



Mid Goulburn Groundwater Management Area

Local Management Plan

November 2014



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Cover photos by K.Joy and taken in the south of the Mid Goulburn GMA

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Quick reference guide to the Plan rules

This section lists the Plan rules for quick reference. The reader should refer to the relevant chapter of the Plan for more information about each Rule.

Rule 1: Cap on entitlement (Page 18)

GMW may issue a groundwater licence provided that the Permissible Consumptive Volume for the Mid Goulburn Groundwater Management Area is not exceeded.

Rule 2: Restrictions (Page 19)

If, in a local area, there is a significant fall in groundwater recovery levels observed over time to be:

- a) greater than 3 m in 3 years or
- b) a drawdown in one season of greater than 15 m,

then GMW will investigate the cause and, if necessary, engage with local groundwater users to assess the need for management intervention.

Management options may include:

- installing a new monitoring bore to better understand the local impacts of groundwater pumping on groundwater levels;
- increased monitoring frequency of existing bores;
- some other arrangement whereby groundwater levels can be recorded in the local area on a regular basis with a high degree of confidence (i.e. record levels in private monitoring bores under licence conditions);
- groundwater users lowering their pumps or deepening their bores; or
- declaring a water shortage and announcing a temporary qualification of rights to restrict groundwater pumping in the affected area.

Rule 3: Transfer of entitlement (Page 20)

GMW may approve an application to transfer groundwater entitlement provided matters under the Act have been considered and the following conditions are satisfied:

- a) Entitlement may be permanently transferred within or between zones provided the following management zone limits are not exceeded:

Management Zone	Zone Limits (ML/yr)
Kialla Zone	8,000
Nagambie Zone	8,000

NB: the entitlement cannot exceed the permissible consumptive volume (refer chapter 4.1.)

- b) Entitlement may be temporarily transferred within or between management zones regardless of zone limits
- c) Entitlement may be temporarily transferred into the Mid Goulburn GMA provided that the permissible consumptive volume is not exceeded

Rule 4: Carryover (Page 20)

GMW will apply to the Minister for Water to declare the availability of carryover in the Mid Goulburn GMA up to a maximum of 20% of entitlement in each year.

Rule 5: Groundwater monitoring (Page 24)

GMW will:

- (a) Obtain periodic groundwater levels readings, where practicable, from State observation bores listed in Schedule 1 or their replacement
- (b) Establish a program of targeted sampling of licensed bores to collect and measure groundwater salinity each year
- (c) Collect groundwater samples from selected State observation bores identified in Schedule 1 where practicable, or their replacement, and send them to a NATA accredited laboratory for analysis

Rule 6: Metering (Page 24)

GMW will read flow meters on licensed bores at least once annually and record usage in the Victorian Water Register and consider the data collected as part of the Plan review.

Rule 7: Communications (Page 25)

By 1 October each year GMW will provide Mid Goulburn GMA customers with a newsletter reporting on groundwater resource status, licensed groundwater use and trade activity for the previous season. The newsletter will also identify any need to amend the Plan.

Rule 8: Plan review (Page 25)

GMW will:

- (a) Review the need for any amendments to the Plan on an annual basis.
- (b) Undertake a detailed review of the Plan when average groundwater usage exceeds 50% of entitlement over a period of three years
- (c) Consult with the Goulburn Broken Regional Water Service Committee, licence holders and other stakeholders on proposed amendments to Plan rules.

Endorsement

This groundwater Local Management Plan (the Plan) has been developed for the Mid Goulburn Groundwater Management Area (GMA) and is a significant step forward in the management of groundwater resources for the area.

The Plan provides a clear operational framework to manage groundwater resources in the Mid Goulburn GMA and provides specific guidance and information to Goulburn-Murray Water's customers relating to the take and use of groundwater.

The development of the Plan has been guided by consultation with Goulburn-Murray Water's customers and key stakeholders and fulfils an obligation of the Northern Region Sustainable Water Strategy (DSE, 2009).

The Plan recognises social, environmental and economic values of groundwater and provides clear rules for the use of groundwater in an equitable and sustainable manner.

The Plan will require periodic review, particularly in light of the Murray-Darling Basin Plan and the Victorian Water Law Review, as changes to Victoria's groundwater management framework take effect and as the understanding of groundwater resources in the Mid Goulburn GMA improves.

The Plan fits within the broader Victorian water allocation and management framework contained in Victorian legislation and associated instruments. It is anticipated that local management plans will form an important component of broader water resource plans that are required to be developed by Victoria as part of the Murray-Darling Basin Plan.

Goulburn-Murray Water will continue to work with our customers, local communities and other stakeholders to ensure that the Plan is reviewed and updated where necessary.



Simon Cowan
Goulburn-Murray Water
Manager Groundwater and Streams

Date: 6 November 2014



Stephen Gemmill
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Customer Services Manager Diversions - East

Date: 13 November 2014

Acknowledgements

Goulburn-Murray Water recognises the value of local knowledge and undertook to consult widely with the local community during the development of this Plan. This included a public meeting at the commencement of the process, a survey of groundwater users and the appointment of a Reference Group which comprised groundwater users and other stakeholders.

Goulburn-Murray Water would like express its appreciation to those who attended the public meeting and participated in a workshop to develop the objectives for the Plan.

Goulburn-Murray Water would also like to thank those who completed the survey. This information proved invaluable in drafting the Plan.

Finally, Goulburn-Murray Water would like to sincerely thank Reference Group members for their contribution to refine the objectives and comment on management proposals. The Reference Group members were:

Adrian Pogue	Landholder
Michael Gaffy	Landholder
David Rowe	Landholder
Jenny Rowe	Landholder
Sam Gallo	Landholder
Stuart Rea	Landholder
Craig Madden	Goulburn Broken Water Services Committee & Landholder
Andrea Montgomery	Goulburn Murray Landcare Network
Paul McCrohan	Baiada Poultry
Steven Hicks	Strathbogie Shire Council
Tim Barlow	Goulburn Broken Catchment Management Authority

The Reference Group was supported by the Goulburn-Murray Water project team, which included Karina Joy, Brendan Cossens, Matt Hudson, Suzanne Giles and Josh Cimera.



Public meeting May 2014



Reference Group meeting May 2014

Glossary

Term/Acronym	Description
Act	Victorian Water Act 1989
Allocation	A percentage of licence volume that can be extracted in season.
Aquifer	An underground layer of rock or sand or other geological unit that contains water
Drawdown	The groundwater level difference between pumping and non-pumping conditions
DEPI	Department of Environment and Primary Industries
Entitlement	Licensed volume of groundwater specified as megalitres per year
GDE	Groundwater dependent ecosystem
GL	One gigalitre; which is equal to one thousand megalitres
GMA	Groundwater Management Area
GMW	Goulburn-Murray Rural Water Corporation (trading as Goulburn-Murray Water)
Licence	Licence issued to take and use groundwater under section 51 of the Water Act.
m	Metre
ML	Megalitre or one million litres
NATA	National Association of Testing Laboratories
PCV	Permissible Consumptive Volume is the volume of groundwater that the Minister for Water has declared may be extracted from a defined area in a season
Plan	Local management plan
Recovery	The level to which groundwater rises during winter/spring each year
Season	Period of 12 calendar months beginning on 1 July in any year and ending on 30 June in the following year
Trade	The transfer of a groundwater licence
WSPA	Water Supply Protection Area
Zone	A defined part of the groundwater management area

Table of Contents

QUICK REFERENCE GUIDE TO THE PLAN RULES.....	I
ENDORSEMENT	III
ACKNOWLEDGEMENTS.....	IV
GLOSSARY.....	V
TABLE OF CONTENTS	VI
1 INTRODUCTION	1
1.1 BACKGROUND.....	1
1.2 MID GOULBURN GROUNDWATER MANAGEMENT AREA.....	1
1.3 DEVELOPMENT OF GROUNDWATER RESOURCES	4
1.4 PLAN OBJECTIVES	4
2 GROUNDWATER SYSTEM.....	5
2.1 AQUIFERS	5
2.1.1 <i>Coonambidgal Formation</i>	5
2.1.2 <i>Shepparton Formation</i>	5
2.1.3 <i>Deep Lead</i>	5
2.1.4 <i>Bedrock</i>	5
2.2 GROUNDWATER RECHARGE.....	7
2.3 GROUNDWATER LEVELS	7
2.4 GROUNDWATER SALINITY	7
2.5 GROUNDWATER FLOW.....	7
2.6 GROUNDWATER DISCHARGE	10
2.7 MANAGEMENT ZONES	10
2.8 WATER BALANCE	10
3 GROUNDWATER DEPENDENT VALUES AND PUMPING IMPACTS	11
3.1 GROUNDWATER PUMPING IMPACTS	11
3.2 GROUNDWATER DEPENDENT VALUES	12
3.2.1 <i>Groundwater dependent ecosystems</i>	12
3.2.2 <i>Groundwater interaction with surface water</i>	14
3.2.3 <i>Groundwater quality</i>	15
3.2.4 <i>Licensed use</i>	15
3.2.5 <i>Domestic and stock use</i>	16
4 GROUNDWATER MANAGEMENT.....	18
4.1 ENTITLEMENT	18
4.2 GROUNDWATER LICENSING.....	18
4.3 MANAGING GROUNDWATER EXTRACTIONS	18
4.3.1 <i>Restrictions</i>	18
4.3.2 <i>Interference</i>	19
4.4 GROUNDWATER TRADING	19
4.5 CARRYOVER	20
5 MONITORING PROGRAM.....	22
5.1 GROUNDWATER LEVELS	22
5.2 GROUNDWATER QUALITY.....	22
5.2.1 <i>Targeted sampling of licensed bores</i>	24
5.2.2 <i>Sampling of State observation bores</i>	24
5.3 METERED USE	24
6 PLAN IMPLEMENTATION.....	25

6.1	COMMUNICATIONS	25
6.2	PLAN REVIEW	25
6.3	RECOMMENDED WORKS	25
SCHEDULE 1	27
7	REFERENCES.....	28
8	APPENDIX A	29

1 Introduction

1.1 Background

Groundwater in Victoria is managed under the *Water Act 1989* (the Act). The Department of Environment and Primary Industries (DEPI) is responsible for monitoring and management of groundwater resources in Victoria. DEPI provides advice to the Minister for Water on groundwater policy and management. More information about groundwater and DEPI's role can be found on the website: <http://www.depi.vic.gov.au/water/groundwater>

Goulburn-Murray Water (GMW) is responsible for issuing groundwater licences and for managing and administering groundwater use in accordance with the Act. These responsibilities include developing and implementing a local management plan in the Mid Goulburn GMA.

This Local Management Plan (the Plan) has been developed to provide groundwater users with clear, cost effective and adaptive rules which facilitate the use of groundwater in the Mid Goulburn GMA.



Groundwater used to irrigate fruit trees



Groundwater use at poultry farm

1.2 Mid Goulburn Groundwater Management Area

The Mid Goulburn GMA is located in the Goulburn River Catchment in northern Victoria and is part of the Murray Darling Basin. It extends from the foothills of the Great Dividing Range near Avenel to Wunghnu in the north, incorporating the towns of Nagambie, Murchison, Tatura and Shepparton (Figure 1).

The Mid Goulburn GMA is located within the Goulburn-Broken Groundwater Catchment Unit (Figure 2). Groundwater Catchment Units are areas that comprise connected groundwater resources.

It covers an area of approximately 1,600 km². The depth limit has been set as 200 m below the natural surface, or 50 m below the base of the Deep Lead, whichever is the greater, based on DSE (2012).

The Mid Goulburn GMA is overlain by the Shepparton Irrigation Region Groundwater Management Area north of Murchison (Figure 3). In these areas, the Mid Goulburn GMA commences at 25 m below the surface. In the remaining area, the Mid Goulburn GMA commences at the ground surface.

Groundwater in the Mid Goulburn Groundwater Management Area (GMA) is highly valued. It is shared between the environment, domestic and stock users, irrigated agriculture and industrial and commercial users.

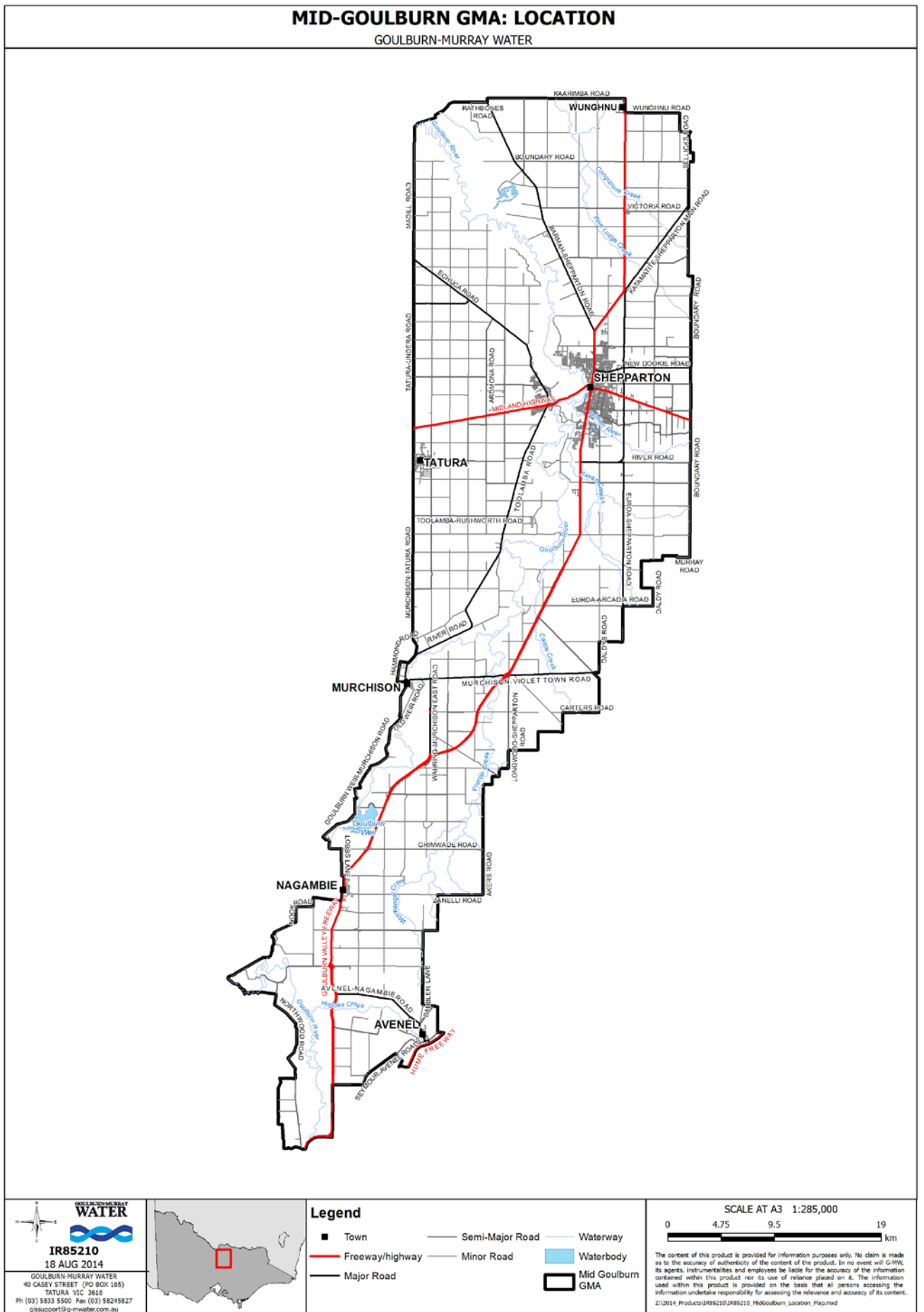


Figure 1 Mid Goulburn Groundwater Management Area

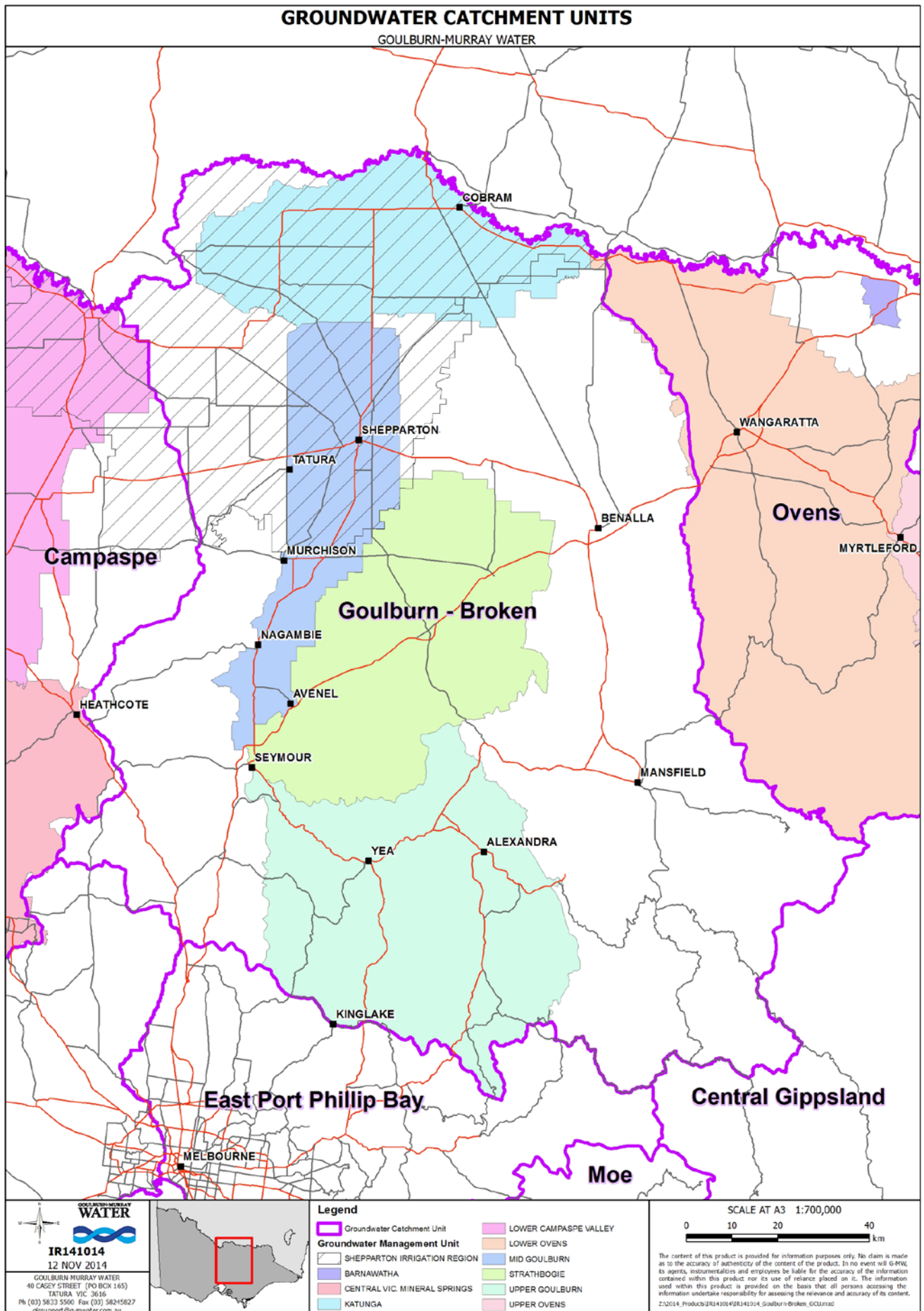


Figure 2 Mid Goulburn GMA in relation to Groundwater Catchment Units

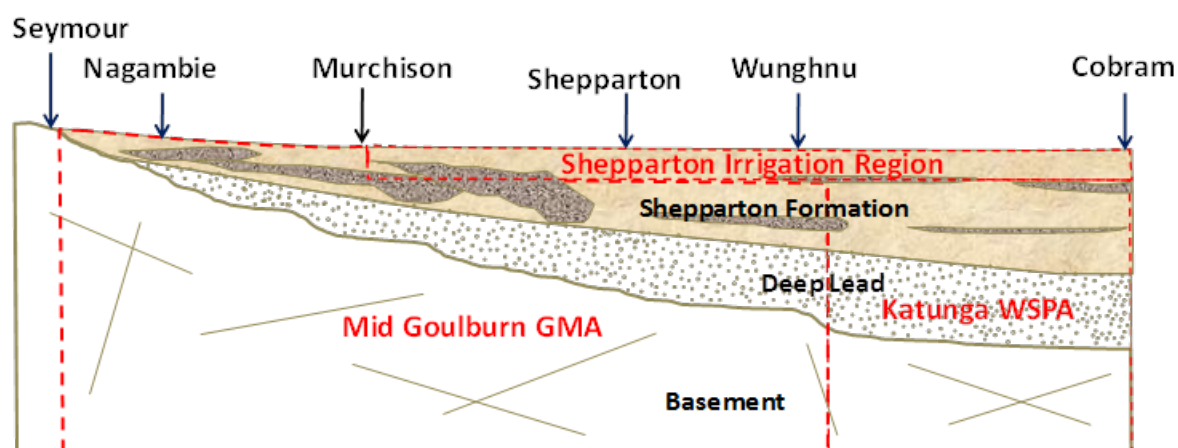


Figure 3 Cross section of the Mid Goulburn GMA in relation to adjoining Groundwater Management Units

1.3 Development of groundwater resources

Records indicate that groundwater use has increased steadily since the late 1960s with stepped increases in 1983, 1988 and 2003 in response to dry conditions.

The area also has a long history of land salinity management with the development of the Goulburn Broken Dryland Salinity Management Plan in 1989 in response to rising groundwater levels (GBCMA, 2002). The Dryland Salinity Management Plan was developed to manage areas with high watertables, stream salt loads and stream salinities. This included wetlands around Nagambie that were considered to be at risk from rising saline water tables (DCE 1992). Activities were undertaken to reduce recharge and manage discharge areas through targeted tree planting and perennial pastures to combat land salinity. Groundwater pumping was also promoted under the Dryland Salinity Management Plan.

1.4 Plan objectives

The aim of this Plan is to manage groundwater in an equitable manner so as to ensure long term sustainability of the resource.

Through broad consultation with stakeholders the following specific objectives were developed:

1. protect social, economic and environmental groundwater dependent values
2. effectively communicate information on the management and status of groundwater resources
3. provide flexible trading opportunities
4. provide enhanced value of entitlements through cost effective management
5. provide security of access to groundwater
6. manage groundwater resources with an adaptable local management plan.

There are a number of aspects to each of these objectives which are described in Appendix A.

2 Groundwater system

2.1 Aquifers

There are four aquifers found within the Mid Goulburn GMA, namely: Coonambidgal Formation, Shepparton Formation, Deep Lead, and Bedrock (GHD, 2012).

2.1.1 Coonambidgal Formation

The Coonambidgal Formation (Quaternary Aquifer) is the youngest aquifer in the area. It is made up of sands, gravels and clay of different sizes and occurs along and immediately underlies waterways. It is difficult to distinguish between the Coonambidgal Formation and the underlying Shepparton Formation, so its thickness is not defined (GHD 2012).

2.1.2 Shepparton Formation

The Shepparton Formation (Upper Tertiary/Quaternary Aquifer) comprises clay, silt and discontinuous sand lenses and is found at the surface across most of the area. Clay content in the Shepparton Formation increases to the north of the Mid Goulburn GMA (SKM, 2006). The Shepparton Formation ranges in thickness from 20 m in the south to over 100 m in the north. Yields and groundwater salinity can be highly variable.

The Shepparton Formation overlies the Deep Lead. Where the Deep Lead is not present, the Shepparton Formation overlies bedrock.

2.1.3 Deep Lead

The Deep Lead is comprised of the Calivil Formation (Upper Tertiary Aquifer) and the Renmark Group (Lower Tertiary Aquifer). It is an ancient river bed consisting of coarse sand and gravel with some clay.

The Deep Lead generally follows the path of the Goulburn River until north of Shepparton where it widens before merging with the Murray Valley Deep Lead further north (Figure 4 and Figure 5). The Deep Lead increases in depth and thickness to the north. In the south it outcrops around Mangalore and is around 30 m thick. In the north it is around 80 m below the surface and can be up to 80 m thick (GHD, 2012).

The Deep Lead is the main aquifer utilised for licensed groundwater extraction in the area as it is higher yielding.

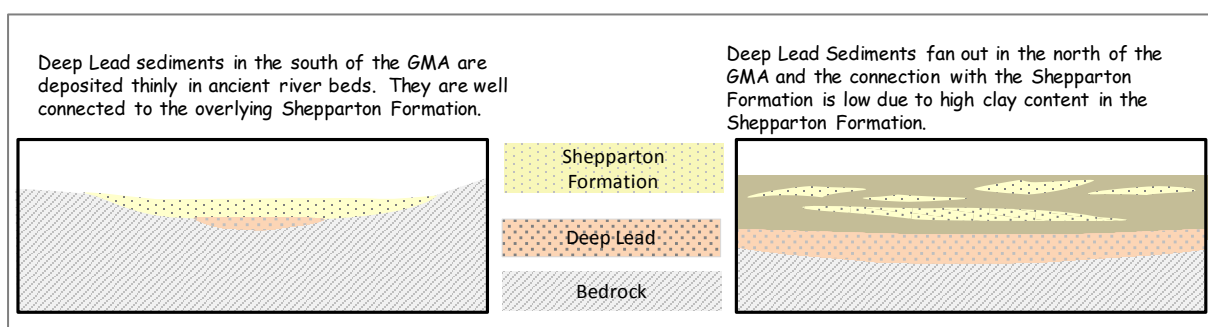


Figure 4 Schematic east-west cross sections of the Mid Goulburn GMA

2.1.4 Bedrock

The Bedrock Aquifer is mostly Ordovician aged sediments of shale, slate and sandstone with some intrusive granites and granodiorites in the south (SKM, 1998a, SKM, 1998b; URS, 2001). Bedrock outcrops in the southern margins of the GMA. The Bedrock aquifer is lower yielding and groundwater is typically more saline than in other aquifers.

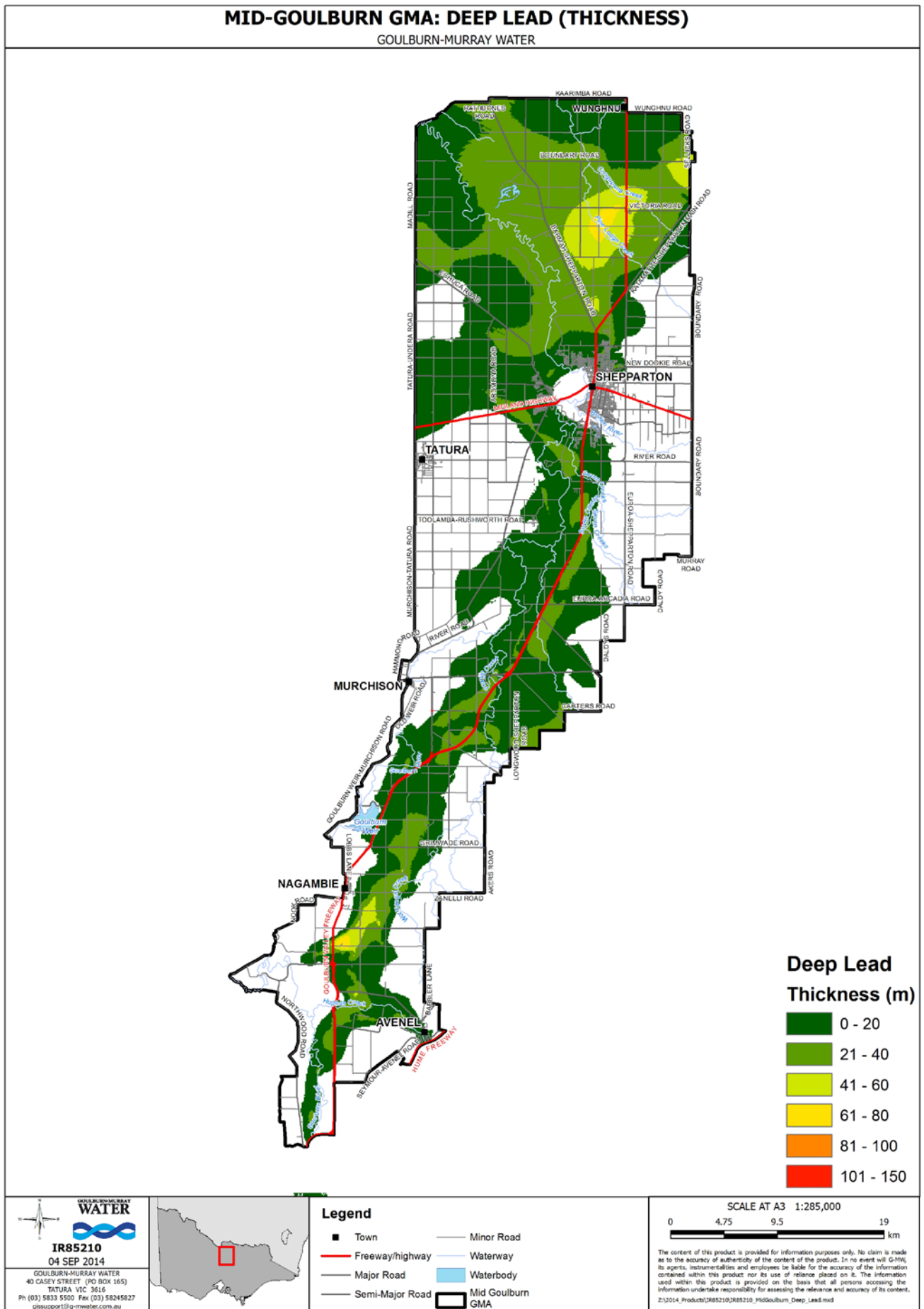


Figure 5 Extent and thickness of the Deep Lead in the Mid Goulburn GMA (after GHD, 2012)

2.2 Groundwater recharge

The Shepparton Formation is largely recharged from rainfall across the area. Recharge also occurs from streams leaking to the groundwater system, flood events and from deep percolation of irrigation water. The Deep Lead is generally recharged vertically from the overlying Shepparton Formation and more directly by rainfall in the south where it outcrops near Mangalore (SKM, 1998a; SKM 1998b).

2.3 Groundwater levels

In the south of the GMA, groundwater levels in the Deep Lead and Shepparton Formation fell by around five metres during the dry period extending from the mid-1990s to 2010. Groundwater levels recovered strongly following above average rainfall and reduced groundwater extraction in 2010/11, but the levels remain below those seen in the mid-1990s (Figure 6).

In the north, groundwater levels in the Deep Lead declined by approximately 10 m from the mid-1990s to 2010, and recovered strongly following rainfall in 2010/11 (Figure 7). In comparison, groundwater levels in the Shepparton Formation only fell by less than five metres over the same period.

The response in groundwater levels suggest that there is good hydraulic connectivity between the Deep Lead and the overlying Shepparton Formation in the south, but connectivity decreases to the north as the clay content in the Shepparton Formation increases.

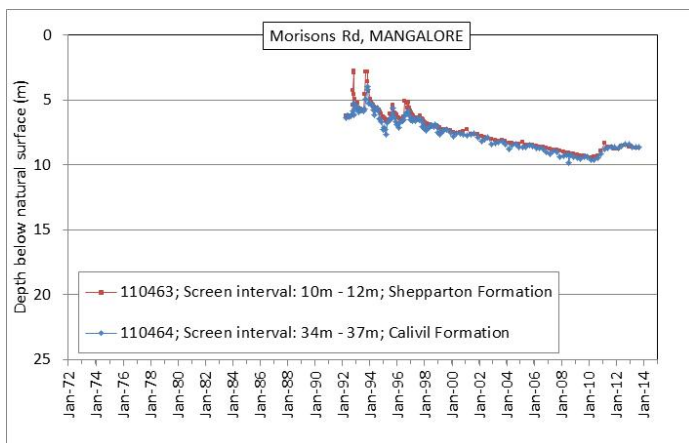


Figure 6 Nested observation bores at Mangalore

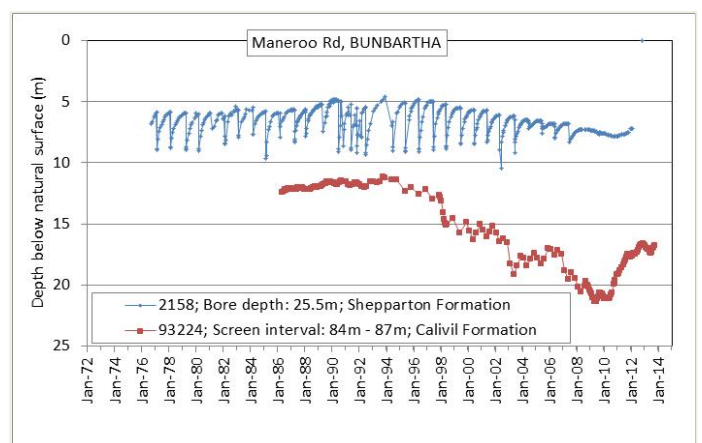


Figure 7 Nested observation bores at Bunbartha

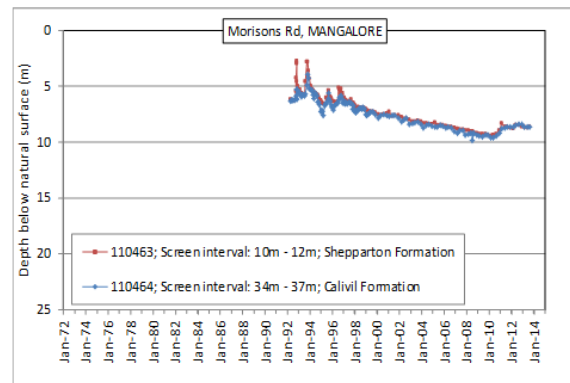
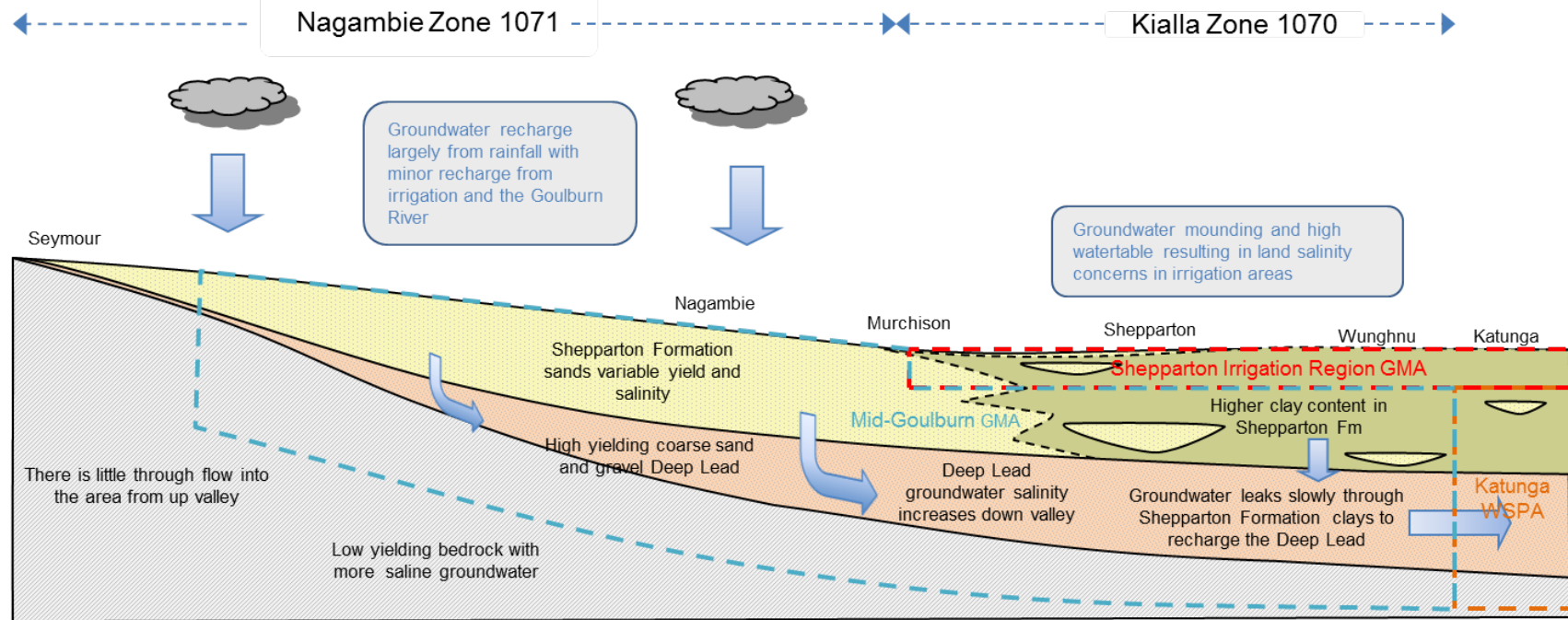
2.4 Groundwater salinity

Groundwater in the Deep Lead in Mid Goulburn GMA ranges in salinity from 1,000 mg/L to 4,000 mg/L (Total Dissolved Solids) generally becoming saltier to the north. There is also a lens of relatively fresh Deep Lead groundwater near Shepparton (SKM, 2006).

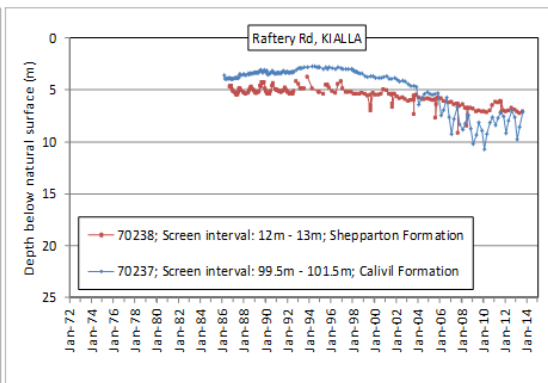
When compared with the Deep Lead, the Shepparton Formation is saltier and ranges from 2,000 to 6,000 mg/L (Total Dissolved Solids).

2.5 Groundwater flow

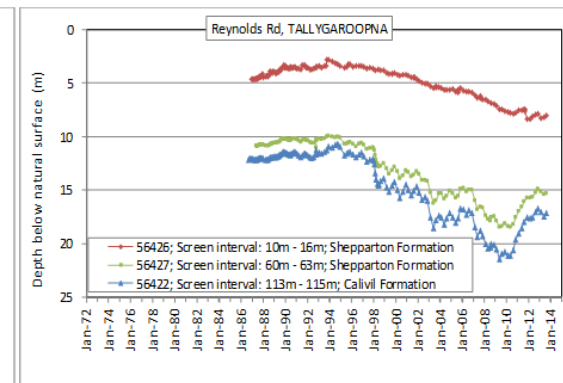
Regionally, groundwater flows north towards the Murray River via the Katunga Water Supply Protection Area (WSPA). The Deep Lead is the primary conduit for groundwater flow.



Groundwater levels relatively stable in the south with little seasonal variation and the Deep Lead is hydraulically well connected to the Shepparton Formation



Seasonal fluctuations in Deep Lead not seen in Shepparton Formation suggesting aquifers not as well connected. Hydraulic gradient reversed from upward to downward in early 2000s.

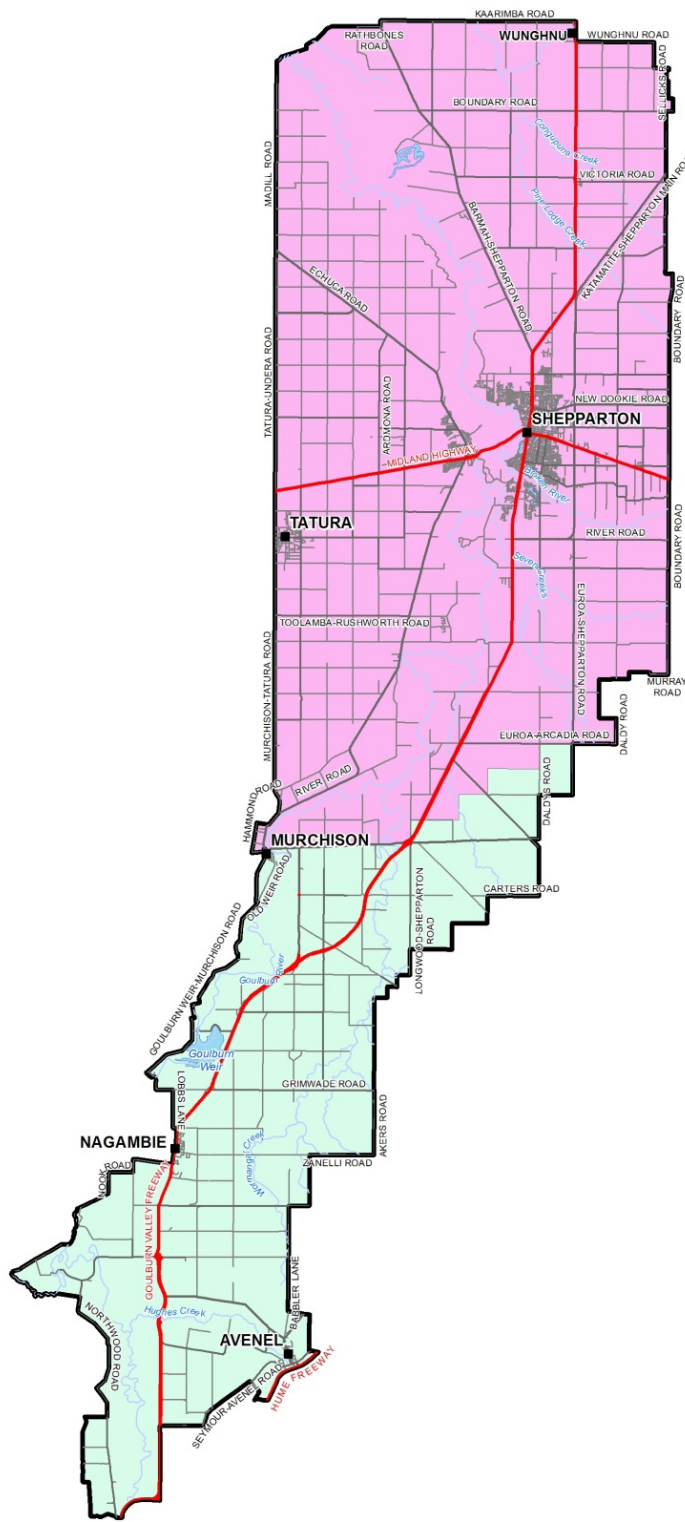


Greater rates of change in long term trends and seasonal fluctuations in the Deep Lead compared to the upper Shepparton Formation

Figure 8 Mid Goulburn Groundwater Management Area conceptual understanding of groundwater system

MID-GOULBURN GMA: MANAGEMENT ZONES

GOULBURN-MURRAY WATER



GOULBURN-MURRAY WATER
IR85210
 04 SEP 2014
 GOULBURN-MURRAY WATER
 40 CASEY STREET (PO BOX 165)
 TATURA VIC 3616
 Ph (03) 5833 5500 Fax (03) 58245827
 gisupport@g-mwater.com.au



Legend

■ Town	— Minor Road	Management Zone
— Freeway/highway	— Waterway	1070 Kialla
— Major Road	— Waterbody	1071 Nagambie
— Semi-Major Road	□ Mid Goulburn	
	□ GMA	

SCALE AT A3 1:285,000

0 4.75 9.5 19 km

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Figure 9 Mid Goulburn Groundwater Management Area Management Zones

2.6 Groundwater discharge

Groundwater is discharged from the Mid Goulburn GMA by evapotranspiration, aquifer throughflow to the Katunga WSPA in the north and groundwater pumping. It may also discharge as springs or base flow in low lying parts of the landscape.

A conceptual overview of the groundwater system is provided in Figure 8.

2.7 Management Zones

Based on the characteristics of the groundwater system in the Mid Goulburn GMA, particularly the recharge mechanisms and the aquifer response to pumping, two management zones have been established (Figure 9):

- Nagambie Zone 1071; and
- Kialla Zone 1070.

The Nagambie Zone extends from Mangalore in the south to Murchison. In this region the Shepparton Formation and Deep Lead are well connected.

In the Kialla Zone, from Murchison to Wunghnu, the Deep Lead broadens and thickens. In this zone the Deep Lead is not as well connected to the upper Shepparton Formation due to increased clay within the Shepparton Formation.

The Kialla Zone commences at 25 m below the ground surface as it is overlain by the Shepparton Irrigation Region GMA. The boundary between the management zones aligns with the boundary of the Shepparton Irrigation Region GMA.

2.8 Water balance

A water balance has been developed to determine the impacts of groundwater extraction for various climatic conditions (GMW, 2014a).

The greatest inputs to the groundwater system are rainfall recharge in the Nagambie Zone and leakage from the Shepparton Formation to the Deep Lead in the Kialla Zone, shown in Figure 10. Leakage from the Goulburn River and aquifer throughflow provide smaller contributions.

The greatest output from the groundwater system is aquifer throughflow to the Katunga Water Supply Protection Area. In the past, groundwater pumping has represented a small output of the water balance.

The water balance indicates that the aquifer is not under stress and groundwater levels would remain relatively steady under average climatic conditions if historical usage were to continue.

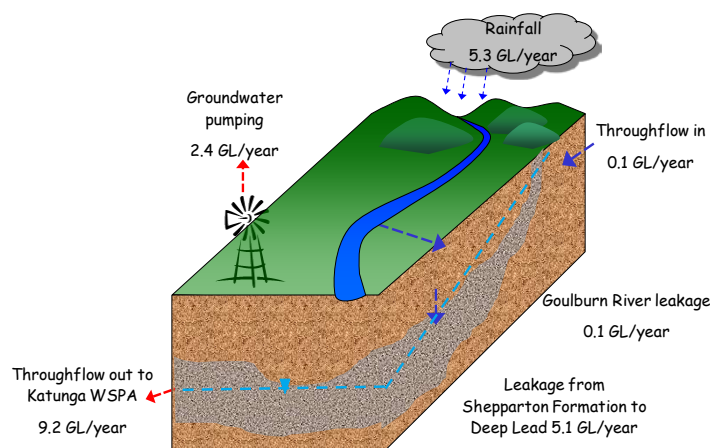


Figure 10 Mid Goulburn GMA water balance for average rainfall years

3 Groundwater dependent values and pumping impacts

3.1 Groundwater pumping impacts

Groundwater pumping lowers the groundwater level around the bore being pumped. This decline in groundwater level is referred to as the drawdown cone (Figure 11). The size and shape of the drawdown cone depends primarily on the nature of the aquifer as well as the pumping rate and duration. Drawdown decreases with distance from the bore, and the cone expands in size whilst pumping continues until steady-state conditions are reached.

Groundwater level interference can occur when the drawdown cone intersects a neighbouring bore or environmental feature such as a stream or a spring. The impacts from groundwater pumping are site specific as the pumping requirements are likely to be different and aquifer hydraulic characteristics can vary. Interference is considered by GMW when assessing licence applications (refer chapter 4.3.2).

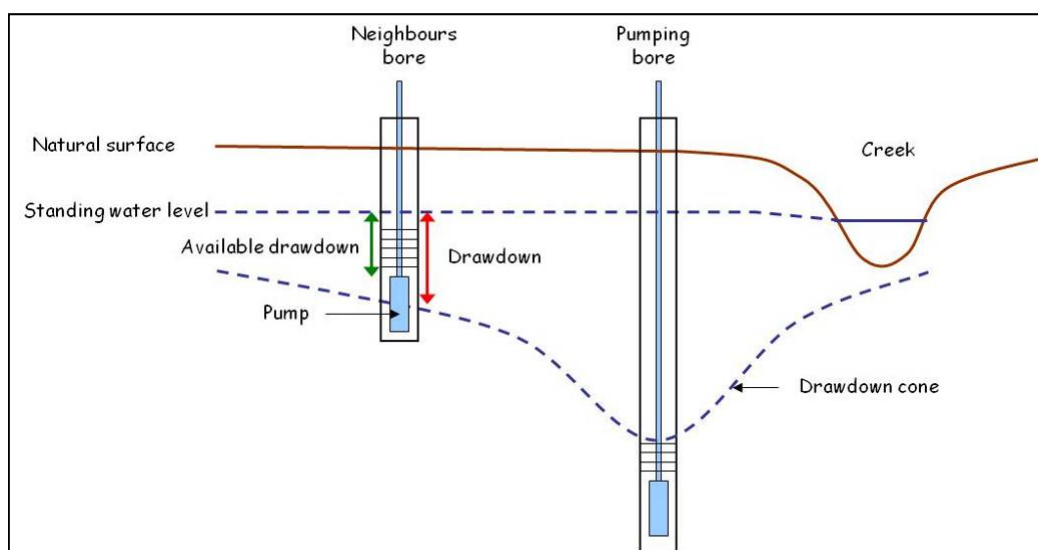


Figure 11 Drawdown cone caused by groundwater pumping

When bores located in close proximity are extracting from the same aquifer it can result in intersecting drawdown cones. Unacceptable drawdown levels can be a consequence of the cumulative impacts of a number of pumps operating in a local area (intensive groundwater pumping) (Figure 12).

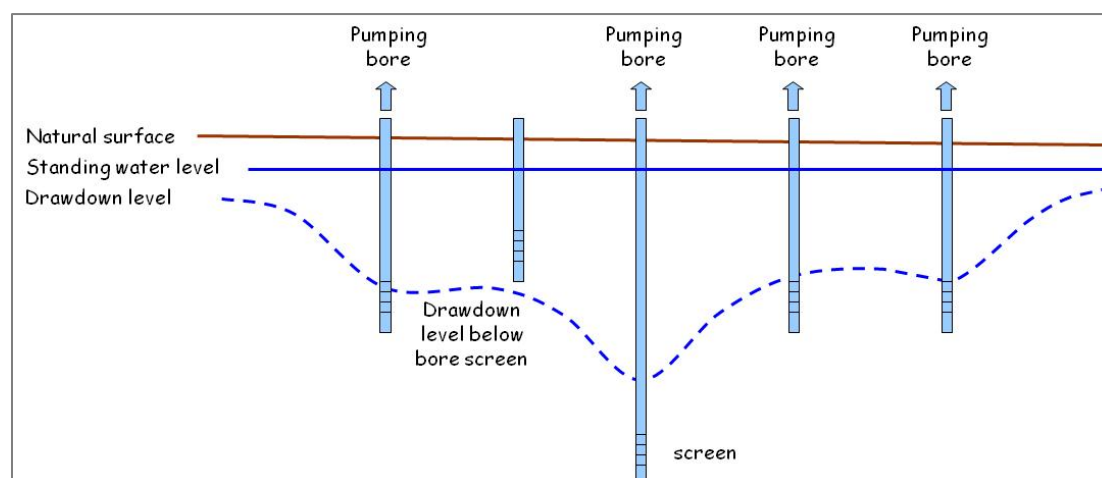


Figure 12 Interference caused by cumulative impacts of groundwater pumping

There is a higher density of licensed extraction bores around Toolamba, Kialla, Warring and Avenel but monitoring suggests seasonal drawdown is less than 5 m. By comparison, seasonal drawdown in the nearby Katunga Water Supply Protection area is around 15 m. Restrictions on groundwater extraction can manage groundwater levels (refer chapter 4.3.1)

Where groundwater is extracted beyond sustainable limits groundwater recovery levels will continue to decline regionally. In the Mid Goulburn GMA, the findings of the water balance (GMW, 2014a) and groundwater monitoring indicate that the aquifer is not stressed.

3.2 Groundwater dependent values

After consulting with groundwater users, community members and key stakeholders, a number of groundwater dependent values have been identified in the Mid Goulburn GMA. These values, shown in Table 1, underpin the Plan objectives (refer chapter 1.4).

Table 1 Groundwater dependent values in the Mid Goulburn GMA

Environmental	Social	Economic
<ul style="list-style-type: none"> • Groundwater dependent ecosystems (ecological monitoring thresholds, fish refuges) • Goulburn River • Wetlands 	<ul style="list-style-type: none"> • Stock and domestic reliability / security of access where no reticulated supply is available • Schools and sporting facilities (e.g. golf clubs, sports grounds) • Cultural and recreational values 	<ul style="list-style-type: none"> • Economic development through use of water (development/trading) • Preserve investment in infrastructure (security of supply) • Water quality end use, noting that groundwater quality is also important for environmental and social values

The groundwater dependent values identified are discussed in more detail below.

3.2.1 Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are those ecosystems that utilise groundwater to meet some or all of their water requirements. The National Atlas of Groundwater Dependent Ecosystems suggests that they are mostly associated with the Goulburn River and its tributaries, swamps and billabongs (Figure 13), but more work needs to be undertaken to confirm their presence, identify their value and assess their dependence on groundwater. The Goulburn Broken Catchment Management Authority is currently undertaking works to identify GDEs in the Goulburn catchment. The outcomes of this work will contribute to Plan review (refer chapter 6.2).

Lower groundwater levels can reduce the amount of water available to streams and terrestrial vegetation. However, higher groundwater levels may pose a risk to land salinity and increase the discharge of saline groundwater to streams.

In the Nagambie Zone groundwater levels are generally greater than 5 m below the surface, so the risk to GDEs is considered low.

In the Kialla Zone, GDEs are considered within management arrangements for the Shepparton Irrigation Region GMA.

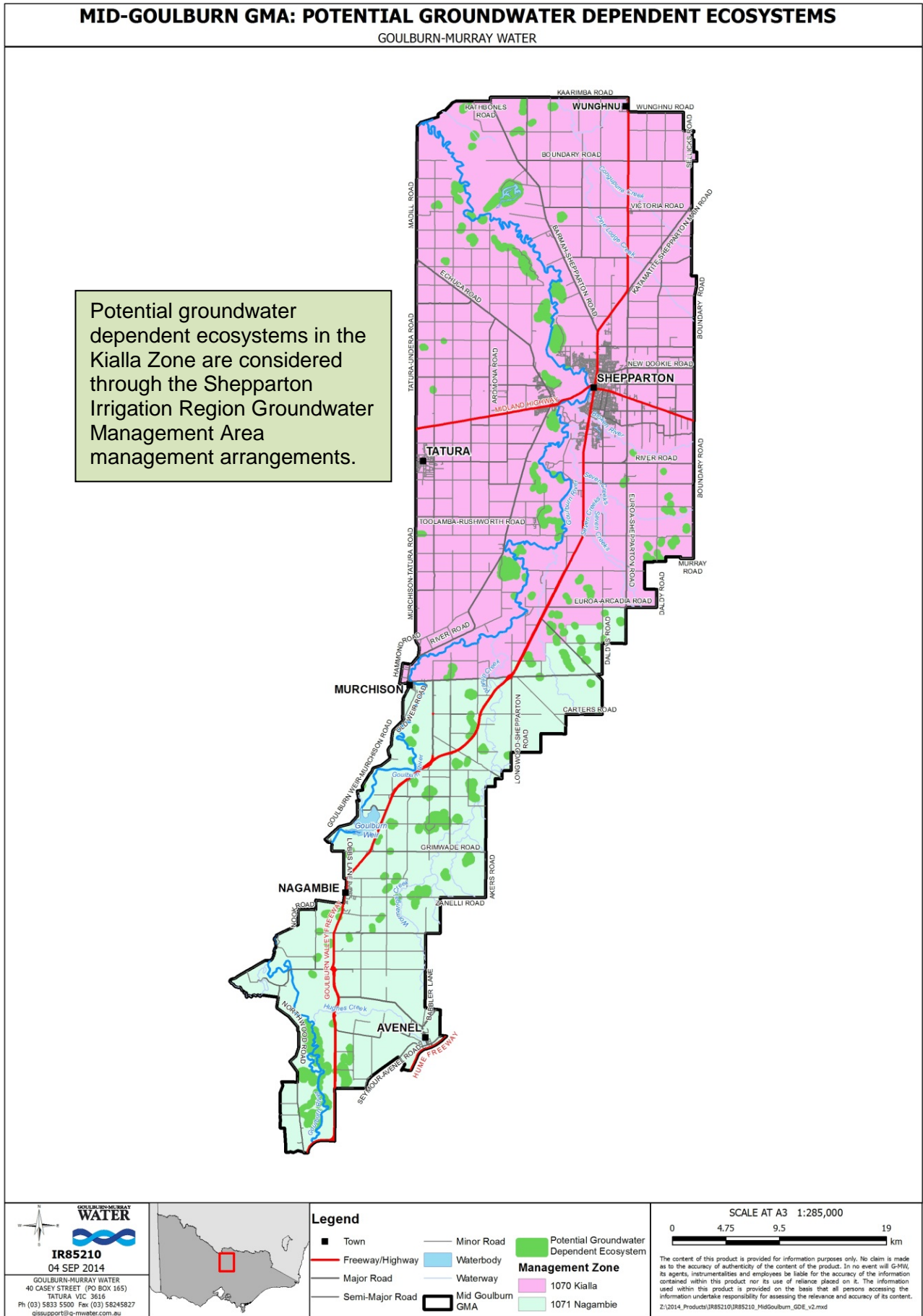


Figure 13 Potential groundwater dependent ecosystems in the Nagambie Zone

3.2.2 Groundwater interaction with surface water

The Goulburn River is the main river within the Mid Goulburn GMA. The Broken River, Hughes Creek, Creighton's Creek, Major Creek and Seven Creeks are all tributaries of the Goulburn River.

Flow in the Goulburn River is regulated by structures at Lake Eildon, upstream of the Mid Goulburn GMA, and the Goulburn Weir located within the GMA. Flow in the Broken River is regulated by structures at Lake Nillahcootie upstream of the Mid Goulburn GMA. The remaining waterways in the GMA are unregulated and managed according to Local Management Rules (refer to www.g-mwater.com.au). These waterways generally have low annual flow volumes (many are ephemeral), and their flow paths comprise a relatively small part of the GMA.

There are a number of points along the Goulburn River between Goulburn Weir and Murchison and in Hughes Creek where groundwater discharges to surface water (SKM, 2006). These groundwater contributions may support aquatic flora and fauna refuges and wetlands or may be a threat to ecosystems if it is saline.

The Goulburn River and tributaries are valued for water supply to meet domestic and stock and licensed demands such as irrigation. Waterways in the GMA are also valued for recreational and cultural purposes. These include values of the local indigenous communities the Yorta Yorta Nation and the Taungurung clans as well as aesthetic values.

Lower groundwater levels can reduce the volume of water discharging to waterways, or increase in the volume of water that leaks to the groundwater system. This can impact flows in streams and is particularly important during dry periods when base flow can provide an important supply for downstream users and the environment.

A water balance (refer section 2.8) developed for the Mid Goulburn GMA indicates that there is leakage from the Goulburn River to the groundwater system, although this volume is very small (GMW, 2014a). Further, as the Goulburn and Broken Rivers are regulated, there is very little risk to flows in these waterways from groundwater extraction.



Goulburn Weir



Goulburn River at Murchison

3.2.3 Groundwater quality

Groundwater quality is important from an economic perspective as poor quality groundwater can affect bore function as well as impacting the end use of water, such as crop growth and production.

Lower groundwater levels in the Kialla Zone can induce more saline groundwater from adjacent aquifers (i.e. the upper Shepparton Formation) into the Deep Lead. However, the risk of increasing Deep Lead groundwater salinity through pumping is considered low because of the relatively small volume of groundwater extracted relative to other inputs to and outputs of the Deep Lead aquifer, as indicated by the water balance (GMW, 2014a).

Regular monitoring of groundwater salinity should be undertaken to provide early identification of any unexpected water quality changes (refer chapter 5.2).

3.2.4 Licensed use

The total entitlement volume in the Mid Goulburn GMA is 12,464.9 ML/yr. Entitlement is split evenly across both the Kialla and Nagambie Zones (Table 2).

Table 2 Entitlement volumes in the Mid Goulburn GMA

Zone	No. Licences	No. Bores	Entitlement (ML/year)
Kialla Zone	25	28	6,235.9
Nagambie Zone	39	52	6,234.0
TOTAL	64	80	12,469.9

Metering of licensed bores was completed in 2007/08. Metered groundwater use data indicates that annual extraction is typically between 10% and 30% of entitlement, depending on climatic conditions and availability of surface water (Figure 14). Bores licensed for less than 20 ML/yr prior to 2004 were not required to be metered under the State wide metering program (DSE, 2010). This accounts for two licences with a combined volume of 18 ML/year (0.1% of entitlement) which are currently unmetered.

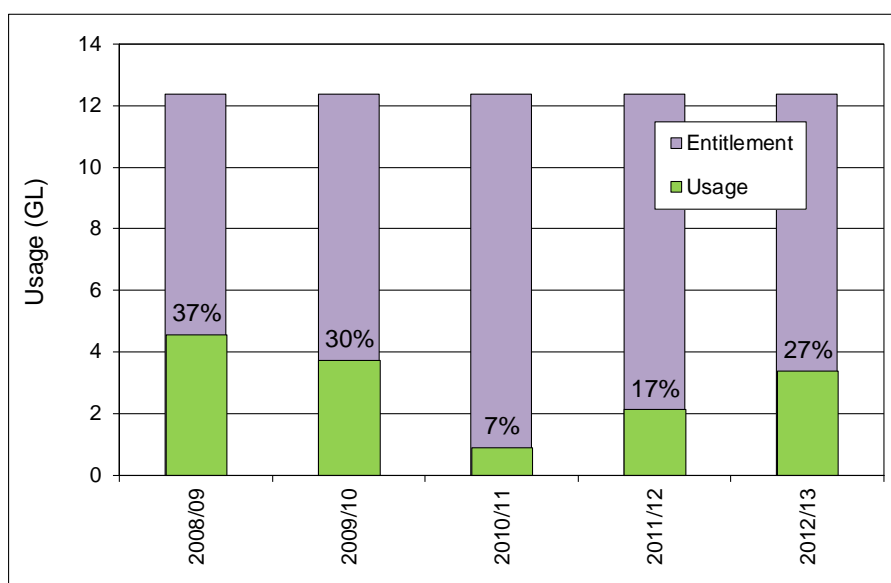


Figure 14 Percentage of entitlement used seasonally

The low level of usage may be attributed to a reliance on surface water, cost to extract groundwater or licence holders choosing to retain entitlement for future use. The majority of entitlement is used for irrigation. Groundwater is also licensed for industrial and commercial purposes and communal domestic and stock use (Figure 15).

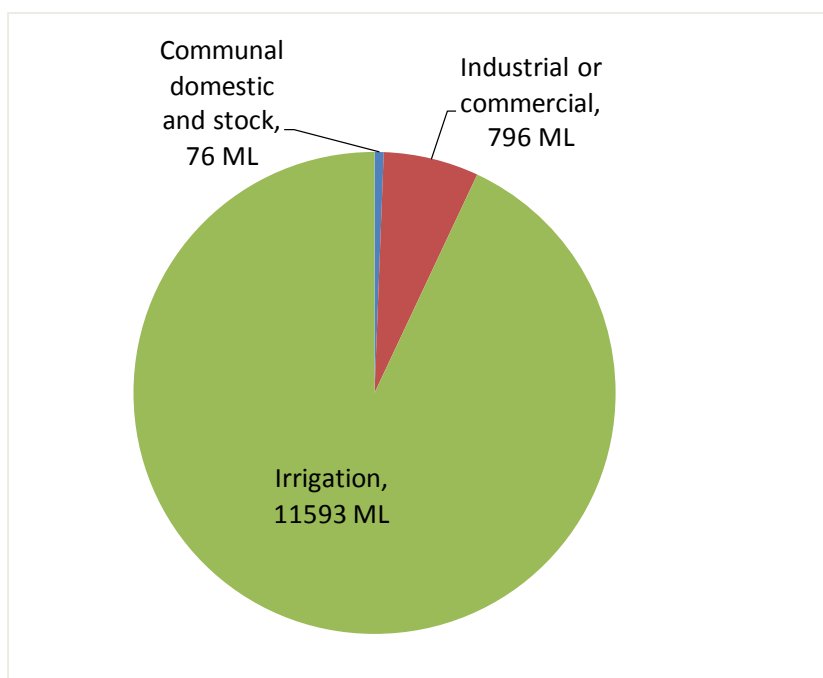


Figure 15 Licensed use types

The location of licensed bores is shown in Figure 16.

3.2.5 Domestic and stock use

Domestic and stock use of groundwater is a statutory right under the Act and is not required to be licensed or metered. Landholders can apply to GMW for a works licence to construct a bore for domestic and stock purposes. In the Mid Goulburn GMA, there are approximately 200 domestic and stock bores with an estimated use of around 400 ML/yr per year (GMW, 2014b). The majority of these bores are located in the Nagambie Zone (Table 3).

Table 3 Estimated domestic and stock use in the Mid Goulburn GMA

Zone	Estimated number of bores	Estimated use (ML/year)
Kialla Zone	78	156
Nagambie Zone	124	248
TOTAL	202	404

During dry periods groundwater levels can fall. Therefore domestic and stock bores should be constructed to a depth that considers both seasonal and long term variations in groundwater levels. Further, pumping from nearby bores can result in groundwater level drawdown, particularly during the summer. Constructing the bore to an appropriate depth is the best way of improving security of access to groundwater.

GMW considers impacts on domestic and stock bores when making licensing decisions. For this reason domestic and stock users are encouraged to ensure that their bore is registered.

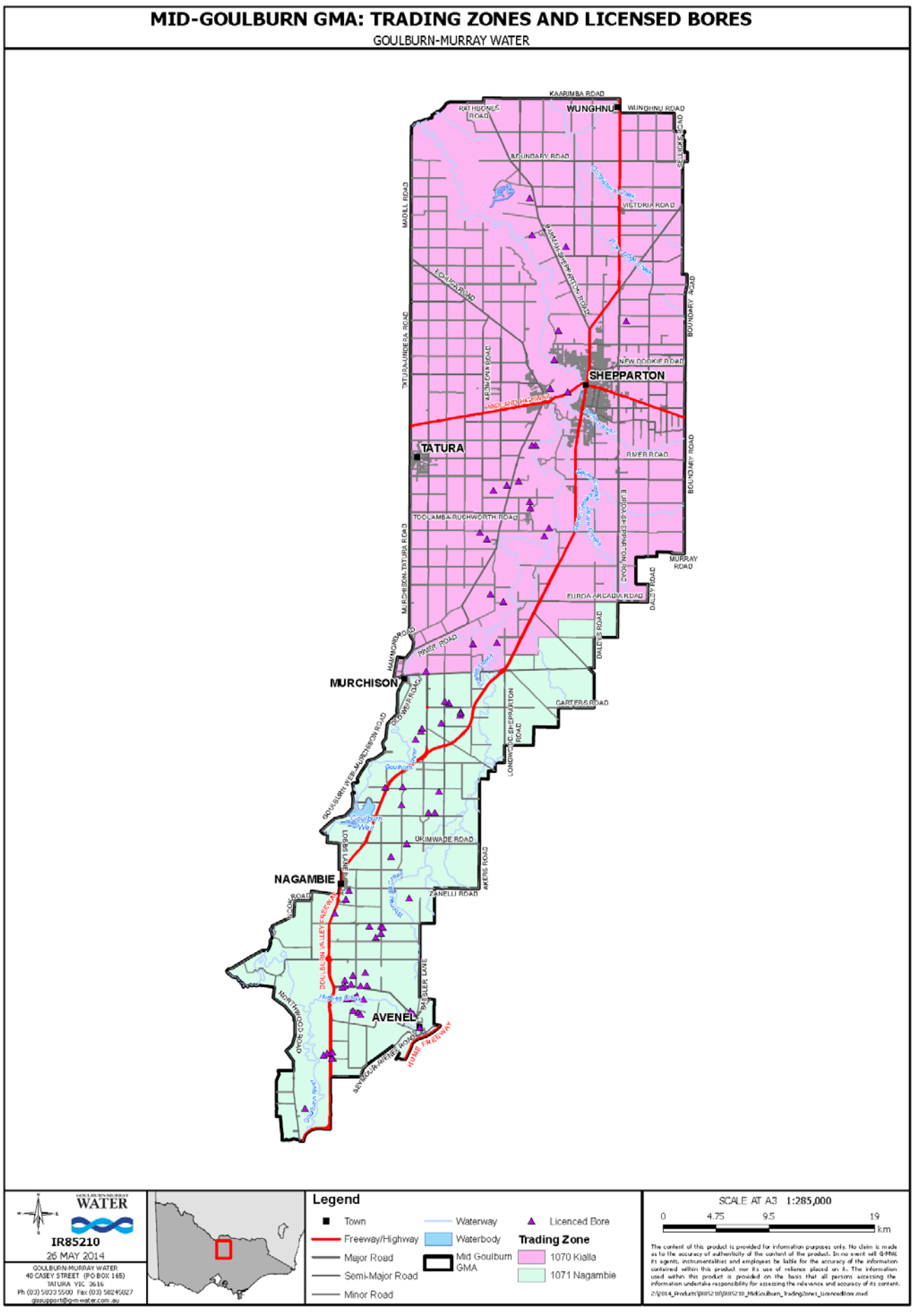


Figure 16 Licensed bores in the Mid Goulburn GMA

4 Groundwater management

4.1 Entitlement

The groundwater system in the Mid Goulburn GMA is not considered to be under significant stress, however historical usage is typically less than 30% of entitlement even in dry periods. As such it is considered prudent to cap entitlement and promote groundwater trading. Capping entitlement provides greater certainty and security of access to existing groundwater users and the environment and reduces the risk of requiring future restrictions.

GMW will make an application to the Minister for Water to cap entitlement in the Mid Goulburn GMA and declare the Permissible Consumptive Volume of 12,465 ML/yr. A water balance has been used to inform the establishment of a cap (GMW, 2014a).

The cap will limit entitlement at the current volume. Those seeking entitlement can transfer from existing licence holders on a temporary or permanent basis (refer chapter 4.4).

Rule 1: Cap on entitlement

GMW may issue a groundwater licence provided that the Permissible Consumptive Volume for the Mid Goulburn Groundwater Management Area is not exceeded.

4.2 Groundwater licensing

Bore construction and groundwater extraction are managed through licensing. A works licence must be obtained from GMW to drill and construct a bore. Groundwater bores must be drilled by a licensed driller. The Australian Drilling Industry Association (www.adia.com.au) provides contact details of its members.

A take and use licence must be obtained from GMW to extract groundwater for irrigation, commercial, dewatering and urban use. A range of matters will be considered when assessing the application, including the potential impacts to existing authorised users and the environment.

Licences may be issued with conditions relating to the exact location and depth from which groundwater can be extracted, the annual volume of water that can be pumped and the rate at which pumping can occur. If groundwater is used exclusively for domestic and stock purposes, a take and use licence is not required.

GMW incurs a range of costs in providing water related services. These costs are recovered from customers including irrigators, commercial users, urban water corporations and environmental managers. GMW prices are developed in consultation with customers and approved by the Essential Services Commission.

More information on groundwater licensing, including fees and charges, is available on GMW's website <http://www.g-mwater.com.au/>.

All incidents of the unlawful take or use of water should be reported to GMW. The incidents are dealt with under the Act in a manner consistent with the National Framework for Compliance and Enforcement Systems for Water Resource Management (DSEWPC, 2012).

4.3 Managing groundwater extractions

4.3.1 Restrictions

Restrictions are typically introduced through the use of allocations to limit groundwater extractions and manage groundwater levels. Allocations are a percentage of licence volume that can be extracted during a water season.

In the Mid Goulburn GMA, the risk to groundwater dependent values from groundwater extraction is considered to be low (refer chapter 3). Even with the dry conditions experienced

between the mid-1990s to 2010 groundwater levels remained relatively steady with groundwater recovery levels only falling by between 5 and 10 m. In comparison, recovery levels fell by around 15 m between the late 1990s and 2010 in parts of the Katunga Water Supply Protection Area, located immediately north of the Mid Goulburn GMA.

Given the modest fall in groundwater levels during the recent dry period, and the small level of seasonal drawdown observed in response to pumping, it is not currently considered necessary to include any restrictions in this Plan. However, GMW may consider the need for restrictions should circumstances arise that require attention.

Rule 2: Restrictions

If, in a local area, there is a significant fall in groundwater recovery levels observed over time to be:

- a) greater than 3 m in 3 years or
- b) a drawdown in one season of greater than 15 m,

then GMW will investigate the cause and, if necessary, engage with local groundwater users to assess the need for management intervention.

Management interventions may include:

- installation of a new monitoring bore to better understand the local impacts of groundwater pumping;
- increased monitoring frequency of existing bores;
- some other arrangement whereby groundwater levels can be recorded in the local area on a regular basis with a high degree of confidence (i.e. record levels in private monitoring bores under licence conditions);
- groundwater users lower their pumps or deepen their bores; or
- declaring a water shortage and announcing a temporary qualification of rights to restrict groundwater pumping in the affected area.

4.3.2 Interference

Interference is considered by GMW when assessing groundwater licence applications. This includes the potential impacts to existing groundwater users and the environment (refer chapter 3.1). Where there are concerns about pumping impacts, the applicant may be required to undertake their own detailed investigations to satisfy GMW that no unacceptable impacts will result.

Groundwater users who believe that they are being adversely impacted by interference from neighbouring groundwater pumping can report their concerns to GMW for investigation. Groundwater users should ensure that their bore is functioning correctly and that they have a record of groundwater levels in their bore over time to assist with any investigations.

4.4 Groundwater trading

Groundwater trading allows for entitlement to be transferred to develop new opportunities or grow existing businesses. It also provides licence holders with greater flexibility to manage production in response to seasonal demands or climatic conditions.

To undertake a trade, a licence holder can advertise their intent to sell or buy groundwater entitlement, or use a water broker. The price for the transfer of entitlement is negotiated between the buyer and the seller. Once the buyer and seller have come to an agreement, an application to transfer a licence must be made to GMW.

Licence holders should apply well in advance of requiring the water as it can take a number of weeks to process an application. The trade must be approved in writing by GMW before the water may be taken. Penalties apply for unauthorised take and use.

Entitlement may be transferred temporarily within zones or between zones for a period of up to five years. This recognises present low usage and provides greater opportunity for groundwater trading. Entitlement may be permanently transferred within or between zones provided that zone caps are not exceeded. Entitlement within each zone is capped to avoid large volumes being transferred into any one zone which could result in unacceptable impacts.

Entitlement may be transferred in to or out of the Mid Goulburn GMA provided that the permissible consumptive volume is not exceeded. GMW will consider a range of matters when assessing an application to transfer entitlement, including the potential impacts to existing authorised users and the environment.

Rule 3: Transfer of groundwater entitlement

GMW may approve an application to transfer groundwater entitlement provided matters under the Act have been considered and the following conditions are satisfied:

- a) Entitlement may be permanently transferred within or between zones provided the following management zone limits are not exceeded:

Management Zone	Zone Limits (ML/yr)
Kialla Zone	8,000
Nagambie Zone	8,000

NB: the entitlement cannot exceed the permissible consumptive volume (refer chapter 4.1)

- b) Entitlement may be temporarily transferred within or between zones regardless of zone limits
- c) Entitlement may be temporarily transferred into the Mid Goulburn GMA provided that the permissible consumptive volume is not exceeded

4.5 Carryover

Carryover is unused allocation that may be used in the following season. It provides groundwater users with the flexibility to use water when it is of greatest benefit to them.

Rule 4: Carryover

GMW will apply to the Minister for Water to declare the availability of carryover in the Mid Goulburn GMA up to a maximum of 20% of entitlement in each year.

To enable the use of carryover, GMW will apply to the Minister for Water to declare the availability of carryover up to a maximum of 20% of entitlement in the Mid Goulburn GMA.

An example of how carryover can be utilised and is calculated is shown on the next page.

Example

A licence holder has an entitlement of 100 ML/yr and can carryover a maximum of 20% of their entitlement (20 ML).

Season	1	2	3
Entitlement (M)	100	100	100
Carryover (ML)	0	20	15
Trade in (ML)	0	0	0
TOTAL AVAILABLE	100	120	115
Trade out (ML)	0	-35	-25
Usage	-70	-70	-70
TOTAL OUT	-70	-105	-95
Balance (ML)	30	15	20
Available for carryover	20	15	20

In season 1 the licence holder uses 70 ML and has 30 ML remaining. Only a maximum of 20% of entitlement (20 ML) can be carried over to the next season.

In season 2 the licence holder has 120 ML available to use. The licence holder trades out 35 ML and uses 70 ML. This leaves 15 ML available to carryover to season 3.

In season 3 the licence holder has 115 ML available to use. The licence holder trades out 25 ML and uses 70 ML. This leaves 20 ML remaining to carryover to the following season.

5 Monitoring program

Monitoring, evaluation and reporting are important elements which lead to improved groundwater resource management.

5.1 Groundwater levels

Monitoring groundwater levels on a regular basis provides valuable information on the availability of groundwater and how groundwater levels change over time. This is important to enable GMW to assess the impacts of groundwater pumping and climate on the resource.

Groundwater level monitoring is also important to assist with understanding recharge, and the interaction between aquifers and between groundwater and surface water features. Groundwater level monitoring is used to assess licence applications, including trading, and inform management decisions such the need for restrictions.

GMW will obtain periodic groundwater levels readings from State observation bores listed in Schedule 1 to support Plan implementation and review. State Observation Bores are shown on Figure 17, and bores to be monitored for this Plan are highlighted.



Nested State monitoring bores at Murchison



Drilling of a State monitoring bore

5.2 Groundwater quality

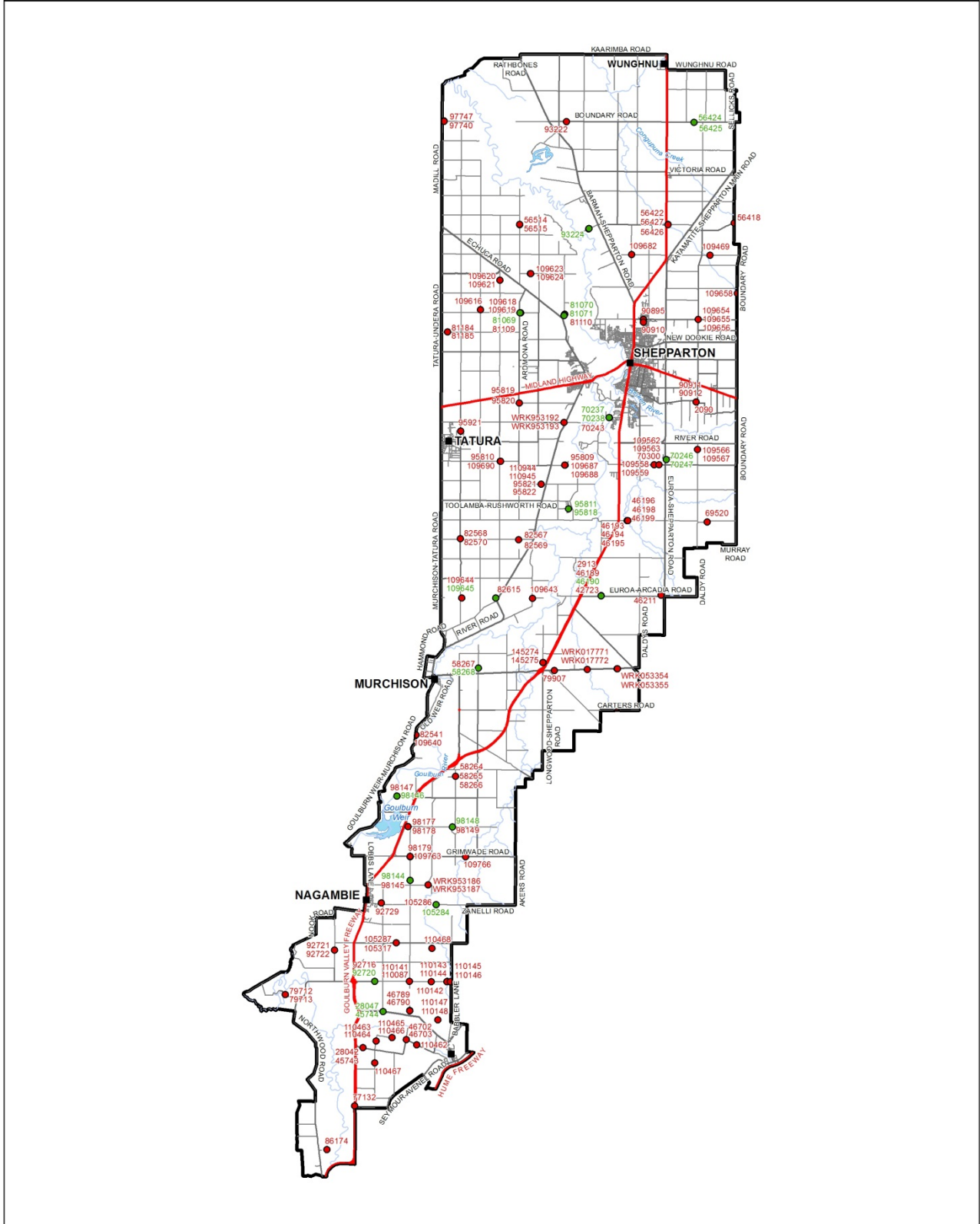
Monitoring groundwater salinity over time is important to identify any emerging changes to water quality. A two pronged approach has been adopted to provide improved data sets for future analysis:

1. targeted sampling of licensed bores
2. sampling of State observation bores

If there is a consistent increasing groundwater salinity trend observed over time then investigations should be undertaken to determine if any resource management action is required.

MID-GOULBURN GMA: STATE OBSERVATION BORE NETWORK

GOULBURN-MURRAY WATER



<p>GOULBURN-MURRAY WATER IR85210 04 SEP 2014</p>		<p>Legend</p> <ul style="list-style-type: none"> ● State Observation Bore ● Plan Monitoring Bore ■ Town ▬ Freeway/highway ▬ Major Road ▬ Semi-Major Road ▬ Minor Road ▬ Waterway ▬ Waterbody ▭ Mid Goulburn GMA 	<p>SCALE AT A3 1:285,000</p> <p>0 4.75 9.5 19 km</p> <p><small>The content of this product is provided for information purposes only. No claim is made as to the accuracy of authenticity of the content of the product. In no event will G-MW, its agents, instrumentalities and employees be liable for the accuracy of the information contained within this product nor its use of reliance placed on it. The information used within this product is provided on the basis that all persons accessing the information undertake responsibility for assessing the relevance and accuracy of its content.</small></p> <p><small>Z:\2014_Products\IR85210\IR85210_MidGoulburn_SOB_N_PlanBore.mxd</small></p>
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Figure 17 Mid Goulburn State observation bores

5.2.1 Targeted sampling of licensed bores

A program of targeted salinity monitoring of licensed bores is to be established. The purpose of the program is to ensure that samples are consistently collected from a number of strategically located bores which will provide an improved data set to aid in understanding any changes in groundwater salinity.

Sampling is to be undertaken by the licence holders. GMW will provide advice to the licence holder on groundwater sampling and measure the salinity of the water. GMW will invite licence holders to participate in the program. Licence holders are encouraged to participate in the program.

5.2.2 Sampling of State observation bores

Sampling and analysis of selected nested State observation bores (screened in the Shepparton Formation and Deep Lead) is to be undertaken to observe any changes in groundwater quality between aquifers.

The bores will be sampled annually in summer and groundwater analysed for major chemical components as well as quality parameters at a NATA (National Association of Testing Laboratories) accredited laboratory. The bores to be sampled are listed in Schedule 1.

Rule 5: Groundwater monitoring

GMW will:

- a) Obtain periodic groundwater levels readings, where practicable, from State observation bores listed in Schedule 1 or their replacement.
- b) Establish a program of targeted sampling of licensed bores to collect and measure groundwater salinity each year.
- c) Collect groundwater samples from selected State observation bores identified in Schedule 1 where practicable, or their replacement, and send them to a NATA accredited laboratory for analysis.

5.3 Metered use

Recording groundwater usage is important to gauge the actual level of use relative to the licensed volumes, understand how the groundwater system responds and ensure that users comply with their licence conditions.

Meters will be read at least once each season. In drier seasons, when usage is greater they may be read more frequently.

Meter readings will be stored in the Victorian Water Register to enable reporting on use.

While most licensed bores are metered, those that were licensed prior to 2004 for less than 20 ML/yr may not be metered as they were exempt under the metering program (DSE, 2010). Where a meter is not available, usage will be estimated to assist with accounting for use.

It is the responsibility of the licence holder to monitor their groundwater usage. If a licence holder needs more water than they are licensed to take, it is their responsibility to secure a licence transfer and obtain confirmation from GMW that the transfer has been approved before any additional water is extracted.

Rule 6: Metering

GMW will read flow meters on licensed bores at least once annually and record usage in the Victorian Water Register and consider the data collected as part of the Plan review.

6 Plan implementation

6.1 Communications

Each year, GMW will prepare a newsletter to provide information on groundwater levels, usage and trade and summarise outcomes from the Plan review. The newsletter will be made available on GMW's website <http://www.g-mwater.com.au/>. Customers are encouraged to visit the website for the latest information.

Rule 7: Communications

By 1 October each year GMW will provide Mid Goulburn GMA customers with a newsletter reporting on groundwater resource status, licensed groundwater use and trade activity for the previous season. The newsletter will also identify any need to amend the Plan.

6.2 Plan review

Local management plans are designed to be adaptive. As new information becomes available and policy changes, amendments to the Plan may be necessary.

At the time of the development of this Plan, implementation of the Murray-Darling Basin Plan (Basin Plan) had commenced. As requirements of the Basin Plan become clearer and take effect, this Plan may need to be reviewed to ensure it is up to date.

A review of the Plan will be undertaken annually including an assessment of the Plan rules. Further, if average usage exceeds 50% of total entitlement over a period of three years then a detailed review should be undertaken.

GMW will consult with the Goulburn Broken Regional Water Service Committee on any proposed amendments and, if the amendments are likely to impact on rights of access to water, consult with licence holders and other affected stakeholders. Any significant amendments to the Plan must be based on sound technical understanding or a change in policy.

Any suggestions for how the Plan could be improved can be sent to GMW via their website www.g-mwater.com.au or by calling GMW on 1800 013 357.

Rule 8: Plan review

GMW will:

- (a) Review the need for any amendments to the Plan on an annual basis.
- (b) Undertake a detailed review of the Plan when average groundwater usage exceeds 50% of entitlement over a period of three years
- (c) Consult with the Goulburn Broken Regional Water Service Committee, licence holders and other stakeholders on proposed amendments to Plan rules.

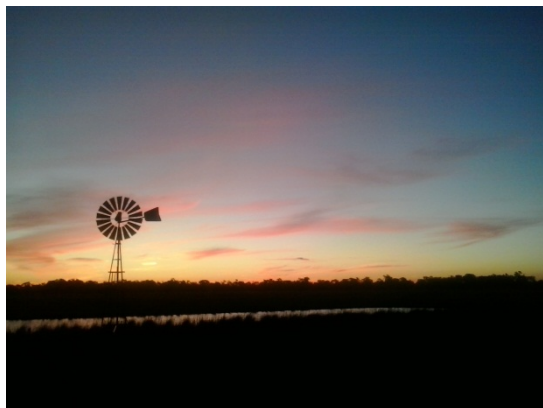
6.3 Recommended works

Works that could improve groundwater resource management in the Mid Goulburn GMA and inform future reviews of the Plan are provided in Table 4.

Table 4 Recommended works to inform Plan review

Works	Description
Enhance water balance to review the Permissible Consumptive Volume	<ul style="list-style-type: none"> • improve rainfall recharge estimates • improve estimates of transmissivity and storativity of the Deep Lead aquifer • improve estimates of conductance of the Shepparton Formation clays • improve throughflow and leakage estimates
Identify risk to Groundwater Dependent Ecosystems	Validate potential GDE mapping in the Nagambie Zone and establish a monitoring program to determine groundwater dependence and sensitivity to change
Investigate ways to promote groundwater use	Investigate options to encourage groundwater trading
Further investigate the relationship between Katunga Water Supply Protection Area and Mid Goulburn Groundwater Management Area	Improve understanding of throughflow from Mid Goulburn GMA to Katunga WSPA

GMW will pursue these recommendations with the Goulburn Broken Catchment Management Authority and DEPI.



Windmill near Wahring



Cattle near Avenel

Schedule 1

State observation bores to be monitored

Bore ID	Nested with	Monitoring purpose				
		Aquifer interaction	Ground-water quality	Interaction with surface water	Pumping intensity	Water balance
Kialla Zone (1070)						
2158		✓				✓
46190						✓
56424	56425	✓				✓
56425	56424	✓				✓
58268	58267			✓		✓
70237	70238	✓				✓
70238	70237	✓				✓
70246	70247	✓				✓
70247	70246	✓				✓
81069	81109					✓
81070		✓				✓
81071		✓				✓
93224		✓				✓
95811	95818	✓	✓		✓	✓
95818			✓		✓	✓
Nagambie Zone						
28047	45744				✓	✓
45744	28047				✓	
92720	92716					✓
98144	98145					✓
98146				✓		✓
98148	98149			✓		✓
105284	105286					✓
109645	109644					✓
Outside GMA						
86174						✓
90778				✓		✓
48290	48291					✓

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8 Appendix A

Components that underpin the Plan objectives identified through community consultation

Objectives	Plan chapter reference	How objective is addressed in Plan
1. Protect social, economic and environmental groundwater dependent values		
Identifying high social and environmental value ecosystems that might be groundwater connected and highly sensitive to changes in groundwater and protect/manage them - proactive management rather than reactive	2, 3 and 1	<ul style="list-style-type: none"> - Presentation of conceptual understanding of groundwater system including groundwater level response to pumping and climate - Identification of groundwater dependent values and potential impacts from groundwater pumping - Cap on licence volume - Consideration of features when licensing groundwater extraction
2. Effectively communicate information on management and status of groundwater resources		
Effective monitoring (quality and levels) and reporting to licence holders/ agencies/ and local government	5 and 6	<ul style="list-style-type: none"> - Annual review of Plan - Annual reporting
3. Effectively monitor and report on groundwater resources		
Effective monitoring (quality and levels) and reporting to licence holders/ agencies/ and local government	5 and 6	<ul style="list-style-type: none"> - Annual sampling of nested State observation bores - Targeted sampling of licensed bores - Periodic monitoring of groundwater levels in selected key State observation bores
4. Provide flexible trading opportunities		
Improved trading opportunities both permanent and temporary	4.4	<ul style="list-style-type: none"> - Temporary trading within zones and between zones available - Permanent trading within zones and between zones provided caps not exceeded
Introduce carryover	4.5	<ul style="list-style-type: none"> - Carryover introduced as a maximum of 20% of licence volume
Licence holder list (for trading) (online or email)	Considered	<ul style="list-style-type: none"> - Outside plan scope. GMW is investigating how they can better facilitate groundwater trading.
Improved irrigation practices to address water waste	Considered	<ul style="list-style-type: none"> - Outside plan scope - refer to the DEPI website for information on water use efficiency http://www.depi.vic.gov.au/
5. Provide enhanced value of entitlements through cost effective management		
Amalgamate licences	4.2	<ul style="list-style-type: none"> - Groundwater licensing explained
No price increase	4.2	<ul style="list-style-type: none"> - Plan implantation costs are recovered by GMW through groundwater licence fees. - Information on new tariff is available from the GMW website http://www.g-mwater.com.au/ - The introduction of this Plan has strived to be cost neutral
Impact of new pricing - tariff review impact	Considered	<ul style="list-style-type: none"> - Information on new tariff available at GMW website http://www.g-mwater.com.au/

6. Provide security of access to groundwater for everyone		
100% allocation every year	4.3	- No allocation/restrictions introduced
If usage goes to 100% what management plan comes in to ensure system remains sustainable?	4.3	- Arrangements for management action if groundwater levels fall at a significantly high rate
Equity across entitlements. Zero allocation stifles development	4.4	- New development may occur through the transfer of entitlement - Rules introduced to provide greater opportunity and flexibility to transfer entitlement
Expanded licensing base with an entitlement - rationalise current entitlement (redistribution?)	4.4	- Rules introduced to provide greater opportunity and flexibility to transfer entitlement - Zone caps introduced so that entitlement is not all transferred into any one zone
What is the actual safe water use in ML comparing to what we are using at present (Sustainable development of aquifer (is 100% usage viable))	3	- A sound understanding of the groundwater system and water balance has been developed that indicates that the aquifer is not currently under stress. - Licence volume has been capped and flexible rules around the transfer of entitlement established to enable resource to be further developed - As usage increases, then the cap can be revised based on aquifer response.
Maintain capping of licences	3	- Licence volume has been capped
Emergency water access - livestock	3.2.5	- Domestic and stock use is a private right under the Water Act 1989 - Licence volume has been capped and monitoring is to be undertaken to identify any risk to domestic and stock use
7. Manage groundwater resources with an adaptable local management		
Future risks- what are they? Can plan adapt?	5, 6.2	- Monitoring program put in place along with plan review and recommended works. Plan can adapt to changes identified at plan review
Future opportunities (regional development)	4.4	- Further development of the groundwater resource available through the transfer of entitlement