



# Lower Campaspe Valley Water Supply Protection Area Groundwater Management Plan

Annual Report

For year ending 30 June 2016

# Document History and Distribution

## Version (s)

Version	Date	Author(s)	Notes
Draft v1-v6	17 August 2016	Luke Boehm	Document Creation and Edits
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## Distribution

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# Foreword

Goulburn-Murray Water (GMW) is pleased to present the annual report for the Lower Campaspe Valley Water Supply Protection Area Groundwater Management Plan (the Plan) for the 2015/16 water year.

GMW is responsible for the implementation, administration and enforcement of the Plan which was approved by the Minister administering the *Water Act 1989* (the Minister) in October 2012.

This report has been prepared in accordance with section 32C of the *Water Act 1989* (the Act).

This report provides an overview of the groundwater management activities in the Lower Campaspe Valley Water Supply Protection Area and documents the successful operation of the Plan during the 2015/16 water year.

A copy of this report is available for inspection at the GMW Tatura office, or it can be downloaded from the GMW website.



Neil Brennan

INTERIM MANAGING DIRECTOR

Date

# Executive summary

The Lower Campaspe Valley Water Supply Protection Area (WSPA) Groundwater Management Plan (the Plan) was approved by the Minister in October 2012.

The 2015/16 water year marks the fourth year of operation under the Plan.

Allocations in 2015/16 were 100% of licence entitlement in all management zones of the Lower Campaspe Valley WSPA.

Metered use in the Lower Campaspe Valley WSPA was 81% (44,993.6 ML) of licence entitlement, the greatest ever recorded.

There was an increase in trade activity during 2015/16. There were 43 temporary licence transfers for a total of 7,838 ML. There were also 12 permanent licence transfers for a total of 2,224 ML/yr.

The usage and trade activity is greater than previously reported and may be attributed to the dry conditions and reduced availability of surface water.

Licence holders in the Lower Campaspe Valley WSPA are entitled to carryover a maximum of 25% of licence entitlement. A total 12,707 ML of entitlement has been carried over to 2016/17.

Groundwater level monitoring indicates that seasonal aquifer recovery is relatively strong and levels are generally within observed historical ranges. However, it was noted that in some local areas of intensive groundwater pumping the drawdown level was the lowest ever recorded. This may be attributed to a falling groundwater recovery levels in recent years and greater extractions in 2015/16 in response to drier conditions.

Groundwater monitoring and metering programmes continue to be successfully undertaken to support the implementation of the Plan.

The Lower Campaspe WSPA Groundwater Management Plan is continuing to achieve its stated objectives.

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# 1 Introduction

## 1.1 Purpose

This annual report has been prepared to meet the requirements of Prescription 7 of the Plan and section 32C of the Act.

This report provides an overview of groundwater management activities undertaken in accordance with the Plan from 1 July 2015 to 30 June 2016.

## 1.2 Water Supply Protection Area

The Lower Campaspe Valley WSPA was declared in June 2010. It extends from Lake Eppalock in the south to Echuca in the north and includes the towns of Axedale, Goornong, Elmore, Lockington and Rochester.

There are four management zones within the Lower Campaspe Valley WSPA, which are the Barnadown, Elmore-Rochester, Bamawm and Echuca Zones (Figure 1).

The WSPA includes groundwater resources to all depths except where it is overlain by the Campaspe West Salinity Management Plan Area and the region to the north of the Waranga Western Channel including the Shepparton Irrigation Region Groundwater Management Area. In these areas, the Plan only applies to the management of groundwater resources greater than 25 metres (m) depth.

## 1.3 Groundwater Management Plan

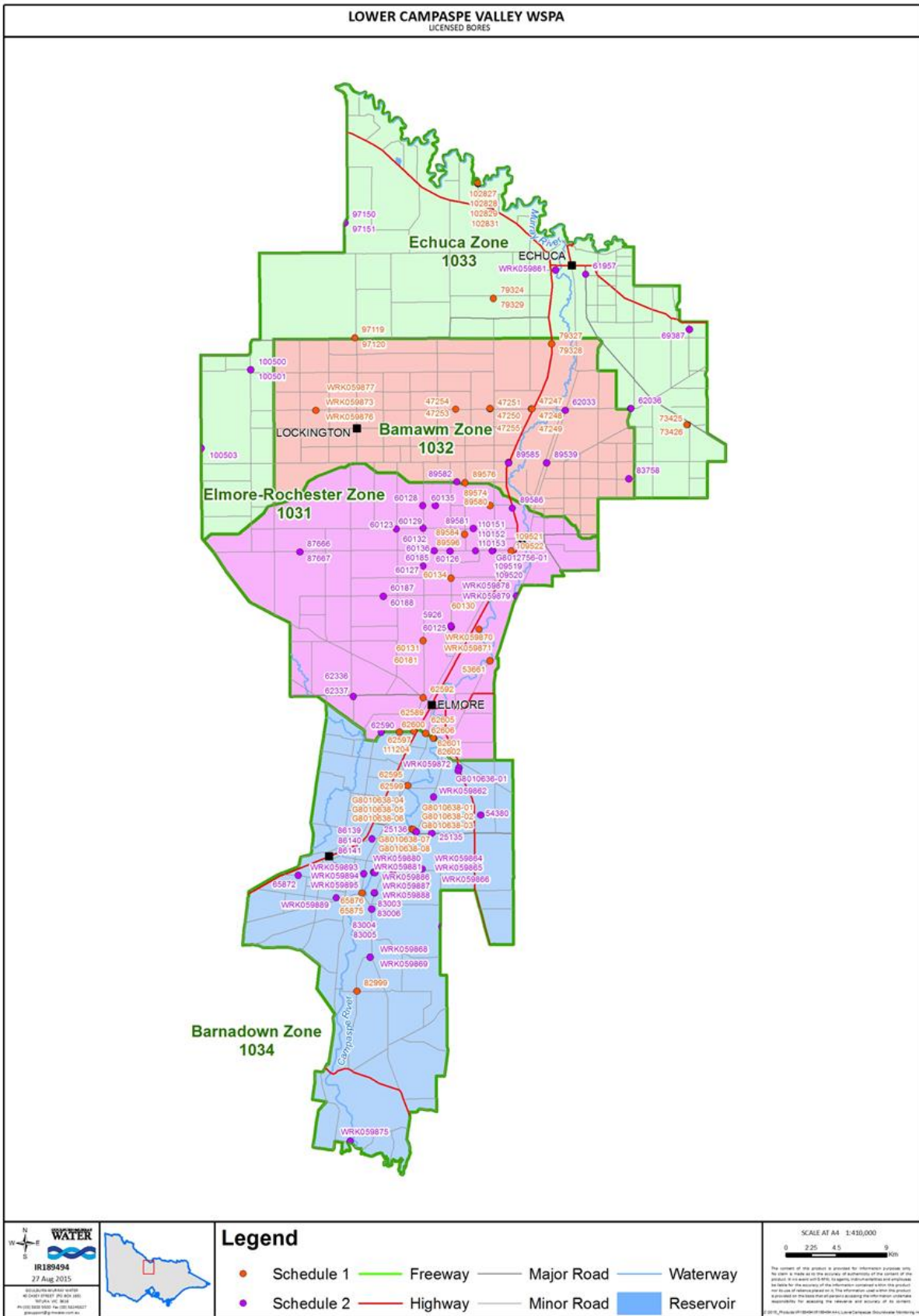
The Plan was approved by the Minister in accordance with section 32A(6) of the Act on 17 October 2012.

The objective of the Plan, as defined in section 32A(1) of the Act, is to make sure that groundwater resources of the WSPA are managed in an equitable manner so as to ensure the long-term sustainability of those resources. More specifically, the Plan seeks to:

- protect existing groundwater users and the environment by managing groundwater levels and the potential for change in groundwater salinity;
- enable equitable development of groundwater resources to realise the potential for its use in the region; and
- communicate the Plan's objectives, management rules and resource status with stakeholders and the wider community.

GMW is responsible for the implementation, administration and enforcement of the Plan. An assessment summary of GMW's activities in accordance with Plan prescriptions is presented in Appendix A.

A copy of the Plan can be downloaded from GMW's website at [www.g-mwater.com.au](http://www.g-mwater.com.au).



**Figure 1 Lower Campaspe Valley Water Supply Protection Area**



# 2 Groundwater management

## 2.1 Licence volume

The Minister declared the Permissible Consumptive Volume to be 55,875 megalitres per year (ML/yr) in March 2013 (Victorian Government Gazette, 2013). At 30 June 2016 the licence entitlement volume in the Lower Campaspe Valley WSPA was 55,860 ML/yr (Table 1).

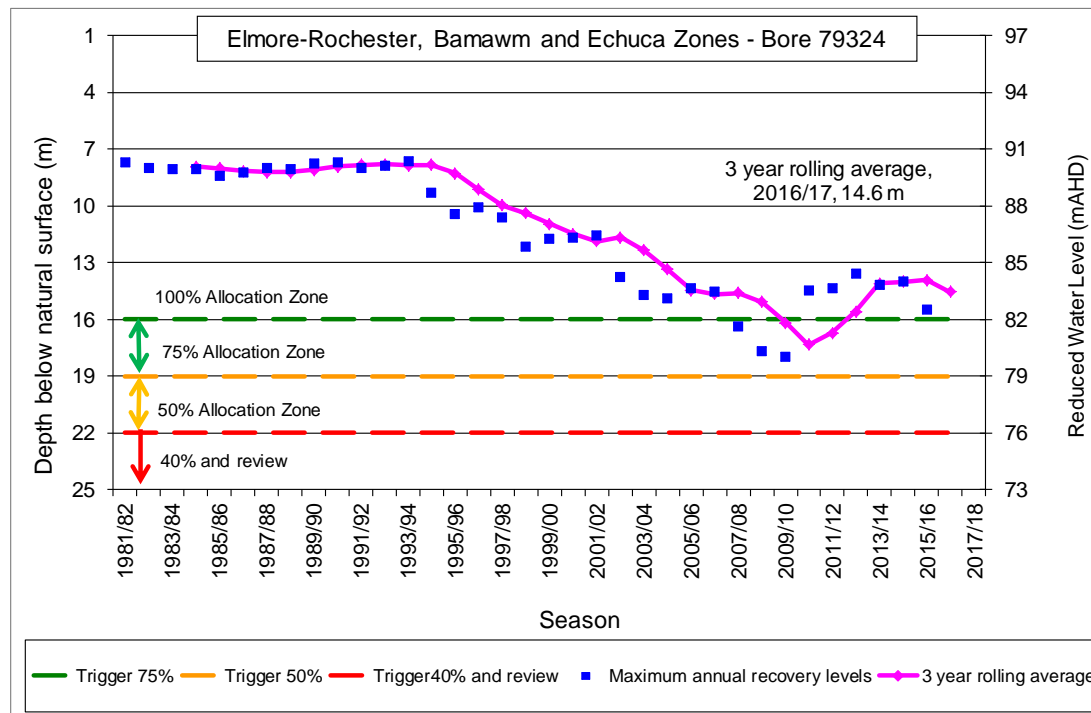
**Table 1 Licence entitlement in the Lower Campaspe Valley WSPA**

Zone	Number of Licences	Licensed bores	Licence volume (ML/yr)
Elmore-Rochester - 1031	55	66	17,198.6
Bamawm - 1032	44	49	25,747.3
Echuca - 1033	16	17	4,919.5
Barnadown - 1034	20	55	7,995.0
<b>Total</b>	<b>135</b>	<b>187</b>	<b>55,860.4</b>

Licence entitlement as at 30 June 2015 was 55,870.4 ML/yr. The 10 ML/yr reduction in licence entitlement is due to the surrender of a licence in 2015/16.

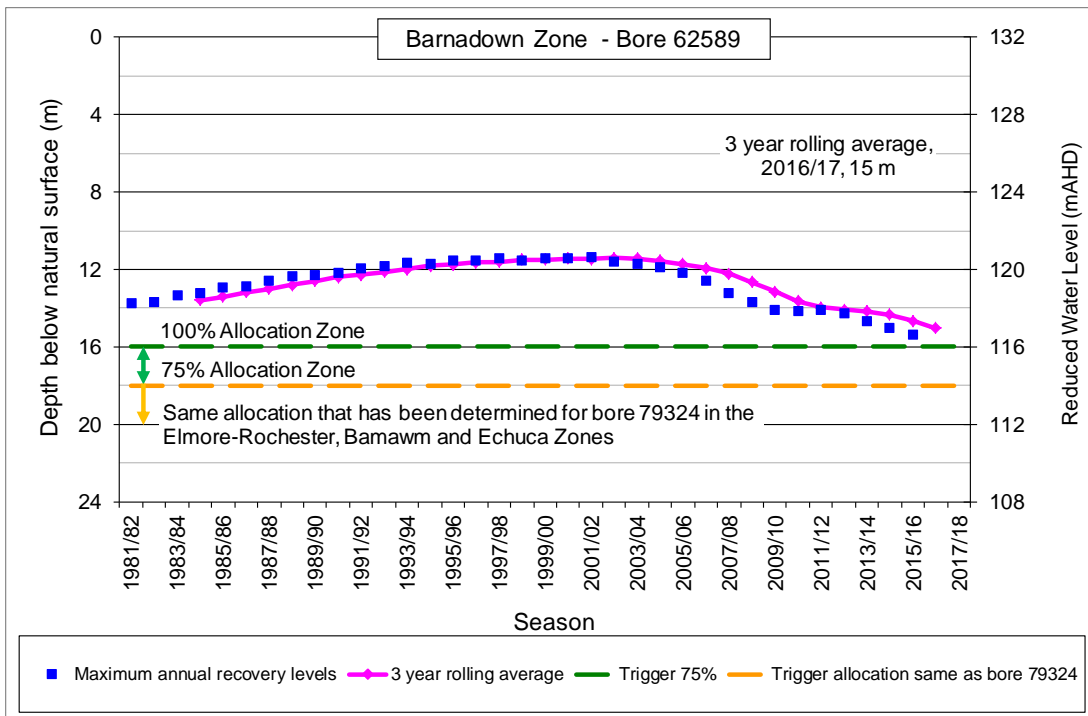
## 2.2 Groundwater allocations

Allocations are a percentage of licence entitlement that may be extracted in a given water year. Allocations are determined by comparing the three-year rolling average of the maximum annual groundwater recovery levels in bores 79324 and 62589 with the Plan trigger levels (Figure 2 and Figure 3). Allocations of 100 per cent (%) were announced on 1 July 2015 for all management zones for the 2015/16 water year.



**Figure 2 Trigger levels to determine allocations in the Elmore-Rochester, Bamawm and Echuca Zones**

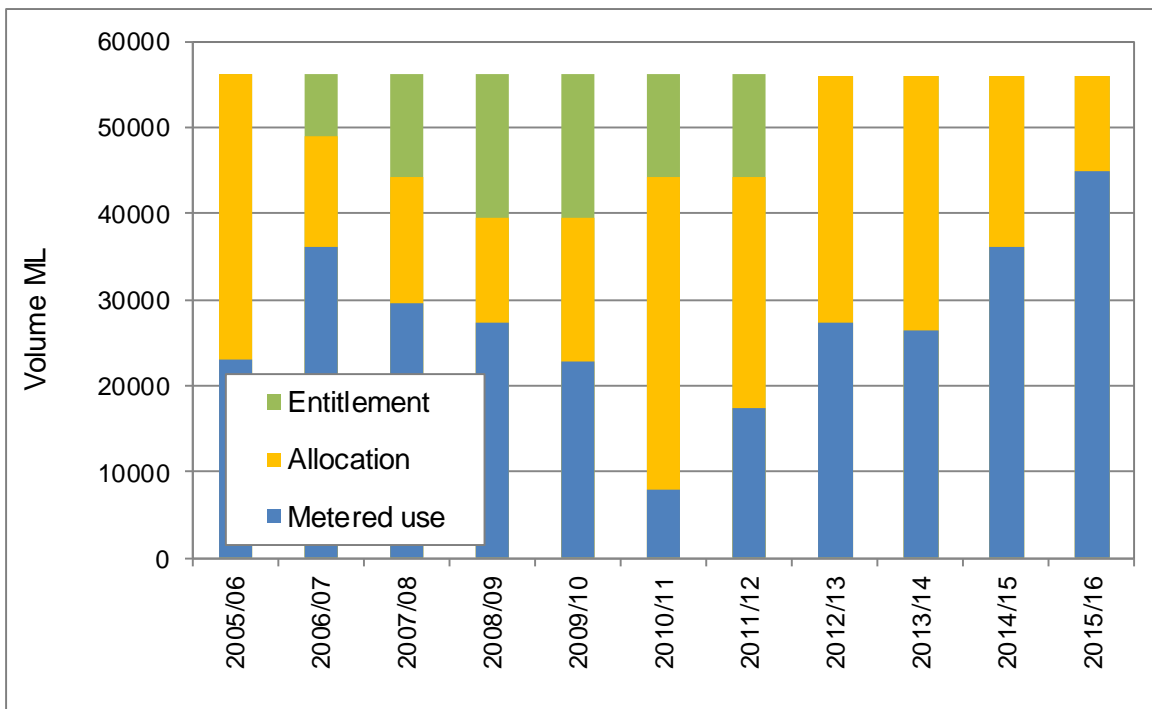




**Figure 3 Trigger levels to determine allocations in the Barnadown Zone**

### 2.3 Groundwater use

Metered use in the Lower Campaspe Valley WSPA in 2015/16 was 44,993.6 megalitres (ML). This equates to 81% of licence entitlement, which is the highest recorded usage from the area (Figure 4). The high usage may be attributed to increased demand for groundwater due to the dry conditions and reduced availability of surface water.



**Figure 4 Metered use in the Lower Campaspe Valley WSPA**

Metered use was highest in the Bamawm Zone (Table 2).

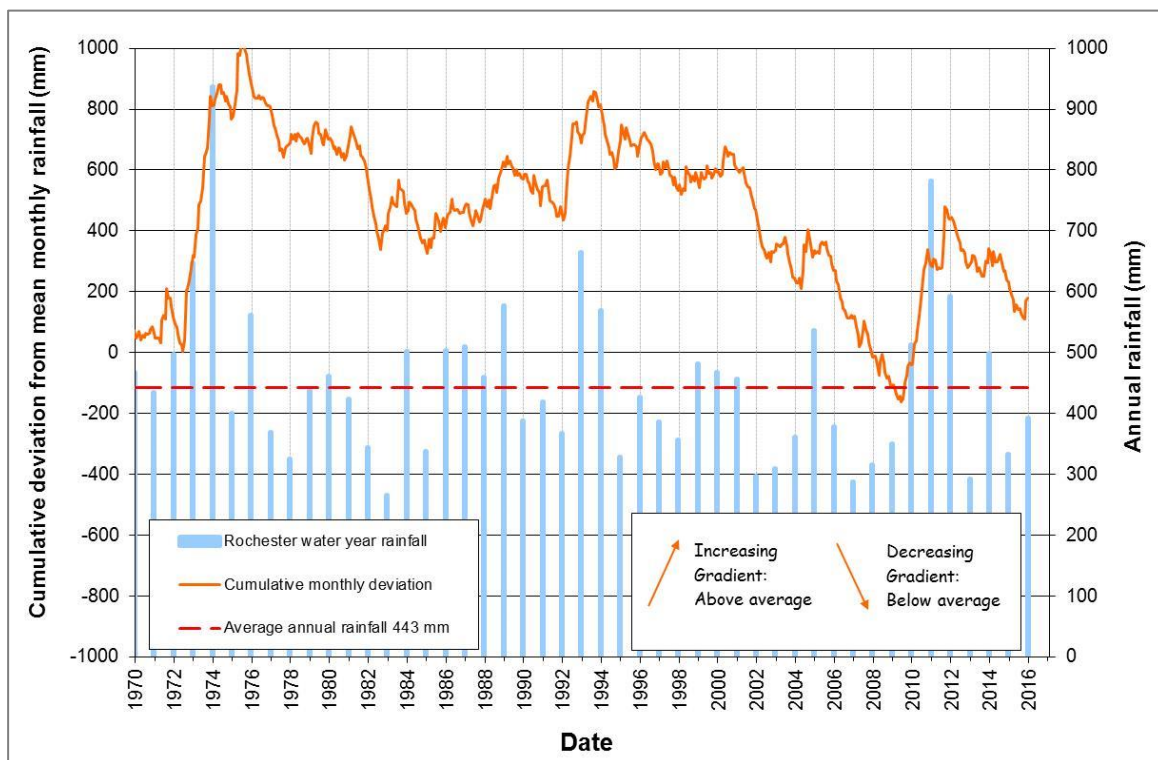
**Table 2 Metered usage in the Lower Campaspe Valley WSPA in 2015/16**

Zone	Licence volume (ML/yr)	Metered use (ML)	Percentage of licence entitlement
Elmore-Rochester - 1031	17,198.6	12,601.1	72%
Bamawm - 1032	25,747.3	23,724.6	92%
Echuca - 1033	4,919.5	2927.6	60%
Barnadown - 1034	7,995.0	5,740.3	72%
<b>Total</b>	<b>55,860.4</b>	<b>44,993.6</b>	<b>81%</b>

Note: Licence volume extracted from Victorian Water Register 30 June 2016 and metered use extracted from IPM 1 July 2016.

## 2.4 Rainfall

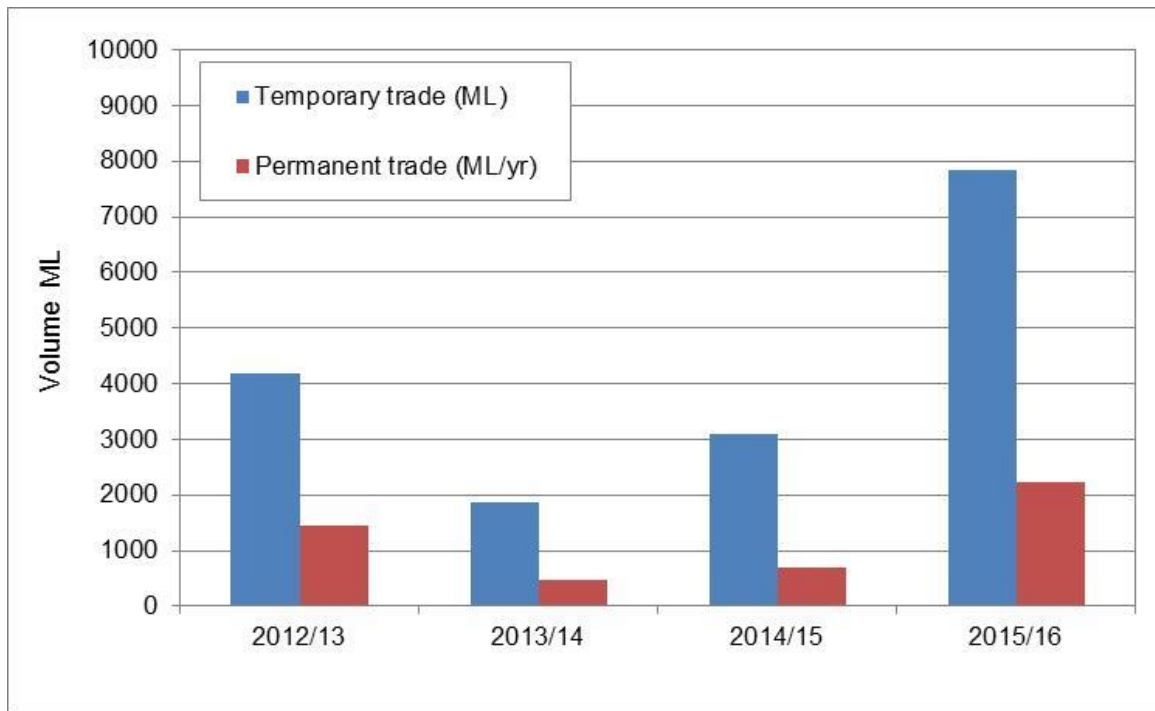
Rainfall data from the Bureau of Meteorology (BoM) weather station at Rochester is provided below in Figure 5 as a good indicator of trends across the WSPA. The data shows that rainfall was high in the early 1970's; was below average in the early 1980s; remained relatively steady to the mid 1990's; and was below average until the high rainfall events in 2010/11. In recent years rainfall has mostly been below average which has resulted in reduced recharge to the groundwater system.



**Figure 5 Rainfall at Rochester (BoM station 080049)**

## 2.5 Transfer of entitlement

The Plan allows groundwater licence holders to temporarily or permanently transfer licence entitlement. In 2015/16 there were 43 temporary licence transfers for a total of 7,838 ML/yr and 12 permanent transfers for a total of 2,224 ML/yr. This indicates an increase in the transfer of licence entitlement relative to recent water year, which may be attributed to increased demand for groundwater (Figure 6).



**Figure 6 Total licence transfer volume traded in the Lower Campaspe Valley WSPA**

The majority of temporary licence transfers occurred within the same management zone (Table 3). There were some transfers between zones. A total of 442 ML/yr was temporarily transferred into the Bamawm Zone while there was 41 ML/yr temporarily transferred out of the Echuca Zone and 401 ML/yr temporarily transferred out of the Elmore Rochester Zone. Additionally, there was also 400 ML/yr temporarily transferred out of the Lower Campaspe Valley WSPA from the Barnadown Zone into the Unincorporated Zone.

There was a total of 363 ML/yr transferred permanently into the Elmore-Rochester Zone while there was 171 ML/yr permanently transferred out of the Echuca Zone and 192 ML/yr permanently transferred out of the Bamawm Zone.

**Table 3 Licence transfers in the Lower Campaspe Valley WSPA in 2015/16**

Zone	Temporary				Permanent			
	Transfer from		Transfer to		Transfer from		Transfer to	
	No. of transfers	Volume (ML/yr)	No. of transfers	Volume (ML/yr)	No. of transfers	Volume (ML/yr)	No. of transfers	Volume (ML/yr)
Elmore-Rochester - 1031	13	1,601.3	10	1,200.3	1	50.0	1	413.0
Bamawm - 1032	21	4,694.4	24	5,136.4	8	1,718.0	8	1,526.4
Echuca - 1033	4	717.0	4	676.0	2	451.4	2	280.0
Barnadown - 1034	5	825.0	3	425.0	1	5.0	1	5.0
<b>Total</b>	<b>43</b>	<b>7,837.7</b>	<b>41</b>	<b>7,437.7</b>	<b>12</b>	<b>2,224.4</b>	<b>12</b>	<b>2,224.4</b>

## 2.6 Carryover

The Minister declared that groundwater licence holders in the Lower Campaspe Valley WSPA were authorised to take carryover from November 2012 (Victorian Government Gazette, 2012).

The maximum amount of entitlement that may be carried over by a licence holder in a water year is 25% of their licence volume (13,965 ML).

There was a total of 13,425 ML of carryover available to licence holders in the Lower Campaspe Valley WSPA in the 2015/16 water year.

At the conclusion of the 2015/16 water year, groundwater licence holders in the Lower Campaspe Valley WSPA were able to carryover 12,707 ML into the 2016/17 water year.

## 2.7 Domestic and stock bores installed

GMW received three bore completion reports for bores constructed for domestic and stock purposes in the Lower Campaspe Valley WSPA during the 2015/16 water year.

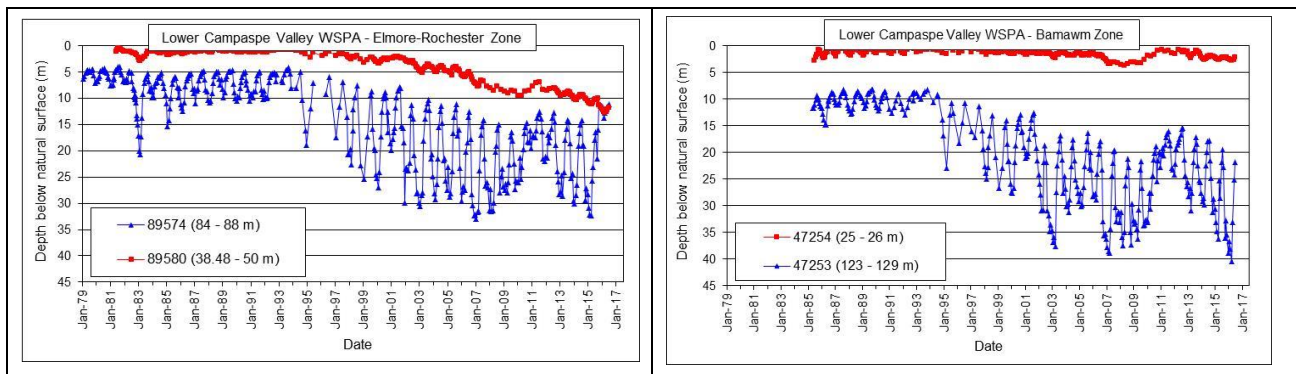
# 3 Monitoring program

## 3.1 Groundwater levels

The Department of Environment, Land, Water and Planning (DELWP) monitored 132 bores from the State Observation Bore Network on a quarterly basis in the Lower Campaspe Valley WSPA (Figure 1).

GMW conducted monthly monitoring of 60 key State observation bores identified in Schedule 1 of the Plan (Appendix B). Monitoring indicates that seasonal groundwater level recovery is strong and observation bore levels are generally within observed historical ranges.

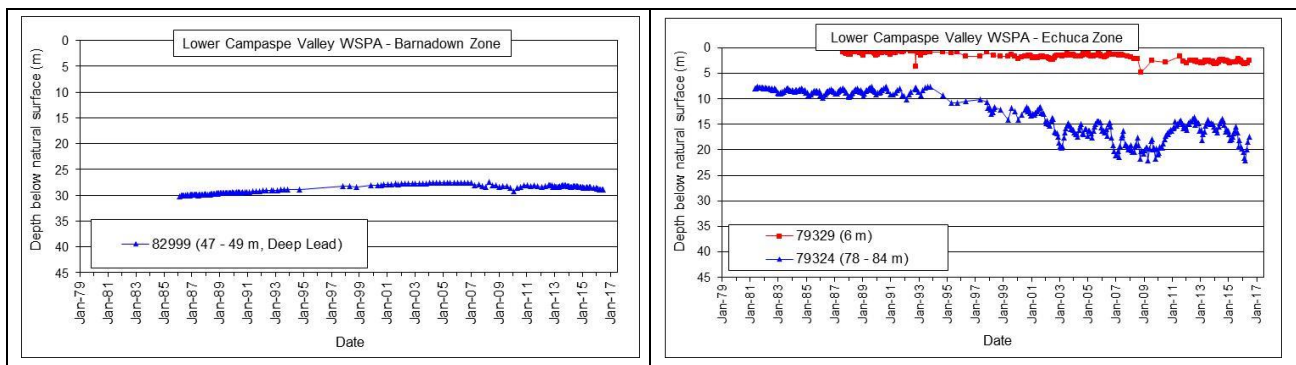
In the Elmore-Rochester and Bamawm Zones, groundwater recovery levels were lower than 2014/15. Seasonal drawdown of up to 18 m was observed in more intensively pumped areas in 2015/16 (Figure 7). In some areas the groundwater drawdown levels were the lowest ever recorded (e.g. bore 47253).



**Figure 7 Groundwater levels in the Elmore-Rochester and Bamawm Zones**

In comparison, in the Barnadown and Echuca Zones groundwater recovery levels have remained relatively steady and seasonal drawdown of up to around 5 m is seen.

Interestingly, in the Barnadown Zone groundwater levels continued to rise through the dry period until about 2005, whereas in other areas levels were generally falling from the mid-1990s. Further, the groundwater levels in the Barnadown Zone did not recover strongly following the wet period in 2010/11 as they did in other areas. Rather, the groundwater levels in the Barnadown Zone appeared to steady, but have been gently declining over the recent water years (Figure 8).



**Figure 8 Groundwater levels in Barnadown and Echuca Zones**

## 3.2 Groundwater quality

### Groundwater user salinity sampling

GMW sent 202 sample bottles and a reply paid envelope to licence holders, and domestic and stock users upon request, to collect a groundwater sample from their bore for analysis. There were 50 samples returned for analysis (a return rate of 25%).

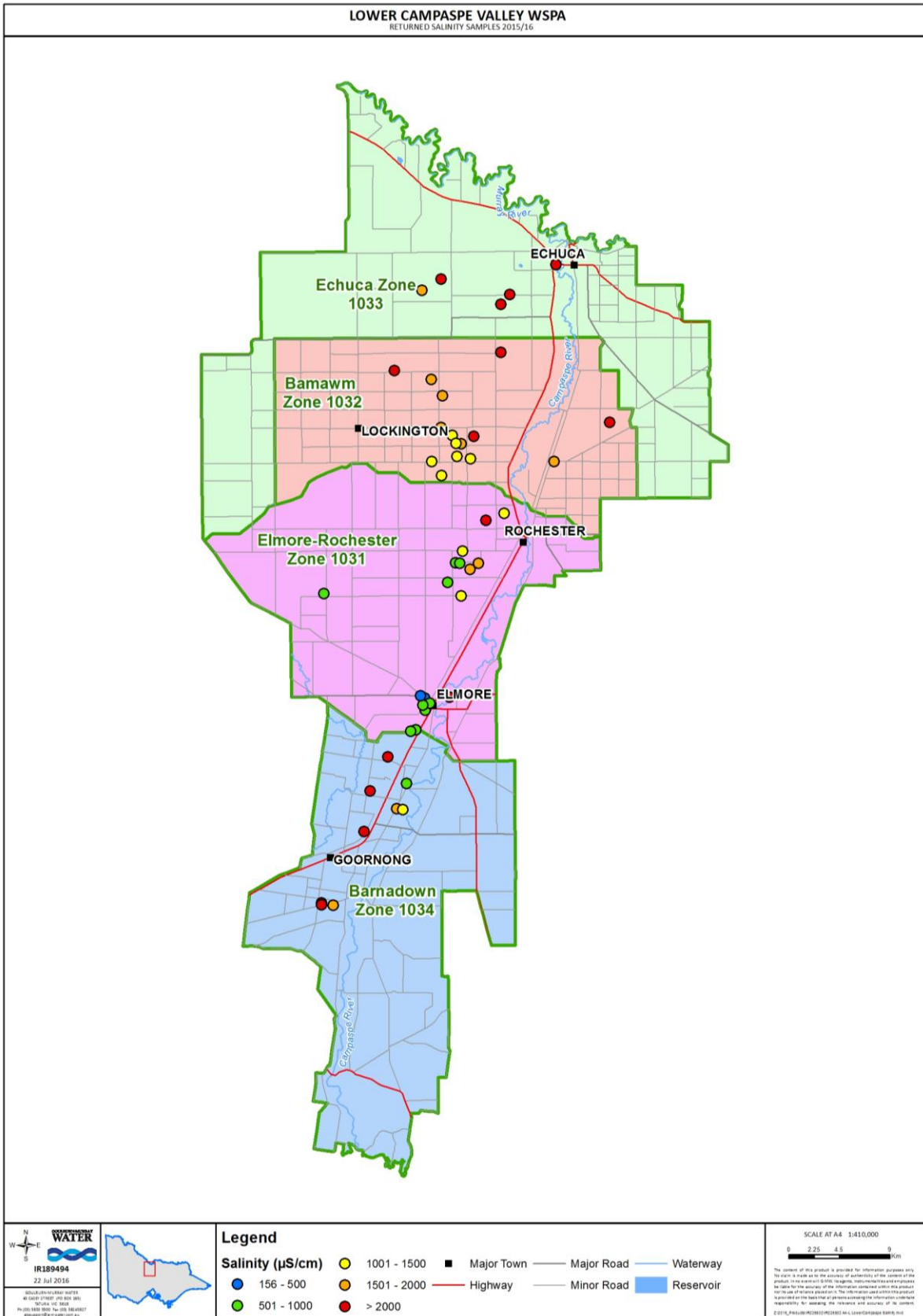
GMW measured the groundwater salinity, advised each bore owner of the result and recorded the data in the State groundwater database. The results are shown spatially in Figure 9 and show more saline groundwater in the northern parts of the Lower Campaspe Valley WSPA. Higher groundwater salinity levels west of the Campaspe River in the Barnadown Zone may be influenced by groundwater contributions from the Huntly Deep Lead.

A higher and more consistent sample return rate would assist with spatially assessing any changes in groundwater salinity over time. Groundwater users are strongly encouraged to participate in this program so that they can identify any changes in groundwater salinity; which in turn enables a greater understanding of how using groundwater from their bore might impact on their business.

### Targeted sampling of licensed bores

GMW has enlisted six licence holders to participate in the targeted groundwater salinity monitoring program. The purpose of the program is to ensure that samples are consistently collected each year from private bores in strategic locations that will provide a reliable data set to aid in understanding any changes in groundwater salinity over time. The results are presented in Appendix C.





**Figure 9 Location of returned samples analysed for groundwater salinity**



## Sampling from State observation bores

Groundwater samples from nested State observation bores were sent to a National Association of Testing Authorities (NATA) accredited laboratory for analysis. Nested sites feature two or more monitoring bores in close proximity, each monitoring a different aquifer. The State observation bores used for water quality testing are located in the areas of intensive groundwater pumping west of Rochester and at the northern margins of the Lower Campaspe Valley WSPA.

Groundwater salinity results are presented in Table 4. The results have been compared to earlier measurements of groundwater salinity (Appendix C). Continued monitoring of groundwater quality will enable any trends to be identified with greater confidence.

**Table 4 Groundwater salinity levels in key monitoring bores October and November 2015**

Bore number	Zone	Screen depth below natural surface (m)	EC ( $\mu\text{S/cm}$ )
102827	Echuca	108 - 114	4,940
102828	Echuca	160 - 167	4,070
102829	Echuca	70 - 74	4,350
73425	Echuca	87 - 89	11,400
73426	Echuca (SIR)	6 - 18	9,830
WRK059873	Bamawm	82 - 87	4,230
WRK059876	Bamawm	91 - 97	3,270
WRK059877	Bamawm	34 - 37	4,470
47250	Bamawm	73 - 85	1,860
47251	Bamawm	22 - 27	4,300
89584	Elmore-Rochester	84 - 88	5,170
89596	Elmore-Rochester	2 - 14	Bore dry

## 3.3 Metering

All operational licensed bores in the Lower Campaspe Valley WSPA were metered as of 30 June 2016. There were nine meters that required maintenance activity in 2015/16 (Table 5).

All meters were read at least twice during the 2015/16 water year.

**Table 5 Metering activities**

Metering activity	Year ending 30 June 2016
Number of meters installed	1
Number of meters replaced	15
Meter maintenance events	5
Total number of meters in WSPA	136
Total number of meter reads	272

### 3.4 Licence compliance

There were no prosecutions or convictions relating to groundwater matters in the Lower Campaspe Valley WSPA in 2015/16.

There were four incidents of unauthorised take and use of groundwater. These incidents have been investigated and GMW has taken action in accordance with the National Framework for Compliance and Enforcement of Systems for Water Resource Management (DSEWPC, 2012). This includes verbal and written notification not to take water without authorisation; a direction to apply to transfer entitlement to account for usage; and providing information on groundwater licence transfer options.

# 4 Future management considerations

## 4.1 Groundwater Reference Committee

The Groundwater Reference Committee, appointed in accordance with Prescription 7(c) of the Plan, met on 2 September 2015. Key points of discussion included:

- Dry conditions;
- Metered usage;
- Trading;
- Carryover;
- Groundwater level response; and
- Groundwater salinity.

There were no actions from the meeting.

## 4.2 SOBN review

The State Observation Bore Network (SOBN) is owned and managed by DELWP.

DEWLP completed the review of the SOBN in 2015/16 which has resulted in a reduction in the number of bores to be monitored in the future.

GMW will seek its customers' views on future groundwater monitoring needs through its Regional Water Services Committees and the Groundwater Reference Committee.

## 5 References

Australian Government Department of Sustainability, Environment, Water, Population and Communities, 2012. National Framework for Compliance and Enforcement of Systems for Water Resource Management. Viewed 28 August 2014, <http://www.environment.gov.au/system/files/resources/d4367a3b-28a9-430d-a869-2effbda8a447/files/ris-water-compliance-enforcement.pdf>

Goulburn-Murray Water, 2013. Lower Campaspe Valley Water Supply Protection Area Groundwater Targeted licensed bore sampling. Unpublished report by Goulburn-Murray Water, Tatura. Document reference number 3503975.

Department of Sustainability and Environment, 2012. Lower Campaspe Valley Water Supply Protection Area Groundwater Management Plan October 2013. Department of Environment and Primary Industries, Melbourne

Victorian Government, 2012. Victorian Government Gazette No. G43 25 October 2012. Victoria Government, Melbourne

Victorian Government, 2013. Victorian Government Gazette No. G10 7 March 2013. Victoria Government, Melbourne

## Appendix A – Assessment of activities against Plan prescriptions

Prescription	Activity	Compliant
<p><b>Prescription 1: Triggers and Restrictions</b></p> <p>By 1 July each year the Corporation will:</p> <ul style="list-style-type: none"> <li>(a) Determine the rolling average of the maximum annual groundwater recovery levels from the preceding three seasons for the relevant bore, or its replacement, and announce a corresponding allocation for the subsequent season for zones as detailed in the Plan.</li> <li>(b) Announce seasonal allocations by listing them on its website; sending letters to all licence holders and placing public notices in local newspapers.</li> <li>(c) Not apply restrictions to any water authorised to be taken in a subsequent water season (carryover).</li> </ul>	<p>GMW determined the rolling average of the maximum annual groundwater recovery levels from the preceding three water years and announced allocations of 100% in all management zones on 1 July 2015.</p> <p>GMW announced allocations by listing them on their website, sending letters to all licence holders and placing public notices in local newspapers.</p>	Yes
<p><b>Prescription 2: Trading rules</b></p> <p>The Corporation may approve a transfer of a groundwater licence under section 62 of the <i>Water Act 1989</i> provided section 53 matters have been considered and it accords with the following:</p> <ul style="list-style-type: none"> <li>(a) Transfer of licence entitlement can occur between zones as specified in the Plan</li> <li>(b) Despite (a) above, if the groundwater level falls to a depth of 18 metres below the natural surface in bore 62589 a licence may be transferred between the Barnadown Zone and other zones</li> <li>(c) Limits on the maximum licence volume in each zone as specified in the Plan are not exceeded.</li> </ul>	<p>GMW processed 43 temporary transfer transactions for a total of 7,838 ML; and 12 permanent transfer transactions for a total of 2224 ML in 2015/16.</p> <p>GMW processed all groundwater licence applications in accordance with Prescription 2(a) and (c).</p>	Yes
<p><b>Prescription 3: Intensive groundwater pumping</b></p> <p>The Corporation may approve an application to take and use groundwater under section 51 or a transfer under section 62 of the <i>Water Act 1989</i> provided that section 53 matters have been considered and the following conditions are satisfied:</p> <ul style="list-style-type: none"> <li>(a) For a permanent transfer, the total licence entitlement of bores within a 4 km radius of an applicant's bore is less than 7.5 GL/yr.</li> <li>(b) Where summed licence entitlement exceed the limits specified in (a) above, then a licence holder's usage is to be limited to 125% of entitlement in one water season whether it occurs through either temporary transfer of entitlement or carryover.</li> <li>(c) Usage may exceed 125% of entitlement as specified in (b) above through temporary or permanent transfer of entitlement from others within the 4 km radius.</li> </ul>	<p>GMW processed all groundwater licence applications in accordance with Prescription 3.</p>	Yes

<p><b>Prescription 4: Monitoring groundwater levels</b></p> <p>The Corporation will:</p> <ul style="list-style-type: none"> <li>(a) Obtain monthly groundwater level readings (up to 480 readings per season) from key State observation bores from the list in Schedule 1, or their replacement, where practicable.</li> <li>(b) Install at least one new observation bore in the Coonambidgal Formation to better inform groundwater interaction with the Campaspe River.</li> </ul>	<p>GMW obtained monthly groundwater level readings from bores listed in Schedule 1 of the Plan where practicable.</p> <p>A new observation bore is still to be installed in the Coonambidgal Formation. Consideration will be given to the installation of this bore now that the Department of Environment, Land, Water and Planning have completed the review of the State Observation Bore Network.</p>	<p>Yes</p>
<p><b>Prescription 5: Monitoring groundwater salinity</b></p> <p>The Corporation will:</p> <ul style="list-style-type: none"> <li>(a) Support annual groundwater user salinity sampling by: <ul style="list-style-type: none"> <li>(i) Providing a sample bottle and a reply paid envelope to each groundwater licence holder and request that they collect a groundwater sample from all their licensed bores and return the samples to the Corporation for salinity analysis.</li> <li>(ii) Providing a sample bottle and a reply paid envelope to any domestic and stock groundwater user upon their request for them to provide a sample for salinity analysis.</li> <li>(iii) Measuring groundwater salinity in all returned sample bottles and providing the bore owner with the results.</li> <li>(iv) Entering the groundwater salinity results into the State groundwater database.</li> </ul> </li> <li>(b) Establish a targeted groundwater salinity monitoring program to collect and analyse groundwater samples from selected licensed bores each year.</li> <li>(c) Collect groundwater samples from selected State observation bores identified in Schedule 1 where practicable, or their replacement.</li> </ul>	<p>GMW provided a sample bottle to licence holders and domestic and stock users upon request. GMW measured the groundwater salinity in returned samples, advised bore owners of the result and entered the results into the State groundwater database.</p> <p>GMW engaged with the six land holders participating in the target sampling of licensed bores. A total of 11 bores were sampled in 2015/16.</p> <p>GMW collected groundwater samples from nested State observation bores identified in Schedule 1 where practicable and sent them to a NATA accredited laboratory for analysis.</p>	<p>Yes</p>
<p><b>Prescription 6: Metered licensed use</b></p> <p>The Corporation will:</p> <ul style="list-style-type: none"> <li>(a) Ensure that a meter is fitted to all operational licensed bores.</li> <li>(b) Read each meter at least once a year and enter readings into the Water Register.</li> </ul>	<p>All operational licensed bores are metered. Meters were read in February/March and May/June 2016 and data entered into the Water Register.</p>	<p>Yes</p>

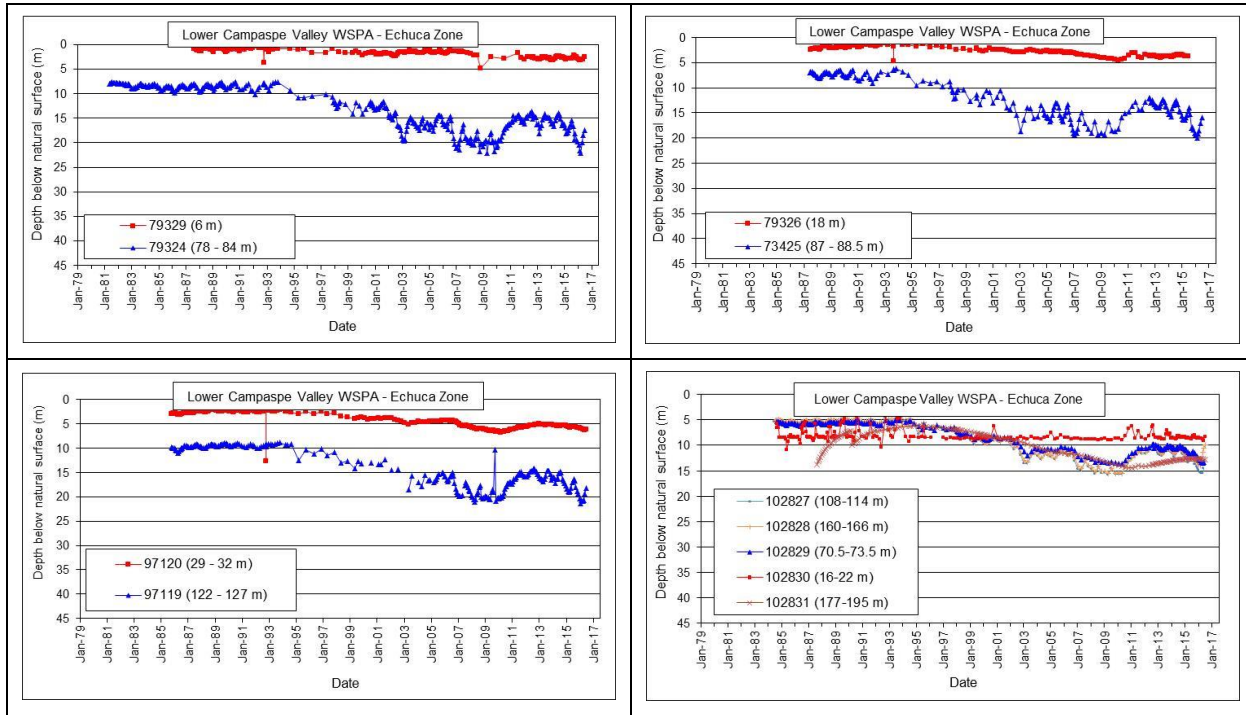
<p><b>Prescription 7: Plan implementation</b></p> <p>The Corporation will:</p> <ul style="list-style-type: none"> <li>(a) Post on its website the Plan; annual reports and newsletters; groundwater levels; and rolling average for trigger bores.</li> <li>(b) Mail a newsletter in October each year to groundwater licence holders, and domestic and stock users upon request, in the Lower Campaspe Valley WSPA and relevant agencies stating the resource position and summarising outcomes in the annual report.</li> <li>(c) Meet with the Groundwater Reference Committee at least once each year to report on the groundwater resource status and implementation of the Plan and consider the need to review the Plan.</li> <li>(d) Undertake a comprehensive review of the Plan after five years from</li> </ul>	<p>GMW has posted on its website the Plan, annual reports, groundwater level and rolling average for trigger bores.</p> <p>Newsletters reporting on resource status and implementation of the Plan were provided in September 2015.</p> <p>GMW met with the Groundwater Reference Committee in September 2015 to discuss Plan implementation.</p>	<p>Yes</p>
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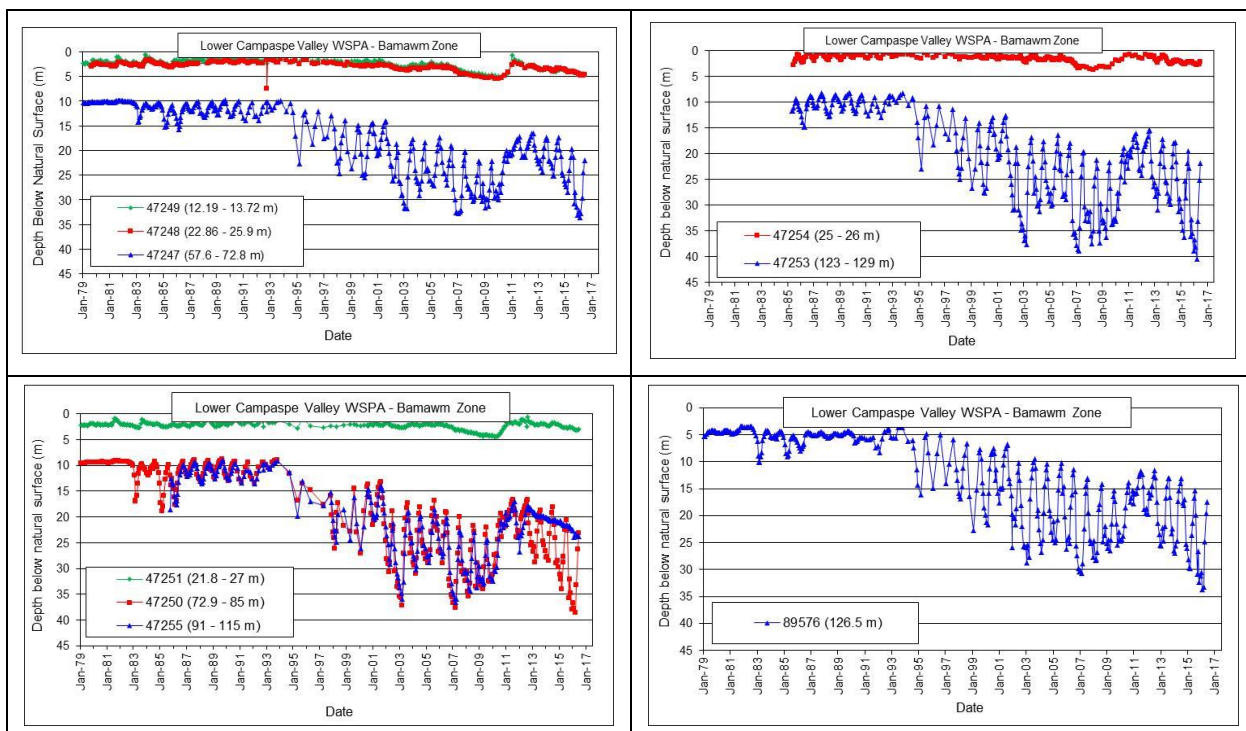
# Appendix B – Hydrographs

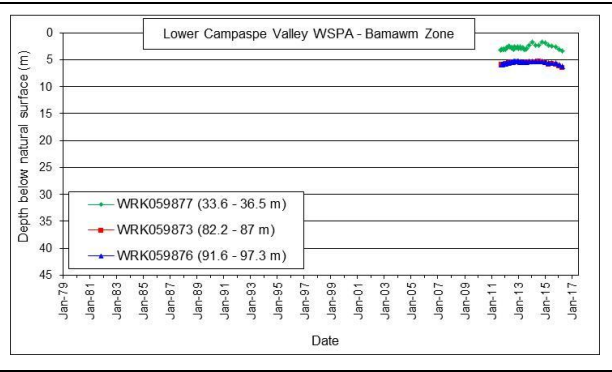
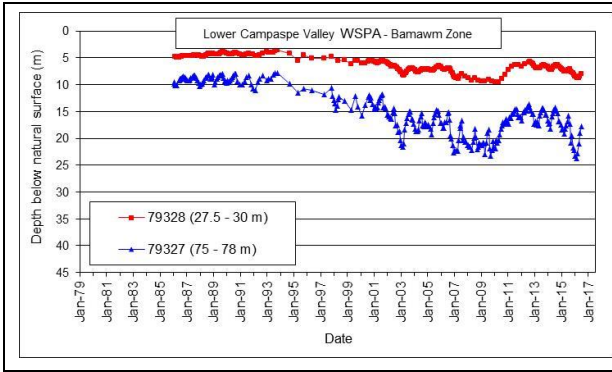
Hydrographs for key monitoring bores listed in Schedule 1 of the Plan. Further groundwater level information from other State observation bores is available on the Visualising Victoria's Groundwater website at <http://www.vvg.org.au>.

## Echuca Zone

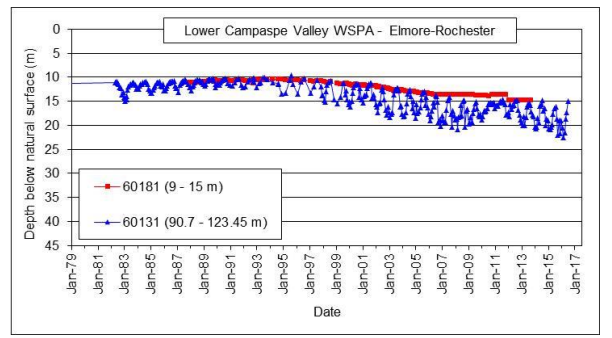
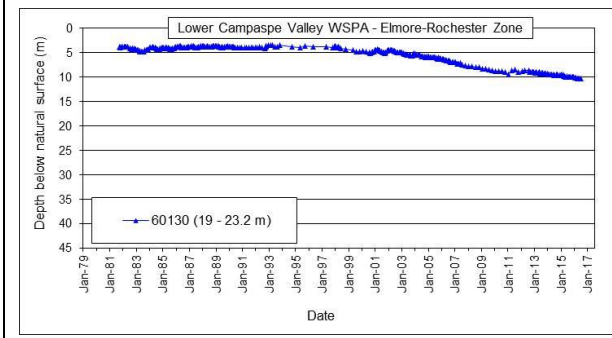
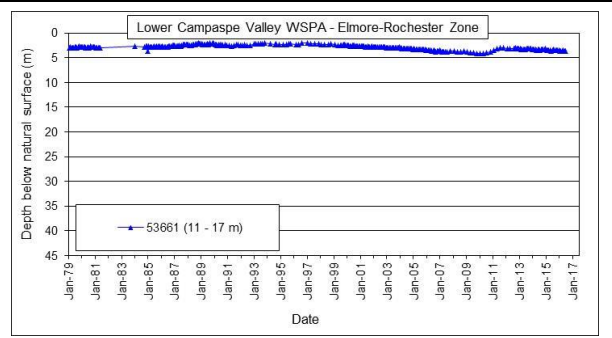
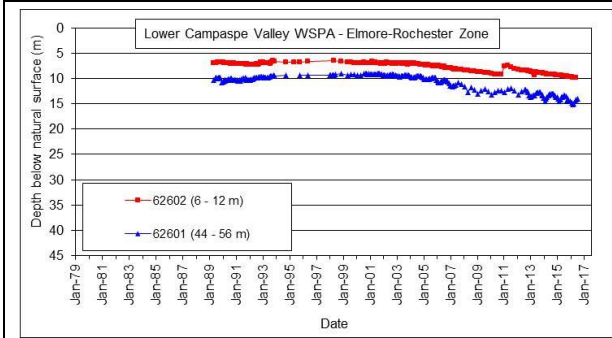
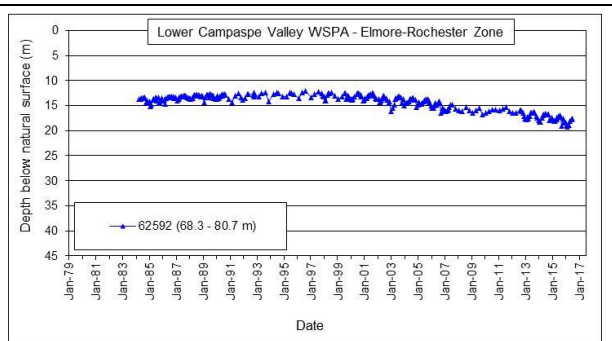
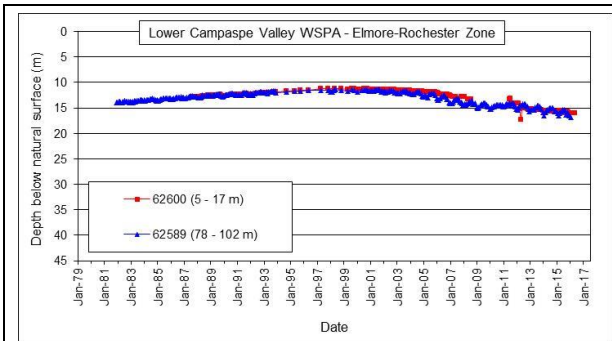


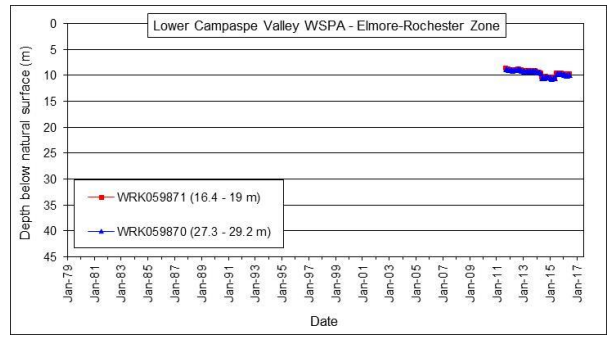
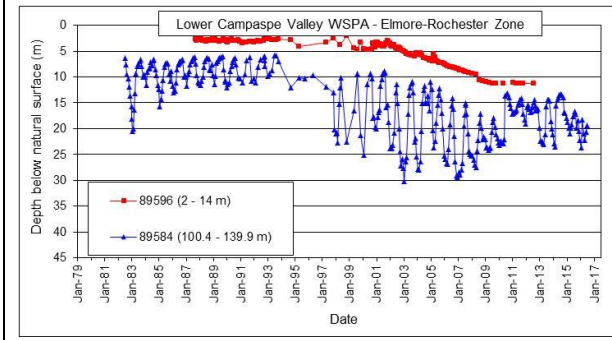
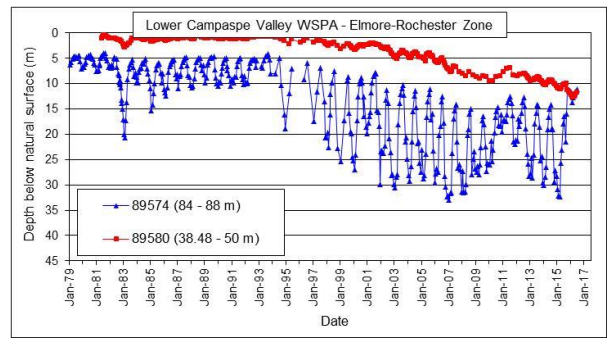
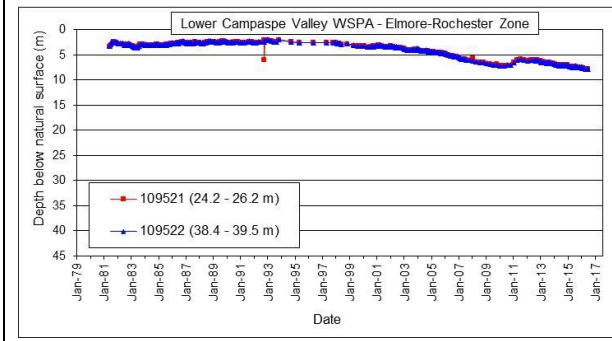
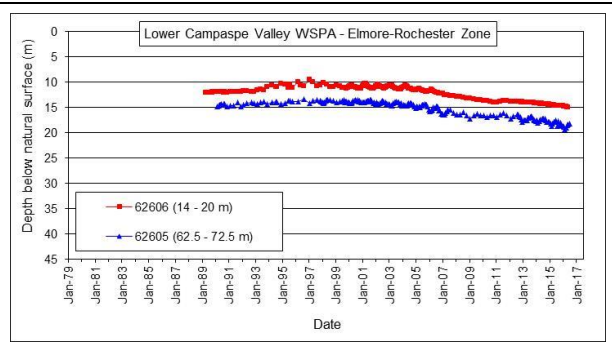
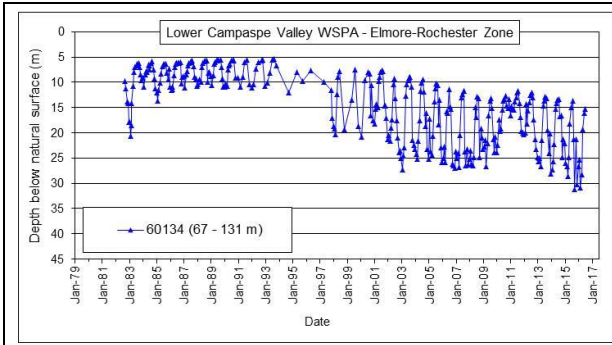
## Bamawm Zone



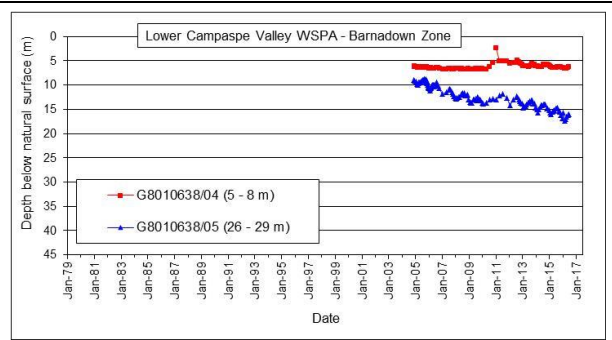
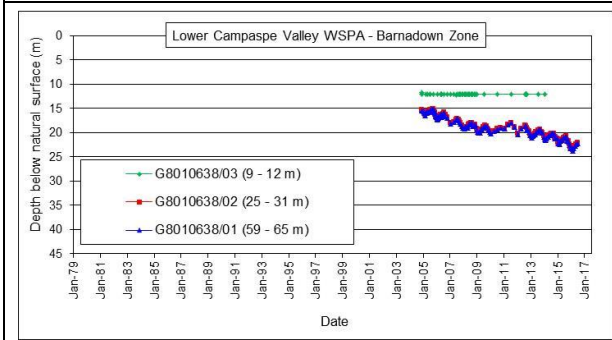
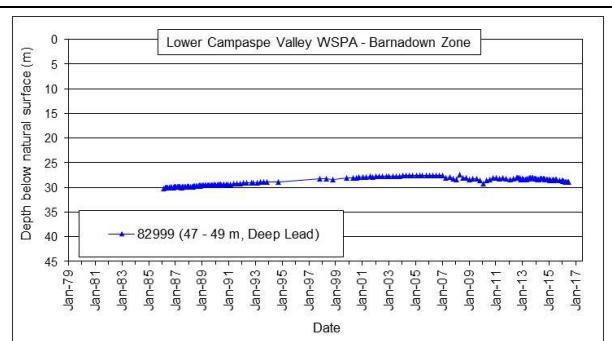
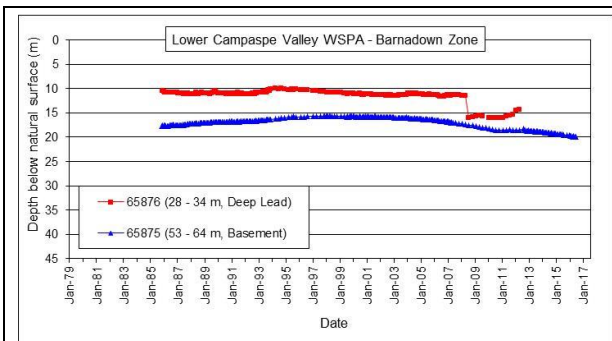


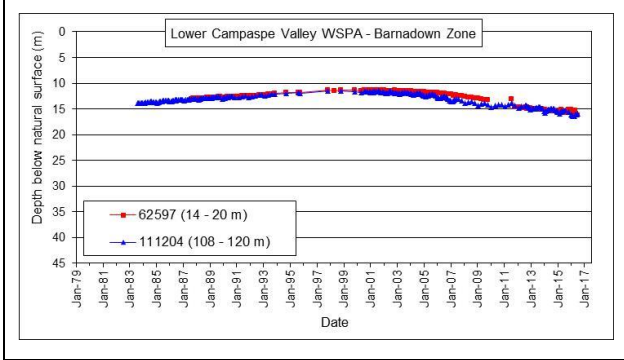
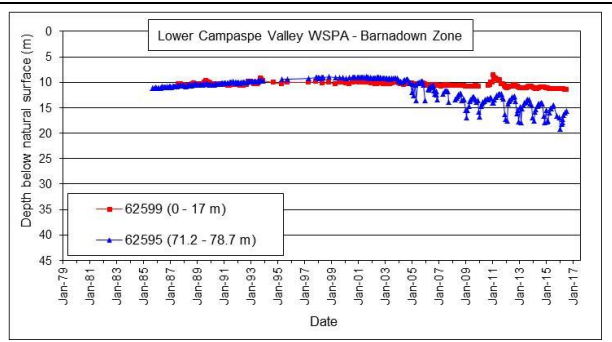
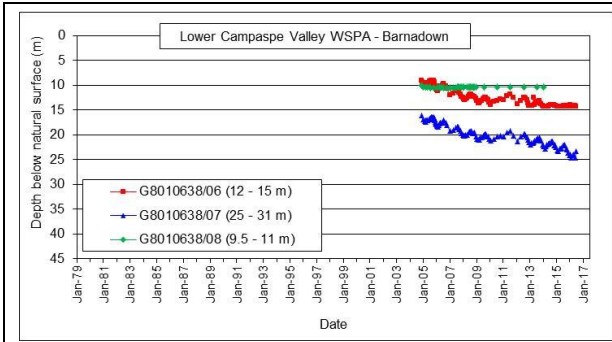
## Elmore-Rochester Zone





## Barnadown Zone

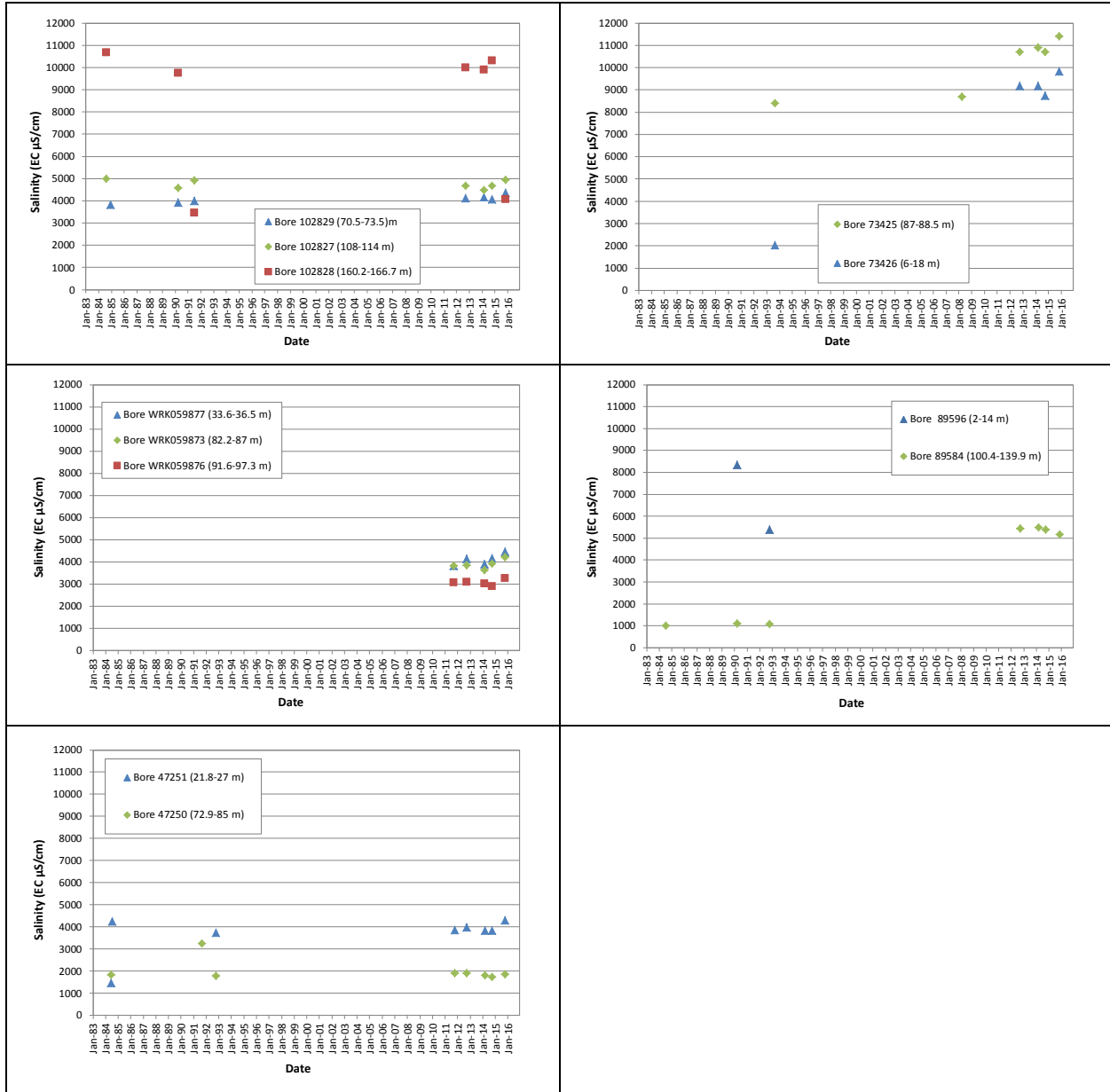






# Appendix C – Groundwater quality

Historical groundwater salinity from State observation bores listed in Schedule 1 of the Plan



## Groundwater quality results from State observation bores listed in Schedule 1 of the Plan

Analyte	Bore	102828	102827	102829	WRK 059873	WRK 059876	WRK 059877	47251	47250	73425	73426	89584
		17/11/16	17/11/16	17/11/16	15/10/16	15/10/16	15/10/16	15/10/15	15/10/15	16/11/15	16/11/15	16/11/16
Electrical Conductivity @ 25°C	µS/cm	4350	4940	4070	4230	3270	4470	4300	1860	11400	9830	5170
pH Colour	Units	7.84	8.83	7.46	7.06	7.08	7.31	8.77	8.98	7.21	6.94	5.48
Oxidised Nitrogen	mg/L	0.01	0.01	0.03	0.03	0.06	0.94	0.14	0.02	0.04	2.26	0.01
Sulphate as SO <sub>4</sub> - Turbidimetric	mg/L	267	184	318	205	2	318	193	15	528	809	2
Ionic Balance	%	4.71	5.78	2.59	1.93	0.32	3.28	3.45	8.32	1.31	1	12.2
Total Anions	meq/L	38.9	42.4	36.4	37.4	30	40.4	37.6	17	114	98.1	44.6
Total Cations	meq/L	42.7	47.6	38.3	38.9	29.8	43.2	40.3	14.4	112	100	30
Total Alkalinity, as CaCO <sub>3</sub>	mg/L	199	135	209	148	188	166	154	79	214	44	1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	mg/L	199	104	209	148	188	166	125	58	214	44	1
Calcium	mg/L	36	11	28	72	44	58	11	1	128	121	58
Carbonate Alkalinity as CaCO <sub>3</sub>	mg/L	1	31	1	1	1	1	29	21	1	1	1
Chloride	mg/L	1040	1270	906	1070	929	1080	1080	536	3520	2850	1580
Hydroxide Alkalinity as CaCO <sub>3</sub>	mg/L	1	1	1	1	1	1	1	1	1	1	1
Potassium	mg/L	8	11	7	10	8	12	14	5	13	7	7
Sodium	mg/L	770	872	712	605	498	735	778	293	1850	1690	381
Ammonia	mg/L	0.02	0.09	0.02	0.09	0.1	0.03	0.16	0.14	0.12	0.02	1.25
Nitrite	mg/L	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate	mg/L	0.01	0.01	0.03	0.03	0.06	0.94	0.14	0.02	0.04	2.26	0.01
Total Kjeldahl Nitrogen as N	mg/L	0.1	0.6	0.1	0.1	0.4	0.1	0.2	0.4	0.3	0.1	3.6
Total Nitrogen as N	mg/L	0.1	0.6	0.1	0.1	0.5	0.9	0.3	0.4	0.3	2.3	3.6
Arsenic	mg/L	0.001	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Iron	mg/L	0.05	0.05	14.7	5.13	0.21	0.05	0.05	0.05	0.98	0.05	502
Magnesium	mg/L	88	107	70	106	70	97	67	18	297	248	126
Manganese	mg/L	0.013	0.129	0.316	0.193	0.096	0.001	0.057	0.025	0.109	0.003	16.8
Total Dissolved Solids @ 180°C	mg/L	2320	2670	1990	2440	2030	2340	2260	936	6220	4930	2720
Turbidity	NTU	46.6	54.4	104	7.2	19.3	0.8	35.7	25	7.2	46.4	51.2
Total Phosphorus as P	mg/L	0.04	0.01	0.04	0.03	0.1	0.01	0.01	0.01	0.05	0.04	0.04
Total Organic Carbon (TOC)	mg/L	1	1	1	1	4	1	1	1	1	1	2
Lead	mg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/L	0.093	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.005	0.001
Chromium	mg/L	0.001	0.001	0.001	0.001	0.001	0.007	0.001	0.003	0.001	0.001	0.001
Copper	mg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004
Zinc	mg/L	0.01	0.005	0.005	0.005	0.005	0.007	0.005	0.005	0.005	0.007	0.023

# Groundwater salinity results from targeted sampling program with available historical data

