Review of the

Katunga

Water Supply Protection Area

Groundwater Management Plan

Final Report

February 2012

Document Number: 3237386

Glossary

Term/Acronym	Description
Act	*Water Act* 1989
AHD	The Australian Height Datum is a geodetic datum for altitude measurement in Australia. It is the mean sea level for 1966-1968 and is assigned the value of zero.
Aquifer	an underground layer of rock or sand or other geological unit that contains water
Available drawdown	The depth of water in the bore minus 2 metres.
Carryover	Carryover is unused allocation that may be used in subsequent years.
Corporation	Goulburn-Murray Water Rural Water Corporation acting as a delegate of the Minister
DBNS	Depth below natural surface
Deep Lead	The sand and gravel aquifer formed by the deposits of the Calivil Formation and Renmark Group (geological units)
Drawdown	groundwater level fall from the standing water level due to groundwater pumping
Entitlement	Licensed volume of groundwater specified as megalitres per year
GDE	Groundwater dependant ecosystem
Groundwater licence	Licence issued to take and use groundwater under section 51 of the Act
GMA	Groundwater Management Area
GMS	Groundwater Management System is a database of groundwater information managed by the Department of Sustainability and Environment Victoria
PCV	Permissible Consumptive Volume is the volume of groundwater that the Minister has declared may be extracted from a defined area in a season
Sustainable yield	Groundwater extraction regime, measured over a specified planning timeframe, that allows acceptable levels of stress and protects the

	higher value uses that have a dependency on water
Transfer	Transfer of licensed groundwater entitlement from one licence holder to another
ML	Megalitre or one million litres
Maximum groundwater level recovery	The highest groundwater level to which groundwater will return to after pumping has ceased
Season	Period of 12 months commencing 1 July
WSPA	Water Supply Protection Area
Zone	A part of the groundwater management area

Executive Summary

It is a requirement of the Katunga Water Supply Protection Area Groundwater Management Plan (the Plan) that a performance review of the Plan is undertaken after five years of its implementation. The Plan has been reviewed and several recommendations for improvement are proposed.

The aim of the review is to consider the performance of the groundwater management plan since its approval in 2006, taking into account new information gathered over the life of the Plan, changes in policy and legislation, and the views of groundwater users. As part of the review a survey of groundwater licence holders was undertaken, with 20% of licence holders providing their views on the Plan.

The Plan has provided a robust management framework which has ensured that licence holders and stock and domestic users have retained access to valuable groundwater resources throughout a period of extended drought. Although the Plan has worked well, the review has concluded that some changes should be considered that could improve groundwater management even further.

The recommended changes relate primarily to the annual allocation methodology, and to the current trading rules. In addition it is recommended that the introduction of carryover be considered, along with improvements to the way groundwater salinity is monitored.

The current allocation methodology is based on a five year rolling average usage trigger, with the objective of keeping five year average groundwater recovery levels within 20 m of the natural surface. Five year average groundwater levels have been slowly declining since the groundwater resource was developed in the early 1990's and these average levels are now 3 m below the target level of 20 m. Although this is not an immediate cause for concern, it does suggest that the assumed relationship between groundwater use and groundwater level has not been maintained during the extended drought. Alternative allocation approaches have been considered and it is proposed that a groundwater level based trigger may be a more appropriate basis for setting allocations.

When the Plan was developed and implemented in 2006 the trading prescriptions that were included were considered relatively innovative, and they have enabled groundwater users the flexibility to manage groundwater over the period of the Plan. This review has identified that there are opportunities to 'free up' trade even further by considering temporary transfers above 100% of entitlement and by permitting the temporary transfer of entitlement to landholders who do not already have a groundwater extraction licence. It is proposed that the intensity rules governing permanent transfers

also be applied to temporary transfers. For permanent transfers, the review has concluded that the need for the current constraints on trade within 2 km of the River Murray be reassessed, and that the prescription requiring 20% clawback of entitlement in permanent trade be removed.

The Plan's salinity monitoring requirements were reviewed and changes are recommended to the way salinity is monitored in the WSPA. This change would allow more effective data to be collected, better informing groundwater management in the longer-term.

Some minor changes to groundwater level monitoring are recommended due to changes in the available infrastructure as a result of the recent State Observation Bore Network (SOBN) refurbishment project.

The WSPA boundary and zone boundaries have been reviewed and it is considered that no changes are required.

Finally, it is recognised there are several key groundwater resource issues that are poorly understood. These are:

(a) The timing, magnitude and distribution of vertical leakage through the Shepparton Formation, and the controls on this (i.e. what is the impact of pumping relative to rainfall recharge, irrigation recharge, and evapotranspiration?);

(b) The extent of inflows and outflows from/to the River Murray and the impact of pumping from the deep lead on the River Murray;

(c) The source of the lower salinity groundwater in the north east of the WSPA (i.e. is this 'old' groundwater, more recent vertical leakage or horizontal flow from the east?);

(d) The volume of lateral inflow and outflows to and from the 'deep lead';

(e) The impact of groundwater extraction between NSW and Victoria.

It is recommended that a review of the costs and benefits of further technical work in these areas be considered a priority.

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1 Introduction

1.1 Background

The Katunga Water Supply Protection Area (WSPA) was declared on 14 January 1999 under Part 3 of the Water Act 1989 (referred to hereafter as "the Act"). The Groundwater Management Plan (the Plan) was approved by the Minister for Water in July 2006.

The Katunga WSPA incorporates parts of the flood plains of the River Murray, Broken Creek and the Goulburn River between Yarrawonga and Barmah and covers an area of approximately 2,100 km^2.

The Katunga WSPA includes groundwater resources at depths greater than 25 m below the surface. The groundwater resources occur in the unconsolidated alluvial deposits generally referred to as the Murray Valley Deep Lead Aquifer system. The overlying upper Shepparton Formation aquifers (at depths less than 25 m) also contain significant groundwater resources that are managed separately under the Shepparton Irrigation Region Groundwater Management Plan.

The objective of the Plan as set out in the Act is to make sure that *the water resources of the area are managed in an equitable manner so as to ensure the long-term sustainability of those resources*. The Plan contains a number of management prescriptions which seek to achieve equitable and sustainable use of the groundwater resource.

Section 12 of the Plan states that '*in each fifth annual report the Authority will make comment on the need to review the management plan*'.

The Plan is now five years old therefore Goulburn Murray Water (G-MW) has undertaken a performance review of the plan. This report presents the findings of the review.

1.2 Terms of Reference

The aim of the review was to consider the performance of the Plan since its approval in 2006, taking into account new data gathered over the life of the Plan, changes in policy and legislation, and the views of groundwater users.

The review should be considered as a 'health check' which assesses how the Plan has been working and whether any improvements are required. The review has not included a detailed hydrogeological re-appraisal of the aquifer system nor has it

involved detailed analysis of future options. However, where issues or potential improvements have been identified these have been highlighted as areas for further consideration.

The Plan aims to manage groundwater extractions so that the average spring five-year groundwater level recovers to 20 metres below natural surface (mBNS). Importantly, this report does not seek to review the specific objectives of the plan, as defined by the previous Committee, and so the plan has been reviewed against the stated objectives.

If the objectives of the plan were changed then a more comprehensive review may be required. Should a committee be appointed to review the Plan, it is recommended that the committee give consideration to the Plan objectives to determine whether these are still the most relevant to the community.

2 Policy and Legislation

Section Summary

Significant new water resources policy and legislation has been implemented since the Plan was approved in 2006, including the Commonwealth Water Act (2007), and the Victorian Northern Region Sustainable Water Strategy (2009). Other relevant new guidelines include the NWC Policy Guidelines for Water Planning and Management (2010). This review has concluded that the Plan is broadly consistent with this new policy and legislation, however the following specific areas were identified as requiring further consideration in this review:

a) the Dairy Shed Water Licence Transition Program and the impact of new entitlement on the Permissible Consumptive Volume and the Plan's allocation methodology;

b) The potential to improve flexibility through more liberal trade rules;

c) The potential to improve flexibility by implementing carryover;

d) Investigation of the use of trigger levels to set allocations;

e) Further consideration of the environmental impacts of groundwater extraction, particularly on groundwater dependent ecosystems (GDEs) and waterways.

It is recognised that there are likely to be significant policy and legislative changes in the future, with the publication of the Draft Murray Darling Basin Plan (later in 2011) and the future implementation of the Victorian government's Secure Allocations Future Entitlements project. However the scope and content of these changes is not yet clear, and so have not been considered in this review.

2.1 Background

There have been a number of policy and legislation changes since the Plan was approved in 2006 at a national, state and local level. The key changes are summarised below, and where appropriate, reference has been made to the implications for the future management of groundwater resources in the Plan.

2.2 Discussion

The National Water Initiative

In 2004 the Council of Australian Governments (COAG) agreed to the National Water Initiative (NWI); Australia's blueprint for national water reform.

As part of the NWI, the National Water Commission is required to[1] ensure that state governments work towards:

- preparing water plans with provision for the environment;
- dealing with over-allocated or stressed water systems;
- introducing registers of water rights and standards for water accounting;
- expanding the trade in water;
- improving pricing for water storage and delivery; and
- meeting and managing urban water demands.

As part of the NWI, the National Water Commission, in conjunction with state water agencies and the Murray–Darling Basin Authority, developed Policy Guidelines for Water Planning and Management (2010). These guidelines highlight good practice approaches to planning and management of water resources through the following areas:

- Overarching water planning principles
- Stakeholder engagement
- Plan development
- Describing the water resource
- Setting objectives and outcomes
- Management arrangements
- Monitoring

These guidelines have been examined in the context of the Plan, and the Plan is believed to largely be aligned with these principles.

Northern Region Sustainable Water Strategy

Regional sustainable water strategies were legislated through the 2005 amendments to the *Victorian Water Act, 1989*, and help to fulfil Victoria's commitment to the

[1] Refer to http://www.nwc.gov.au/www/html/117-national-water-initiative.asp

National Water Initiative. The Northern Region Sustainable Water Strategy is a Victorian Government initiative to secure the region's water future. Its purpose is to guide the development, integration and implementation of management plans prepared by rural water corporations and catchment management authorities operating within northern Victoria.

The strategy recommends the adoption of a number of measures to address groundwater issues including the introduction of carryover and permanent trade. The key areas considered to be directly relevant to the Plan are:

- The Dairy Shed Water Licence Transition Program and the impact of increased entitlement on the Permissible Consumptive Volume, and the annual allocation methodology (Section 4 – 'Groundwater Entitlement' of this review);
- The potential to improve flexibility through more liberal trade rules (Section 8 –'Trading – Permanent Transfers' & Section 9 –'Trading - Temporary Transfers' of the review);
- The potential to improve flexibility by implementing carryover (Section 10 – 'Carryover' of the review);
- Investigation of the use of trigger levels for allocations (Section 5 –'Annual Groundwater Allocations' of the review); and
- Further consideration of the environmental impacts of groundwater extraction, in particular, impacts to groundwater dependent ecosystems (GDEs) and waterways (Section 14 –'Environmental Considerations' of the review).

Each of these issues is discussed in more detail within this review.

The Commonwealth Water Act 2007

On 15 December 2008, the new Murray–Darling Basin Authority absorbed all the functions of the former Murray–Darling Basin Commission, which ceased to exist. One of the roles of the Authority is to prepare a Basin Plan in consultation with states and communities. The first Draft Basin Plan is currently scheduled for publication in late 2011. It will include setting limits on the amount of water (both surface water and groundwater) that can be taken from the Basin on a sustainable basis.

Secure Allocation Future Entitlement (SAFE)

The Secure Allocation Future Entitlement project (SAFE), funded by the NWC, aims to create a new groundwater management framework whereby all groundwater resources in Victoria are managed in a defined groundwater management area.

The specific objectives of the project are to develop:

- Management boundaries that cover all groundwater in the state instead of only part of it;
- Guidance for decisions about managing each area;
- Guideline for better determining the volume of groundwater available for use.

It is recognised that there are likely to be significant policy and legislative changes in the future with the publication of the Draft Murray Darling Basin Plan and the Victorian governments SAFE project, however the scope of and content of these changes is not yet clear, and so these have not been considered in this review.

3 Water Supply Protection Area Boundary

Section Summary

The existing boundaries of the Katunga WSPA have been reviewed and the key conclusions are:

a) the northern boundary is fixed by the state boundary (Murray River);

b) the north western boundary is the Barmah Forest national park and there is no reason to include this in the WSPA as the key groundwater resource management issue here is the risk posed by rising water levels. There is little risk posed to the Barmah forest as a result of groundwater pumping;

c) the deep lead aquifer is not present along the south eastern boundary;

d) to the south west of the WSPA the groundwater quality is significantly more saline, and there are no licensed bores and only a handful of domestic and stock bores;

e) there is an area of undeveloped deep lead resource to the south-south east of the Katunga WSPA, currently within Unincorporated Area, where the water quality is potentially suitable for development (with shandying), however it is considered more appropriate to assess this as part of any future amendment of the Mid Goulburn GMA;

f) There is no justification for considering changes to the vertical boundary of the Katunga WSPA given the limited vertical connection between the upper and lower Shepparton Formation, and given that the primary objective of the SIR Groundwater Management Plan is to management the risk of shallow groundwater on land productivity and the environment.

This review has concluded that no changes to the existing boundaries are necessary.

3.1 Background

The current boundary of the Katunga WSPA is shown in Figure 1 below. The state boundary (River Murray) forms the northern and north eastern boundary, with the north western boundary defined by the Barmah Millewa National Park.

The rationale for the south western, southern and south eastern boundaries is a combination of factors including; the extent of the surface water irrigation system (the Murray Valley Irrigation System), the distribution of lower salinity groundwater (Figure 2), the saturated thickness and extent of the deep lead aquifer (Figure 3) and the pattern of intensive groundwater use (Figure 4).

The WSPA covers groundwater users with bores deeper than 25 mBNS.

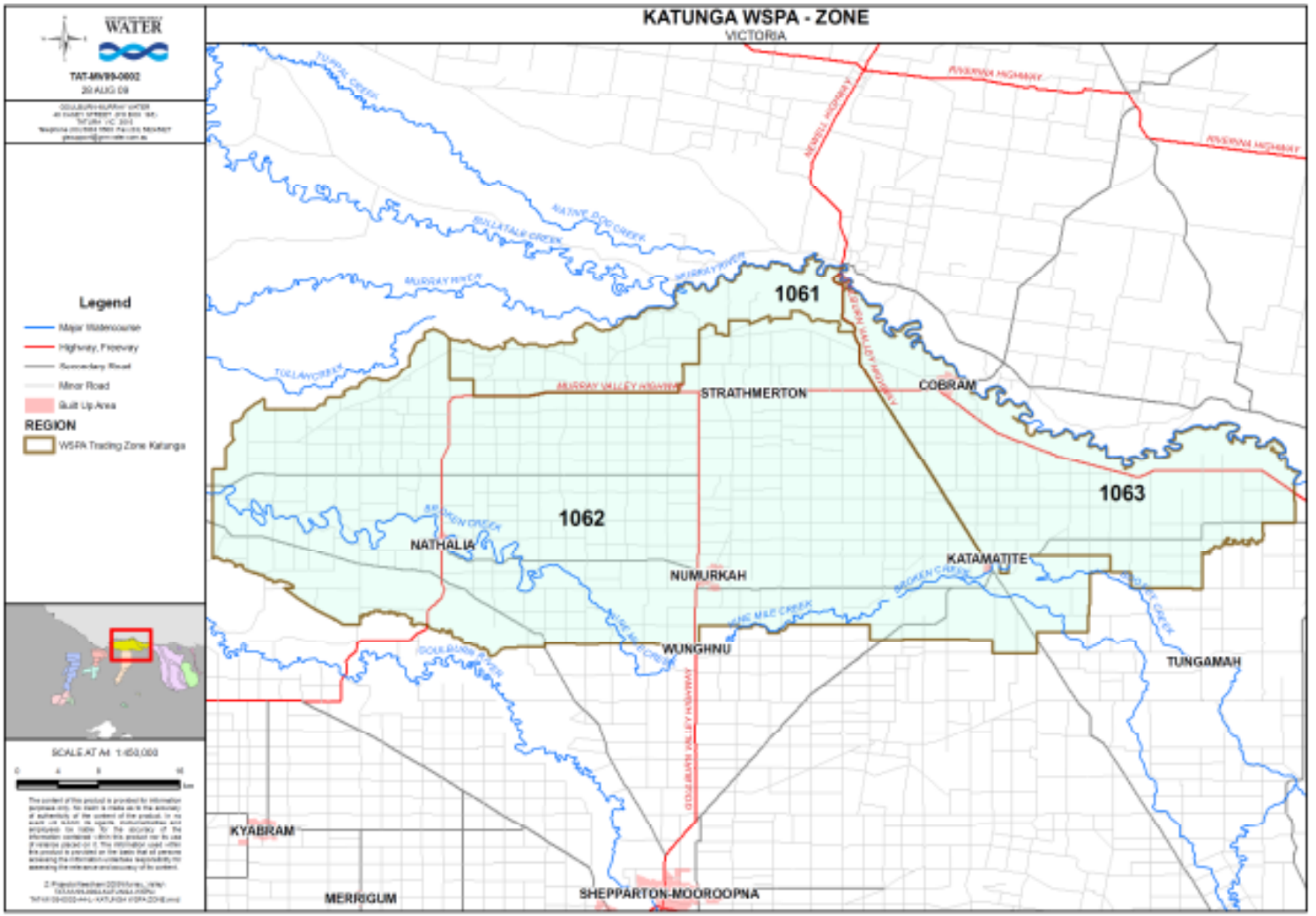


Figure 1 Katunga WSPA and zone boundaries

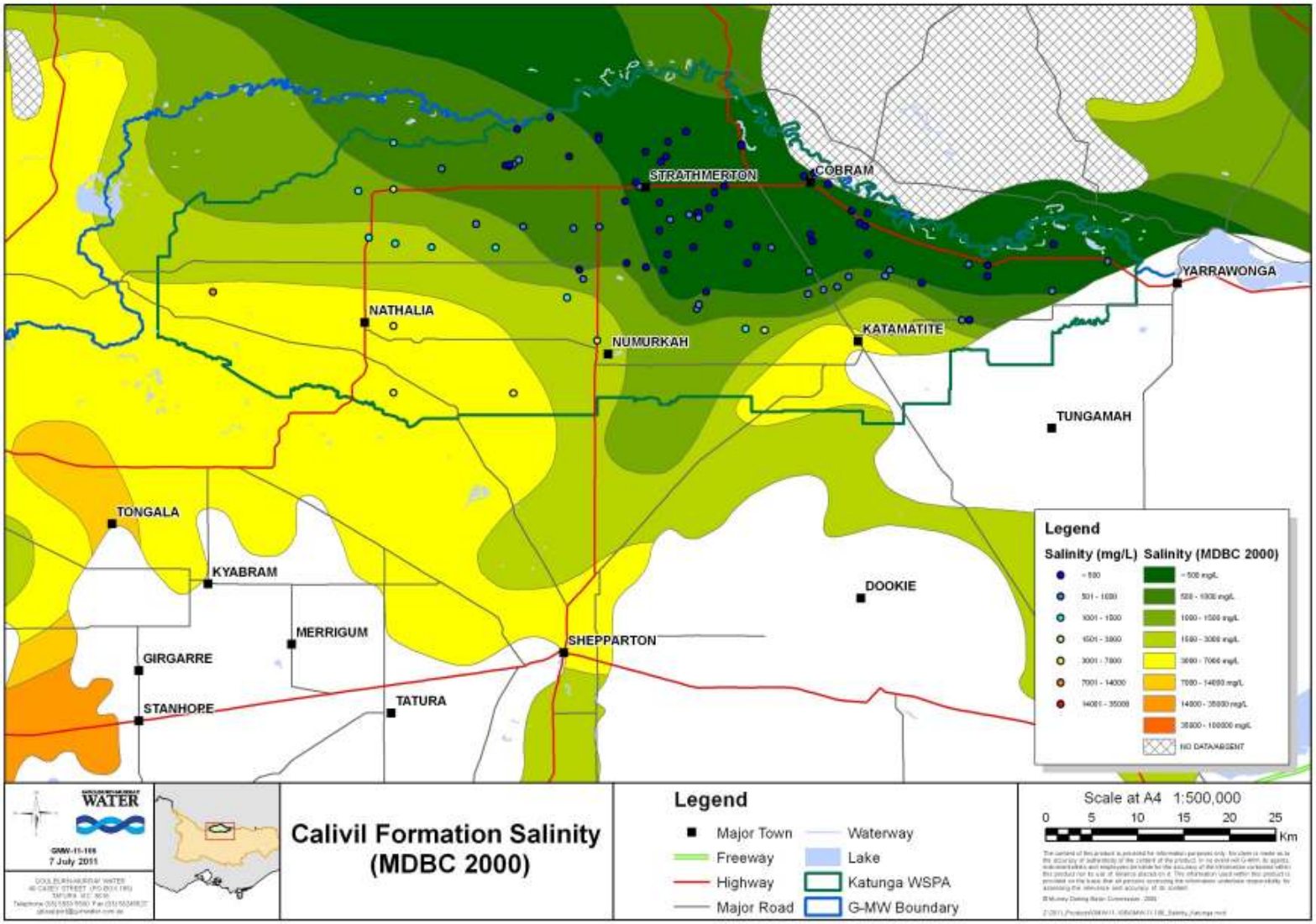


Figure 2 Calivil Formation ('Deep Lead') Salinity (MDBC, 2000 vs. 2006-2010 Pumped Values

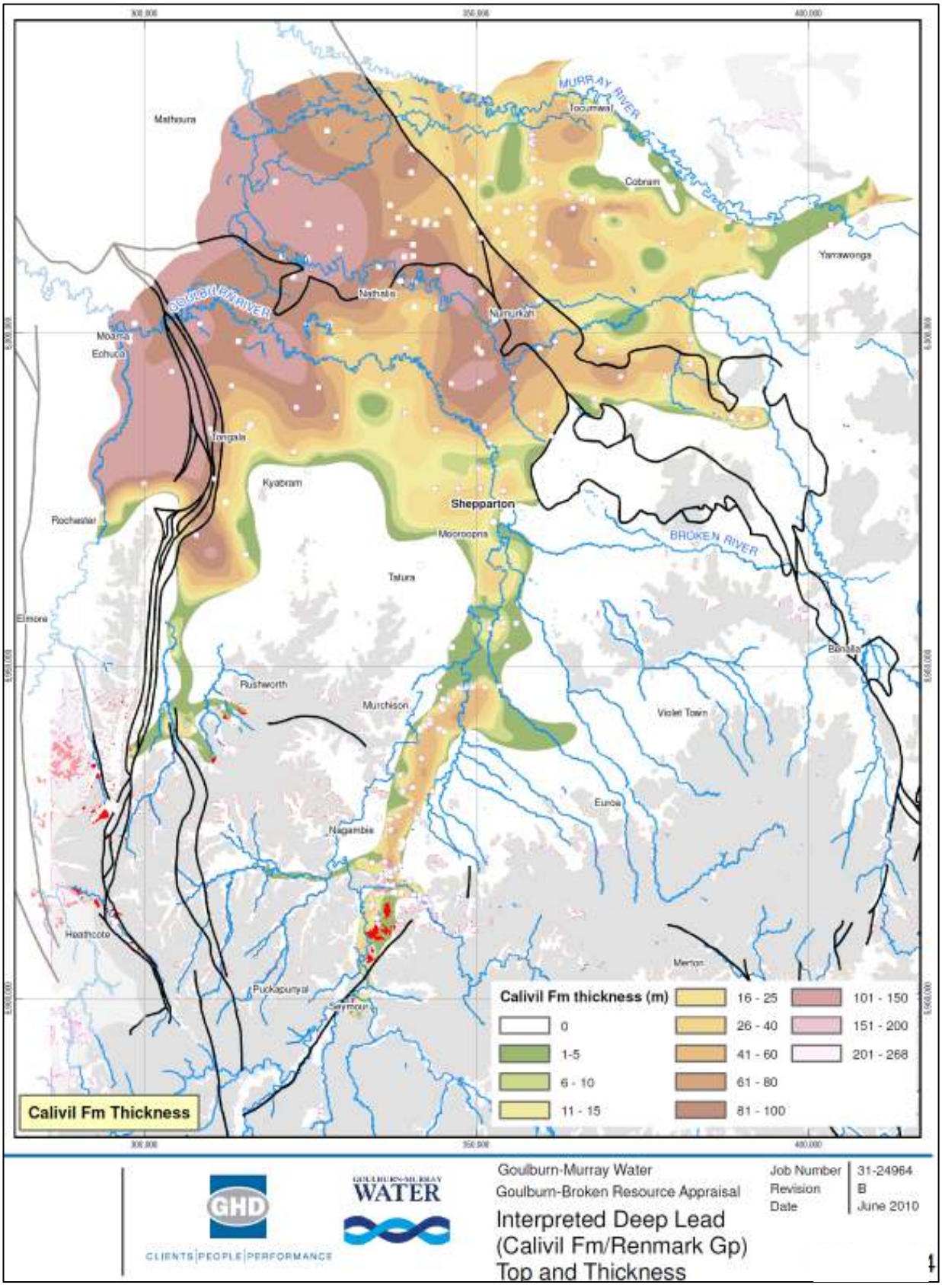


Figure 3 Calivil Formation/ Renmark Group Thickness (GHD, 2010)

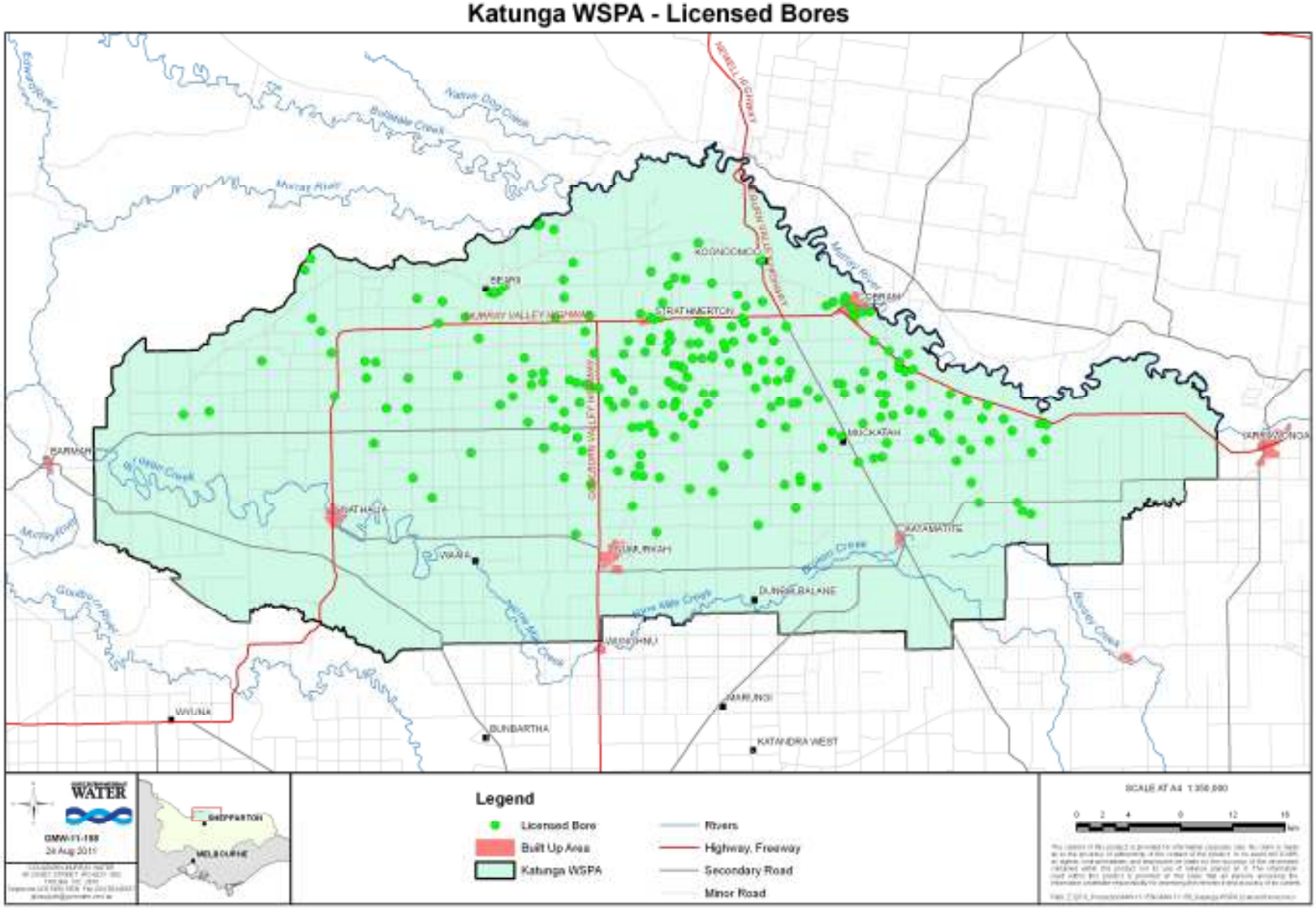


Figure 4 Katunga WSPA Licensed bore locations

3.2 Discussion

The northern boundary of the Katunga WSPA is fixed by the state boundary (River Murray) and cannot be moved. It is recognised that groundwater flows into the WSPA from NSW in the north-east, and flows out to NSW in the north-west.

The north-western boundary of the WSPA is bounded by the Barmah-Millewa National Park and there remains no reason to include this within the Katunga WSPA. The key groundwater issue in the Barmah forest is the risk of high water tables causing salinisation rather than impacts of pumping from the deep lead lowering heads in the Upper Shepparton Formation. In this respect pumping from the Katunga WSPA may actually be having a beneficial effect (albeit small). Groundwater extraction in the National Park itself is generally not likely to be required given the land use, nor allowed (given the National Park status) and therefore there is not a direct driver to include this in the WSPA.

The south central boundary of the WSPA is delineated by the northern extent of the Mid Goulburn GMA. There is no technical reason to extend the Katunga southwards at the expense of the Mid Goulburn GMA, as there is little or no usage south of Numurkah in the Katunga WSPA.

The remaining boundaries, the south-west and the south-east, areas were also considered. Groundwater salinity in the deep lead increases significantly in the south west (Figure 2).This area is not overlain by a surface irrigation network so there is little shandying capacity. Furthermore there are currently no licensed bores to the south-east of Nathalia, and only a handful of stock and domestic bores (Figure 4). It is concluded that there is no driver for extending the Katunga boundary in the south-west.

In the south-east the deep lead is absent east of Katamatite (see Figure 3). There is, however, an area of deep lead to the south and west of Katamatite – heading towards Benalla – that is currently not included within the WSPA boundary. This area is largely unused, and if it were to be developed it is unlikely to have a major impact on pumping heads in the central area of the WSPA. There are no immediate drivers for this section of deep lead to be covered by a groundwater management unit. If, in the future, it is considered that this area should be managed within a GMA, it is considered more appropriate for the area to be included in the Mid Goulburn GMA because the area is hydrogeologically more similar to the Mid Goulburn GMA than the Katunga WSPA.

4 Groundwater Entitlement

Section Summary

The Plan identified 195 groundwater licences in the WSPA authorising a total of 59,780 ML/year.

Groundwater entitlement has varied over the period of the Plan due to:

a) improvements to data quality in the Water Register;

b) clawback of licence associated with permanent transfers (Prescription 10);

c) new dairy shed water licences being issued.

The revised total entitlement volume, including pending dairy shed water licence applications, is 60,645 ML/year, from 246 licenses.

A recalculation of zonal entitlement has identified significant differences in entitlement compared to 2006, particularly in zone 1061 and 1062. The changes are largely the result of more accurate data management and reporting, rather than real movement in entitlement.

4.1 Background

The use of groundwater for other than stock and domestic use is authorised under a groundwater licence issued under Section 51 of the Act. The Plan identified 195 groundwater licences in the WSPA authorising a total of 59,780 ML/year.

4.2 Discussion

Groundwater entitlement has varied over the period of the plan due to:

- data improvements implemented through the Water Register;
- clawback of licence associated with permanent transfers (Prescription 10); and
- new dairy shed water licences being issued.

Improvements to data systems

Since the development of the original groundwater management plan, a Water Register has been developed to record all Victorian water entitlements. This has resulted in greater transparency and ease of reporting entitlement details. The data

cleansing process undertaken with the implementation of this register has resulted in some changes to the entitlement volume attributed to the Katunga WSPA. Although the quality of data available in the Water Register is generally high, there remain instances where inaccurate or incomplete data issues occur.

Clawback relating to permanent transfer (20%)

Prescription 10 of the Plan stipulates a reduction of 20% of entitlement associated with permanent transfers. The annual permanent transfer totals over the period of the plan are shown below.

Table 1 Permanent Trade Volume Katunga WSPA

Permanent trade volume in Katunga WSPA (ML)					
2006/7	2007/8	2008/9	2009/10	2010/11	Total
0	496	109.6	256	587	1449

This prescription has had only a small impact on the total volume of entitlement, which has been reduced by a total of 289.8 ML since 2006/07.

Dairy Shed Water Licence Transition program

The aim of the Dairy Shed Water Licence Transition program is to ensure water historically used in dairy sheds is appropriately licensed (use of water in dairy sheds requires a Section 51 licence). The program involved an amnesty period, during which dairy farm owner operators were able to apply to license their existing historic use. The amnesty concluded on 23 April 2010.

Over 1000 ML of new licence entitlement has been applied for in the Katunga WSPA, and the majority of these applications were processed in 2010/11. The increase in entitlement associated with Dairy Shed Water Licence volume since 2006 is 1199 ML (including 141 ML still to be issued).

Annual Entitlement

The revised total entitlement volume, including pending dairy shed water licence applications, is 60,645 ML/year, from a total of 246 licenses. This figure is shown below, along with entitlement in previous years.

Table 2 Reported annual entitlement volume, Katunga WSPA

Reported annual entitlement volume in Katunga WSPA (ML)					
At 30 June 2006	At 30 June 2007	At 30 June 2008	At 30 June 2009	At 30 June 2010	At 30 June 2011
59,778	59,734	59,577	59,538	59,450	60,645*

* Includes 141 ML dairy shed water licence volume still to be issued.

It is noted that in the recently approved August 2011 permissible consumptive volume (PCV) order[2] dairy shed water licences can be issued in excess of the gazetted annual volume.

Zone Entitlement

The Katunga WSPA is split into three management zones; zone 1061, 1062 and 1063. These zones are discussed in more detail in Section 6 – 'Management Zones'. The management zones are shown in Figure 1.

There are significant differences between the entitlement volumes in each of the zones listed in the plan and the Water Register as shown in Table 3 below. Domestic & Stock volumes are included for information only, as these volumes while included in the Water Register, are not Section 51 licence volumes. There is likely to be Domestic & Stock volume that is not included in the Water Register. This volume has been estimated and is considered to be a small percentage of total entitlement (approximately 0.8%).

Table 3 Katunga WSPA entitlement volume by zone

Management Zone	Katunga Plan volume (June 2006) (ML)	Water Register Take and use Volume (ML) (June 2011)	Difference (ML)	Water Register Domestic & Stock Volume (ML)
1061	4,621	1,883	-2,738	64
1062	34,414	37,999.7	+3,585.7	338
1063	20,745	20,762	-17	136
Total	59,780	60,645*	+865	538

* Includes 141 ML dairy shed water licence volume still to be issued.

The difference in entitlement volume between 2011 and 2006 in zones 1061 and 1062 are largely a result of more accurate data management and reporting, rather than real movement in entitlement. Zone volumes are discussed further in Section 6 – 'Management Zones'.

[2] *Victoria Government Gazette G 28 14 July 2011 p1639*

5 Annual Groundwater Allocations

Section Summary

The annual groundwater allocation methodology has been reviewed.

The current annual allocation methodology set out by the plan is based on an assumed groundwater-usage relationship. This methodology has enabled groundwater users to maintain access to groundwater up to 70% of entitlement through a severe drought period. However five-year average groundwater recovery levels have continued to decline over the period of the plan, and the plan has not met its objective of maintaining the average spring recovery groundwater level at 20 mBNS.

It is recommended that an alternative allocation methodology is adopted. Alternative allocation methodologies have been reviewed and it is recommended that a groundwater level based trigger would be more appropriate.

5.1 Background

One of the main objectives of the Plan is to maintain access to groundwater resources for existing licence holders and stock and domestic users. Prescriptions 1 to 6 of the Plan list the relevant activities to be undertaken by G-MW regarding seasonal allocations.

The Plan seeks to achieve this objective by maintaining a five-year rolling average of spring groundwater recovery levels which is no greater than 20 mBNS. This target level was based on anecdotal evidence and feedback from users and a local pump installer following the peak demand year of 2002/03 when it was reported that some groundwater users could not access groundwater.

Groundwater recovery levels are monitored in eight key bores listed in Schedule 2 of the Plan.

5.2 Allocation Methodology

During the Plan's development, metered usage and measured groundwater levels were compared to investigate the influence of different seasonal usage on groundwater level. In order to draw out the detail of this relationship, a number of other 'dummy' years were included reflecting the usage in 2002/03 (in which usage

peaked at 40,530 ML), as is shown in Figure 5 below. The key features of the comparison were that when groundwater usage is 30,000 ML, the recovery level ranges between 19 mBNS and 21 mBNS. At higher usages, such as 40,000 ML, the recovery level was projected to be between 23 mBNS and 25 mBNS.

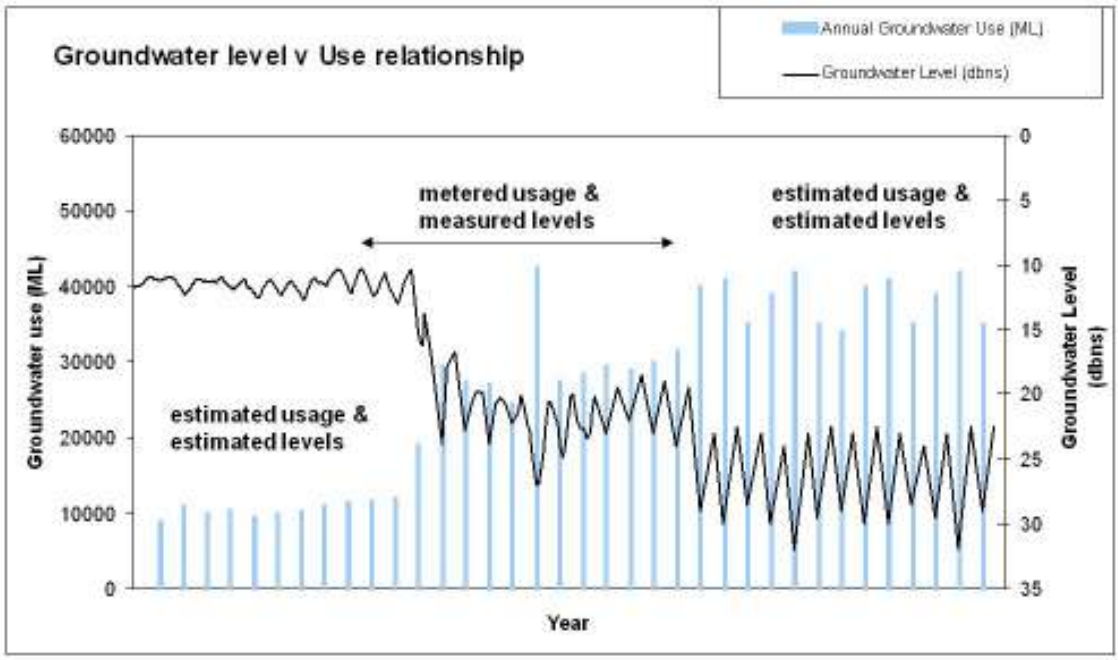


Figure 5 Groundwater level vs. use relationship (Katunga WSPA Groundwater Management Plan)

The existing allocation methodology is based on the observed relationship between the 5 year average groundwater recovery levels measured in the schedule 2 bores and groundwater usage, for the period 1992-2006, with the exception of one year (2002/03) where usage peaked at 40,530 ML. This relationship is shown in Figure 6.

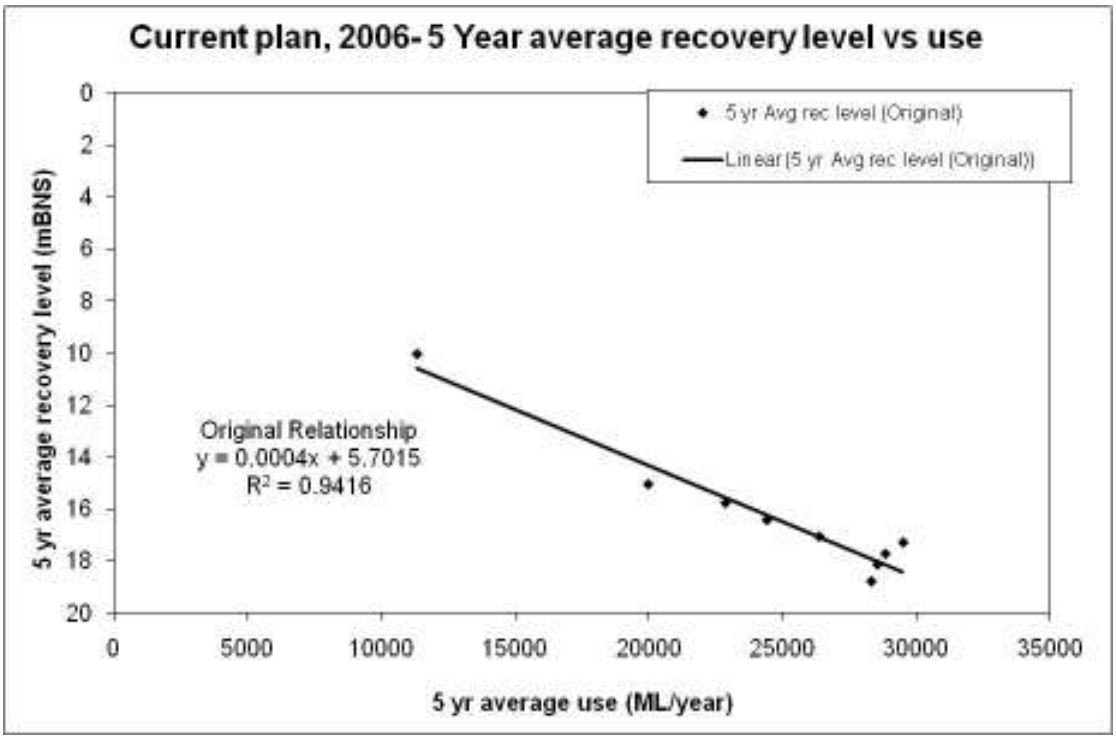


Figure 6 Relationship between 5 year average use (ML/year) and 5 year average recovery level (mBNS)

This relationship between five-year average groundwater level and use suggested that if the five-year average annual usage is maintained below 30,000 ML/year, the five-year average groundwater level will be maintained above 20 mBNS.

A maximum average groundwater level depth of 20 m was considered sufficient to maintain access to groundwater for users across the Katunga WSPA.

5.3 Discussion

Groundwater recovery levels have typically been 1-3 m lower than the '20 m' objective over much of the WSPA during the period of the Plan as shown in Figure 7 and in Figure 8.

The highest autumn drawdown levels recorded during the operational period of the plan were recorded in the 2009/10 season. The groundwater levels were 30-32 mBNS in the central-eastern area of zone 1062 and 35-45 mBNS in zone 1063. These levels are slightly lower than the groundwater levels recorded during the 2002/03 season when annual groundwater extraction was at a peak of 40,530 ML and reflect cumulative effects of significant groundwater usage throughout the drought period.

G-MW has not received any complaints from domestic and stock users or licence holders about low pumping water levels or access concerns over the period of the Plan (since July 2006). In addition, there is no evidence that deterioration in water quality or any adverse environmental impact from falling deep lead heads has occurred (albeit data and understanding on these issues is limited).

The survey of licensed groundwater users undertaken as part of this review identifies that the average pumping water level from the respondents was around 30 mBNS, and that the average pump depth is typically around 40 mBNS. The survey results suggest that if groundwater levels continue to fall then this may impact on users' ability to access groundwater.

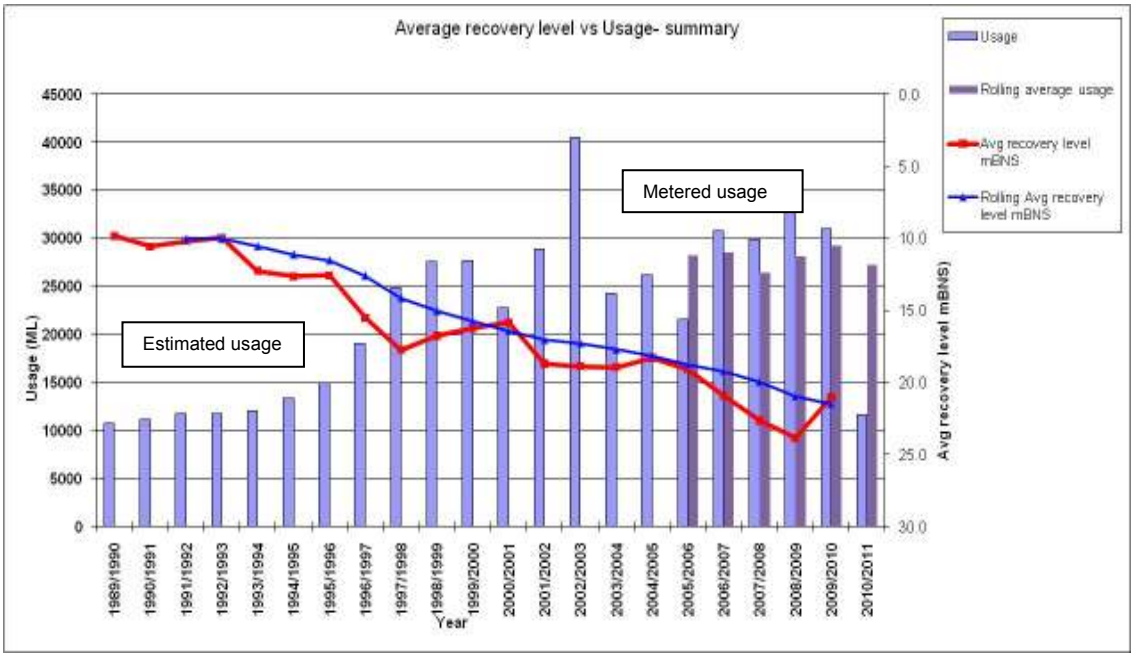


Figure 7 Average Groundwater Level Recovery vs. Use

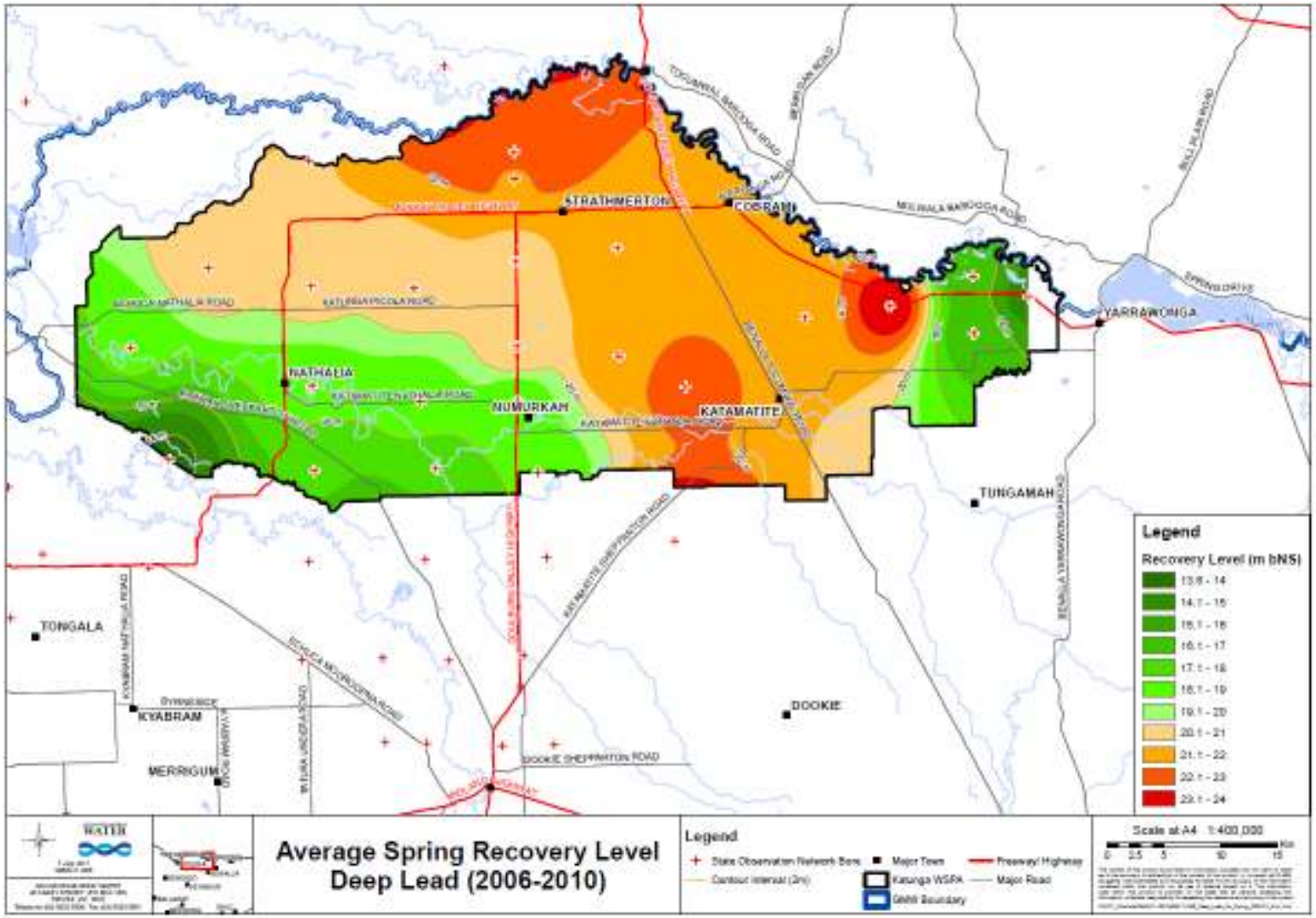


Figure 8 Deep Lead Average Spring Recovery Level 2006-2010

Recent Groundwater Level Recovery

As reported in the 2010/11 Annual Report for the Katunga WSPA, the above average rainfall conditions over the irrigation season of 2010/11 caused groundwater extraction to be less than one half of the typical seasonal usage. Groundwater levels rose rapidly over this period. The current understanding of groundwater recharge to the deep lead aquifer of the Katunga WSPA is that the majority of recharge occurs via leakage of groundwater through the Shepparton Formation. The hydraulic potential from the Shepparton Formation to the Deep Lead aquifers is expected to be less during times of above average rainfall relative to that of peak drought and usage groundwater levels. As the hydraulic potential is lower, recharge to the deep lead via leakage is expected to be lower. The recent recovery of groundwater levels is considered to be a pressure response to the significantly reduced groundwater pumping which occurred over the 2010/11 irrigation season rather than the result of groundwater recharge. Development of a water balance model for the Katunga groundwater resource would improve our conception of these processes.

5.4 Future methodology

The existing allocation methodology has not maintained average groundwater heads within 20 mBNS. It is recommended that an alternative allocation methodology is used in future. The following list of alternative methods for determining annual allocations has been identified as part of the review:

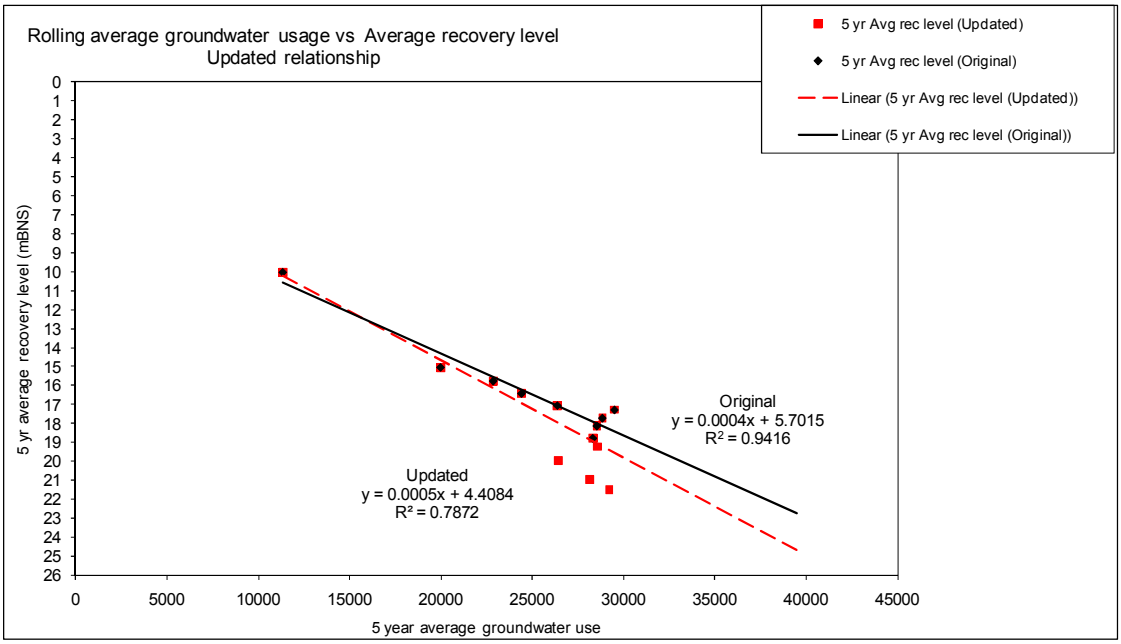
- use the same methodology with an updated correlation of use versus level relationship;
- develop a groundwater level based trigger;
- develop a trigger based on calculated long term average recharge.

One of the Schedule 2 bores, Bore 109860 was decommissioned in 2009 as recommended by Hyder Consulting and in consultation with DSE. This bore is not considered to require replacement given that the removal of the bore has the potential to impact of the calculated five-year average recovery level by only 0.1-0.2 m. It is recommended that this bore is deleted from the Schedule 2 monitoring bore list. Any future review of the current allocation methodology should consider adding an alternative bore to Schedule 2, in place of bore 109860 in order to maintain the spatial distribution of the monitoring bores used to calculate the annual allocation.

Using an Updated Groundwater Level versus Use Correlation

An updated correlation of average groundwater level versus average groundwater usage has been produced and is shown in Figure 9. The updated correlation would not change the existing allocation methodology because the value of usage for a 20 mBNS groundwater recovery level is still 30,000 ML/yr. This is because the existing correlation for an extraction of 30,000 ML/yr is a groundwater recovery level of 18 mBNS (which was rounded to 20 mBNS in the 2006 plan). The spread of data at usage volumes of 30,000 ML/year is also greater with the revised correlation, and there are several data points which suggest that to maintain a level of 20 mBNS would require average usage to be around 27,000 ML/yr. Using a methodology based on the lower usage data points would have resulted in 50% allocations being triggered during the period of the existing plan.

Whilst this approach is consistent with the current methodology, and it is transparent and easy to communicate, it still relies on a sound correlation between groundwater level and use. It is not clear whether the revised correlation is robust enough to stand



up to future climate scenarios, or over extended drought conditions.

Figure 9 Revised relationship between five-year average recovery level and five-year average groundwater level

Using a Level Based Trigger

In order to avoid the uncertainty associated with developing a correlation between usage and groundwater level, a simpler option would be to base allocations solely on average groundwater level data. For example based on the five-year average groundwater recovery level plotted in Figure 7 above, a 50% allocation would have

been set in 2008/09 and 2009/10 as the rolling average groundwater level fell below 20 mBNS. A 70% annual allocation was maintained throughout these years under the current allocation methodology.

Managing to a level based trigger allows annual allocations to respond directly to the management aim identified by the Consultative Committee in 2006, of maintaining supply to users by maintaining a five-year average spring groundwater recovery level within 20 m of the natural surface.

This method is also transparent and easy to communicate.

Using a Trigger Based on Long Term Average Recharge

Victorian experience to date highlights the difficulty in calculating the volume of long term average sustainable diversion limits for groundwater systems. This is due to a lack of detailed technical understanding, the impacts of climate variability, and limited monitoring and metering data. The approach in Victoria has been to develop management plans which restrict use when groundwater levels fall below agreed target levels[3].

One of the major disadvantages of basing an allocation methodology on a water balance or a groundwater modelling approach is that it is more difficult to communicate the process and the outcomes of the methodology, because the process is less transparent.

Nevertheless there is a case to be made for developing a greater understanding of the water balance for the Katunga WSPA which could include development of an improved numerical groundwater model for the Katunga WSPA. Significant features of the groundwater resource of the Katunga WSPA are poorly understood. These uncertainties include:

- the impact of groundwater pumping groundwater on the River Murray, and the extent of recharge from the river to the aquifer system;
- the controls on leakage through the Shepparton Formation into the deep lead;
- the components of the water balance (annual volumes of leakage, lateral inflows and outflows);
- the impact of pumping either side of the border on groundwater levels and flows

[3] NRSWS Page 44 Managing Groundwater Extractions

Further work which details the components of the water balance and aquifer processes would improve current understanding of how the aquifer behaves under a range of future climatic scenarios.

Until there is a better understanding of these issues it is not recommended that this approach is used to determine annual allocations.

5.5 Recommendation

It is recommended that an alternative annual allocation methodology is considered. It is recommended that the most suitable method at this time is a groundwater level-based trigger.

6 Management Zones

Section Summary

No changes are recommended to the existing management zone boundaries.

It is recommended that zone entitlement limits are reduced as follows:

a) zone 1061 is reduced from 6,500 ML/year to 2,700 ML/year

a) zone 1062 is reduced from 25,000 ML/year to 21,000 ML/year

6.1 Background

There are currently three management zones set out in the management plan (1061, 1062 and 1063) as shown in Figure 10 below.

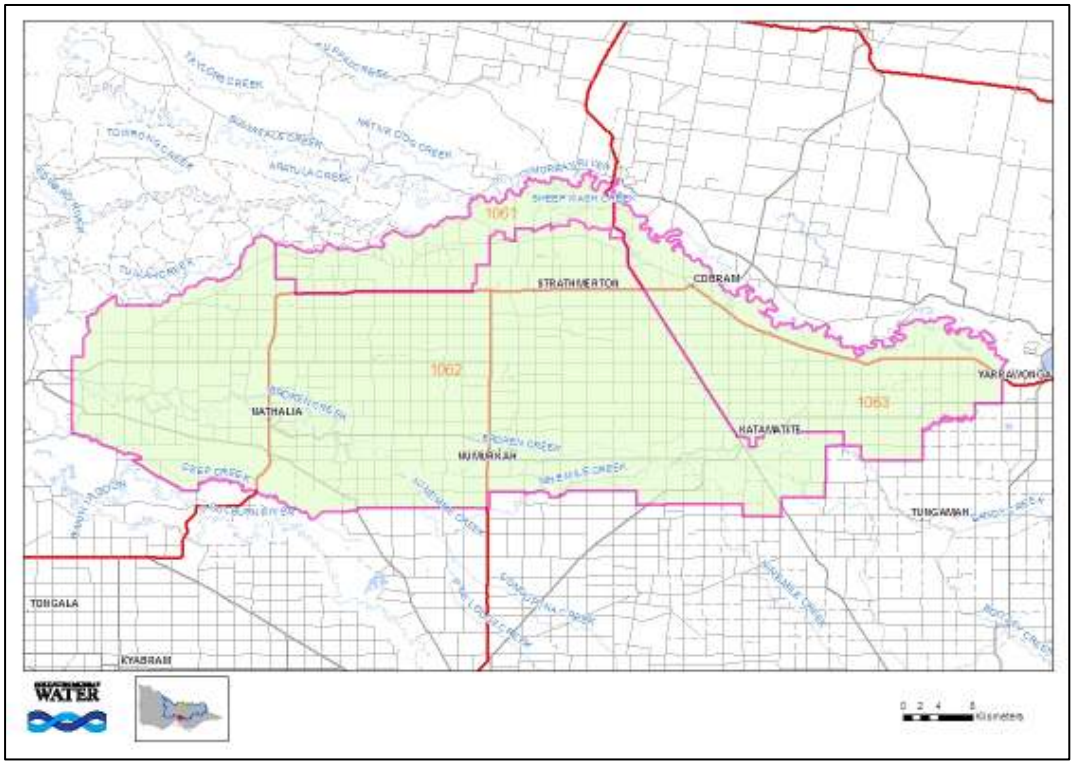


Figure 10 Katunga WSPA Management Zones

Groundwater management zones are essential mechanisms for managing regions of intensive use. They are part of a hierarchy of management measures implemented in the Plan and outlined in Figure 11.

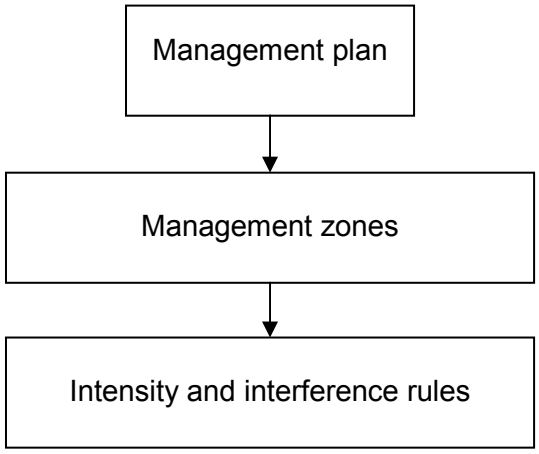


Figure 11 Hierarchy of management measures

The groundwater management zones of the Katunga WSPA are set out in Section 7 of the Plan. Prescriptions 8(c) and 11(c) detail restrictions on transfers between zones. They are the management mechanisms that are used to prevent excessive groundwater drawdown from occurring at a regional scale.

Zone 1061 - (Dryland North West)

Zone 1061 covers the north-west dryland area of the WSPA. The technical work undertaken to support the Plan identified that the shallow and intermediate aquifers surrounding, and to the north east of the Barmah forest, may be seasonally affected by deep groundwater pumping. These bores are primarily used for domestic and stock purposes. Many farmers in the area have no other source of water for domestic and stock purposes and their groundwater access needs to be protected.

In the Plan, licensed entitlement may be transferred within the zone. Transfer of licensed entitlement from other management zones to zone 1061 is not allowed if the amount of groundwater licence entitlement in the zone reaches 6,500 ML/year. The limit in this zone was set so that the maximum volume of water available for extraction under a 70% allocation is 4690 ML/year. This is approximately equivalent to the total groundwater licence entitlement in Zone 1061 at the time the Plan was approved.

Zone 1062 - (Central and West)

Zone 1062 covers the bulk of the central and western parts of the WSPA. Zone 1062 is predominantly within the Murray Valley Irrigation Area, to the west of the Tocumwal/Katamatite Road. In Zone 1062 a licence can be transferred within the zone or from any other management zone into Zone 1062. There is no specific rationale for this zone and it is effectively defined as the residual area after Zone 1061 and 1063 were defined. There is no entitlement limit defined for this zone.

Zone 1063 - (East)

Zone 1063 covers the eastern region of the WSPA from Tocumwal/Katamatite Road to the eastern edge of the WSPA near Yarrawonga. The technical work undertaken to support the Plan identified that the western part of this area was experiencing the greatest seasonal drawdown in the Katunga WSPA. The zone was delineated to avoid an excessive increase in drawdown in this area whilst providing some flexibility to allow users to adjust to the new management arrangements. Licence transfers from other zones into Zone 1063 will not be approved if the total groundwater licence entitlement in the zone exceeds 25,000 ML/year. The groundwater licence entitlement in Zone 1063 totalled 20,745 ML/year at the time the Plan was developed. The maximum zone limit (25,000 ML/year) represented about 120% of the total groundwater licence entitlement in Management Zone 1063 at the time the Plan was approved.

Zone Entitlement Limits

The current Plan uses zone entitlement limits as the primary mechanism to manage regional drawdown and pumping intensity. Local intensity is managed through intensity rules and is discussed in Section 7 – 'Intensity Rules' of this report.

The current entitlements in each zone are shown in Table 4. The discrepancy between the entitlement volumes included in the Plan and the current (June 2011) figures are discussed in Section 4 – 'Groundwater Entitlement'. The table shows that the zone limits are unlikely to be exceeded in the next five year plan period based on:

- the existing licence entitlement being well below the zone limits; and
- the low volume of groundwater permanent transfer that has occurred between management zones.

Table 4 Licence entitlement volume

Management Zone	Katunga Plan volume (ML) (as at 2006)	Water Register Take and use Volume (ML) (Jan 2011)	Katunga Plan Zone Limit (ML)
1061	4,621	1,883	6,500
1062	34,414	37,999.7	No Limit
1063	20,745	20,762	25,000
Total	59,780	60,645	

6.2 Discussion

Zone 1061 - Boundary

The rationale for this zone is considered to be sound. Recent groundwater level data (shown below in Figure 12) suggest that in the north west of the zone pumping from the deep lead and upper Shepparton Formation may be having a significant impact on shallow groundwater levels. It is recommended that the boundary for zone 1061 is maintained.

Figure 12 Groundwater Levels in the west of Zone 1061

Zone 1061 - Entitlement

Zone 1061 is predominately a dryland area and the major use of deep lead groundwater in this area was identified as domestic and stock use. As groundwater users in this area do not have access to regulated surface water, retaining access to domestic and stock water is a high priority. Current entitlement volume is 1,883 ML/year, 29% of the entitlement limit for this zone (6,500 ML/year).

Although seasonal drawdown in this zone is small compared to other parts of the WSPA, groundwater levels recorded in Schedule 2 and 3 bores indicate that spring recovery levels in this part of the Katunga WSPA did not generally recover to 20 mBNS for the period 2006-2010, and were typically greater than 22 mBNS (as shown in Figure 12). This may in part be due to the impact of groundwater extraction across the border in NSW; however the extent of any impact is not clear. Given the objective of the Plan is to maintain spring recovery levels to within 20 mBNS, groundwater levels in this area of the WSPA are a concern. Because the current

entitlement volume in zone 1061 is approximately 30% of the entitlement limit set out by Prescription 8 (c) and 11 (c) of the plan, groundwater trade has the potential to further reduce spring recovery groundwater levels.

It is therefore recommended that the zone entitlement limit for zone 1061 is further reduced. Assuming the current (Jan 2011) volume of entitlement should be available to be extracted given a 70% allocation, the new zone limit would be calculated as:

(1,883 ML/year * 0.43) + 1883 ML/year = 2693 ML/year

This figure is rounded up to 2700 ML/yr, 70% of 2700 ML/year is approximately 1883 ML/year.

Zone 1062 - Boundary

Zone 1062 represents the area left over after delineation of zones 1061 and 1063. The deep lead becomes more saline to the west and south west of the aquifer and as a result groundwater use is concentrated in the east of the zone. One option that has been considered is to split the zone in two, to encourage trading into the area to the west where there is very little entitlement. However due to the relatively high salinity in this area there is little opportunity for significant development and this option has been discounted. There is no obvious reason to amend the zone boundary of zone 1062.

Zone 1062 - Entitlement

There is no specific entitlement limit for zone 1062.

Groundwater level data for the period 2006 -2010 show that there has been a modest amount of seasonal drawdown, particularly in the east of zone 1062 (see Appendix 1), and that average spring recovery levels were below 20 m for much of the eastern part of the zone. However the drawdown and the average groundwater levels are not solely the product of pumping within this zone, and are influenced by the large drawdown in zone 1063. It would be unworkable to impose a limit for zone 1062 as the sum of three zones would then be different to the PCV for the entire WSPA.

It is also noted that groundwater transfer volumes to date have been relatively low and this is likely to continue in the foreseeable future given the current surface water availability.

For these reasons it is recommended that no entitlement limit is placed on this zone, and the conditions prescribed within the existing plan remain unchanged.

Zone 1063 - Boundary

Work prepared for the development of the Plan identified that the western part of zone 1063 experiences the greatest seasonal drawdown of any management zone (this can also be seen in Appendix 1).

There is an area of intensive use in zone 1063 as shown in Figure 13. This area highlights the importance of maintaining the existing management zone boundary to ensure that groundwater entitlement does not increase, causing further drawdown stress in this area.

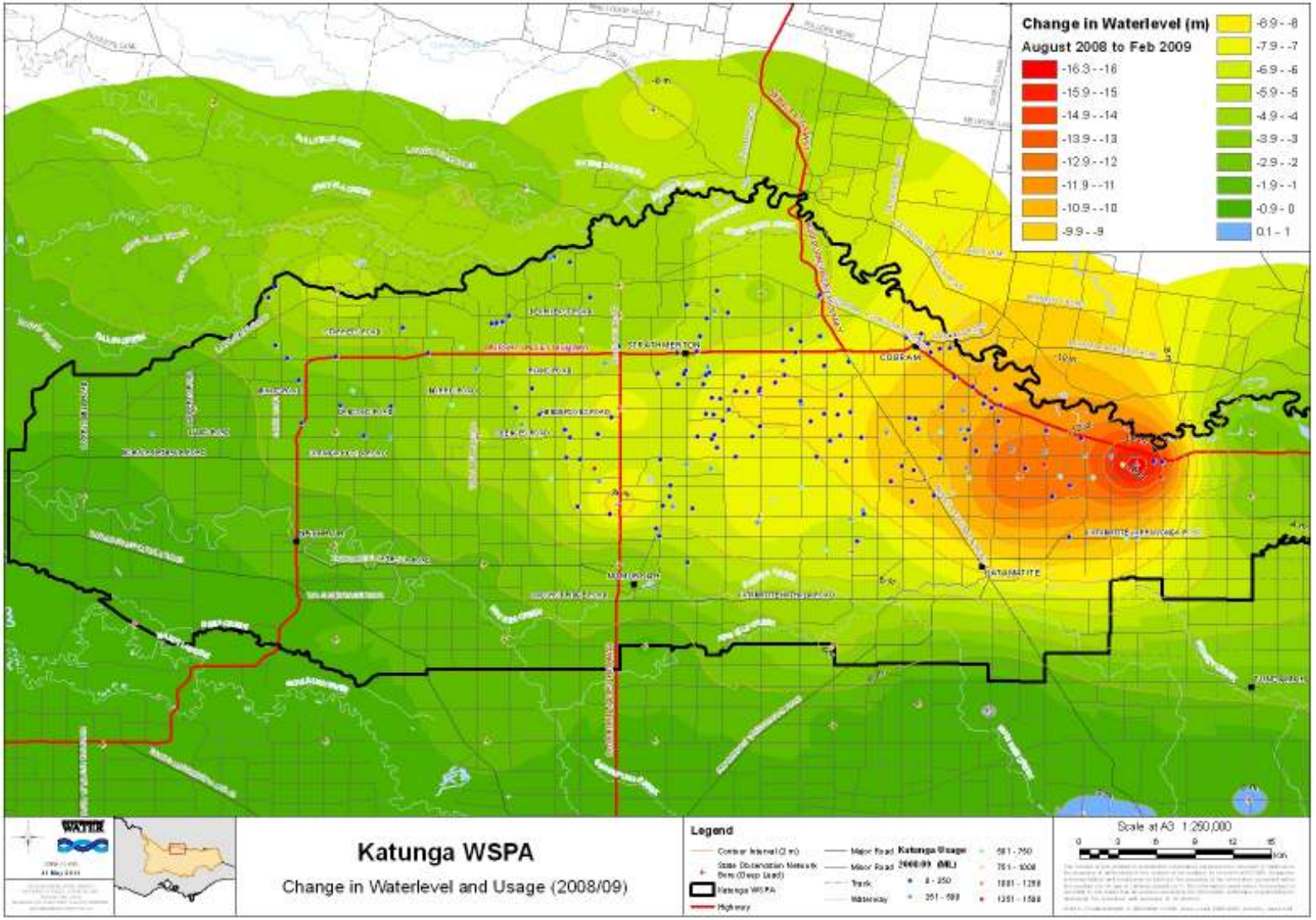


Figure 13 Seasonal drawdown August 2008 to February 2009

Zone 1063 - Entitlement

The volume of entitlement (20,762 ML/year) within this zone is consistent with the volume in the plan (20,745 ML/year). The current zone intensity limit within this zone is 25,000 ML/year.

Zone 1063 is the zone with the most significant seasonal drawdown. 15 m of drawdown was experienced in the eastern part of the zone during the 2008/09 season (see Figure 14 below). Average spring recovery levels for the period 2006 – 2010 are lower than 20 mBNS over most of this zone, and over 24 m in the centre of the zone.

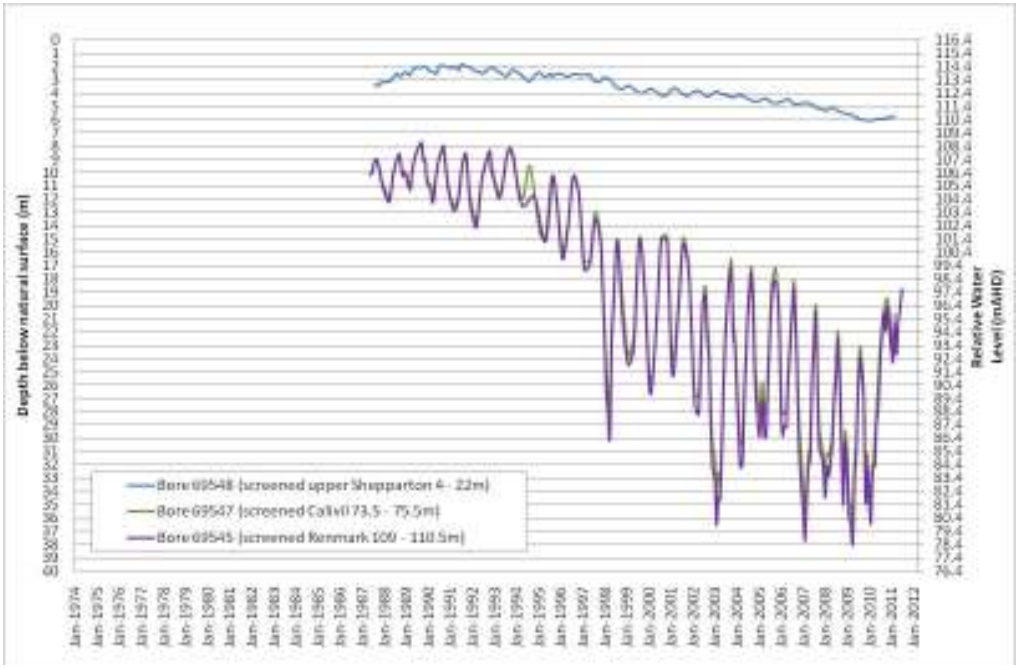


Figure 14 Groundwater levels from nested bores located at the centre zone 1063

Given the objective of the Plan is to maintain spring recovery levels to within 20 m of natural surface, groundwater levels in this area of the WSPA are a concern. Groundwater trade has the potential to further reduce spring recovery groundwater levels.

It is therefore recommended that the entitlement limit for zone 1063 is reduced to 21,000 ML/year to limit further concentration of entitlement in this zone.

6.3 Recommendations

The following recommendations are made regarding the Katunga WSPA management zone boundaries:

- No changes be made to the management zone boundaries set out in the Plan;
- No entitlement limit need be set for zone 1062;
- The entitlement limit for zone 1061 should be reduced from 6,500 ML/year to 2,700 ML/year
- The entitlement limit for zone 1063 should be reduced from 25,000 ML/year to 21,000 ML/year.

7 Intensity Rules

Section Summary

It is considered that the intensity rule maintains an additional level of protection to existing users.

The following recommendations are made:

a) the intensity rule volume is reviewed and the volume is reduced;

b) the intensity rule be applied to temporary trade, if the proposal to allow temporary trade to increase from the currently allowed volume is implemented.

7.1 Background

Local intensity rules aim to manage situations where a number of bores located in close proximity are extracting from the same aquifer resulting in localised areas of potentially excessive groundwater drawdown. This localised drawdown has the potential to impact on the ability of groundwater users to access water (historically in the late summer and autumn).

Intensive local groundwater use is different to regional groundwater level decline that results from reduced recharge or extraction beyond the sustainable yield of the aquifer. Zone and management plan scale extraction limits aim to restrict usage over broader areas within the WSPA to ensure that extraction from an aquifer is sustainable.

During development of the Plan, groundwater users indicated that seasonal drawdown greater than that experienced in the year 2002/03 would be unacceptable. The Consultative Committee determined that limits were required on transfers to ensure pumping intensity did not exceed that seen in 2002/03, which had the highest metered use on record prior to 2006.

Prescriptions 8 and 11 of the Plan relate to local intensity rules, and ensure that permanent trade does not cause licence entitlement to exceed 3700 ML within a 2 km radius of any licensed bore.

This local intensity rule is designed to ensure that intensity of use within a 2 km radius of any bore is no greater than that seen during the year 2002/03. During this year, groundwater usage was less than 2600 ML within a 2 km radius of 95% of

bores. The rule is based on entitlement rather than use and assumes a 70% allocation of entitlement (2600 ML use = 3700 ML entitlement x 70%).

Intensity rules do not apply to temporary transfers. This is because under the current rules licence holders are only allowed to temporarily transfer a volume to offset the impact of allocations (allowing use of no greater than 100% of their entitlement).

Temporary transfer is further discussed in Section 9–'Trading- Temporary Transfers'.

7.2 Discussion

In reviewing the intensity rules for groundwater pumping, consideration has been given to:

- Information collated in the development of the Plan and the views of the Consultative Committee;
- Current interference issues;
- Assessment of future interference 'hotspots' with regard to managing pumping intensity in developing areas;
- Current entitlement and use; and
- Providing some scope for development in areas with intensive pumping.

Reasons for retaining the intensity rule

- Drawdown effects from multiple pumping bores are difficult to assess using standard interference calculation techniques, and an existing Section 40[4] assessment may underestimate this risk. Local intensity rules can provide an additional level of protection to groundwater users.
- There is an opportunity to restrict temporary transfer volumes by employing a local intensity rule. This will be particularly useful if temporary transfer rules are changed to allow transfers above 100% of entitlement (as discussed in Section 9 – 'Trading - Temporary Transfers').

[4] A 'Section 40 assessment' refers to the assessment that G-MW undertakes for a groundwater licence application. Section 40 of the Water Act, 1989 sets out the 'matters to be taken into account' by the authority when assessing an application to extract water. In particular, Section 40 requires that the approval of a groundwater licence does not cause a negative impact to existing licensed users or to the environment.

- Intensity rules are in place in the Mid-Loddon GMA and are likely to be developed for the Lower Campaspe WSPA and Loddon Highlands WSPA (both areas have management plans currently under development).

Reasons against retaining intensity rule

- The highest groundwater usage recorded since the Plan was implemented was 79% of allocation (32,849 ML) for the 2008/09 period. This represents 55% of the PCV volume and is well below the extraction experienced in the 2002/03 irrigation season (40,470 ML);
- Pumping intensity over the plan period has been significantly lower than in 2002/03 with usage being less than 1500 ML/year within any 2 km radius of 95% of licensed bores;
- There has only been one recorded instance over the past five seasons of a groundwater permanent transfer being refused as a result of the intensity rule;
- Administration of permanent transfer rules is made more complex as a result of the intensity rule;
- There is a significant data quality issue in administering the intensity rule as the two key qualities that are required (location and licence entitlement) while generally known, are not always able to be reported accurately. Basing the refusal or approval of an application on potentially poor quality location data may be an issue.

Although there are reasons to suggest that maintaining a local intensity rule may not be ideal, it is concluded that the concerns of the consultative committee in 2006 are still valid, and that there is the potential for intensive use to be a problem if usage in local hotspots were to reach the 2002/03 levels again. It is concluded that the intensity rules should remain as this will maintain an additional level of protection to existing users.

Maintaining the intensity volume limit at the current level of 3,700 ML/year will ensure that intensity of use does not exceed that observed in the highest demand year (2002/03). Results of the customer feedback survey (2011) indicate there is some support for reducing the extraction volume prescribed by the intensity rule (see Section 15 – 'Groundwater User Survey'); however there is no evidence to date to suggest that the volumetric intensity limit needs to be reduced. This limit may need to be reviewed if groundwater levels continue to fall.

It is also recommended that the intensity rules be applied to temporary trade, if the proposal to extend temporary trade to allow individual use to be greater than 100% of licence entitlement is implemented.

7.3 Recommendations

It is recommended that the current intensity rules should remain unchanged as this will maintain an additional level of protection to existing users.

It is also recommended that the intensity rules be applied to temporary trade, if the proposal to allow individual use to be greater than 100% of licence entitlement is implemented.

8 Trading – Permanent Transfers

Section Summary

Rules in the Plan allowing permanent transfer of groundwater entitlement have been reviewed. The following changes are recommended:

a) Review the basis for the 2 km buffer zone from the Murray River, which restricts permanent trade to new users;

b) Remove the permanent trade limit of 43%;

c) Remove the 20% entitlement clawback rule currently imposed on permanently traded entitlement volumes.

8.1 Background

Permanent trade of groundwater within the Katunga WSPA is currently permitted in accordance with Prescription 8, 9 and 10 of the Plan.

Prescription 8

Prescription 8 contains three parts:

- 8 (a) No permanent trade to bores within 2 km of the River Murray except in cases where an existing groundwater licence already exists.
- 8 (b) Permanent trade must not cause licence entitlement to exceed 3700 ML/year within a 2 km radius of any licensed bore.
- 8 (c) Total licence entitlement volume may not exceed 6,500 ML/year in zone 1061 and 25,000 ML/year in zone 1063.

Prescription 9

Prescription 9 allows for limited transfer (43% of annual licence volume) of water to an existing licence within 2 km of the River Murray.

Prescription 10

Prescription 10 requires 20% of licence volume to be forfeited upon permanent transfer of a licence (apart from transfer of land).

Historic permanent trade volumes

The permanent trade volume that has occurred over the past four irrigation seasons is shown in Table 5.

Table 5 Permanent transfer volumes

Permanent trade volume in Katunga WSPA (ML)					
2006/7	2007/8	2008/9	2009/10	2010/11	Total
0	496	109.6	256	587	1448.6

8.2 Discussion

Prescription 8 (a)

The current conceptual understanding of connectivity between the deep lead and the River Murray is that:

- There is potential for greater groundwater recharge to occur from the River Murray floodplain in the Burramine-Mulwala area;
- In the eastern area of the Katunga WSPA, the Shepparton and Calivil Formations are more strongly connected vertically (e.g. the Burramine-Mulwala and Muckatah areas);
- In the western area of the Katunga WSPA, the Shepparton formation is considered to have more low permeability clay layers, and thus the Shepparton Formation is considered less connected with the Calivil formation.

Restriction of trade within 2 km of the River Murray was intended to address a concern that further lowering of groundwater heads in the Calivil/Renmark and Lower Shepparton Formations near the river could increase leakage from the upper Shepparton Formation, and thereby reduce baseflow to, or increase leakage from, the River Murray. Further technical assessment is required to better understand these risks.

The case for retaining the 2 km restricted trade zone for permanent transfer is that:

- It is a precautionary approach which provides a measure of protection to the River Murray until a more definitive assessment can be made;

The case for dispensing with the 2 km restricted trade zone for permanent transfer is that:

- The prescription may be over-conservative;
- The current conceptual understanding of the resource indicates that the Shepparton Formation is more vertically well-connected with the Calivil Formation in the eastern area of the WSPA and poorly connected in the

western area of the WSPA. The prescription may only be appropriate along the north-eastern boundary of the WSPA;

- The prescription is not consistent with management north of the River Murray where pumping may occur to within 40m of any river or creek[5].

If the 2 km restricted trade zone for permanent trade is removed, the risk to surface water would still be managed by undertaking site specific technical assessments.

Prescription 8 (b)

Intensity rules aim to manage groundwater levels at a local scale. Intensity rules are discussed in Section 7 – 'Intensity Rules'.

Prescription 8 (c)

Entitlement limits in the WSPA zones are discussed in Section 6 – 'Management Zones' of the review.

Prescription 9

Prescription 9 limits the volume of water that may be permanently transferred within 2km of the River Murray to 43% of licence entitlement. The intention of this prescription was to limit the impact of permanent transfer within the 2 km restricted trade zone to those that occurred before the plan was implemented.

The value of 43% is based on the expected allocation of 70%. When an additional volume of 43% is added to a licence, the entitlement becomes 100% of the pre-restriction volume as shown in the example below.

> For example:
>
> A 10 ML licence, with 70% allocation = 7ML available allocation.
>
> Add 43% of licence volume for permanent transfer = 4.3ML
>
> 10ML (existing volume) + 4.3ML (transfer volume) = 14.3 ML14.3ML @ 70% allocation = 10ML allocation, equivalent to 100% of the pre-restriction volume.

The case for retaining this prescription is strengthened in that:

- It enables existing licence holders that were in place at the time of the implementation of the management plan the opportunity to extract all of their original licence volume through a permanent trade.

[5] NSW DOW (2011). Water Sharing Plan for the Lower Murray Groundwater Source, 2011.

The case for removing the prescription may be supported in that:

- The prescription may no longer be relevant because the plan has been in implementation since 2006, providing sufficient time for existing licence holders within the 2 km zone to apply for a permanent trade; and
- Each application will have a different potential impact on the River Murray. A more appropriate approach may be to consider each application on its own merits, based on a site specific technical assessment.

Prescription 10

The intention of Prescription 10 was to provide a mechanism for gradually reducing total groundwater entitlement over time.

There has been a modest reduction in entitlement volume as a result of the prescription (289.8 ML between 2006/07 and 2010/11).

The advantages of retaining this prescription are:

- It is a positive measure which seeks to address the over-allocation of entitlement of groundwater resources in the WSPA.

The issues associated with retaining this prescription include:

- The reduction in entitlement since 2006 is modest - 0.5% (289.8 ML) of the total entitlement volume. The prescription may not necessarily be fulfilling its objective, and therefore placing an unnecessary burden on trade in the WSPA;

The Dairy Shed Water Licence Transition Program recently issued new licence entitlement in the Katunga WSPA of 1058.3 ML/year which is well in excess of the reduction in entitlement affected by Prescription 10.A case can be made for making changes to Prescriptions 8, 9 and 10.

8.3 Recommendations

The following recommendations pertaining to Prescriptions 8, 9 and 10 are made:

- It is recommended that the 2 km restricted trade zone from the River Murray for permanent trade to new users (Prescription 8 a) be reviewed. It is considered that the prescription places a potentially unnecessary barrier to groundwater trade and that applications should be made on a case by case basis. It may be the case that the prescription is appropriate in the north-east of the WSPA where there is some limited evidence for good connection between the Shepparton Formation and the Calivil/Renmark Formations. Further technical work is required to assess the risk of groundwater pumping

to the Murray River as outlined below. Future technical work is discussed in Section 17- 'Technical Understanding';

- If Prescription 8 (a) is removed, Prescription 9 will also require review. It is recommended that Prescription 9 is removed from the Plan and that permanent transfer volumes are considered on a case by case basis;
- It is recommended that Prescription 10 be removed from the Plan as it is not providing an effective mechanism for addressing over-allocation, and therefore carries an unnecessary burden.

9 Trading - Temporary Transfers

Section Summary

The rules governing temporary transfers have been reviewed. The following recommendations are made:

a) To permit the temporary transfer of entitlement to landholders who do not already have a groundwater extraction licence;

b) To remove the current restriction which limits TTWE to the equivalent of 100% of the existing licence volume;

c) To adopt relevant local intensity rules to manage temporary trade;

d) To consider relevant changes caused by introducing carryover.

9.1 Background

Enabling temporary trade of licence entitlement provides groundwater users with the flexibility to manage their groundwater use and to respond to short term variability in demand or supply: this is particularly important in low allocation years. The Northern Region Sustainable Water Strategy (2009) highlights the importance of providing flexibility for groundwater users via trading rules.

The Plan allows temporary transfers on an annual basis. There is a limit on the volume transferred such that the licence holder is restricted to a usable volume which is up to 100% of their permanent entitlement. For example, if allocations are at 70%, then temporary transfers up to 30% of existing entitlement are allowed.

Temporary transfers of water entitlement (TTWE) are only allowed to those landholders with an existing groundwater licence, subject to a technical assessment of any potential interference impacts. There are no zone or intensity related restrictions on the temporary trade of entitlement.

The total annual volume of groundwater TTWE traded has remained steady over the past four seasons at around 3,000 ML/year, with a notable reduction in TTWE in 2010/11 due to the lower demand on groundwater. This represents approximately 10% of average licensed groundwater usage within the WSPA and approximately 5% of total entitlement. The TTWE volume that has occurred over the past four seasons is shown in Table 6 below.

Table 6 TTWE Volume (ML) (note inter-zone TTWE volumes are included in zone totals)

Management Zone	2006/7	2007/08	2008/09	2009/10	2010/11
Within zone 1061	158	0	0	0	0
Within zone 1062	985	776	1196	1032	0
Within zone 1063	1591	1071	1324	1334	0
TTWE between zones	Not recorded	1317	920	549.5	217.5
Surface water Allocation (HRWS)	95 %	43 %	35 %	100 %	100 %
Total	2734	3164	3470	2915.5	217.5

Temporary transfers are most actively sought during years when there is less surface water availability, as highlighted by the contrast in temporary transfer volume between 2010/11 compared with previous years.

9.2 Discussion

The following changes to the temporary transfer rules have been considered:

- To remove the current restriction which limits TTWE to the equivalent of 100% of the existing licence volume;
- Allowing temporary transfers to the owner of a bore who does not hold an extraction licence
- Multi-year temporary transfers

Temporary transfer restrictions

The case for allowing temporary transfer of groundwater entitlement in excess of the equivalent of 100% of a licensee's existing entitlement is supported by the following:

- It increases user flexibility. Improving trading opportunities and flexibility is one of the key actions of the NRSWS (Action 5.6 p.109) and an objective of the NWI;

- Consistency with temporary trade arrangements in other Victorian Groundwater Management Units

The main concern with allowing greater flexibility of temporary transfer is that there is the potential for such a change to increase annual extraction; which could in turn trigger allocation restrictions earlier.

In addition there is potential that the change to temporary transfers could increase use in concentrated areas, causing localised drawdown that is in excess of acceptable levels.

These risks are considered to be low if current rules around groundwater extraction intensity are applied to temporary transfers. The risk of local interference is also mitigated by the development and use of technical assessment methods such as the interference assessment tool that allows Section 53 of the Act to be appropriately considered.

Customers without a groundwater licence

Customers without a groundwater entitlement are able to temporary transfer groundwater in all G-MW groundwater management areas except for the Katunga WSPA and the Shepparton Irrigation Region WSPA.

The benefits of allowing TTWE include the following:

- It enables groundwater entitlement to be transferred to new locations within the WSPA. This supports new development and would further align the plan with the objectives of the NRSWS and NWI.
- It facilitates the transfer of entitlement away from areas of intensive use;
- From a management perspective TTWE allow extraction of water in a new location such that the impacts on surrounding users and the environment may be assessed prior to water being permanently traded to that location. This reduces the risk associated with applications for new entitlement.

The Plan does not allow extraction to occur from new locations if the customer concerned does not hold a licence entitlement. Amending Prescription 7 would be beneficial as long as the following controls are in place:

- Any subsequent transfers take into account appropriate intensity rules and zone entitlement limits of the Plan.
- Licence applications will be subject to technical assessment which will include an interference assessment and an assessment of the potential for impact on the surface water environment (including the River Murray).

Multi-year temporary transfers

Multi-year temporary transfer of entitlement may provide extra flexibility and security to customers. Currently these transfers can be permitted after consultation with the Executive Director, Water Resources (DSE)[6]. The SWS foreshadow possible changes to the Policy for Managing Take and Use Licences to permit these transfers when the risk to third parties is deemed to be low.[7]

The administrative burden of such transfers should be weighed against the benefits of allowing multi-year temporary transfer, in particular the likely frequency of applications for multi-year temporary transfer.

9.3 Recommendations

The following changes to the plan are recommended:

- Revise Prescription 7 of the Plan to permit the temporary transfer of a licence to landholders who do not have a groundwater extraction licence;
- To allow temporary transfers of entitlement such that total entitlement can be greater than 100% of the existing permanent licence volume.
- Adopt relevant local intensity rules to manage temporary trade (in accordance with any recommendation made on review of the intensity rules discussed in Section 7- 'Intensity Rules').

[6] Clause 26(5)(b) of Policies for Managing Take and Use Licences (consolidated), DSE, September 2010.

[7] Action 3.12(d) Western Region Sustainable Water Strategy, Victorian Government, Department of Sustainability and Environment (2011).

10 Carryover

Section Summary

Carryover has been considered and it is recommended that the groundwater management plan be updated to include carryover.[8]

10.1 Background

The Sustainable Water Strategy provide for the introduction of carryover in suitable groundwater systems to improve flexibility.

The deep lead aquifers managed within the Katunga WSPA are considered to comprise an appropriate groundwater system for consideration of carryover due to the large storage capacity relative to the annual entitlement.

The benefit of introducing the carryover of groundwater licence entitlement in the Katunga WSPA is improved flexibility of licence holders to manage their groundwater use as identified in the NRSWS (Action 5.5).

The potential issues associated with allowing carryover of groundwater licence volume to occur include:

- The potential to increase actual extraction in any single year, which could in turn trigger allocation restrictions earlier, particularly in a sequence of dry years;
- The groundwater resource is considered over-allocated, with permanent restrictions in place (maximum 70% allocation).

It is expected that the impact of carryover would be relatively small for the following reasons:

- In order to qualify for carryover, a licence holder must have used less than their allocation in the previous year;

[8] Carryover is authorised outside of the management planning process, under section 62A of the Water Act (1989). However it is considered appropriate that consultation on the rules for carryover is undertaken through the same process for consideration of future amendments to the management plan.

- The aquifer has significant storage capacity and the effects of varying extraction over two years will be buffered by the aquifer;
- The impact of carryover could be mitigated by limiting the proportion of entitlement that could be carried over (e.g. 20%);
- The impact of carryover could be further mitigated by allowing it only during years of 70% allocation.

10.2 Recommendations

It is recommended that carryover is introduced in the Katunga WSPA. It is noted that carryover may be applied without altering the groundwater management plan, however there should be consultation on the rules for carryover and this should be done as part of the process for consideration of future amendments to the management plan..

11 Metering

Section Summary

Metering of groundwater usage in the Katunga WSPA has been reviewed. It is recommended that Prescription 19 is taken out of the Plan as it is no longer relevant. A minor change to Prescription 20 is recommended so that it covers both newly constructed and newly licensed bores.

11.1 Background

The G-MW metering program operates in accordance with the 'National Framework for Non-urban Water Metering – Victorian State Implementation Plan' (March 2010). All bores with greater than 20ML of entitlement have been metered. All new bores constructed since 2002 have been metered.

11.2 Discussion

Prescriptions 19 to 25 of the Plan implement the obligations of G-MW to the state-wide metering policy.

Prescription 19 and 20

Prescription 19 states that 'Within 12 months from the time that the management plan commences, the Authority must ensure that a meter is fitted to every operational bore listed on a groundwater licence that authorises the extraction of 20 ML/year or more'.

Prescription 20 states that 'The Authority must ensure that a meter is fitted to any new bore that is constructed in the Protection Area that is used for other than stock and domestic purposes'.

Prescriptions 21 and 23

Prescription 21 and 23 relate to the inspection and maintenance of meters by G-MW staff, and to the meter reading requirements.

Prescriptions 22 and 25

Prescription 22 relates to the obligations of the landholder to take reasonable care of the meter and to provide information to G-MW in the event the meter is defective. Prescription 25 states that the licensee must provide the Authority with a meter reading upon request.

Prescription 24

In cases where G-MW is unable to measure the volume of water taken through a meter, this volume is estimated.

Metering Compliance Program

Since the Plan was approved in 2006, metering compliance has been a priority. G-MW has appointed a compliance team to ensure metering compliance objectives have been prioritised. Prioritisation of metering compliance has delivered the following:

- A pro-active communication strategy aimed at reminding Katunga WSPA groundwater users that extraction must not exceed entitlement;
- Auditing and installation of tamper proof seals;
- Regular compliance checks on all licensed bores.

The program has ensured that metering compliance is robust and enforceable and that accurate groundwater usage information is collected.

11.3 Recommendations

All bores licensed with more than 20 ML/year of entitlement have been metered. Prescription 19 is no longer required. It is recommended that Prescription 19 is removed from the Plan. Prescription 20 covers any newly constructed bore. Prescription 20 should be changed such that it covers newly licensed bores as well as newly constructed bores.

12 Groundwater Level Monitoring

Section Summary

In general, the groundwater level monitoring network is sufficient. The following recommendations are made:

a) Remove bore 109680 from Schedule 2 of the Plan;

b) Add the newly drilled bores WRK059813, WRK059814, WRK059815 and WRK061880 to Schedule 3 of the Plan.

12.1 Background

The Plan requires water levels in 67 bores to be monitored in the Katunga WSPA in accordance with Prescription 26, 27 and 28. These include:

- 17 bores monitoring the mid Shepparton formation
- 15 bores in the lower Shepparton formation
- 35 bores in the Calivil Formation/Renmark group

Bores that are monitored to determine groundwater recovery levels are referred to as Schedule 2 bores (listed in Schedule 2 of the Plan); all monitoring bores prescribed by the plan are referred to as Schedule 3 bores (listed in Schedule 3 of the plan). The locations of Katunga WSPA monitoring bores are shown in Figure 15.

There is generally good groundwater monitoring coverage in the Katunga WSPA. A technical report completed during management plan development (2005) indicated that there were gaps in the conceptualisation of the depth and location of the Murray Trench north and north-east of Katamatite. In addition the report considered that the coverage in the mid-Shepparton Formation was sparse. The Plan outlined the need for two additional bores in the east of zone 1062 and one additional bore in the centre of zone 1063 (page 16 of the plan).

Two additional sites were drilled in 2011 as part of the State Observation Bore Network refurbishment program. A nested site including three bores was drilled in zone 1063 (WRK059814, WRK059815 & WRK059813). An additional bore was drilled in the east of zone 1062 (WRK061880). The bores are shown below in Figure 15. These bores address the recommendations of the Plan and have increased the understanding of the depth and location of the Murray Trench.

Bore 109680 is listed for monitoring in Schedule 2 of the Plan. This bore was identified as defective and was decommissioned in 2009 on the advice of Hyder Consulting and in consultation with DSE[9]. This bore is not considered to require replacement given that the removal of the bore has the potential to impact of the calculated five-year average recovery level by only 0.1-0.2 m.

It is recommended that a new clause is included in the plan which permits monitoring of schedule bores to stop or alternative bores to be monitored in the event that monitoring bores fail or other changes to the schedule are necessary.

12.2 Recommendations

The following changes to the Plan are recommended:

- Remove bore 109680 from Schedule 2 of the Plan;
- Add the newly drilled bores WRK059813, WRK059814, WRK059815 and WRK061880 to Schedule 3 of the Plan.
- A new clause is included in the plan which permits monitoring of schedule bores to stop or alternative bores to be monitored.

[9] Department of Sustainability and Environment AA002257 Staged approach to the removal of SOBN Bores – SIRWSPA.

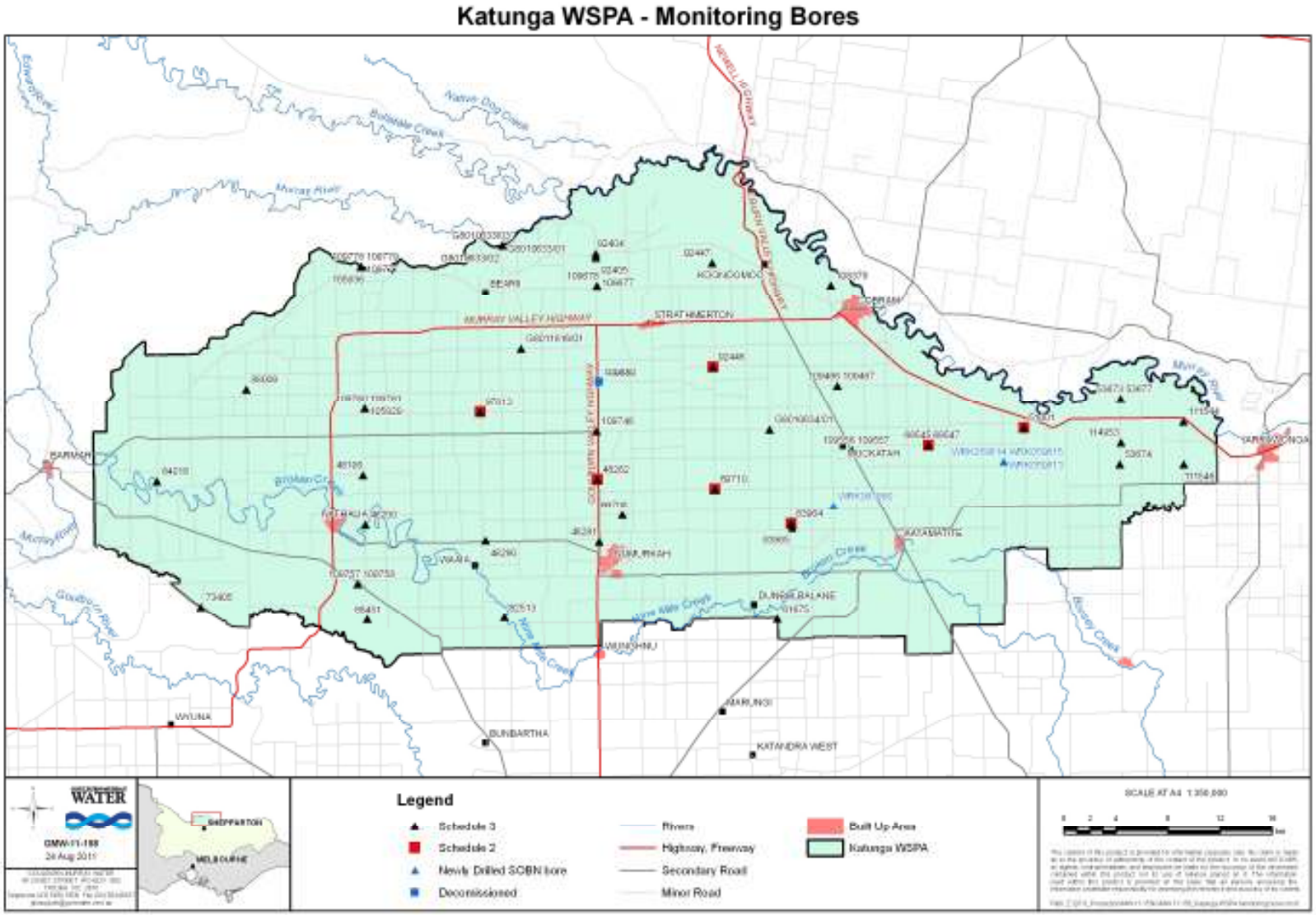


Figure 15 Katunga WSPA Schedule 2 & 3 monitoring bores

13 Groundwater Salinity

Section Summary

Groundwater salinity monitoring in the Katunga WSPA has been reviewed. Although there is no evidence that groundwater salinity has changed since the Plan was approved in 2006, it was found that salinity monitoring could be improved to assist in long-term groundwater management planning. The customer salinity survey set out by Prescription 29 has not been successful.

The following recommendations are made:

a) The costs and benefits of retaining the customer salinity mail-out as defined by Prescription 29 should be reviewed;

b) Alternative salinity monitoring aimed at addressing long-term groundwater management objectives should be investigated.

13.1 Background

Water pumped from the lower Shepparton and Calivil/Renmark Formations (the Deep Lead) is sourced mainly from leakage through the Shepparton Formation. In general, the upper Shepparton Formation has poorer water quality than the lower Shepparton and Calivil/Renmark Formations. There is therefore concern that pumping from the deep lead may induce poorer quality water to recharge the deep lead aquifer which could potential degrade the resource over time.

Salinity (as Electrical Conductivity) in the upper Shepparton is generally greater than 1500 µS/cm in the Katunga WSPA. A small area in the north-east of the WSPA, south west of Cobram, has salinity less than 500 µS/cm.

Salinities in the lower Shepparton and Calivil/Renmark Formations are generally similar. In the north, central and eastern area, salinity varies from less than 500 µS/cm in the north-east, to 1500 µS/cm at the centre of the WSPA. Salinity in the lower Shepparton and Calivil/Renmark Formations increases above 1500 µS/cm towards the western and southern boundaries of the WSPA.

Groundwater quality appears to deteriorate to the south and west of the WSPA. This is thought to be due to the following factors:

- There is potential for greater groundwater recharge to occur from the Murray River floodplain in the Burramine-Mulwala area (north-east of the catchment);
- In the eastern area of the Katunga WSPA, the Shepparton and Calivil Formations are more strongly connected vertically (e.g. the Burramine-Mulwala and Muckatah areas);
- There is thought to be greater recharge of fresh water in the Cobram area (in the north-east of the catchment) where there is a region of poorly–sorted 'Murray Meander Deposits' and the Shepparton Formation thins;
- In the western area of the Katunga WSPA, the Shepparton formation is considered to have more low permeability clay layers, and thus the Shepparton Formation is considered less connected with the Calivil formation.
- Groundwater deep lead residence time increases (it is thought that the deep lead sediments are more fine grained in the south and west of the catchment) (GHD, 2010);
- The Mid-Goulburn deep lead contributes water with higher salinity (GHD, 2010).

The relative influence of each of these processes is poorly understood.

Annual Salinity Mail-out

In order to monitor the water quality impacts of pumping from the deep lead, Prescription 29 of the Plan obliges G-MW to collect and analyse a groundwater sample for assessment of salinity (as Electrical Conductivity) from every groundwater licence holder each year. Stock and domestic users may also request a salinity analysis on an annual basis. The results are reported to each customer who submits a sample, and the data are entered in the GMS and reported in the Katunga WSPA annual report.

13.2 Discussion

Review of Prescription 29

The sample return rate of the customer salinity survey in the Katunga WSPA has been between 23% and 35%. In addition, the number of consecutive returns is limited (only one customer returned a sample on five consecutive years between 2000 and 2010; only seven customers returned a sample on three consecutive years between 2000 and 2010). Salinity results recorded from the salinity mail-out are consistent with Murray-Darling Basin Commission salinity mapping undertaken in 2000 (Figure 16 below).

There are a number of limitations in the bore salinity data collected under Prescription 29 including:

- No single bore in the Katunga WSPA has been sampled in each year of operation of the salinity survey. There is therefore no time series of salinity information;
- The geographical distribution of samples is variable from year to year;
- Vertical changes in salinity within different aquifers at the same location cannot be assessed;
- Salinity from production bores may represent aquifers from more than one screened interval and there is significant variability in salinity between geological formations both vertically and laterally. The amount of water sourced from each formation, and the degree of hydraulic connection between aquifers will play a major part in determining the salinity reading;
- Samples from licensed bores are collected by licence holders and there is therefore poor quality assurance that the sample is collected from the same bore each year etc.;
- The time of year that the sample is collected (i.e. prior to, during or following the irrigation season), the method used to take the sample (e.g. purging/ not purging the bore), and the duration of pumping, is not controlled and may have a significant influence on the salinity reading obtained;
- Bores are less likely to be sampled during year of high surface water availability as groundwater pumping may not occur.

There are some potentially important future management questions that cannot be answered with the existing salinity dataset. These include:

- What is the impact of different pumping intensity in the deep lead for salinity in the overlying aquifers and the deep lead?
- Does pumping from the deep lead induce poorer quality groundwater to migrate from the south and west of the Katunga WSPA?
- How do variations in the salinity of the Upper Shepparton Formation impact on deep lead salinity?
- What is the mechanism for low salinity water to enter the deep lead, and what is the impact of groundwater pumping on the River Murray?

Changes in Salinity over time

There does not appear to be any significant change in salinity of the deep lead groundwater resource since 2006. However, because the annual customer salinity

mail-out has had a poor return rate and due to the limitations listed above, making robust conclusions around salinity management based on this data is difficult.

13.3 Recommendations

The following recommendations are made regarding the management of salinity within the Plan:

- The costs and benefits of the customer salinity mail-out as defined by Prescription 29 should be reviewed;
- Alternative salinity monitoring aimed at addressing long-term groundwater management objectives should be investigated.

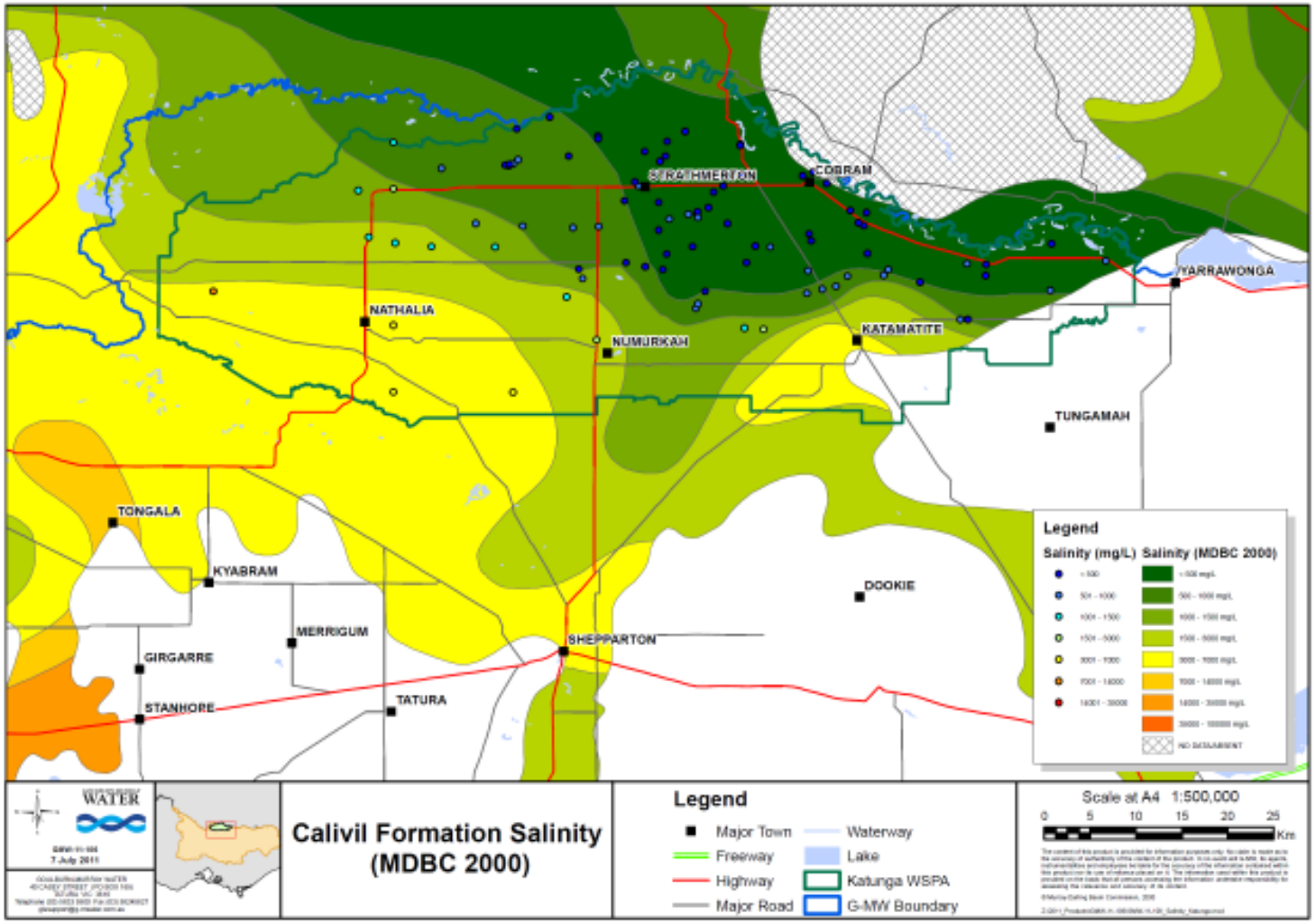


Figure 16 Calivil Formation salinity with salinity mail-out results (2006-2011)

14 Environmental Considerations

Section Summary

There is a low risk to the environment posed by groundwater extraction managed under the Plan. However, some key uncertainties warrant further work. These include:

a) Establishing the existence, location and extent of groundwater dependent vegetation communities within the WSPA;

b) Understanding the impacts of groundwater pumping on the River Murray.

14.1 Background

Groundwater Dependent Ecosystems (GDEs)

Groundwater Dependent Ecosystems are ecosystems that utilise groundwater to meet some or all of their water requirements (SKM, 2011). There are a number of environmental features overlying the Katunga WSPA that may be dependent on groundwater however, the extent of this dependence is uncertain. A detailed survey to identify significant groundwater dependent environmental features has not been undertaken within this review however, the following features are likely to have some level of groundwater dependence:

- The riparian corridors of the Murray and Goulburn Rivers as well as the Broken Creek which include the Broken Boosey State Park and National Park areas;
- The RAMSAR listed Barmah Millewa National Park;
- Remnant vegetation on public and private land.

The presence of high watertables (i.e. within 4 m of the natural surface) across most of the Shepparton Irrigation Area (SIR), including within boundaries of the Katunga WSPA, is by far the greatest threat to ecosystem health due to the impact of high levels of salinity, and waterlogging. The Katunga WSPA manages groundwater below 25 mBNS. The risks of high water tables are managed by the SIR WSPA groundwater management plan.

Surface water - groundwater interactions

Prescription 8 of the Plan restricts applications for permanent trade of entitlement within 2 km of the Murray River. This prescription was introduced as a precautionary measure as the interaction between groundwater and surface water near the River Murray at the time of Plan's development was not well understood. Prescription 8 is discussed further in Section 8 – 'Trading- Permanent Transfers' of this review.

14.2 Discussion

The groundwater resources of the Katunga WSPA occur below 25 m from the ground surface. Although environmental features are unlikely to be sourcing water from this depth, extraction of water from aquifers within the WSPA has the potential to affect hydraulic gradients between the shallow water table aquifers in the Shepparton formation and deeper aquifers in the lower Shepparton and Calivil/Renmark formations. This may impact surface features in areas where clay sequences are not present that would otherwise form a significant barrier to flow.

The magnitude of change to shallow groundwater levels caused by pumping from the deeper formations is considered to be small as:

- Rainfall and irrigation are orders of magnitude greater in volume than groundwater extraction in the overall water balance;
- Aquitards are present over much of the WSPA area, causing the target formations to be largely confined or semi-confined;
- Pumping from shallow aquifers is likely to have a far greater impact on groundwater levels in the shallow aquifer system relative to possible enhanced vertical leakage and recharge to the deep aquifers caused by groundwater pumping in the deep aquifers;
- Groundwater hydrographs for nested sites across the Katunga WSPA indicate very poor hydraulic connection between the upper Shepparton formation and the lower Shepparton and Calivil/Renmark Formations.

Goulburn and Murray River riparian corridors

The Goulburn and Murray River riparian corridors overlie predominantly the Coonambidgal Formation, which is made up of alluvial sediments. Connection between the Coonambidgal Formation and the waterway will vary across these catchments. Connectivity between the Coonambidgal formation and the upper Shepparton Formation will vary across the catchments. Across most of the Katunga WSPA, it is considered that the upper Shepparton Formation is poorly connected with the lower Shepparton formation and Calivil/Renmark formations (See Appendix 1).

There is evidence that the River Murray is better connected with the deep lead sediments in the north-east of the Katunga WSPA as discussed in Section 8 – 'Trading- Permanent Transfers'.

Barmah Millewa National Park

The key groundwater issue in the Barmah Millewa National Park is the risk of high watertables causing salinisation rather than the risk that pumping from the deep lead will lower groundwater heads in the upper Shepparton Formation. Nested bore hydrographs for the Barmah Millewa National Park indicate that there is a significant degree of confinement between the upper Shepparton Formation and the lower Shepparton and Calivil/Renmark Formations (for example by comparison of bores 1626 and 1665 on Figure 17). This indicates that the impacts of pumping from the deep lead are constrained to the possibility of increasing leakage from the upper Shepparton Formation. This is unlikely to be a significant impact as outlined in Section 14.2 and may actually have the beneficial effect of helping to mitigate the risk of high water tables in the area (albeit a small influence).

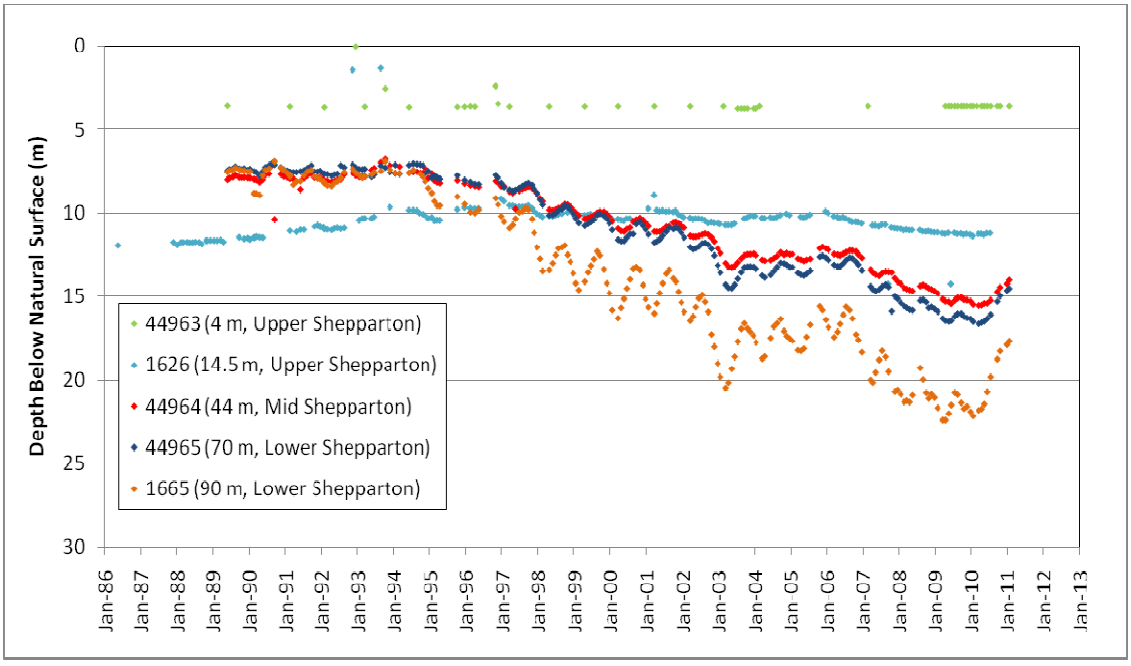


Figure 17 Barmah Millewa National Park nested bore hydrographs.

Other Remnant Vegetation

There is remnant vegetation on both private and public land as well as riparian vegetation along the Broken Creek.

There is little pumping in proximity to the Broken Creek over much of its length. In addition, a similar degree of connection between the Goulburn and Murray Rivers

and underlying aquifers as described above is also considered to exist for the Broken Creek.

14.3 Recommendations

Other than a general concern regarding the River Murray, potential impacts of groundwater pumping on environmental features are not considered to be a significant issue.

The following recommendations are made with respect to considering environmental requirements of the Plan:

- Further work is required to establish the existence, location and extent of groundwater dependence of vegetation within the WSPA;
- Groundwater drawdown in the Katunga WSPA is not considered to cause significant impacts to remnant vegetation in the area due to the depth of the aquifer where the majority of groundwater extractions are occurring; the small influence that groundwater has in the overall water balance when compared with the magnitude of surface water flows and irrigation, and the relatively low rate of vertical leakage from the Shepparton formation to the underlying Calivil/Renmark Formations.

15 Feedback from Groundwater Users

Section Summary

Twenty percent of groundwater licence holders responded to the customer survey. Responses indicated the following key points:

a) Many customers were amenable to changes to the Plan which would allow more flexible groundwater trading rules;

b) Customers are likely to support the introduction of carryover;

c) Customers are generally positive about the current annual allocation methodology, having maintained access through a prolonged drought period;

d) Information provided on pump depths and pumping water levels suggest that there is generally less than 10 m of pumping head in licensed irrigation bores.

15.1 Background

In June 2011, Katunga WSPA customers were invited to provide feedback on how groundwater is managed in the Katunga WSPA. An irrigation customer survey was mailed to 185 licence holders, and also placed on G-MW's website. A domestic and stock user survey was also placed on G-MW's website.

The survey asked questions relating to pumping depths and pumping water levels, trade, carryover, salinity, the annual groundwater allocation methodology and groundwater demand.

15.2 Discussion

Thirty-seven responses were received to the irrigation survey (a 20% return rate). No responses were received to the domestic & stock user survey. There was a good geographical spread of returned surveys.

Water levels and pump depth

Figure 18 and Table 7 below summarise the water level and pump depth results from the user survey. The depth of licensed bores reported in the survey ranged from 30 m to 162.5 m with an average depth of 106.9 m. This corresponds well with bore depths recorded in the GMS (range: 30 m to 180 m).

Licensed pump depths ranged from 20 m to 80 m with an average depth of 40.2 m. This corresponds well with anecdotal information from pump installers which indicates that pumps are generally installed at 40 m. The user survey undertaken in 2000 indicated that pump depths were between 15 m and 41 m. It is likely that the greater pump depths reported in the 2011 survey are reflective of pump lowering that is anecdotally reported to have occurred during the dry period between 2000 and 2010.

Average five-year static water levels within the WSPA are between 13.6 m and 24 m (Schedule 2 bores). The static water levels reported in the licensed user survey were between 13 m and 45 m with a median of 30 m. In the 2000 survey, water levels were reported to be between 9 m and 33 m with a median response of 15 m.

Pumping water levels ranged between 13 m and 45 m with an average of 29.6 m.

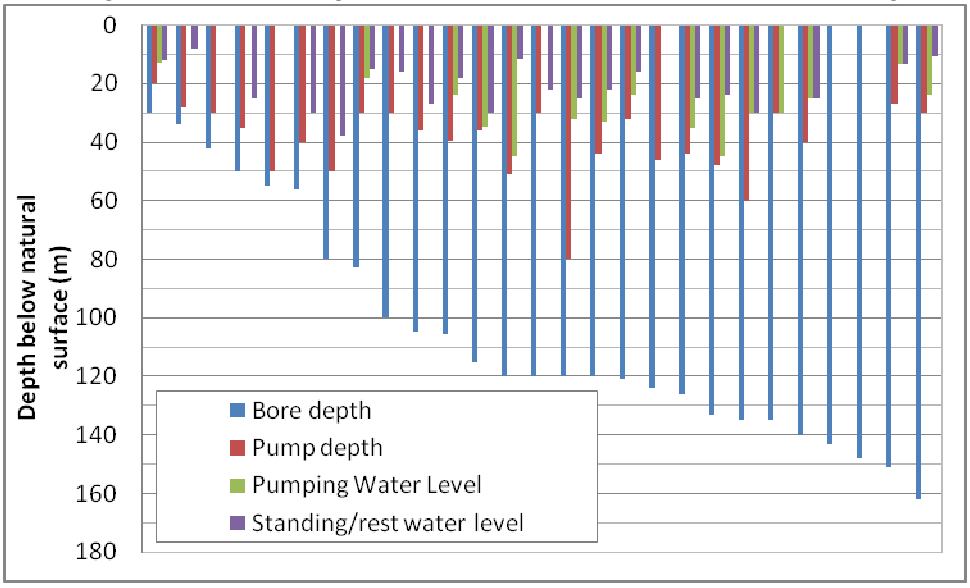


Figure 18 Water level and pump depth information- User Survey 2011

Table 7 Water level and pump depth information- User Survey 2011

	Number of responses	Max	Min	Median	Average
Depth of bores	33	162.1 (m)	30 (m)	117.5 (m)	106.9 (m)
Depth to pump	30	80 (m)	20 (m)	37.8 (m)	41.2 (m)
Static water level	22	38 (m)	8 (m)	22 (m)	22.4 (m)
Drawdown water level	31	45 (m)	13 (m)	30 (m)	29.6 (m)

Temporary Transfer

Forty-three percent of respondents (16 responses) considered that there was no problem with temporary trading. Eleven percent of respondents (4 responses) indicated that trading to a maximum of 100% of entitlement is too restrictive and that it would be appropriate to increase this limit. Twenty-seven percent of respondents (10 responses) declined to comment on temporary trade.

Permanent Transfer

Thirty percent of respondents (11 responses) indicated they had no concerns with permanent transfer. Twenty-seven percent of respondents (10 responses) made no response. Twenty-two percent of respondents (8 responses) indicated that the loss of 20% of traded volume ('clawback' as per Prescription 10 of the plan) should be abandoned. Eleven percent of respondents (4 responses) indicated that the intensity rule should be made more conservative i.e. the volume allowed for extraction within a 2 km radius should be reduced.

Forty-six percent of respondents (17 responses) indicated that they would like to use more groundwater. Sixty-five percent of these respondents indicated their licence volume prevented them from using more groundwater. Twenty-nine percent of the respondents indicated that trading rules prevented them from using more groundwater.

Carryover

Eighty-seven percent of respondents (32 responses) indicated they were in favour of carryover. In general, the respondents were in favour of carryover so long as it did not result in reduced allocations.

Annual allocation methodology

Forty-nine percent of respondents (18 responses) indicated that they thought that 20 m below the ground surface was an appropriate level to manage groundwater levels to. One respondent thought the level was too high, one respondent thought the level was too low and forty-three percent of respondents (16 responses) were unsure. Many of the respondents commented that the annual allocation methodology maintained supply throughout the drought.

Groundwater Salinity

Seventy-six percent of respondents (28 responses) indicated that they either had no concerns with regard to groundwater salinity, or that they were aware of the salinity of the water and able to manage these issues. The response indicates that salinity is not a major management concern.

Management plan annual report

Fifty-seven percent of respondents (21 responses) indicated they found the annual report useful. There was some concern about the annual report being made available to customers on the internet only.

15.3 Summary

The response to the 2011 Licensed Groundwater User Survey indicates the following:

- Customers may be amenable to changes to rules around groundwater trade;
- Customers are likely to support the introduction of carryover;
- Customers are generally positive about the current annual allocation methodology;
- Information provided on pump depths and pumping water levels suggest that there is generally less than 10m of headroom in licensed irrigation bores;
- A significant proportion of customers (27% or 10 respondents) did not read the annual reports or thought they were too complicated.

16 Annual Reporting

Section Summary

The annual report is an important mechanism to assess the performance of the management plan but communication of the report needs to be improved.

16.1 Background

The Plan sets out the obligation for G-MW to submit a report on the enforcement and administration of the Plan, for the period 1 July – 30 June, by 30 September of each year.

The report is submitted to the Minister for Water and the Goulburn Broken Catchment Management Authority and is made publicly available. The annual report is published on the G-MW website and hard copies are made available on request.

Each fifth annual report must make comment on the need for the Plan to be reviewed (this report).

Five annual reports have been submitted since approval and implementation of the Plan in 2006. The survey of groundwater licence holders suggests that a significant proportion of customers do not read the annual report. There was general comment that customers are less likely to read the report if it can only be accessed via the internet.

16.2 Recommendations

It is recommended that alternative communication methods are investigated with the aim of increasing the proportion of licence holders who read information on the administration of the Plan.

17 Recommended Future Technical Work

Section Summary

There are several key areas of conceptual understanding that underlie the Plan and are poorly understood. These are:

(a) The timing, magnitude and distribution of vertical leakage through the Shepparton Formation, and the controls on this (i.e. what is the impact of pumping relative to rainfall recharge, irrigation recharge, and evapotranspiration?).

(b) The extent of inflows and outflows from/to the River Murray and the impact of pumping from the deep lead on the River Murray.

(c) The source of the lower salinity groundwater in the north east of the WSPA (i.e. is this vertical leakage or horizontal flow from the east).

(d) The volume of lateral inflow and outflows to and from the deep lead.

17.1 Recommended Future Technical Work

Water Balance

There is currently a poor understanding of recharge to the deep lead aquifer system. A water balance which investigates the timing, magnitude and distribution of vertical leakage through the Shepparton formation as well as throughflow components of recharge is required. Gaining a more sophisticated understanding of the water balance components will better inform groundwater management, particularly ensuring there is resilience in the management framework for changed future climate scenarios and groundwater pumping scenarios.

Impacts to the River Murray

There are currently significant knowledge gaps concerning the risk that further groundwater extraction in the vicinity of the River Murray will have on baseflow to and leakage from the river. This prevents the risk of alternative management strategies in areas proximate to the River Murray to be adequately addressed. It is recommended that further work to assess this risk is undertaken. The work should include, but is not limited to the following:

- clarification of the conceptual hydro-geological understanding of groundwater and surface water systems along the River Murray;

- quantification of existing groundwater and surface water heads, river bed sediment thickness and hydraulic characteristics, and the losses and gains in the River Murray that result from groundwater pumping (from below 25 m);
- assessment of the risk posed by future extraction (below 25 m) on the River Murray (including extractions within 2 km).

Groundwater Salinity

There are some potentially important future management questions that cannot be answered with the existing salinity dataset. These include:

- What is the impact of different pumping intensity in the deep lead for salinity in the overlying aquifers and the deep lead?
- Does pumping from the deep lead induce poorer quality groundwater to migrate from the south and west of the Katunga WSPA?
- How do variations in the salinity of the upper Shepparton Formation impact on deep lead salinity?
- What is the mechanism for low salinity water to enter the deep lead, and what is the impact of groundwater pumping on the Murray River?

Groundwater Dependent Ecosystems

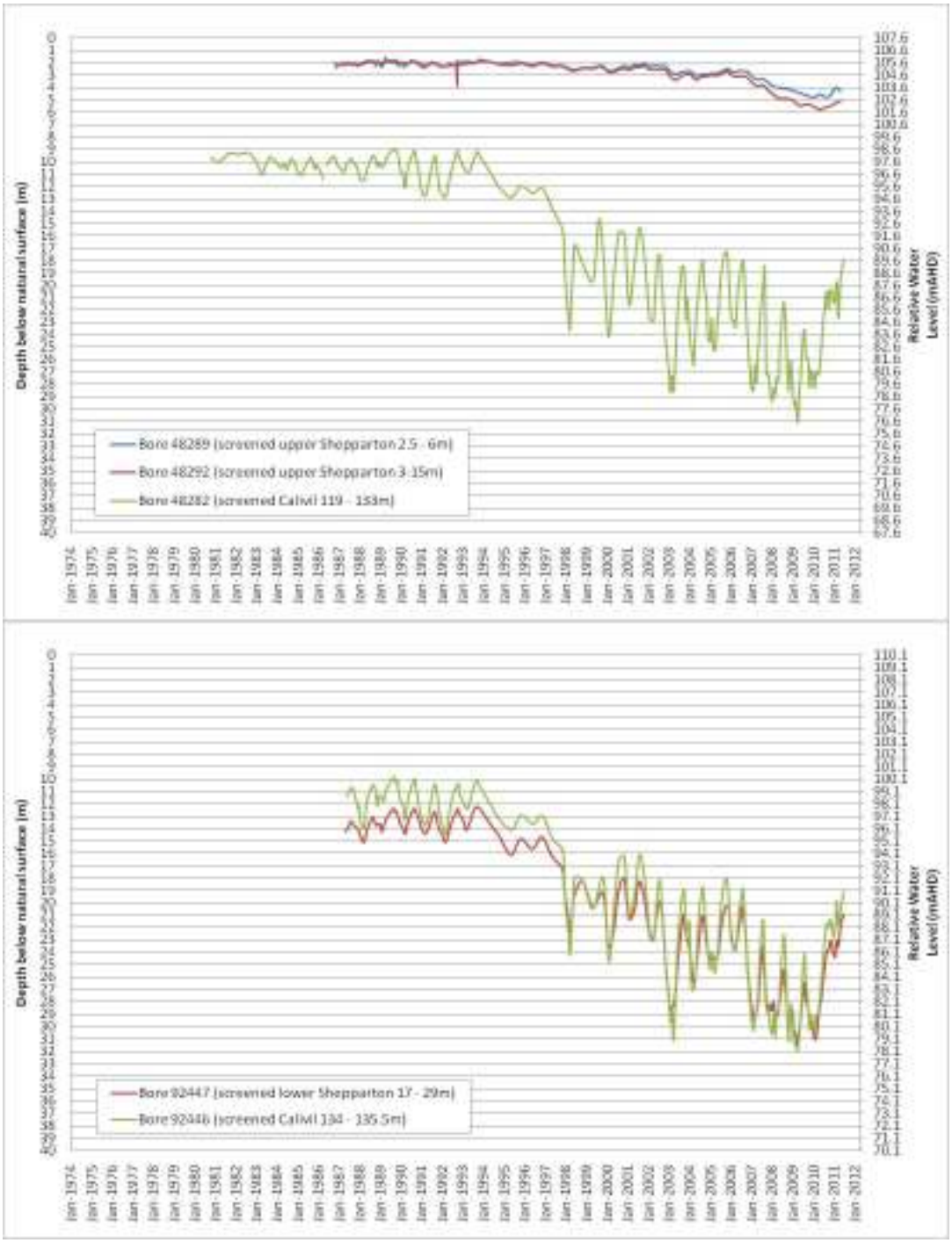
The following recommendation regarding environmental considerations included in the Plan:

- Further work is required to establish the existence, location and extent of groundwater dependent vegetation within the WSPA.

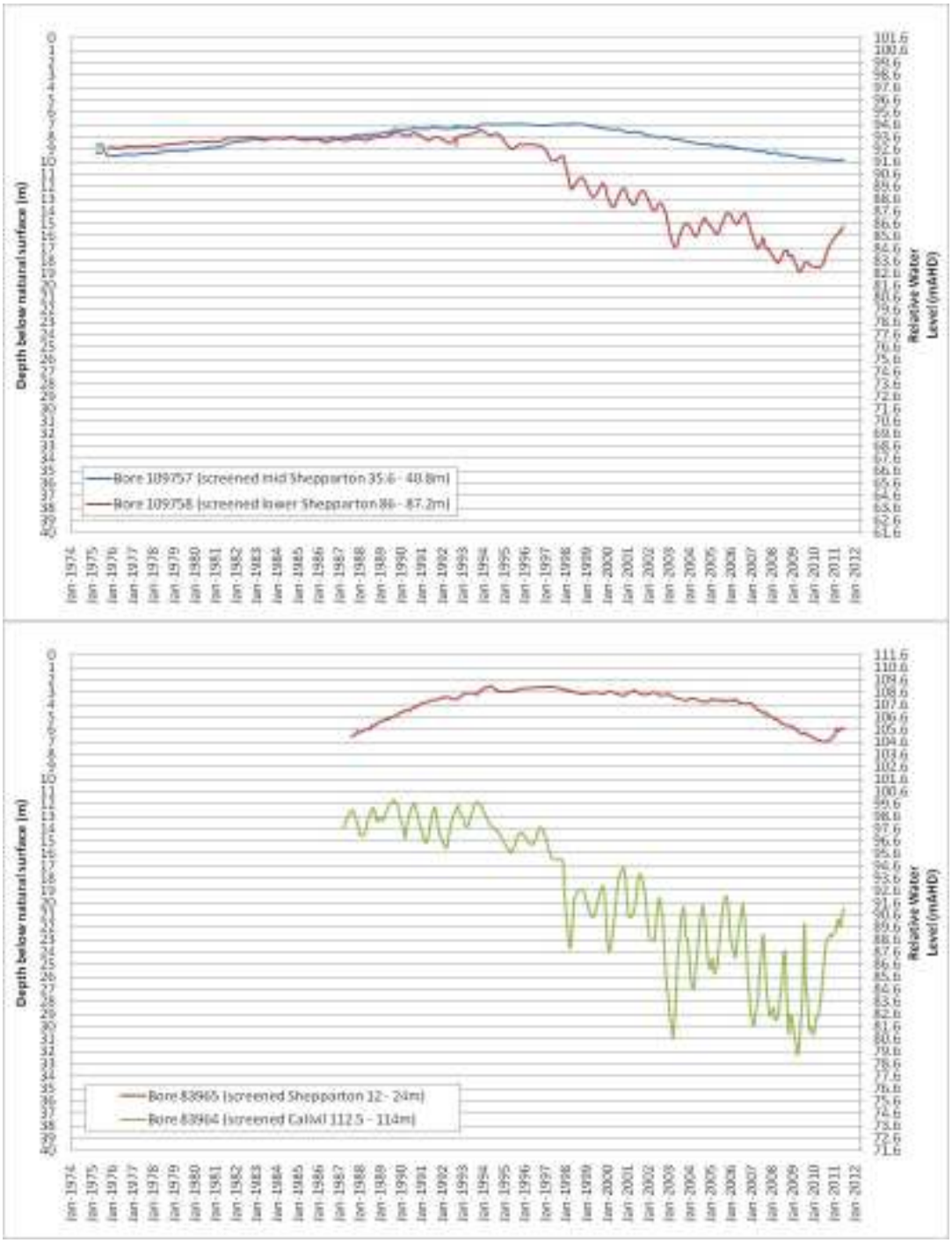
Appendix 1 – Representative Hydrographs

a) Zone 1061

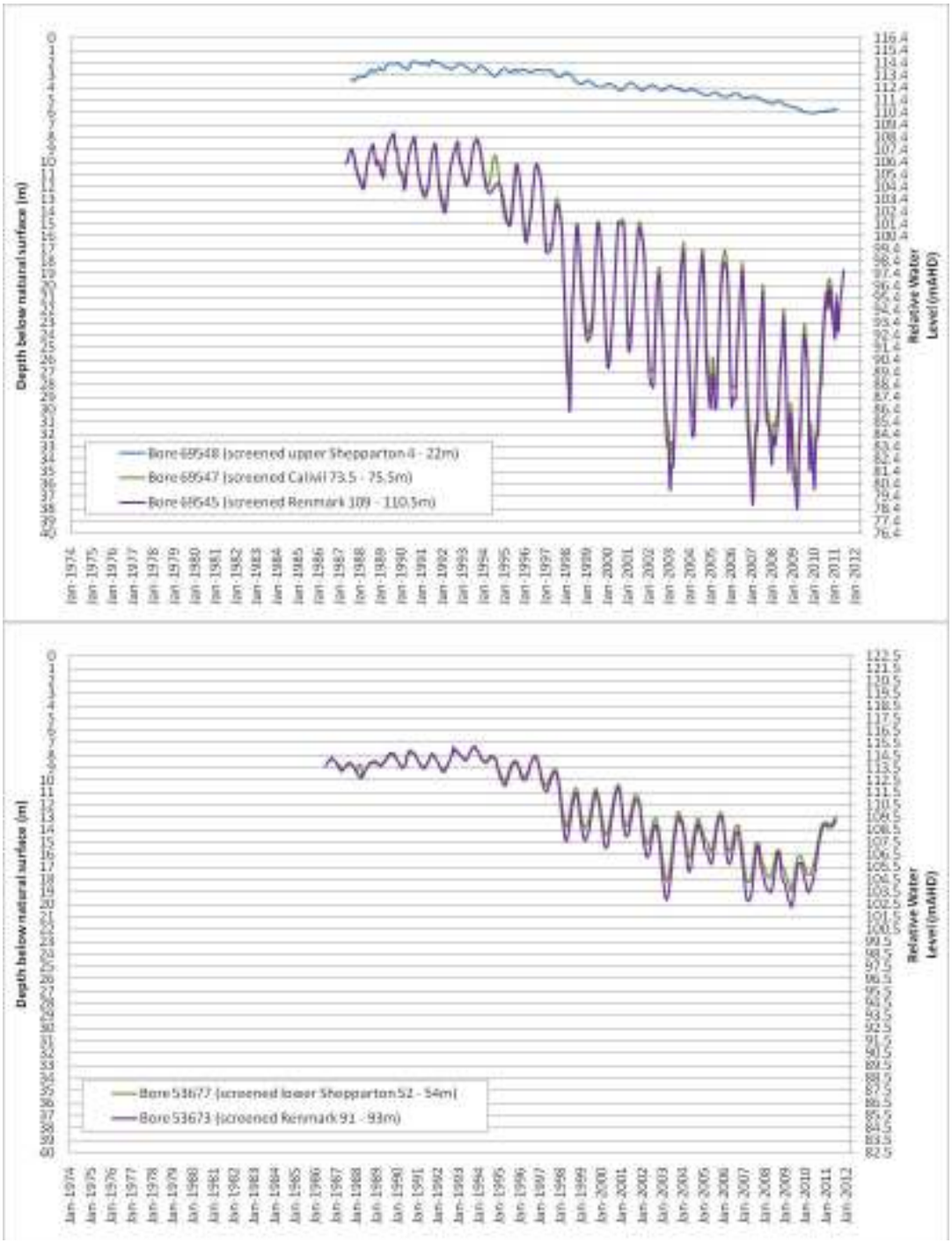
b) Zone 1062


Depth below natural surface (m)
Relative Water Level (mAHD)
Bore 48289 (screened upper Shepparton 2.5 - 6m)
Bore 48292 (screened upper Shepparton 3-15m)
Bore 48282 (screened Calivil 119 - 153m)
Bore 92447 (screened lower Shepparton 17 - 29m)
Bore 92446 (screened Calivil 134 - 135.5m)

Zone 1062 cont…



c) Zone 1063


Depth below natural surface (m)
Relative Water Level (mAHD)
Bore 69548 (screened upper Shepparton 4 - 22m)
Bore 69547 (screened Calivil 73.5 - 75.5m)
Bore 69545 (screened Renmark 109 - 110.5m)
Bore 53677 (screened lower Shepparton 52 - 54m)
Bore 53673 (screened Renmark 91 - 93m)