A preliminary investigation into the groundwater salinity of the Robinson Lens, Streaky Bay, South Australia

Keith G. Brown and Glenn A. Harrington

Resource Assessment Division
Department for Water Resources

December 2001

DWR Report 2001/019

Department for
Water Resources

Government
of South Australia

Resource Assessment Division
Department for Water Resources
Level 11, 25 Grenfell Street, Adelaide
GPO Box 1047, Adelaide SA 5001

Phone	National	(08) 8463 6800
	International	+61 8 8463 6800
Fax	National	(08) 8463 6999
	International	+61 8 8463 6999
Website	www.dwr.sa.gov.au	

Acknowledgements
We wish to acknowledge the assistance of SA Water in particular Michael (Bruce) Taylor from the Streaky Bay office for his assistance in the field.

Preferred way to cite this publication
Brown, K.G., and Harrington, G.A., 2001. A Preliminary Investigation into the Groundwater Salinity of the Robinson Lens, Streaky Bay, South Australia. *South Australia. Department for Water Resources. Report,* DWR 2001/019.

Cover — PIRSA photo numbers 045201, T024975, 045226, 047612, 047855. Water droplet is courtesy of Adam Hart-Davis / DHD Photo Gallery.

FOREWORD

South Australia's water resources are fundamental to the economic and social wellbeing of the State. Water resources are an integral part of our natural resources. In pristine or undeveloped situations, the condition of water resources reflects the equilibrium between rainfall, vegetation and other physical parameters. Development of surface and groundwater resources changes the natural balance and causes 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. Degradation may also be very gradual and take some years to become apparent, imparting a false sense of security.

Management of water resources requires a sound understanding of key factors such as physical extent (quantity), quality, availability, and constraints to development. The role of the Resource Assessment Division of the Department for Water Resources is to maintain an effective knowledge base on the State's water resources, including environmental and other factors likely to influence sustainable use and development, and to provide timely and relevant management advice.

Bryan Harris
Director, Resource Assessment Division
Department for Water Resources

ABBREVIATIONS

General

AHD	Australian height datum
DWR	Department for Water Resources
EC	electrical conductivity
yr	year

Measurement

Units of measurement used in this volume are those of the International System of Units (SI) as well as units outside the SI which have been authorised for use within Australia's metric system.

cm	centimetre (length; 10^{-2} m)
km	kilometre (length; 10^{3} m)
L	litre (volume; 10^{-3} m^3)
m	metre (length)
mg	milligram (mass; 10^{-6} kg)
ML	megalitre (volume; 10^{3} m^3)
mm	millimetre (length; 10^{-3} m)
μS	microsiemens (electrical conductance; 10^{-6} $A^2.s^3/kg.m^2$)

CONTENTS

Foreword 3
Abbreviations..4

Executive summary 6

Introduction...6

Approach...9

Results and discussion 9

Conclusions...10

Recommendations 10

Appendixes
1 Depth to water and salinity readings, October 2001.......................................11
2 Observed well salinity and depth profiles, October 2001 13

FIGURES
1 Streaky Bay water supply, Robinson Lens observation network.........................7
2 Annual groundwater extractions from Robinson Lens; annual rainfall at Streaky Bay; and selected hydrographs from various parts of the Robinson Basin 8

Department for Water Resources

Report DWR 2001/019

A Preliminary Investigation into the Groundwater Salinity of the Robinson Lens, Streaky Bay, South Australia

Keith G. Brown and Glenn A. Harrington

EXECUTIVE SUMMARY

Results of a recent groundwater salinity sampling program of the Robinson Lens has revealed that the current procedure of using a bailer to obtain salinity samples is inaccurate and that the salinity in the aquifer may be much higher than previously understood.

More than half of the observation wells display an increase in borehole salinity with depth. For example a bore in close proximity to one of the supply trenches exhibits a salinity increase of more than 7000 electrical conductivity units over a 2 m interval. We are not certain whether or not the increase in borehole salinity reflects the actual groundwater salinity in the aquifer.

The monitoring wells urgently need to be purged of silt and stagnant water that has accumulated since the completion of drilling. Pumped samples from the cleared wells will provide accurate salinity distributions in the aquifer which will aid future management of the resource.

INTRODUCTION

Streaky Bay is located on the west coast of Eyre Peninsula, ~700 km by road from Adelaide (Fig. 1). Mean annual rainfall is ~380 mm/yr and there are no reliable surface water resources in the region. Furthermore, the high salinity of groundwater underlying the town renders it unsuitable for domestic use. Since settlement, domestic and municipal supplies have used the relatively fresh groundwater resource of the Robinson Lens situated 10 km southeast of the town. Pumping and supply of water to the town, and routine (monthly) monitoring of groundwater levels and salinity is undertaken by SA Water. The groundwater is pumped from two trenches (Trench 1 and 2) and several bore fields (Bore 20, Bore 485, and a southern and western bore field each comprising 6 bores), then chlorinated and piped into town.

Results from monitoring groundwater resources surrounding the Robinson Lens by SA Water over the last decade indicate significant declines in water levels and increases in groundwater salinity in the production well field. Whilst the volume of groundwater extracted from the lens over the last decade is lower than the previous ten years, and annual rainfall has remained approximately constant, many hydrographs show a steep decline in water level over this period (Fig. 2). The current population of

Streaky Bay Water Supply
Robinson Lens Observation Network

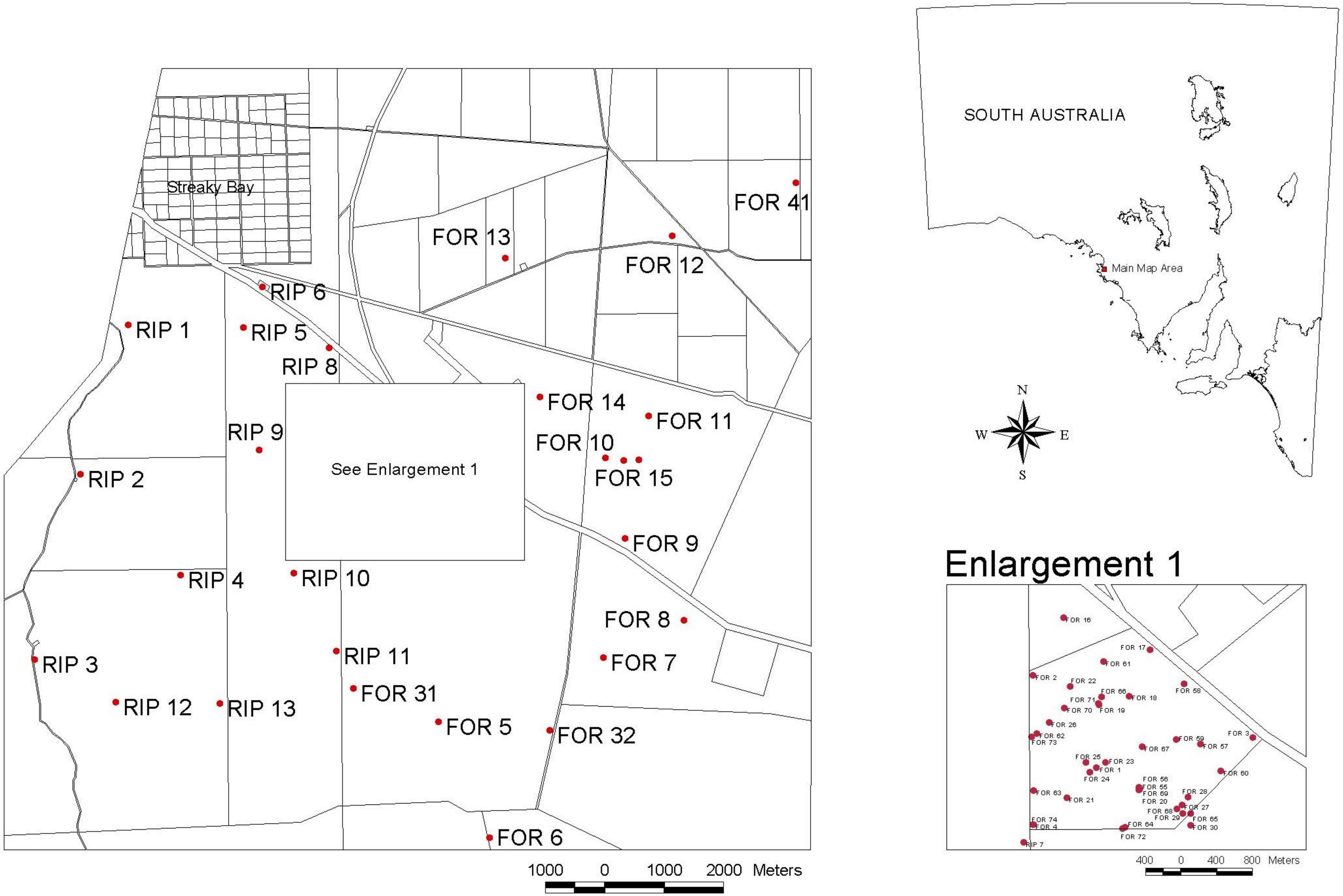

Figure 1

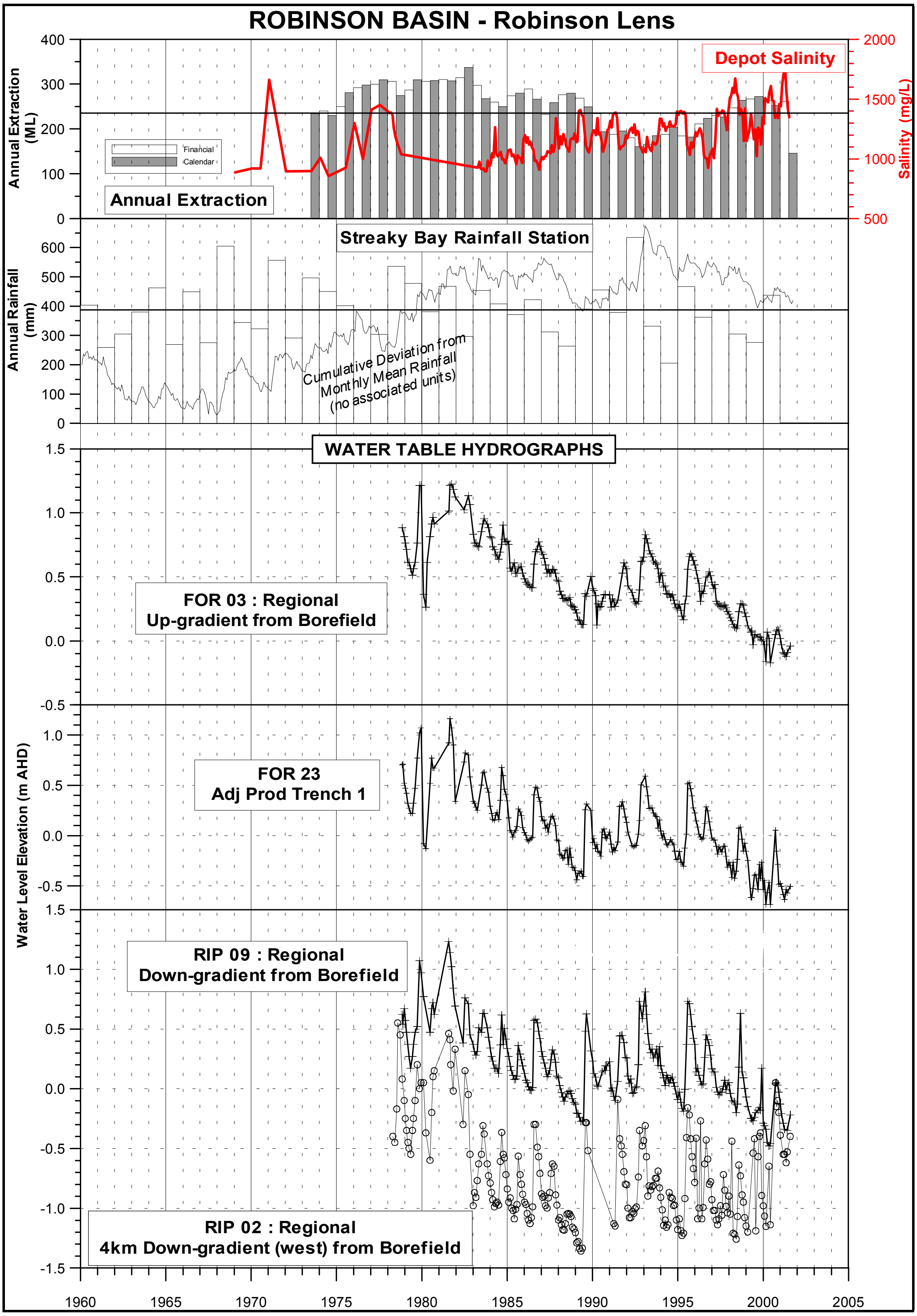

Figure 2 Annual groundwater extractions from the Robinson Lens; annual rainfall at Streaky Bay; and selected hydrographs from various parts of the Robinson Lens region

Streaky Bay is around 1300 people, and given proposed real estate developments there is growing concern as to whether or not the resource is sustainable. During October 2001 two members of the DWR Groundwater Assessment Research and Development Group undertook an investigation to determine the spatial and vertical extent of the fresh groundwater lens. This information is vital for estimating the remaining volume of groundwater available for use.

APPROACH

A YSI® down-hole sonde that enables vertical profiling of chemical parameters (electrical conductivity (EC), pH, temperature and dissolved oxygen) in wells was used to measure EC variations in wells of the Streaky Bay Monitoring Network (Fig. 1). Ideally this technique of measuring vertical groundwater salinity profiles is best suited to wells that are open to the aquifer. The majority of wells sampled in this study are only open over a small (i.e. 1–2 m) interval. Water samples were also taken from windmills and shallow pumping wells for salinity measurement on a WTW® field kit.

RESULTS AND DISCUSSION

Two trenches and a total of 33 wells including monitoring and production bores were measured for EC using either the down-hole sonde or manual sampling approach. Not all of the wells in the monitoring network were sampled because of access difficulties and results of previous monitoring which revealed that many of the wells in the network were dry (App. 1). Groundwater salinities in four monitoring wells were not measured as they were equipped with windmills and had been sampled recently as part of the SA Water monitoring program. Profiling the open section of most wells was unsuccessful because sediment has accumulated at the bottom of the wells and subsequently decreased their total depths significantly.

Because the wells were not purged prior to sampling, it became apparent after testing a small number of wells that salinity in the well column was highly variable, even in sections of the wells that were not open to the aquifer. The results of the sampling show that the groundwater salinity generally increases down the well column and is highest at the bottom of the open section of the well (Appendix B). Surprisingly high salinities were measured in previously identified areas of fresh water. For example well FOR 27 which is located no more than 50 m from Trench 2 (where groundwater is regularly pumped for town supply) has a groundwater salinity that increases from 1875 µS/cm up to 9300 µS/cm over an interval of 1.2 m. Whilst this was the most dramatic variation observed, more than half of the wells exhibited the same trend.

Our results of individual well EC measurements showed major discrepancies with those taken previously by SA Water. We believe this is because the method used by SA Water for sampling groundwater EC involves taking a bailed sample from the watertable in the well column. Generally the sonde data from the uppermost section of the well correlated to the bailed sample data.

A number of the observation wells in the monitoring network are unsuitable for this purpose. They are either open, hand-dug wells or boreholes with poor surface completion, both of which enable surface water to be funnelled into the wells during intense rainfall.

CONCLUSIONS

From our initial study we conclude the following:

1. Groundwater salinity can increase dramatically with depth.

2. The bailed samples taken by SA Water are not representative of the aquifer. Therefore all previous data should be treated as trends only and not absolute variations in groundwater salinity.

3. From our initial investigation if our assumption that borehole profiling over the open section of the well is reflecting actual groundwater salinity, then the condition of the aquifer is much worse than previously understood.

RECOMMENDATIONS

1. All wells in the monitoring network should be purged and redeveloped as a matter of priority.

2. Salinity samples should also be taken (by pumping) for the purpose of mapping the true spatial extent of the freshwater lens.

3. The existence of fresh groundwater lenses such as the Robinson Lens in semi-arid environments is uncommon. The origin and hydrodynamic behaviour of such resources are poorly understood and require further investigation. We suggest a study be undertaken using environmental tracers which will enable recharge rates and the long-term sustainability of the resource to be determined.

4. A review of the suitability of individual monitoring wells in the network should be undertaken to ensure that future monitoring will provide adequate information on the state of the resource.

5. There should be no further development of the aquifer until a more thorough investigation into the resource is undertaken.

6. The monitoring network should be expanded to include the deeper aquifer system.

7. Bailed samples should not be used for salinity monitoring in any part of the State.

APPENDIXES

1 DEPTH TO WATER AND SALINITY READINGS, OCTOBER 2001

Streaky Bay Monitoring Network — December 2001

Water level				Salinity			
Observation well*	Date	Depth to watertable (m)	Comments	Observation well*	Date	EC (µS/cm)	Comments
FOR 2	3.10.01	7.27		FOR 1	3.10.01	3 460	
FOR 3	3.10.01	8.55		FOR 2	3.10.01	2 170	
FOR 4	3.10.01	2.49		FOR 3	3.10.01	2 810	
FOR 5	2.10.01	2.14		FOR 4	3.10.01	2 130	
FOR 6	2.10.01	2.02		FOR 5	2.10.01	7 240	
FOR 7			dry	FOR 6	2.10.01	8 450	
FOR 8	2.10.01	11.98		FOR 7			dry
FOR 9			dry	FOR 8	2.10.01	11 440	
FOR 10	2.10.01	13.46		FOR 9			dry
FOR 11			no access	FOR 10	2.10.01	924	
FOR 14	2.10.01	10.07		FOR 11			no access
FOR 15			no access	FOR 14	2.10.01	680	
FOR 16	2.10.01	4.97		FOR 15			no access
FOR 17	2.10.01	9.67		FOR 16	2.10.01	3 920	
FOR 18	3.10.01	3.88		FOR 17	2.10.01	11 630	
FOR 19	3.10.01	4.94		FOR 18	3.10.01	1 790	
FOR 20	3.10.01	4.57		FOR 19	3.10.01	4 450	
FOR 21	3.10.01	3.93		FOR 20	3.10.01	2 800	
FOR 22	3.10.01	3.99		FOR 21	3.10.01	1 970	
FOR 23	3.10.01	4.64		FOR 22	3.10.01	1 945	
FOR 24	3.10.01	4.06		FOR 23	3.10.01	2 810	
FOR 25	3.10.01	3.92		FOR 24	3.10.01	1 840	
FOR 26	3.10.01	3.07		FOR 25	3.10.01	1 020	
FOR 27	3.10.01	5.04		FOR 26	3.10.01	3 280	
FOR 28	3.10.01	5.44		FOR 27	3.10.01	1 587	
FOR 29	3.10.01	4.89		FOR 28	3.10.01	2 200	
FOR 30			dry	FOR 29	3.10.01	2 410	
FOR 31	2.10.01	1.19		FOR 30			dry
FOR 32	2.10.01	6.53		FOR 31	2.10.01	11 390	
FOR 55	3.10.01	4.71		FOR 32	2.10.01	25 800	
FOR 57	2.10.01	7.16		FOR 55	3.10.01	8 200	
FOR 58			dry	FOR 57	2.10.01	20 200	
FOR 59	2.10.01	5.23		FOR 58			dry
FOR 60	3.10.01	8.28		FOR 59	2.10.01	7 230	
FOR 61	3.10.01	7.02		FOR 60	3.10.01	9 140	
FOR 62	3.10.01	4.29		FOR 61	3.10.01	6 670	
FOR 63			dry	FOR 62	3.10.01	1 505	
FOR 64	3.10.01	4.17		FOR 63			dry
FOR 65	3.10.01	5.15		FOR 64	3.10.01	920	
FOR 66	3.10.01	3.42		FOR 65	3.10.01	3 250	
FOR 67	3.10.01	5.65		FOR 66	3.10.01	4 560	
RIP 1	2.10.01	1.94		FOR 67	3.10.01	3 180	
RIP 2	2.10.01	1.1		FOR 68	3.10.01	2 910	
RIP 3	2.10.01	2.36		FOR 69	3.10.01	3 240	
RIP 4	2.10.01	2.69		FOR 70	3.10.01	2 750	

Water level			
Observation well*	**Date**	**Depth to watertable** (m)	**Comments**
RIP 5			dry
RIP 6	2.10.01	3.25	
RIP 7	2.10.01	2.32	
RIP 8	2.10.01	4.82	
RIP 9	2.10.01	3.03	
RIP 10	2.10.01	5.36	
RIP 11	2.10.01	1.75	
RIP 12	2.10.01	3.55	
RIP 13	2.10.01	9.88	

Salinity			
Observation well*	**Date**	**EC** (µS/cm)	**Comments**
FOR 72	3.10.01	1 310	
FOR 73	3.10.01	2 750	
RIP 1	2.10.01	13 050	
RIP 2	2.10.01	7 820	
RIP 3	2.10.01	10 200	
RIP 4	2.10.01	4 680	
RIP 5			dry
RIP 6	2.10.01	4 510	
RIP 7	2.10.01	2 580	
RIP 8	2.10.01	2 530	
RIP 9	2.10.01	2 720	
RIP 10	2.10.01	3 360	
RIP 11	2.10.01	10 210	
RIP 12	2.10.01	45 600	
RIP 13	2.10.01	47 100	

* No SA_Geodata unit numbers have been assigned to these wells.

2 OBSERVED WELL SALINITY AND DEPTH PROFILES, OCTOBER 2001

Observation well	Electrical conductivity Depth (m)	EC (µS/cm)	Depth of well (m) (field measurement)	Production zone (m) (from SA_Geodata)
FOR 2	7.5	2 310	9	unknown
	8	2 310		
	8.5	2 315		
	9	2 315		
FOR 3	8.7	1 950	9.9	3.35–12.19
	9.5	2 950		
FOR 4	2.5	2 240	6.8	5–7
	3	2 250		
	5	2 255		
	5.5	2 255		
	6	2 255		
	6.5	2 255		
FOR 8	no sample			unknown
FOR 10	24	4 400	24	32–34
FOR 16	no sample			unknown
FOR 17	9.5	9 875	12.3	12–13
	10.5	15 626		
	11.5	21 620		
	12	23 050		
FOR 18	4	1 030	5.15	4–5.25
	5	5 180		
FOR 19	5	4 695	7.02	6–7.02
	6	4 700		
	6.5	4 700		
FOR 20	5	2 915	5.9	4–5.47
	5.9	2 915		
FOR 21	4.5	2 070	7.4	6–7.52
	5	2 070		
	6	2 070		
FOR 22	4	1 230	5.1	4–5.25
	5	6 043		
FOR 23	4.5	2 968	6.3	5.3–6.38
	5	2 955		
	5.5	2 950		
	6	2 950		
FOR 24	4.5	1 913	5.2	3.5–5
	5	1 913		
FOR 25	4	1 248	4.7	2.5–5
FOR 26	3.5	3 360	5.5	4.5–5.6
	4	3 360		
	4.5	3 360		
	5	3 375		
FOR 27	5	1 770	7.2	6–7.2
	5.5	1 775		
	6	1 875		
	6.5	4 200		
	7	8 900		
	7.2	9 300		

Observation well	Electrical conductivity		Depth of well (m) (field measurement)	Production zone (m) (from SA_Geodata)
	Depth (m)	**EC** (µS/cm)		
FOR 28	5.5	2 285	8	4–5.25
	6	2 280		
	6.5	2 280		
	7	2 280		
	7.5	2 280		
	8	2 495		
FOR 29	5	2 050	6.1	5–6.1
	5.5	2 450		
	6	2 950		
FOR 55	5	6 980	5.5	23–24
FOR 57	7.5	17 700	23.5	18.9–41
	9	22 350		
	10	22 930		
	13	23 050		
	15	23 050		
	18	23 060		
	19	23 065		
	20	23 090		
	22	39 150		
FOR 59	5.5	5600	6.9	5–7.5
	6.5	10 730		
	6.9	10 800		
FOR 60	8.5	9 415	11.5	4–6.5
	9.5	9 600		
	10	9 740		
	11	10 425		
	11.5	11 200		
FOR 61	7.5	7 200	7.5	5–12.2
FOR 62	4.5	1 555	6.5	3–6.4
	5	1 550		
	6	1 545		
	6.5	1 550		
FOR 64	4.5	800	5.5	3.5–6.1
	5	1 010		
	5.5	1 215		
FOR 65	5.5	3 430	6.5	2.5–4.5
	6	3 390		
	6.5	3 375		
FOR 66	3.5	3 645	4.1	3–5
	4	5 175		
FOR 67	6	2 995	7.5	5–7
	7	3 510		
RIP 6	3.25	4500–4800		unknown
RIP 8	5	2 530		0–9.14
	8.5	4 910		