	877	<0.01	<0.01	12.6	0.3	3.29	31.07	31.8	0.74	0.6
476434	5788228	MAC 83	8-Apr-02	8.65	1.9	680	344	442	331	182	93	89	0.8	0.8	37	22	59	2	<1	1	153	13	87	<0.01	<0.01	14.4	0.3	0.97	6.27	5.87	0.39	0.2
475057	5788569	MAC 84	8-Apr-02	7.91	5.29	1600	902	1040	781	327	191	136	0.4	5.3	77	33	177	8	<1	214	214	46	291	<0.01	0.03	14.3	0.3	2.7	14.44	13.65	0.79	0.32
480083	5802969	MAC 9	4-Mar-02	7.43	1.52	933	513	606	449	325	267	59	0.1	7.7	107	14	63	11	<1	200	200	19	81	0.03	<0.01	7.32	0.1	24.2	9.53	8.6	0.93	0.24
492016	5829457	MIN 18	5-Mar-02	7.15	3.13	1310	810	852	726	381	305	76	0.1	20.4	122	18	141	3	<1	302	302	14	232	<0.01	0.08	11.8	0.1	<0.01	13.82	13.19	0.63	0.31
482796	5824354	MIN 23	8-Apr-02	7.1	3.2	1480	820	962	753	401	342	59	0.2	39	137	14	147	1	<1	418	418	13	173	<0.01	0.05	13.5	0.2	<0.01	14.44	13.52	0.92	0.32
496933	5834504	MIN 25	5-Mar-02	7.26	3.59	1130	678	735	699	293	242	50	0.2	16.5	97	12	141	1	<1	406	406	38	154	<0.01	0.07	9.31	0.2	0.08	12.01	13.52	1.51	0.32
489486	5823280	MIN 7	5-Mar-02	7.27	3.08	1070	628	696	597	301	243	58	0.1	13.6	97	14	123	1	<1	291	291	29	140	0.02	<0.01	11.9	0.3	2.88	11.4	10.9	0.5	0.28
463045	6019960	MKN2	1-Mar-02	7.47	4.31	1650	1110		946	440	212	228	0.1	18.8	85	55	208	8	<1	278	278	53	338	<0.01	<0.01	24.8	0.6	0.43	18.01	16.24	1.77	0.36
479269	5860867	MON 22	15-Apr-02	7.42	2.75	1260	718	819	634	348	282	66	0.2	20.8	113	16	118	1	<1	275	275	22	176	<0.01	<0.01	17.8	0.2	11.1	12.11	10.94	1.17	0.28
493275	5841033	NAN 21	6-Mar-02	7.02	2.43	1390	886	904	799	488	425	63	0.1	4.5	170	15	123	<1	<1	296	296	93	209	<0.01	0.05	8.77	0.1	<0.01	15.13	13.98	1.15	0.32
484419	5853370	NAN 31	15-Apr-02	7.25	2.6	1310	714	852	671	370	308	61	0.2	36.6	123	15	115	2	<1	326	326	38	164	<0.01	<0.01	14.3	0.2	0.26	12.42	11.94	0.48	0.29
474220	5909079	NAR 48	18-Mar-02	7.47	6.05	2050	1230	1330	1240	480	251	229	0.4	25.5	101	56	305	8	<1	377	377	72	431	<0.01	<0.01	24	1.2	12	23.05	22.12	0.93	0.45
475351	5913329	NAR 64	18-Mar-02	7.6	8.26	3020	1820	1960	1830	634	377	257	0.6	17.9	151	62	478	9	<1	357	357	129	759	<0.01	<0.01	23.1	0.3	2.46	33.67	31.45	2.22	0.59
467016	5902329	NAR 8	18-Mar-02	7.69	13	3200	1990	2080	2040	453	163	289	0.5	20.7	65	70	638	13	<1	510	510	326	565	<0.01	<0.01	38.8	1.9	7	37.12	33.52	3.6	0.63
490968	6121141	PEB1	1-Mar-02	7.13	5.97	2710	1700		1450	632	269	363	0.1	57.6	108	88	345	17	<1	389	389	106	518	0.05	<0.01	28.5	0.9	0.01	28.07	24.67	3.41	0.49
491893	6134747	PEB22	1-Mar-02	8.02	6.06	1800	1070		1060	359	123	235	0.4	4.4	49	57	264	17	<1	235	235	130	360	0.08	<0.01	31.2	1.4	0.08	19.06	17.64	1.42	0.38
494063	6118620	PEB24	1-Mar-02	7.63	5.21	1540	982		886	312	174	138	0	7.6	70	34	212	8	<1	163	163	84	347	0.08	<0.01	26.1	0.6	<0.01	15.65	14.84	0.81	0.34
485397	5868672	PEN 15	15-Apr-02	7.29	3.64	1780	1010	1160	900	438	322	116	0.2	32.3	129	28	175	4	<1	316	316	30	307	<0.01	0.01	29.1	0.4	0.69	16.47	15.63	0.83	0.35
497532	5869148	PEN 2	15-Apr-02	6.78	3.87	1510	933	982	803	340	251	89	-0.7	54.1	100	22	164	<1	<1	163	163	129	273	<0.01	0.07	12.6	0.1	0.01	13.94	13.65	0.29	0.32
495791	5854626	PEN 28	15-Apr-02	7.29	5.5	2090	1090	1360	1050	396	285	111	0.2	35.5	114	27	252	5	<1	347	347	58	368	<0.01	0.07	11	0.4	<0.01	18.99	18.56	0.43	0.39
486132	5858752	PEN 6	15-Apr-02	7.31	4.35	2200	1250	1430	1090	497	391	106	0.3	29.9	157	26	223	3	<1	306	306	40	440	0.16	0.13	16.8	0.2	<0.01	19.7	19.37	0.33	0.41
480202	6111530	PLL1	1-Mar-02	7.57	12.3	4460	2750		2540	587	215	372	0.2	14.9	86	90	685	20	<1	278	278	311	1140	<0.01	0.05	28.2	0.9	0.01	42.01	44.13	2.12	0.79
476571	6097501	PLL24	1-Mar-02	7.5	8.27	2230	1310		1220	348	161	187	0.1	19.3	64	45	355	11	<1	307	307	128	395	0.08	<0.01	27	0.8	<0.01	22.66	20.01	2.65	0.42
479934	6055937	PNN1	1-Mar-02	8.39	4.3	1440	908		827	345	198	147	0.9	1.7	79	36	183	10	10	202	211	73	284	<0.01	0.01	27.6	0.6	0.02	15.1	13.8	1.3	0.32
487878	6082771	PNR6	1-Mar-02	7.53	3.42	1150	768		656	294	161	133	0	12.1	64	32	135	6	<1	206	206	89	174	0.34	0.02	26.1	0.6	<0.01	11.9	10.92	0.98	0.28
492542	6098592	PNR8	1-Mar-02	7.63	4.51	1110	684		655	234	126	108	0	9	50	26	159	7	<1	192	192	84	176	0.07	0.04	29.5	0.8	<0.01	11.77	10.58	1.19	0.27
474266	5889401	ROB 13	18-Mar-02	7.56	10.3	3640	2350	2370	2180	663	350	314	0.5	16.8	140	76	608	16	1	306	306	126	975	<0.01	<0.01	44.1	<0.1	0.31	40.11	36.28	3.83	0.67
471559	5897848	ROB 2	18-Mar-02	7.66	10.7	5220	3900	3390	3150	1110	528	580	0.8	13.8	211	141	816	17	1	316	316	195	1540	<0.01	<0.01	24.1	0.7	4.92	58.07	54.11	3.96	0.95
466663	5892895	ROB 4	18-Mar-02	7.6	15.9	5030	3050	3270	3080	662	228	434	0.5	20.9	91	105	943	25	1	418	418	181	1430	<0.01	<0.01	34.9	2.1	4.45	54.9	52.84	2.06	0.93
492458	5994510	SEN 16	3-Apr-02	7.53	4.69	1930	1070	1250	996	424	189	235	0.2	15.4	76	57	222	11	<1	316	316	59	344	<0.01	<0.01	28.8	0.7	0.42	18.41	17.29	1.12	0.37
481984	5995174	SEN 17	3-Apr-02	7.29	5.98	2980	1820	1940	1510	628	333	296	0.3	7	133	72	345	13	<1	347	347	82	621	<0.01	<0.01	28.8	0.6	0.34	27.88	26.19	1.69	0.51
491390	6006291	SEN 18	3-Apr-02	7.81	5.06	2060	1150	1340	1050	426	172	254	0.5	12.3	69	62	240	12	<1	316	316	82	363	0.04	0.01	27.2	0.7	0.16	19.26	18.3	0.96	0.39
480426	6020142	SHG4	1-Mar-02	7.37	3.95	1490	944		865	392	188	204	0	22.9	75	50	180	8	<1	269	269	52	304	0.11	<0.01	26.5	0.6	0.11	15.84	15.08	0.76	0.34
496862	5978484	TAT 106	11-Mar-02	7.42	7.16	2720	1540	1770	1500	520	230	289	0.1	9.3	92	70	375	11	<1	214	214	106	676	<0.01	<0.01	36.9	0.9	0.49	26.98	25.6	1.39	0.5
488293	5979478	TAT 107	11-Mar-02	7.47	6.88	2620	1450	1700	1490	509	200	309	0.1	9.4	80	75	357	11	<1	286	286	127	630	<0.01	<0.01	34.4	1.1	0.04	26	26.19	0.2	0.51
477656	5967929	TAT 108	11-Mar-02	7.02	3.98	2000	1210	1300	1090	566	369	196	0.1	36.4	148	48	218	7	<1	408	408	51	338	<0.01	<0.01	31.8	0.3	0.06	20.95	18.77	2.18	0.4

TLA SA CONT'D

Easting	Northing	Obswell Number	Sample Date	pH Value	Sodium Adsorption Ratio	Conductivity @ 25'C	Total Dissolved Solids (TDS)	Total Dissolved Solids (Estimated)	Total Dissolved Solids (Calculated)	Total Hardness as CaCO3	Calcium Hardness as CaCO3	Magnesium Hardness as CaCO3	Langelier Index	Free Carbon Dioxide as CO2	Calcium - Filtered	Magnesium - Filtered	Sodium - Filtered	Potassium - Filtered	Carbonate as CaCO3	Bicarbonate as CaCO3	Alkalinity as CaCO3	Sulphate - Filtered	Chloride	Iron - Filtered	Manganese - Filtered	Silica - Filtered	Fluoride	Nitrite and Nitrate as N	Total Cations	Total Anions	Actual (Anion / Cation) Difference	Allowed (Anion / Cation) Difference
						uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	me/L	me/L	me/L	me/L
491139	5968155	TAT 110	11-Mar-02	7.4	5.66	2210	1250	1440	1230	479	265	214	0.2	10.3	106	52	285	9	<1	326	326	69	477	<0.01	<0.01	33	0.4	0.09	22.19	21.42	0.77	0.44
481916	5835549	7022-6661	15-Apr-02	7.47	2.23	1350	748	878	689	434	367	67	0.5	22.8	147	16	107	3	<1	337	337	14	184	<0.01	0.04	12.3	0.2	<0.01	13.39	12.25	1.14	0.3
469224	5826972	YOU 26	8-Apr-02	7.45	0.91	492	280	320	251	183	155	28	-0.1	7.9	62	7	29	<1	<1	194	194	2	22	<0.01	0.04	7.36	0.1	<0.01	4.93	4.55	0.37	0.18
481353	5830904	YOU 33	6-Mar-02	7.22	2.93	1100	656	715	624	333	284	49	0.1	3.8	114	12	123	<1	<1	302	302	79	101	0.01	0.01	4.77	0.1	8.12	12.03	11.23	0.81	0.28

TLA VIC

Easting	Northing	Bore ID	Sample Date	pH Value	Sodium Adsorption Ratio	Conductivity @ 25'C	Total Dissolved Solids (TDS)		Total Dissolved Solids (Calculated)	Total Hardness as CaCO3					Calcium - Filtered	Magnesium - Filtered	Sodium - Filtered	Potassium - Filtered	Carbonate as CaCO3	Bicarbonate as CaCO3	Alkalinity as CaCO3	Sulphate - Filtered	Chloride	Iron - Filtered	Manganese - Filtered	Silica - Filtered	Fluoride	Nitrite and Nitrate as N	Total Cations	Total Anions	Actual (Anion / Cation) Difference	Allowed (Anion / Cation) Difference
						uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	me/L	me/L	me/L	me/L
503311	5916753	49426	7-Mar-02	7.48	9.68	4390	2540			700					122	96	589	14			307	210	1210	<0.01		26.9		0.33	39.98	44.61	4.63	0.8
502800	6135800	49677	13-Mar-02	7.61	15.1	6870	3900		3950	700					76	124	1210	57	<1	342	342	302	1930	0.21	<0.01	36.8	2	1.37	68.09	67.55	0.54	1.15
504030	6130645	49679	6-Mar-02	7.75	14	4700	2670			492					52	88	716	48			270	154	1310	0.15		33		<0.01	42.19	45.4	3.21	0.81
533600	6044500	49951	15-Mar-02	7.56	7.35	1990	1130		1190	337					78	34	310	11	<1	296	296	88	444	0.63	0.05	37.5	0.4	<0.01	20.5	20.28	0.22	0.42
528847	6069365	49952	5-Mar-02	8.13	4.46	1110	682			226					55	22	154	7			151	51	236	0.22		24.3		<0.01	11.42	10.75	0.66	0.27
513600	5929600	50946	6-Mar-02	7.64	2.62	1100	622			316					81	27	107	5			249	27	185	0.04		23.8		0.09	11.09	10.77	0.32	0.27
517196	5915291	51846	20-Mar-02	7.6	7.3	2360	1180		1530	392					83	45	334	11	<1	296	296	87	514	0.66	0.02	32.7	0.4	0.03	22.64	22.24	0.4	0.45
499800	6095350	54636	5-Mar-02	8	6.74	1590	1020			280					58	33	259	10			244	184	312	0.23		34.8		<0.01	17.1	17.52	0.41	0.38
503728	6100298	54642	6-Mar-02	7.67	5.41	1290	798			235					51	26	191	8			182	103	245	0.57		24.2		<0.01	13.22	12.7	0.51	0.3
506500	5946900	60436	21-Mar-02	7.52	6.1	2420	1240		1570	472					105	51	304	13	<1	286	286	92	479	0.47	0.02	34	0.9	0.02	22.98	21.2	1.79	0.44
506500	5987200	60450	17-Mar-02	7.46	11.3	3840	2200		2180	581					97	82	625	24	<1	286	286	183	940	0.8	0.04	41.7	0.2	<0.01	39.41	36.06	3.35	0.67
504300	5789500	65070		7.76	1.84	845	526		441	282					94	12	71	2	<1	187	187	15	119	0.03	<0.01	5.44	0.2	9.01	8.78	8.06	0.72	0.23
514606	6116484	65745	6-Mar-02	7.78	5.02	1470	886			283					59	33	194	12			172	87	308	0.07		29.4		0.03	14.41	13.94	0.48	0.32
517410	6091690	66477	14-Mar-02	7.29	5.9	1990	1190		1150	424					97	44	279	13	<1	270	270	69	430	0.85	0.05	41.3	0.4	<0.01	20.97	18.97	2	0.4
516650	5794650	70857		7.81	1.38	687	450		405	252					89	7	50	3	<1	208	208	<1	85	0.64	0.02	36.4	0.3	<0.01	7.3	6.58	0.72	0.21
500390	5974947	75351	7-Mar-02	7.69	5.46	2430	1490			517					90	71	285	11			255	90	582	0.06		25.6		<0.01	23.01	23.39	0.38	0.47
498300	5976950	75365	16-Mar-02	7.42	7.36	2830	1600		1590	567					97	79	403	12	<1	260	260	104	686	0.71	<0.01	40.9	1	<0.01	29.15	26.78	2.37	0.52
506600	5967100	75651	16-Mar-02	7.56	5.12	1640	974		942	374					79	43	228	9	<1	250	250	44	347	1.07	0.04	32.6	0.4	<0.01	17.6	15.74	1.86	0.35
506600	5886450	76898	20-Mar-02	8.17	14.8	5440	2780		3540	581					56	107	823	36	<1	377	377	285	1360	0.26	<0.01	13.6	4	0.01	48.31	52.05	3.74	0.91
503200	5895350	77850	20-Mar-02	7.24	7.8	3200	1740		2080	563					144	49	425	10	<1	316	316	89	762	<0.01	<0.01	19.9	0.8	5.77	29.97	29.72	0.25	0.57
514637	5937252	79530	6-Mar-02	7.79	4.12	1380	834			330					77	34	172	8			229	39	293	0.29		28.1		<0.01	14.27	13.66	0.61	0.32
506150	6106760	82220	14-Mar-02	7.19	9.46	2700	1570		1630	468					92	58	471	19	<1	551	551	136	471	<0.01	0.02	37.1	1.1	0.24	30.3	27.19	3.11	0.53
502000	5836700	83459		7.3	4.34	1440	858		815	350					110	18	186	<1	<1	291	291	27	287	0.55	0.06	10.7	0.3	0.07	15.1	14.49	0.61	0.33
520562	5953870	84741	17-Mar-02	7.44	4.2	1400	796		797	347					81	35	180	7	<1	255	255	25	276	0.13	<0.01	31.2	0.7	0.02	14.96	13.45	1.51	0.31
500656	5934213	85628	18-Mar-02	7.54	5.7	2130	1110		1380	420					78	55	266	10	<1	296	296	73	441	<0.01	<0.01	33.8	1	0.02	20.23	19.93	0.29	0.42
503000	5806150	87530		7.71	1.77	849	510		467	300					106	8	71	<1	<1	281	281	<1	95	0.01	0.01	14.4	0.2	<0.01	9.07	8.31	0.76	0.24
504248	5798667	87537		7.46	2.16	982	624		539	320					112	10	89	<1	<1	239	239	26	144	1.5	0.02	11.6	0.1	<0.01	10.26	9.38	0.88	0.25
511000	5865000	89851	21-Mar-02	7.28	10.2	8170	5340		5310	1700					241	266	967	22	<1	459	459	226	2400	<0.01	0.02	34.7	4.1	0.02	76.53	81.8	5.27	1.37
506900	5927100	92808	19-Mar-02	7.4	4.9	1870	984		1220	415					100	40	228	9	<1	286	286	55	403	0.13	0.02	33.8	0.7	0.03	18.45	18.26	0.19	0.39
506700	5838700	97046		7.82	3.71	1290	844		721	335					107	16	156	<1	<1	270	270	20	245	<0.01	0.09	11.6	0.2	0.02	13.48	12.73	0.75	0.3
510900	5802600	100515		7.51	1.7	860	518		476	310					100	11	67	3	<1	208	208	69	91	0.03	<0.01	6.08	0.1	2.6	8.89	8.35	0.53	0.24
514400	5785600	101241		8.05	1.35	151	134		126	58					20	2	24	4	<1	78	78	2	26	0.15	0.17	0.56	0.1	0.05	2.29	2.34	0.05	0.14
513700	5831200	103113		8.04	6.85	2230	1220		1190	404					96	40	316	10	<1	416	416	49	410	0.04	0.02	16.7	0.8	<0.01	22.09	20.95	1.14	0.43
536265	6020008	103369	5-Mar-02	7.76	3.94	1120	672			248					63	22	143	8			187	31	224	0.19		23.6		0.09	11.37	10.71	0.66	0.27
505200	5898800	111321	7-Mar-02	7.1	3.82	2130	1290			592					198	24	214	6			307	40	450	7.94		19.9		<0.01	21.27	19.66	1.61	0.41
501700	5820000	113473		8.12	3.61	1180	700		655	315					103	14	147	<1	<1	312	312	26	165	0.07	0.01	9.42	0.2	0.89	12.71	11.51	1.2	0.28
507200	5814150	113474		7.93	4.04	1380	802		764	352					115	16	175	<1	<1	312	312	23	240	<0.01	0.07	6.25	0.1	0.08	14.64	13.51	1.13	0.32
500800	5855400	113475		7.03	2.61	1720	1170		969	574					204	16	144	2	<1	296	296	128	286	<0.01	0.1	8.77	0.1	0.1	17.79	16.66	1.12	0.36
506155	6106762	137197	14-Mar-02	7.2	9.83	2900	1720		1540	442					78	60	439	2	<1	274	274	164	589	0.01	<0.01	38	1.3	0.33	27.98	25.58	2.4	0.5
502010	6135800	137294	13-Mar-02	7.19	38.4	16800	15700		13800	2950					239	572	3930	130	<1	612	612	1620	6910	<0.01	0.61	15.4	3.1	0.02	233	241	7.7	3.84
497560	5937700	141273	19-Mar-02	7.27	5.9	2610	1430		1700	548					110	67	317	13	<1	347	347	94	557	<0.01	<0.01	33.4	1	0.03	25.04	24.67	0.37	0.49

TCSA SA

Easting	Northing	Obswell Number	Sample Date	pH Value	Sodium Adsorption Ratio	Conductivity @ 25'C	Total Dissolved Solids (TDS)	Total Dissolved Solids (Estimated)	Total Dissolved Solids (Calculated)	Total Hardness as CaCO3	Calcium Hardness as CaCO3	Magnesium Hardness as CaCO3	Langelier Index	Free Carbon Dioxide as CO2	Calcium - Filtered	Magnesium - Filtered	Sodium - Filtered	Potassium - Filtered	Carbonate as CaCO3	Bicarbonate as CaCO3	Alkalinity as CaCO3	Sulphate - Filtered	Chloride	Iron - Filtered	Manganese - Filtered	Silica - Filtered	Fluoride	Nitrite and Nitrate as N	Total Cations	Total Anions	Actual (Anion / Cation) Difference	Allowed (Anion / Cation) Difference
					uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	me/L	me/L	me/L	me/L	
490933	5974763	TAT 27	3-Apr-02	8.19	9.34	2340	1230	1520	1200	268	94	173	0.5	3.6	38	42	351	21	<1	255	255	121	462	0.02	0.01	10	1.4	<0.01	21.17	20.72	0.45	0.43
466495	5922272	HYN 33	3-Apr-02	9.09	9	3040	1760	1980	1590	445	185	260	1.8	0.4	74	63	436	38	82	224	306	147	638	<0.01	0.02	7.21	0.7	<0.01	28.83	27.23	1.6	0.53
493060	5919466	BIN 49	3-Apr-02	7.6	7.82	3640	2190	2370	1910	651	270	381	0.4	16	108	92	458	28	<1	306	306	166	855	0.53	0.05	13.2	1.1	<0.01	33.65	33.77	0.12	0.63
466965	5892888	ROB 11	8-Apr-02	7.44	4.4	1550	840	1010	753	313	208	105	0.1	10	83	25	178	5	<1	235	235	17	288	<0.01	<0.01	12	0.3	<0.01	14.12	13.2	0.92	0.31
483086	5889931	JOA 11	3-Apr-02	11.3	6.1	3130	2250	2030	1400	514	514	<1	3.9	<0.1	206	<1	318	10	16	<1	82	15	803	0.03	<0.01	0.77	0.2	0.02	24.37	24.61	0.23	0.49
491773	5880003	CMM 82	3-Apr-02	7.56	9.73	2640	1400	1720	1350	315	157	158	0.1	15.2	63	38	397	16	<1	296	296	85	556	0.46	0.03	11.9	0.3	<0.01	23.96	23.41	0.55	0.47
494746	5860092	PEN 25	8-Apr-02	7.17	3.63	1640	930	1070	826	408	333	75	0.1	34.7	133	18	168	3	<1	347	347	8	267	<0.01	<0.01	16	0.2	<0.01	15.53	14.66	0.87	0.33
483609	5844295	NAN 58	8-Apr-02	7.25	1.71	936	528	608	528	317	279	37	0.2	19	112	9	70	2	<1	347	347	7	104	0.01	0.03	12.4	0.3	<0.01	9.41	10.04	0.63	0.26
495122	5844053	NAN 43	8-Apr-02	7.13	2.56	1370	784	891	711	402	353	49	0.1	36.3	141	12	118	4	<1	347	347	21	188	<0.01	<0.01	14.3	0.3	<0.01	13.25	12.69	0.56	0.3
473960	5842286	GRY 16	15-Apr-02	7.29	1.65	1190	666	774	613	423	333	91	0.3	37.6	133	22	78	2	<1	367	367	11	123	0.23	0.02	18.7	0.3	<0.01	11.91	11.06	0.85	0.28
493371	5840053	NAN 22	8-Apr-02	7.11	2.88	1470	858	956	769	438	374	64	0.1	43.3	150	16	139	4	<1	352	352	20	209	<0.01	<0.01	15.8	0.2	<0.01	14.9	13.35	1.54	0.31
487472	5838138	NAN 42	15-Apr-02	7.7	2.21	1340	752	871	697	439	379	61	0.8	14.2	152	15	106	2	<1	357	357	14	175	<0.01	0.04	14.7	0.2	<0.01	13.46	12.38	1.09	0.3
478091	5835997	YOU 34	15-Apr-02	7.09	1.98	1210	646	787	611	410	335	76	0.1	58	134	18	92	1	<1	357	357	4	134	0.15	0.12	10.9	0.2	<0.01	12.25	11.03	1.22	0.28
491794	5835786	MIN 21	15-Apr-02	7.38	2.16	1390	790	904	701	451	339	113	0.3	28	136	27	105	4	<1	337	337	10	196	<0.01	0.02	16.3	0.2	<0.01	13.71	12.49	1.22	0.3
492018	5829575	MIN 17	15-Apr-02	7.31	2.58	1390	766	904	709	406	336	70	0.3	31.9	135	17	119	3	<1	326	326	18	206	<0.01	0.04	11.9	0.4	<0.01	13.37	12.72	0.65	0.3
476206	5829198	YOU 27	15-Apr-02	7.33	2.67	1310	704	852	653	371	305	66	0.3	30.4	122	16	118	3	<1	326	326	6	179	<0.01	0.03	10.7	0.1	<0.01	12.6	11.72	0.88	0.29
485040	5819436	GAM 75	8-Apr-02	7.38	2.24	1100	674	715	573	335	263	72	0.3	16.2	105	17	94	5	<1	347	347	2	123	<0.01	0.1	15	0.3	0.01	10.91	10.47	0.44	0.27
480975	5815660	BLA 172	15-Apr-02	7.59	2.69	1160	626	754	589	323	229	94	0.4	15.2	92	23	111	5	<1	296	296	16	145	0.02	0.03	14.8	0.3	<0.01	11.43	10.35	1.08	0.27
478356	5814322	BLA 88	8-Apr-02	7.54	2.38	1070	570	696	547	310	226	84	0.3	12.5	90	20	96	6	<1	286	286	12	128	<0.01	0.05	18.5	0.2	<0.01	10.51	9.58	0.93	0.26
482502	5811243	GAM 256	15-Apr-02	7.6	2.75	1180	628	767	698	310	195	115	0.3	14.3	78	28	111	8	<1	286	286	24	159	<0.01	0.01	14.5	0.5	<0.01	11.25	10.74	0.5	0.27
473578	5788386	MAC 77	8-Apr-02	8.29	28.3	1320	760	760	654	1	<1	<1	-0.9	3.5	<1	<1	251	2	<1	337	337	2	155	<0.01	<0.01	1.33	1	<0.01	10.98	11.22	0.24	0.28

TCSA VIC

Easting	Northing	Bore ID	Sample Date	pH Value	Sodium Adsorption Ratio	Conductivity @ 25'C	Total Dissolved Solids (TDS)	Total Dissolved Solids (Estimated)	Total Dissolved Solids (Calculated)	Total Hardness as CaCO3	Calcium Hardness as CaCO3	Magnesium Hardness as CaCO3	Langelier Index	Free Carbon Dioxide as CO2	Calcium - Filtered	Magnesium - Filtered	Sodium - Filtered	Potassium - Filtered	Carbonate as CaCO3	Bicarbonate as CaCO3	Alkalinity as CaCO3	Sulphate - Filtered	Chloride	Iron - Filtered	Manganese - Filtered	Silica - Filtered	Fluoride	Nitrite and Nitrate as N	Total Cations	Total Anions	Actual (Anion / Cation) Difference	Allowed (Anion / Cation) Difference
						uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	me/L	me/L	me/L	me/L
502750	6135800	49676	13-Mar-02	7.55	23.1	7900	4560		4530	512					67	84	1470	55	<1	337	337	260	2370	0.11	0.05	13.5	1.2	1.25	75.59	79.09	3.5	1.33
506600	5987200	60475	18-Mar-02	7.57	8.77	2770	1550		1560	461					79	64	433	17	<1	250	250	91	682	1.29	0.05	36.8	1	<0.01	28.47	26.2	2.27	0.51
506600	5967100	75669	16-Mar-02	7.77	6.96	2240	1280		1280	419					68	60	328	20	<1	286	286	94	521	<0.01	0.03	14.2	2.5	0.08	23.13	22.5	0.63	0.46

APPENDIX B NO_3 (AS NO_3) AND NO_2 (AS NO_2) TO NO_X (AS N) DERIVATION

Determination of NOX (as N) drinking water quality guidelines

The following published drinking water quality guidelines were used (NHMRC 1996):

- NO2 (as NO2) = 3 mg/L
- NO3 (as NO3) = 50 mg/L (for infants)
- NO3 (as NO3) = 100 mg/L (for children and adults)

The conversion factors shown below were used to express nitrate and nitrite concentrations as nitrogen (N):

- NO2 (as NO2) to NO2 (as N) = 0.304
- NO3 (as NO3) to NO3 (as N) = 0.226

NO2 (as NO2) to NO2 (as N) conversion:

- 3mg/L NO2 (NO2) x 0.304 = **0.912 mg/L NO2 (as N)**

NO3 (as NO3) to NO3 (as N) conversion:

- (Infants) 50mg/L NO3 (NO3) x 0.226 = **11.3 mg/L NO3 (as N)**
- (Children/Adults) 100 mg/L NO3 (NO3) x 0.226 = **22.6 mg/L NO3 (as N)**

Using the above conversions, the guidelines are:

Summation of NO3 (as N) and NO2 (as N) to give NOX (as N)

- Infants: NO3 (as N) + NO2 (as N) = 11.3 + 0.912 = 12.212 mg/L ~ **12 mg/L NOX (as N)**
- Children/Adults: NO3 (as N) + NO2 (as N) = 22.6 + 0.912 = 23.512 mg/L ~ **24 mg/L NOX (as N)**