

Upper Murray Groundwater Management Area

Local Management Plan

July 2014

GOULBURN-MURRAY WATER

Cover images (Left to Right): SOBN groundwater monitoring bore near Towong, Omeo/Benambra region, Snowy Creek Streamflow Gauging Station

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DM# 3747717

Summary of rules in the Upper Murray Groundwater Management Area local management plan

Rule 1: Cap on groundwater entitlement **(page 18)**

Goulburn-Murray Water may issue a groundwater licence under section 51 of the Act provided that in doing so it does not exceed the Permissible Consumptive Volume established for the Upper Murray Groundwater Management Area **(Plan LEGL/14-208)**

Rule 2: New Entitlement Zone Limits **(page 19)**

Goulburn-Murray Water may issue a new groundwater licence under section 51 of the Act provided that in doing so it does not exceed the management zone limits specifies in Table 4.

Management Zone	Maximum licence volume permitted (ML/yr)
Hume	**2,158**
Dartmouth	**1,250**
Indi	**4,266**
Total	**7,674**

Table 4 - Maximum licence volume permitted per zone

Rule 3: Transfer of groundwater entitlement **(page 19)**

Goulburn-Murray Water may approve a transfer of a groundwater licence under section 62 of the Act provided that relevant matters under section 53 of the Act have been considered and that the following conditions are satisfied**:**

(a) Transfer is from within the same management zone;

(b) The buyer has a bore with a metered diversion point; and

(c) The approval of a transfer must not cause the sum of total licence entitlement to exceed the Permissible Consumptive Volume established for the Upper Murray Groundwater Management Area and any cap which applies to a management zone as shown in Table 4.

Rule 4: Record meter readings (page 23)

Goulburn-Murray Water will:

(a) Ensure that a flow meter is fitted to all existing licensed operational bores in the Upper Murray GMA which are associated with a licence equal to or greater than 20 ML/year;

(b) Ensure that any new licensed bores are fitted with a flow meter;

(c) Read each meter at least once annually; and

(d) Enter metered groundwater use into the Victorian Water Register database.

Rule 5: Annual newsletter (page 24)

Goulburn-Murray Water will, by 1 October of each year, prepare an annual newsletter to 30 June of that year on the Plan which will include reporting and analysis of:

(a) Total groundwater licence entitlement volumes per management zone, including temporary and permanent transfers;

(b) Annual groundwater use per zone;

(c) The overall groundwater resource position; and

(d) The need for any changes to the Plan.

Goulburn-Murray Water will post on its website in October of each year the Upper Murray GMA annual newsletter.

Rule 6: Review of the Plan (page 24)

Goulburn-Murray Water will consider the need for any amendments to the Plan on a yearly basis in conjunction with the release of the annual newsletter.

If amendments are proposed that directly impact rights of access to water, Goulburn-Murray Water will consult groundwater users in the Upper Murray GMA on the proposed changes to the Plan.

Goulburn-Murray Water may undertake consultation on any proposed amendments via a mail out to licence holders, a public meeting, through advertisements placed in local newspapers, and through consultation with the relevant water service committee.

Endorsement

This groundwater local management plan (the Plan) has been developed for the newly defined Upper Murray Groundwater Management Area (GMA) and it is a significant step in improving management of groundwater resources in the area. The Plan provides a clear operational framework for managing groundwater resources in the Upper Murray GMA. It also provides specific guidance and information to Goulburn-Murray Water's customers about the take and use of groundwater in this area.

The development of the Plan has relied on guidance and feedback from Goulburn-Murray Water's customers and key stakeholders and fulfils an obligation of the Northern Region Sustainable Water Strategy. The Plan is also consistent with relevant Ministerial guidelines in that it explains to groundwater users and the broader community the specific management arrangements governing the extraction of groundwater in the Upper Murray region.

This Plan seeks to strike the right balance between recognising the benefit of using groundwater while supporting the protection of high value environmental assets such as baseflow dependent streams and groundwater dependent ecosystems during critical dry periods. The Plan also seeks to be proactive in its approach, by giving guidance about where groundwater development may occur and documenting rules to manage future development.

This local management plan will require periodic review particularly as the Murray-Darling Basin Plan is implemented, as changes to Victoria's water legislation and groundwater management framework take effect and as information about groundwater resources in the Upper Murray Groundwater Management Area improves.

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

Simon Cowan

Manager Groundwater and Streams

Goulburn-Murray Water Rural Water Corporation

Date: 26 June 2014

Stephen Gemmill

Customer Services Manager Diversions - East

Goulburn-Murray Water Rural Water Corporation

Date: 27 June 2014

Acknowledgements

Goulburn-Murray Water (GMW) would like to express its appreciation to the Upper Murray Groundwater Reference Group which included customer representatives Brooke McKimmie (Towong), Steve Rigoni (Mt Beauty) and Ron McCormick (Towong) from the Kiewa, Mitta Mitta and Upper Murray Regional Water Service Committee as well as representatives from agencies including the North East Catchment Management Authority (Euan Hind), Department of Environment and Primary Industries (Patrick O'Halloran, Charlie Showers).

Feedback from the Upper Murray Groundwater Reference Group members has been invaluable in helping to test and refine the information contained in the local management plan.

Glossary

Term/Acronym	Description
Act	Water Act 1989(Victoria)
AHD	The reference level for groundwater levels is the Australian Height Datum (AHD), the geodetic datum for altitude measurement in Australia. It is the mean sea level for 1966-1968 and is assigned the value of zero.
Aquifer	A geological structure or formation or an artificial land fill permeated or capable of being permeated permanently or intermittently with water;
D&S	Domestic and Stock
GMA	Groundwater Management Area
GMW	Goulburn-Murray Water Rural Water Corporation acting as a delegate of the Minister
Groundwater entitlement	Licensed volume of groundwater specified as megalitres per year
Groundwater licence	Licence issued to take and use groundwater under section 51 of the Act
Groundwater Reference Group	A group of stakeholder representatives consulted during the development and implementation of the Plan
L/sec	Litres per second
m	metre
ML	Megalitre or one million litres
PCV	Permissible Consumptive Volume is the volume of groundwater that the Minister has declared may be extracted from a defined area in a season
The Plan	The Upper Murray Groundwater Management Area local management plan
Season	Period of 12 months commencing 1 July
SOBN	State Observation Bore Network
Trade	Transfer of groundwater entitlement
Zone	A part of a Groundwater Management Area defined for management purposes

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1 Introduction

1.1 Background

The aim of the Upper Murray Groundwater Management Area (GMA) Local Management Plan (the Plan) is to provide groundwater users with a detailed, system-specific management framework. The Plan has been developed by Goulburn-Murray Rural Water Corporation (GMW) in consultation with a groundwater reference group made up of community and groundwater licence holder representatives as well as relevant stakeholder and agency groups, in particular:

- Department of Environment and Primary Industries,
- North East Catchment Management Authority,
- GMW's Kiewa, Mitta Mitta and Upper Murray Regional Water Service Committee.

Local management plans describe how GMW will manage the taking of groundwater licensed under section 51 of the *Water Act 1989* (the Act), using the powers delegated under the Act and in accordance with Victoria's *Policies for Managing Take and Use Licences*.

The development of the Plan is a requirement of Action 4.6 in the Northern Region Sustainable Water Strategy (2009) and it has been developed by GMW as part of a programme to ensure that formal groundwater management arrangements are developed across its entire region. The Plan will be an important 'building block' to enable GMW to meet its obligation to develop a Water Resource Plan, required under the Murray-Darling Basin Plan. This Plan has also been developed to address community concerns raised, particularly during the 1997-2009 drought, about the security of water supplies (both groundwater and surface water); as well as concerns about the impact of diversions on stream flows in the upper catchments.

Several groundwater resource appraisal projects were carried out for the Upper Goulburn catchment (GHD, 2010; GHD, 2011). The methodology for this resource appraisal work has been transferred and adapted to the Upper Murray and has been used to assist with the development of this Plan.

This new approach has been developed to define acceptable limits on groundwater entitlement (GMW, 2013). The approach is focussed on assessing impact of a range of groundwater and surface water diversions on stream flows during periods of low flow.

The Plan includes a cycle of annual reporting with the potential to trigger a review when required. Whilst a more comprehensive review is proposed after 5 years, the Plan may be amended at any time when there is a need to incorporate new knowledge or policy changes.

1.2 Guiding principles

The following guiding principles have been adopted in the development of this Plan:

- The rights of existing groundwater licence holders will not be changed.
- All groundwater use is considered to have equal value (irrigation, commercial, industrial and urban).

- This is a groundwater plan and does not seek to manage surface and groundwater diversions under one set of rules; however the consideration of potential impacts on surface water values from a range of existing diversions has been fundamental to the Plan's development.
- Lack of data is not an excuse for not making decisions.
- Where data is lacking and there is uncertainty over the level of risk posed by take and use of water, a conservative approach has been taken to issuing new groundwater licence entitlement.
- The management approach taken is commensurate with the data, knowledge and resources available to GMW, and to the level of risk posed by the current level of groundwater development.

1.3 Groundwater management objectives

Management objectives have been developed by considering the groundwater values in the catchment and the potential risk to these values from groundwater diversions. The Plan will maintain the reliability of groundwater licences while monitoring the groundwater resource to assess the impact water use has on other users and the environment.

The management objectives for the Upper Murray GMA are to

- Provide a clear and proactive management framework which enables the benefits of groundwater to be maximised in an equitable and sustainable manner,
- Ensure that future groundwater development does not unacceptably impact on environmental assets; such as river flow, springs and groundwater dependent ecosystems, and
- Improve community understanding of groundwater management issues through effective communication, consultation and engagement.

1.4 The Upper Murray Groundwater Management Area

The extent of the Upper Murray GMA is shown in Figure 1.

The Upper Murray GMA comprises the Upper Murray River catchment from Omeo to the Murray River down to Hume Dam, and includes the Mitta Mitta River and Lake Dartmouth. The GMA incorporates the Dartmouth, Indi and Hume catchments and includes the townships of Eskdale, Corryong, Walwa, Dartmouth, Tintaldra, Tallangatta and Omeo.

The groundwater resources covered by the Plan are subject to the depth boundaries defined in the Victorian Groundwater Management Framework (DSE, 2012), as shown in Figure 2.

This means that the Plan relates to groundwater resources to a depth of 200m across the whole of the Upper Murray GMA (this is because the deepest Tertiary age alluvial sediments are less than 150m thick). Bores screened at depth greater than 200 m are not considered to be within the Upper Murray GMA.

If groundwater is extracted at depths greater than 200m then the provisions of the Act will inform management of this groundwater on a case by case basis. There are currently no licensed bores which exceed 200m in depth in the GMA.

The GMA is predominantly fractured rock basement aquifer but with significant alluvial silts, sands and gravel deposits associated with the Murray Valley.

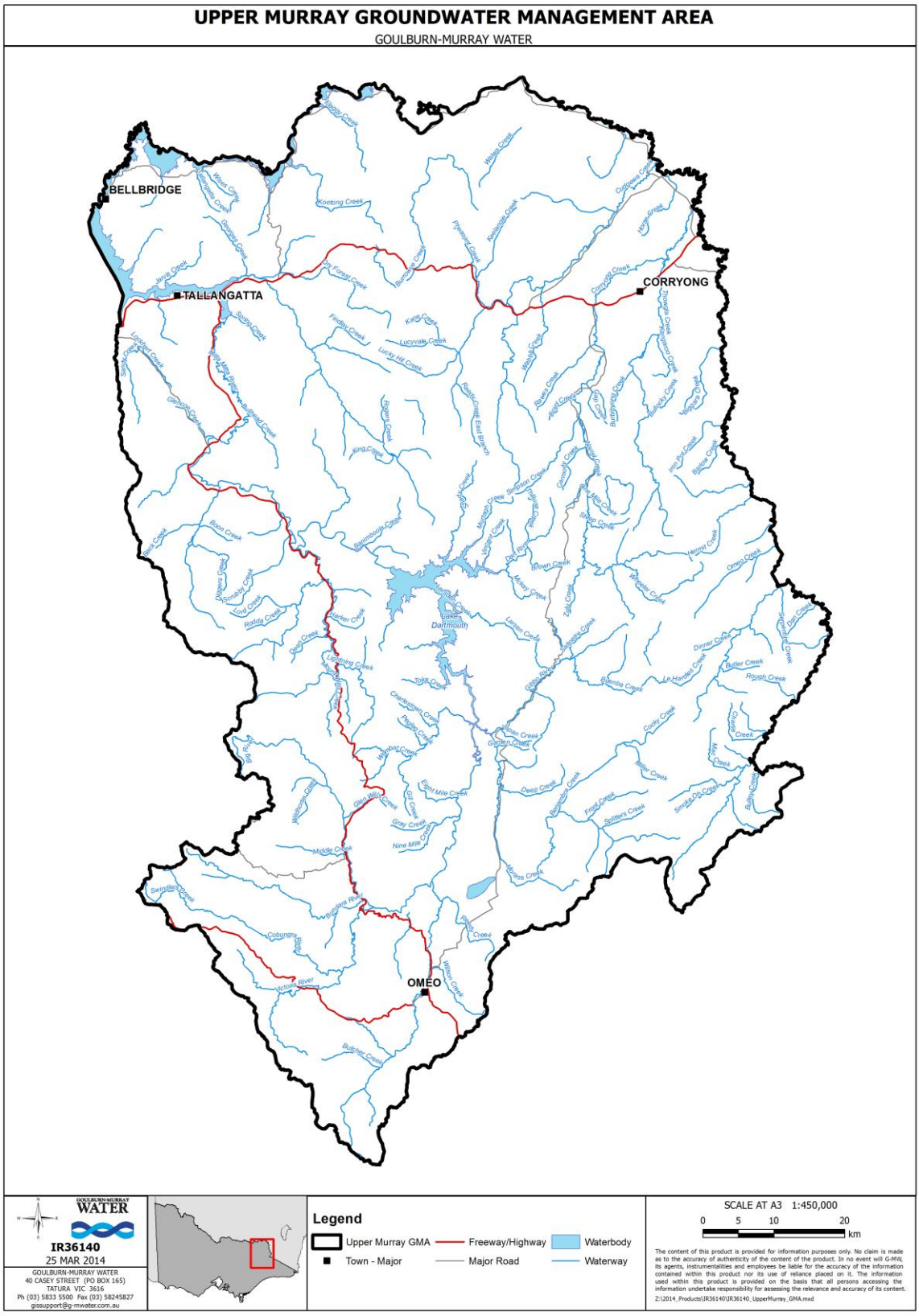

Figure 1 Upper Murray Groundwater Management Area

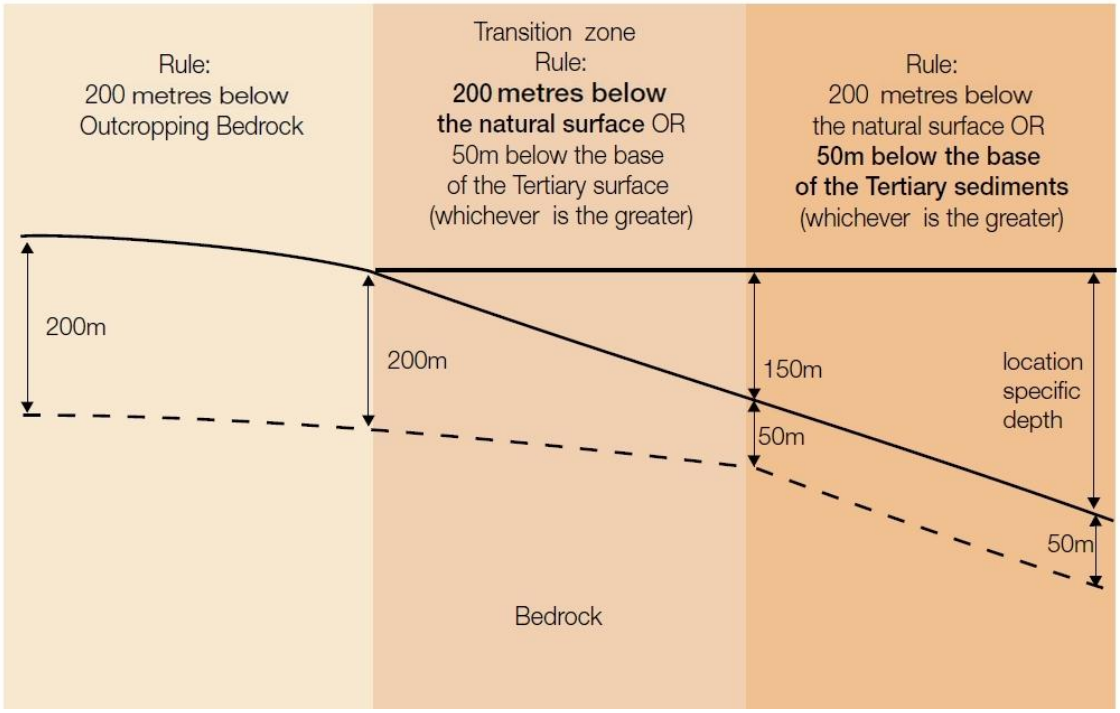

Figure 2 Groundwater management framework depth boundaries (DSE, 2012)

2 Groundwater System

2.1 Aquifers

Groundwater resources within the Upper Murray catchment (Figure 3) broadly occur within two aquifer types:

- Basement Bedrock (Highlands); and
- Alluvial Aquifer (Sedimentary Plain).

The Murray-Darling Basin Plan (the Basin Plan) sets a sustainable diversion limit (SDL) within two groundwater resource SDL units known as the Goulburn-Murray Sedimentary Plain (alluvial aquifers) and the Goulburn-Murray Highlands (basement bedrock aquifers).

The Basin Plan defined the Highlands aquifer as:

- all groundwater in the outcropping Palaeozoic rocks contiguous with the central highlands of Victoria (or where less than 5 metres of saturated aquifer thickness exists above the Palaeozoic surface, or where the aquifers are not contiguous with Shepparton Irrigation Region Water Supply Protection Area or the Sedimentary Plain) from the land surface to 200 metres below the surface.

and the Sedimentary Plain aquifer as:

- all groundwater from the land surface to 200 metres below the surface or 50 metres below the base of the Tertiary sediments, whichever is the deeper, excluding groundwater in the Shepparton Irrigation Region.

The groundwater resources of the Upper Murray GMA are entirely contained within the Basin Plan's Highlands aquifer, as the alluvial sequences found within the GMA are classified as disconnected to the Sedimentary Plains aquifers and therefore meet the Basin Plan's definition of the Highlands aquifer.

2.2 Basement Bedrock

The Upper Murray catchment is composed of areas of metamorphosed bedrock, with intrusive rock (granite) throughout the north and sedimentary bedrock making up the central and southern parts of the GMA (Figure 3). These fractured rocks comprise locally important aquifers.

The intrusive rocks (granite) consist of magma which rose then stabilised in the crust, heating the surrounding rock. The granitic aquifers are made of hard crystalline rock. It has been compacted, folded and faulted over millions of years.

The metamorphic rocks consist of schist and phyllite (which are clay and mudstone), which has been buried, heated, compacted, folded and faulted over millions of years.

The sedimentary rocks consist of marine mudstone and siltstone which has been compacted, folded and faulted over millions of years.

The bedrock has low porosity, which means there is only small pore spaces within the rock framework in which groundwater can move and be stored. Instead, groundwater is stored and moves through fractures and faults in the bedrock. The local aquifer potential depends on the extent of fissuring and on the amount of weathering that has occurred. The highest yields occur in fracture zones and along faults; particularly where these are enhanced by weathering.

Individual bore yields from the bedrock aquifers are generally low (typically less than 0.5 L/sec) however the aquifer does provide an important local groundwater resource for rural households, where it is the primary source of domestic water supply for residents without access to surface water, and it is also used to support industrial, commercial and the agricultural (irrigation) industry.

The groundwater in the bedrock is typically of good quality.

2.3 Alluvial Aquifer (Sedimentary Plain)

The alluvial aquifer sequences are within the Coonambidgal Formation associated with the Murray and the Mitta Mitta River. They consist of gravel, sand and silt sediments deposited along the valley by the ancestral Murray and Mitta Mitta Rivers, extending along river valleys. The alluvial sands and gravels can store large quantities of good quality water which can move freely through the permeable unconsolidated aquifer. Bore yields above 5-10 L/sec can be obtained from the alluvial aquifer, which is typically around 20-50 m thick along the flood plain of the river.

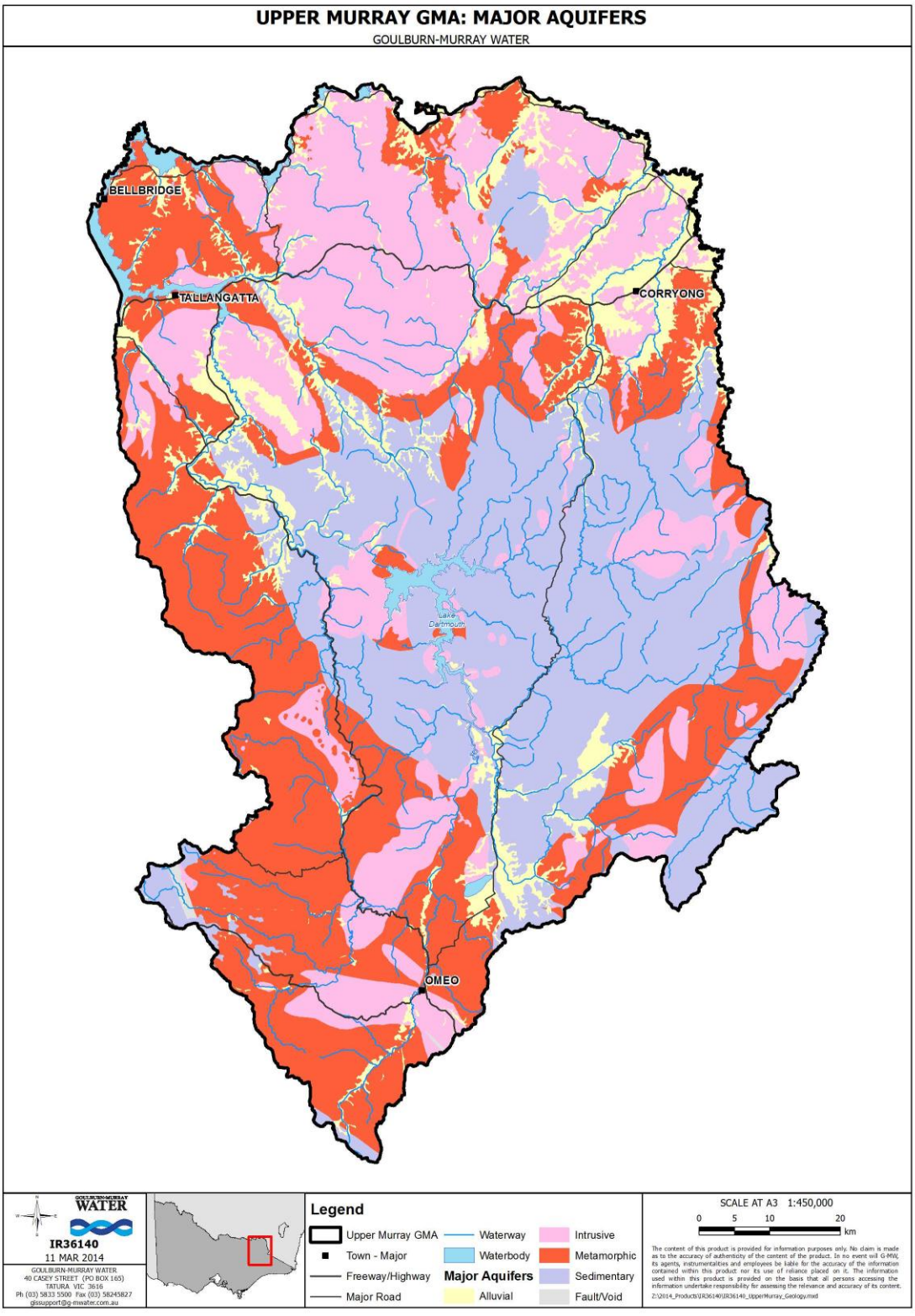

Figure 3 Major aquifers in the Upper Murray GMA

2.4 Groundwater levels

There are 10 State Observation Bore Network (SOBN) bores across the Upper Murray GMA which monitor the bedrock and alluvial aquifers (Figure 9). The majority of bores monitor groundwater in the bedrock aquifers and were installed in early 2011.

Groundwater levels measured in observation bores within the bedrock and alluvial aquifers across the catchment are typically within 0.5 m to 5 m of the ground surface. On the Omeo Valley Road at Hinnomunjie, two SOBN bores (otherwise known as a nested site) measure the water levels within two separate aquifers (Figure 4).

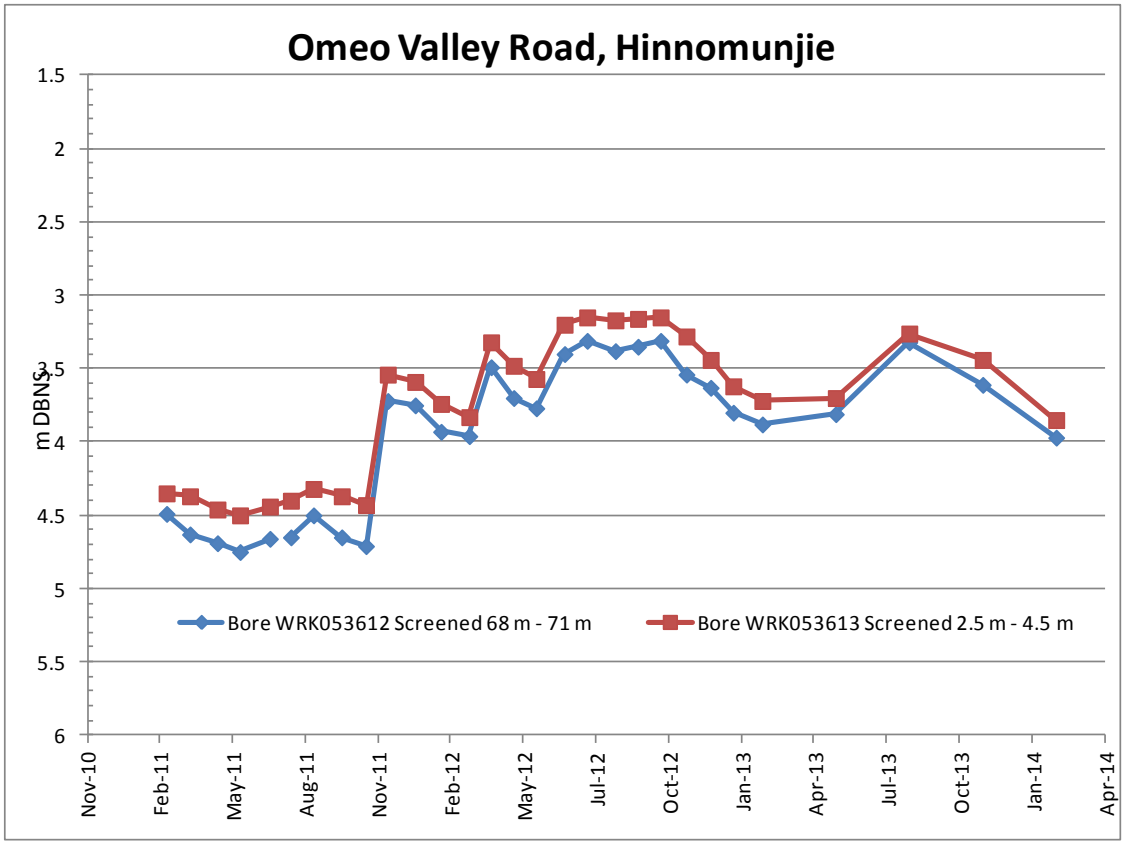

Figure 4 SOBN monitoring of the alluvial and bedrock aquifers at Hinnomunjie.

The hydrograph of the two bore water levels shows the seasonal groundwater level change for the shallow and deep aquifer in this area is typically between 0.5 to 1 m with similar trends. The large increase in water level towards the end of 2011 indicates recharge from heavy rains following a dry period.

Groundwater heads within the bores situated within the deeper aquifer show a similar response to the shallow aquifers. Groundwater heads in the shallow aquifers are often within a couple of metres of the ground surface. Overall the groundwater levels rose following the high rainfall events between 2010 and 2012.

2.5 Groundwater recharge

The majority of recharge to the bedrock aquifers in the GMA originates from rainfall. A significant proportion of rainfall runs over ground directly into streams or is lost through evapotranspiration. The remaining water permeates through the ground and reaches the local watertable.

Where the level of water in a stream is higher than the surrounding groundwater level, some aquifer recharge is likely to occur as the stream loses water to the groundwater system. But where the water level in a stream is below the surrounding groundwater level the aquifer will discharge to the stream (baseflow)

Hydrographs from observation bores situated throughout the Upper Murray Valley shows the Upper Murray River and its tributaries are fed by groundwater. Annual average recharge is estimated to be 459,800 ML/yr for the Upper Murray GMA, with 184,700 ML/yr in the Hume management zone, 96,200 ML/yr in the Dartmouth management zone and 178,900 ML/yr in Indi management zone.

Recharge to the alluvial aquifer occurs through rainfall, runoff from the surrounding upland bedrock, and infiltration from the Upper Murray River (mainly during flooding).

2.6 Groundwater flow

The majority of bedrock groundwater flow occurs in the weathered zones, and in fissure and fracture zones, in the uppermost 100 m of bedrock. Groundwater levels and flow in the bedrock aquifer are likely to mirror topography and flow systems are generally short, as illustrated in Figure 5. Groundwater and surface water catchments are largely the same.

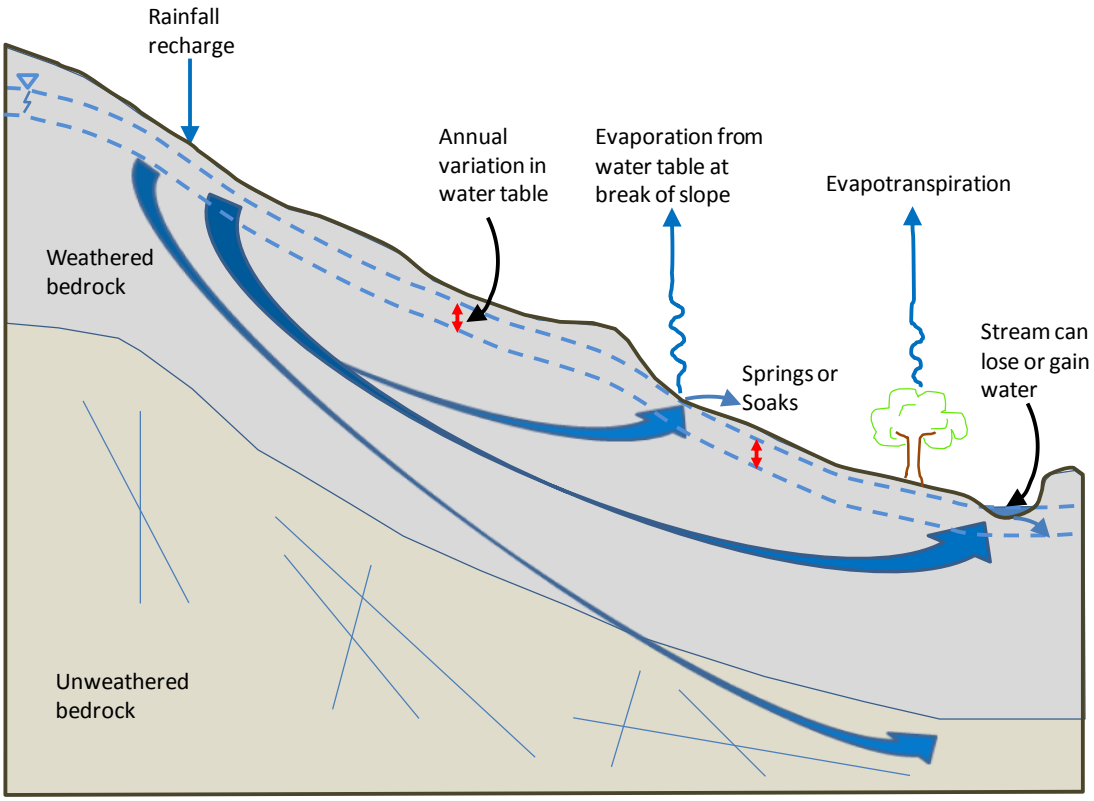

Figure 5 Groundwater flow through a bedrock aquifer

Groundwater flow in the shallow alluvial sequences throughout the Upper Murray GMA will follow the gradient of the river valley and flow locally towards the river and downstream with topography, as illustrated in Figure 6.

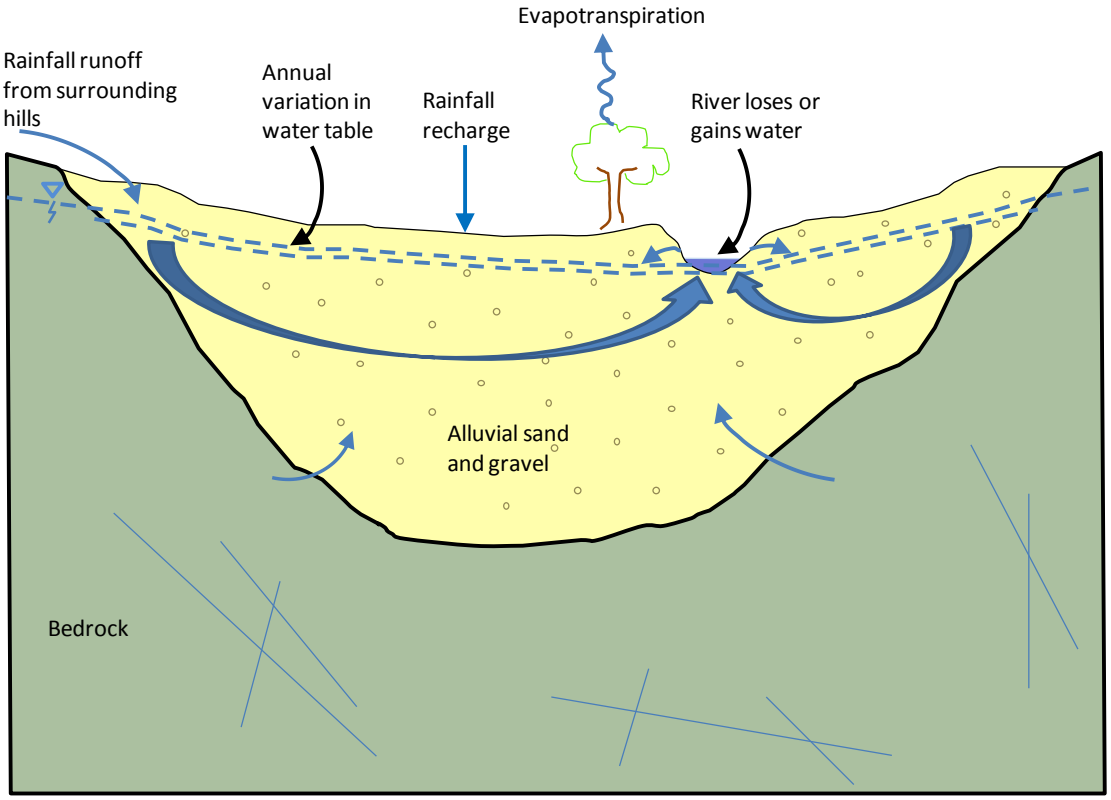

Figure 6 Groundwater flow through an alluvial aquifer

2.7 Groundwater discharge

Groundwater discharge (baseflow) is a major component of total river flow within the Upper Murray GMA. Groundwater discharges into local stream systems, or as springs within the upland area, and some loss occurs due to evapotranspiration from the watertable. Where discharge occurs it is typically in valley bottoms where the water table is close to the surface, at breaks of slope, or where faults and fissures in the rock appear at the surface. A small proportion of groundwater is extracted by bores, estimated to be less than 1% of annual average recharge over the whole GMA (as described in section 3.2).

2.8 Groundwater quality

Groundwater quality is relatively fresh across much of the Upper Murray GMA. However high salinity levels have been recorded within the Omeo Metamorphic Complex up near Omeo and further technical studies would be required to confirm why locally elevated levels of salinity may be occurring.

3 Groundwater use and impacts

3.1 Groundwater licensing

A works licence must be obtained from GMW to drill and construct a bore under section 67 of the Act. A take and use licence is required to extract groundwater for irrigation, commercial, dewatering and urban use under section 51 of the Act. Both works and take and use licences are obtained by submitting an application to GMW which then considers a range of matters when assessing the application, including the potential impacts to existing authorised users, stream flow and the environment.

Licences may be issued for up to 15 years 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 (refer to 3.5)

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

3.2 Volume of groundwater entitlement

There are currently 94 bores authorised to extract a total of 4,043 ML per year, which is less than 1% of annual average recharge over the whole Upper Murray GMA. The total volume of available groundwater entitlement in the GMA, capped at 7,674 ML per year, makes up less than 2% of average annual groundwater recharge (459,800 ML per year).

3.3 Distribution of licensed bores

The distribution of licensed bores is shown in Figure 10. Approximately 8% of groundwater entitlement volume in the Upper Murray GMA is located in the basement bedrock aquifer and 92% in the alluvial aquifer (Table 1). Of the 94 licensed groundwater bores in the Upper Murray GMA, 21 bores extract from the bedrock aquifers and 73 from the alluvial aquifers. Licensed groundwater use is mainly concentrated along the Upper Murray Valley alluvial plain.

Aquifer	No. of Licensed Bores	Total Licence Volume (ML/year)	Percentage of Total Licence Volume
Basement Bedrock	21	293.5	8%
Alluvial	73	3,749	92%
TOTAL	94	4,043	100%

Table 1 Bore and licence distribution by aquifer type

3.4 Metered Use

Groundwater use varies from season to season, and higher groundwater use tends to correlate with lower rainfall years. Actual groundwater use accounts for 1% to 30% of the total licence entitlement volume. This indicates a significant volume of groundwater can be utilised or transferred to support future development.

Meters were installed between 2007 and 2009 on all licensed operational groundwater bores with a groundwater licence entitlement equal to or greater than 20 ML per year. Currently 47% of all groundwater licences in the Upper Murray GMA are less than 20 ML. Metered groundwater use data and estimates will continue to improve in the future and provide valuable information to support management decisions.

3.5 Domestic and Stock Use

Domestic and stock (D&S) bores in the Upper Murray GMA are generally developed in bedrock aquifers to a depth less than 100 m. There are 359 known D&S bores in the Upper Murray GMA (based on State Groundwater Management System records). D&S bores are not required to be metered and there are likely to be a number of D&S bores for which records do not exist. Therefore the amount of D&S use has been estimated to be 484 ML/yr using a methodology developed for the Department of Environment and Primary Industries (RMCG, 2011).

As D&S access to groundwater is a statutory right (private right) under section 8 of the Act, new bores may be developed for this purpose. A licence is required to construct a new D&S bore (section 67 of the Act). GMW registers new bores that are drilled for D&S use, and encourages registration of any currently unregistered bores. Registration of bores will enable GMW to track the growth of D&S bores so that any patterns of significant development can be addressed in future plans if required.

3.6 Groundwater dependent features and values

The development of this Plan has focussed on identifying, as far as possible, the key groundwater dependent features in the GMA, and their potential value. This approach has enabled groundwater management objectives to be determined and it has also ensured that the Plan is focussed on managing those groundwater features considered to have the highest values and most likely to be at risk.

3.6.1 Groundwater dependent features

Groundwater dependent features can include:

- streams which receive a significant contribution from groundwater,
- springs,
- groundwater dependent wetlands and pools,
- riparian and terrestrial vegetation,
- the aquifer itself, and the groundwater resources within it can also be considered a groundwater dependent feature.

Springs and other groundwater dependent features are often considered to be important environmental and cultural features**.**

All of these features occur within the GMA, and are important. However streams, which support a wide range of environmental social and economic values, are of particular importance. Major streams are shown in Figure 1.

3.6.2 Groundwater values

GMW, with the help of key stakeholders, has identified environmental, economic and social values that are dependent on groundwater, and which are associated with the groundwater dependent features identified in the previous section.

The economic value of the Upper Murray region is highlighted in the North East Regional River Health Strategy (North East Catchment Management Authority, 2006) and the North East Draft Waterway Strategy (NECMA, 2014). The Upper Murray River is listed as having high societal and high economic value as well as the upper sections being listed as ecologically healthy.

Key environmental values include a heritage river (Upper Mitta-Mitta River), a number of 'near natural' catchments, significant and endangered riparian fauna, such as endangered Macquarie Perch and Trout Cod (Figure 7), and flora found along the waterways of the Upper Murray GMA (NECMA, 2014).

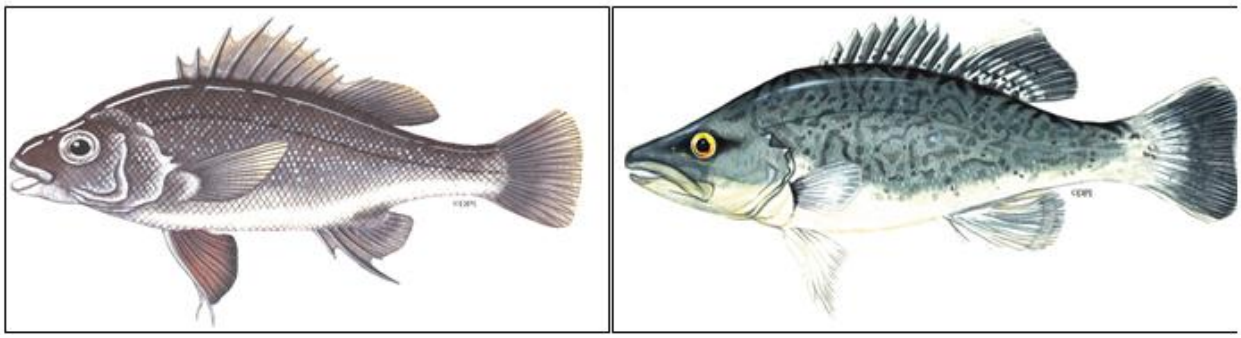

Figure 7 Macquarie Perch and Trout Cod[1]

Of significance within the Upper Murray Valley Sub-catchment are the number of water birds listed within the Regional River Health Strategy (NECMA, 2014) including the nationally endangered Great and Intermediate Egrets that rely on wetlands located on the floodplains.

The river also supports a wide range of other fauna, including other native fish, platypus, invertebrates and in-stream and riparian vegetation.

They provide a strong community focus and are enjoyed by locals and tourists for their aesthetic and amenity value. Many of the regional indigenous values are also associated with waterways.

The waterways are used to provide vital water supplies to domestic and stock users and by irrigators and other users through licensed diversions, in turn supporting the local economy.

Groundwater also has a locally significant social and economic value in the Upper Murray, particularly where groundwater resources have been developed for domestic and stock, irrigation and commercial use.

Historically groundwater use has occurred from alluvial aquifers associated with the floodplains, and these resources have often been intercepted through construction of dams (Figure 8).

[1] These images are © State of Victoria, Department of Primary Industries. Reproduced with permission. Creator of the Macquarie Perch image is Krystii Melaine

Figure 8 Dam accessing groundwater for stock purposes in a shallow alluvial aquifer.

3.7 The impact of diversions on catchment values

The approach taken in this Plan has been to determine the potential impacts of groundwater extraction and other diversions, such as farm dams and surface water extractions on stream flows, and therefore by association the stream flow environmental values.

Environmentally acceptable limits on groundwater use have been defined and consideration given, through consultation with stakeholders, to whether these limits support social and economic values.

A range of diversions can reduce stream flow, including extraction from groundwater bores, domestic and stock bores, direct extraction from streams, and water harvested from farm dams. In developing this Plan consideration has been given to the potential impact of existing levels of diversions on stream flow, particularly during periods of low flow when catchment values are most at risk. Existing groundwater impacts and future groundwater extraction scenarios have been assessed against these baseline low flow conditions (GMW, 2013).

GMW's assessment indicates that the level of surface water, farm dam and groundwater development is low and the catchment characteristics indicate that the streams continue to flow even during dry periods. GMW's methodology has enabled groundwater limits to be identified for the GMA by applying a catchment by catchment assessment approach. The resulting catchment limits on groundwater development are described in section 4.1.

It is widely accepted that pumping from bores can reduce the amount of groundwater that discharges into streams (baseflow), and this can have a significant impact on dry weather stream flow. However, it is recognised that there is often a lag between when groundwater pumping takes place and when the impacts on stream flow occur. It is also possible that some of the groundwater extracted will not impact directly on stream flow and that by lowering the watertable evapotranspiration will instead be reduced.

Nevertheless a conservative approach has been taken in this Plan which recognises the potential for impact. Groundwater pumping impacts on stream flow are assumed to occur on a 1:1 ratio, and impacts are assumed to be spread evenly across the year. As more information becomes available and our knowledge of the groundwater systems improves this approach can be updated if necessary. However, the local impacts of transferring entitlement (upon the environment and surrounding users) will be assessed under section 40 of the Act at the time individual licence transfer applications are made.

Information on the location and sensitivity of springs and other groundwater dependent ecosystems is currently very limited in the Upper Murray GMA. However, where present, these features may be susceptible to dry weather and groundwater extraction, particularly where bores are located in close proximity to such features. Impacts on groundwater dependent ecosystems will be considered by GMW when an assessment is undertaken following a groundwater licence application.

General information on GDEs is available from the National GDE Atlas at http://www.bom.gov.au/water/groundwater/gde/ and GIS layers of Potential Groundwater Dependent Ecosystem Mapping for the North Central CMA are available through the Department of Environment and Primary Industries.

It is recognised that the catchment based limits used in the Plan may be seen as conservative and this may be viewed as a barrier to further groundwater development (and the economic values that this may support). However it is also true that in the last 20 years there has been little demand for new groundwater entitlement in the Upper Murray GMA, and historic use is less than 30% of groundwater entitlement. In the areas where new licensed bores are most likely to be developed, on the major stream or river floodplains around Corryong and the Murray River, there is a reasonable amount of groundwater entitlement available through licence transfer (licence transfer rules are described in section 4.3).

4 Groundwater Management

4.1 Groundwater Management Zones

The Upper Murray GMA includes three catchment based management zones. These are described in Table 2 and illustrated in Figure 9.

Zone	Description
Hume	The Hume zone includes the Hume, Little Snowy, Mitta and Tallangatta catchments downstream of Lake Dartmouth. Aquifers in this zone are mostly fractured bedrock, with alluvial aquifers associated with the Murray River.
Dartmouth	The Dartmouth zone includes the Alpine, Benambra and Omeo catchments upstream of Lake Dartmouth. Aquifers in this zone are mostly fractured bedrock, with some alluvial aquifers associated with Lake Omeo and the upper reaches of Morass Creek
Indi	The Indi zone includes the Corryong, Cudgewa and Indi catchments upstream of the confluence of Swampy Plains Creek and the Murray River. Corryong Creek, Thowgla Creek and the Murray River are all associated with large alluvial sedimentary plains.

Table 2 Groundwater Management Zones

Licensed entitlement within each zone is managed by delineating groundwater access from either bedrock or alluvial aquifers (Figure 3). The management of licence entitlement transfers between and within the aquifers is discussed in section 4.3.

The groundwater management zones, illustrated in Figure 9, are based on the understanding of the hydrogeology and hydrology of the Upper Murray catchment. Groundwater flow and the impacts of groundwater pumping are largely contained within each surface water catchment, and so surface water catchments have been used to define groundwater management zones within the GMA. This enables the impact of groundwater extraction and the impact from other diversions to be examined, and for groundwater to be managed in line with local catchment values.

A conceptualisation and quantification of groundwater in the GMA is contained in separate technical reports which support the Plan (GMW 2014a, GMW 2014b).

Figure 10 shows the distribution of licensed bores within the GMA. Table 3 summarises the number of licensed groundwater bores and groundwater entitlement by zone.

Management Zone	Number of Licensed Bores	Current Licence Volume (ML/yr)	Maximum licence volume permitted (ML/yr)
Hume	**43**	**1,268**	**2,158**
Dartmouth	**7**	**223**	**1,250**
Indi	**44**	**2,552**	**4,266**
Total	**94**	**4,043**	**7,674**

Table 3 Groundwater licence entitlement by zone (February 2014).

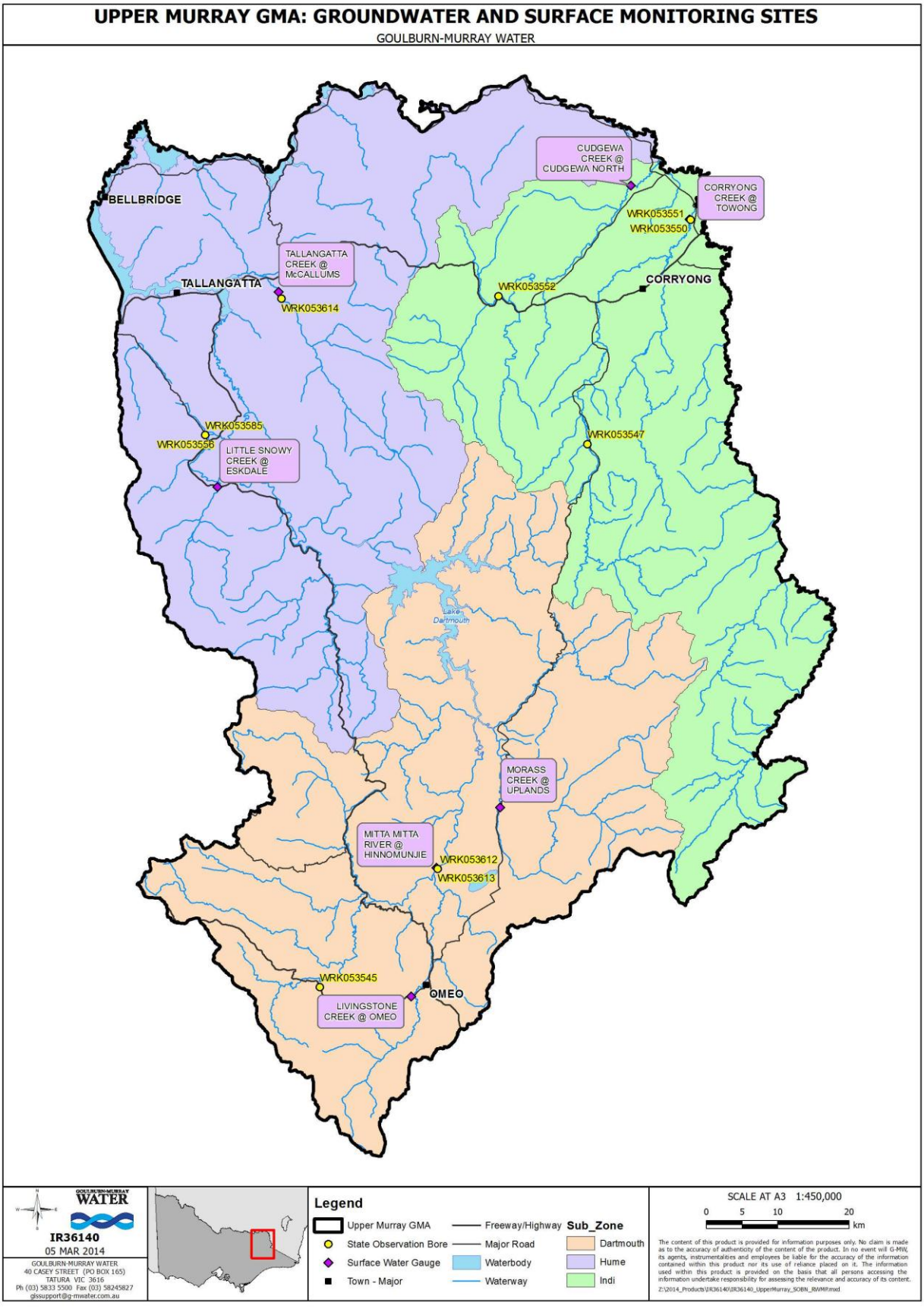

Figure 9 Upper Murray GMA zones, state observation bores and gauging station locations

4.2 Groundwater entitlement availability

In order to protect existing authorised groundwater users and allow development of groundwater to sustainable levels, while at the same time considering uncertainties associated with the understanding of the groundwater resources, groundwater licence entitlement for the GMA will be capped through the declaration of the Permissible Consumptive Volume (PCV). The PCV will be set at 7,674 ML/year (Rule 1). GMW will make an application to the Minister for Water to declare a PCV at this volume.

The cap on groundwater entitlement has been derived using the approach described in section 3.7, and documented in full in a background technical report (GMW, 2014b). Groundwater entitlement limits have been set for each management zone based on a consideration of local catchment values. The sum of these groundwater entitlement volumes is equivalent to the proposed PCV.

The PCV does not include domestic and stock use and GMW may seek to amend the PCV to overcome any administrative oversight, error or other anomaly which occurred prior to the approval of this Plan.

The Sustainable Diversion Limit set by the Murray-Darling Basin Plan for the Highlands (basement bedrock) aquifer allows further entitlement to be accessible within the PCV (Rule 2).

When assessing groundwater licence applications, GMW must make sure that particular matters, including the PCV, are considered in accordance with section 53 of the Act. In addition, GMW will take a precautionary approach to its consideration of new groundwater licence applications to protect water resources and have particular regard for:

a) Any future obligations and requirements set by the Murray-Darling Basin Plan;

b) Contemporary Victorian Government policy relating to the revision of groundwater management unit boundaries, determination of resource capacity and changes to caps on groundwater entitlement; and

c) Contemporary Victorian Government policy on the preferred method of allocating any new groundwater entitlement.

Rule 1: Cap on groundwater entitlement

Goulburn-Murray Water may issue a groundwater licence under section 51 of the Act provided that in doing so it does not exceed the Permissible Consumptive Volume established for the Upper Murray Groundwater Management Area **(Plan LEGL/14-208)**

New groundwater entitlement may occur up to the limit specified in the permissible consumptive volume, subject to management zone limits.

Rule 2: New Entitlement Zone Limits

Goulburn-Murray Water may issue a new groundwater licence under section 51 of the Act provided that in doing so it does not exceed the management zone limits specified in Table 4.

Management Zone	Maximum licence volume permitted (ML/yr)
Hume	**2,158**
Dartmouth	**1,250**
Indi	**4,266**
Total	**7,674**

Table 4 - Maximum licence volume permitted per zone

The caps set for each management zone are above the current total licence entitlement held within each zone. Licence entitlement can be applied for up to the management zone caps without the requirement to transfer.

4.3 Transferring groundwater licence entitlement

Transferring groundwater licence entitlement supports new business opportunities, or enables existing businesses to grow. Licence transfer rules have been developed to:

- Enable access to groundwater in zones where groundwater licence entitlement is capped,
- Increase flexibility for licensed groundwater users to manage production in response to changes in seasonal or climatic conditions,
- Allow licensed groundwater holders to better realise the value of their licence.

Rule 3 relates to groundwater licence transfers. Temporary and permanent transfer of groundwater entitlement is permitted by GMW subject to a consideration of relevant matters identified in the Act. These matters include the need to consider potential impacts on local environmental values and nearby groundwater users.

A transfer of groundwater entitlement can occur within a management zone up to the limit set in each catchment (management zone).

Licence holders applying to transfer groundwater entitlement must have received written approval from GMW before groundwater is extracted.

Rule 3: Transfer of groundwater entitlement

Goulburn-Murray Water may approve a transfer of a groundwater licence under section 62 of the Act provided that relevant matters under section 53 of the Act have been considered and that the following conditions are satisfied**:**

(a) Transfer occurs within the same management zone;

(b) The buyer has a bore with a metered diversion point; and

(c) The approval of a transfer must not cause the sum of total licence entitlement to exceed the Permissible Consumptive Volume established for the Upper Murray Groundwater Management Area and any cap which applies to a management zone as shown in Table 4.

4.4 Carryover

Carryover is the ability for licence holders to bank some of their unused allocation from one year and use it in the following year. It is not proposed to be introduced in the Plan as not all licensed bores are metered in the Upper Murray GMA and the levels of groundwater use are relatively low compared to existing entitlement. Additionally, the aquifers within the GMA are not well enough understood to support the introduction of carryover.

5 Monitoring program

Monitoring, evaluation and reporting are vital to enabling adaptive and improved resource management to occur. The results of groundwater and surface water monitoring and evaluation activities directly shape future management actions and planning.

5.1 Groundwater levels

The expansion of the State Observation Bore monitoring network in the Upper Murray GMA between 2010 and 2012 has greatly improved the monitoring coverage of the region.

There are now 10 strategically located State Observation Bores in the Upper Murray GMA (Figure 9) that are monitored at either monthly or quarterly intervals.

The State Observation Bores reflect the groundwater resource condition and provide valuable data on:

- Groundwater interactions with surface water,
- Groundwater dependent ecosystems,
- Groundwater quality,
- Groundwater system response to recharge,
- Local pumping effects.

Continued monitoring of groundwater levels is required to improve our understanding of how the groundwater system responds to different stresses, such as changing climate and shifts in the distribution of groundwater extractions resulting from the uptake or transfer of groundwater licences. This in turn supports responsible resource management decision making.

Throughout the GMA there is no evidence that groundwater extraction is causing any significant reduction in groundwater levels, or is impacting upon the availability of the resource. There are relatively small seasonal changes in groundwater levels but it is considered very unlikely that this will impact upon the ability of users to access groundwater.

5.2 Surface Water Flows

The surface water flow gauges used in the assessment of groundwater entitlement are shown in Figure 9. These gauges are used by different stakeholders including the Bureau of Meteorology, North East Water and GMW to support a range of surface water management objectives.

From a groundwater resource management perspective this data also enables estimates of groundwater discharge to be made and it provides information on the risk posed to a whole range of environmental, social and economic values from new groundwater licences and from groundwater licence transfers.

Surface water gauging data is available online from the Department of Environment and Primary Industries (currently via the Water Management Information System). GMW will continue to use this data to estimate groundwater discharge and to assess the status of groundwater and surface water resources across the area. This data will be used to assist in any future reviews of the Plan.

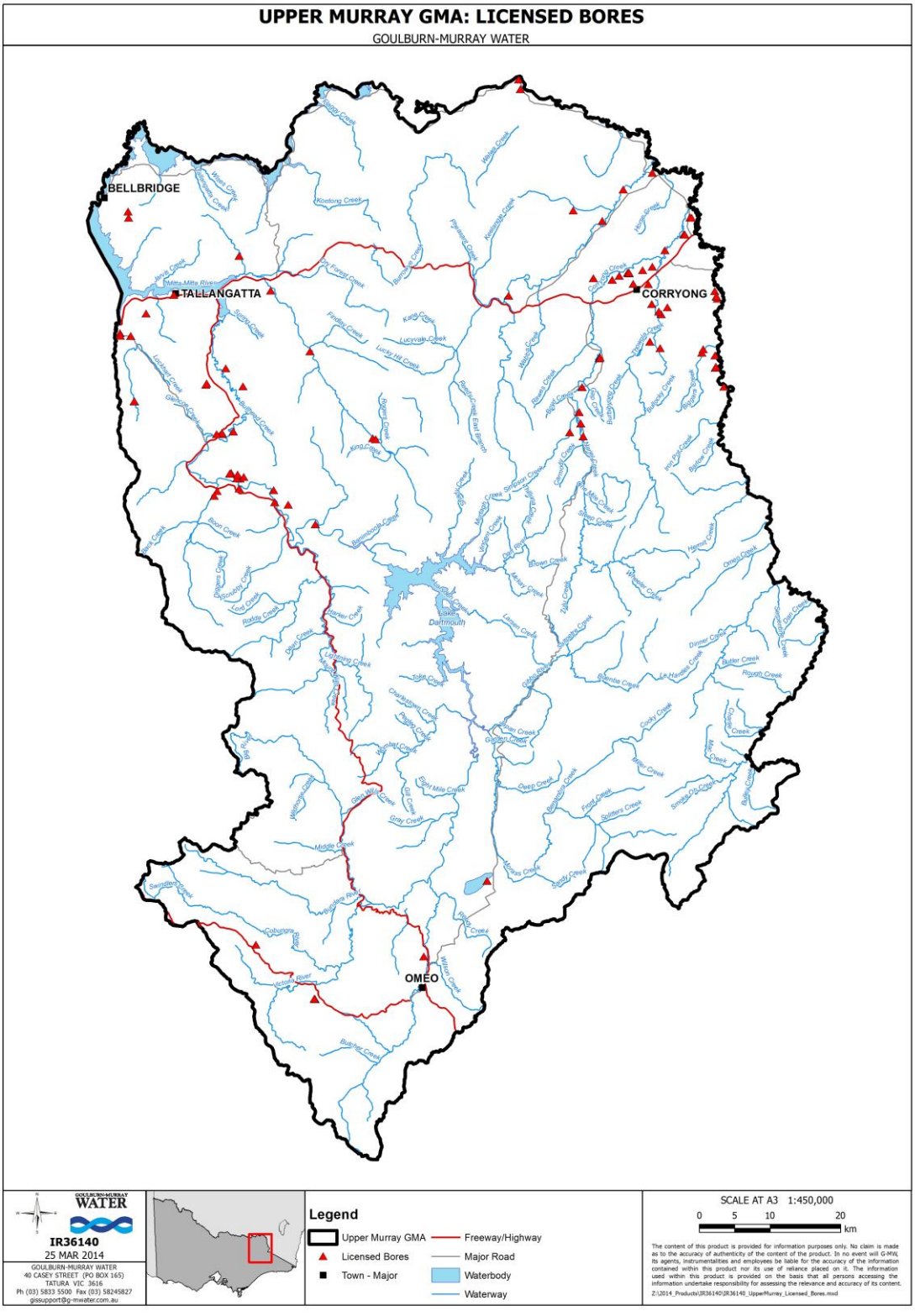

Figure 10 Upper Murray GMA licensed groundwater bore locations

5.3 Meter readings

Recording groundwater usage is an important part of resource management. Under average and wet conditions groundwater usage is a small component of the total water balance of the Upper Murray GMA and it is only slightly more significant during extended dry periods.

Currently there is only a limited amount of metered data for this area as meters were installed after 2009. Recording groundwater use will help to better understand the relationship between groundwater use and climate and gain a clearer indication of the volumes of groundwater pumped in dry periods. This will help GMW assess the potential risk of pumping on surface water resources in future plan reviews.

All existing licensed and operational bores, with a licence volume equal to or greater than 20 ML/year are fitted with a flow meter. Any new licensed bore must also be metered, regardless of the volume of groundwater licence entitlement.

Meters will be read at least once annually. The information will be stored in the Victorian Water Register database to assist with reporting on usage and compliance as well as assisting in improving groundwater knowledge and management over time.

Rule 4: Record meter readings

Goulburn-Murray Water will:

(a) Ensure that a flow meter is fitted to all existing licensed operational bores in the Upper Murray GMA which are associated with a licence entitlement equal to or greater than 20 ML/year;

(b) Ensure that any new licensed bores are fitted with a flow meter;

(c) Read each meter at least once annually; and

(d) Enter metered groundwater use into the Victorian Water Register database.

6 Implementation

6.1 Annual newsletter

GMW will prepare an annual newsletter for the Plan. This newsletter will summarise groundwater entitlement, usage, and transfers in each management zone, and the overall resource position based on the available monitoring data. The newsletter will help GMW to keep customers and stakeholders informed and engaged. The newsletter will be posted to all licensed groundwater customers and be available on the GMW website at: www.g-mwater.com.au

Rule 5: Annual newsletter

Goulburn-Murray Water will, by 1 October of each year, prepare an annual newsletter to 30 June of that year for the Upper Murray GMA which will include reporting and analysis of:

(a) Groundwater entitlement per zone, including temporary and permanent transfers;

(b) Groundwater use per zone;

(c) The overall resource position; and

(d) The need for any changes to the Plan.

Goulburn-Murray Water will post on its website in October of each year the Upper Murray GMA Plan annual newsletter.

6.2 Review of the Plan

Over time this Plan will need to be adapted in response to policy changes in groundwater resource management, as our understanding of the aquifer system increases and as management improvements are identified.

At the time of the development of this Plan, implementation of the Basin Plan had commenced. As requirements of the Basin Plan become clearer, this Plan may need to be reviewed to ensure it is up to date and reflects the requirements of the Basin Plan.

Each year during the preparation of the annual newsletter GMW will consider the need to make amendments to the Plan.

Any significant changes to the Plan must be based on sound technical understanding of the issues and will be subject to consultation.

Rule 6: Review of the Plan

Goulburn-Murray Water will consider the need for any amendments to the Plan on a yearly basis in conjunction with the release of the annual newsletter.

If amendments are proposed that directly impact rights of access to water, Goulburn-Murray Water will consult groundwater users in the Upper Murray GMA on the proposed changes to the Plan.

Goulburn-Murray Water may undertake consultation on any proposed amendments via a mail out to licence holders, a public meeting, through advertisements placed in local newspapers, and through consultation with the relevant water service committee.

7 References

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