NSW GOVERNMENT | Office of Water

Water resources and management overview

Murrumbidgee catchment

Leading policy and reform in sustainable water management

Publisher

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Cover photo: Tumut River upstream of Blowering Dam (courtesy of Dayle Green)

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Contents

Tables

Figures

1 Introduction

The Murrumbidgee catchment covers 84,000 square kilometres of southern New South Wales. It is bordered by the Great Dividing Range to the east, the Lachlan Catchment to the north and the Murray Catchment to the south. The climate is extremely diverse ranging from alpine conditions in the headwaters of the Snowy Mountains to the semi arid conditions of the Riverina plains in the west.

The Murrumbidgee River spans almost 1,600 kilometres, rising in the Monaro Plains near Cooma and flowing westward towards its junction with the Murray River near Balranald (Figure 1). Elevations range from over 2,200 metres in the eastern ranges to less than 50 metres on the western plains (Figure 2). A series of regulated effluents that comprise the Yanco Creek system leave the river in the middle reach of the river and flow southwest to eventually join the Murray River. The lower reaches of the Murrumbidgee River is known as the Lowbidgee, a broad floodplain where the river degrades into a complex area of effluent channels and swamps.

The Murrumbidgee River flows through lands previously occupied by the Wiradjuri people, the largest Aboriginal nation in NSW. They lived along the banks of the river, and its name is derived from the Wiradjuri word for 'plenty of water'. Today the Murrumbidgee catchment supports a population of approximately 520,000 people. It includes the Australian Capital Territory and the national capital, Canberra, as well as NSW's largest inland city, Wagga Wagga, with populations of 314,000 and 57,000 respectively. The catchment also supports numerous regional cities and towns including Cooma, Tumut, Narrandera, Griffith, Leeton, Hay and Balranald.

Major irrigation districts have developed in the middle of the catchment surrounding Griffith and Leeton. The irrigation industry in the Murrumbidgee provides 25 per cent of the state's fruit and vegetable production, 42 per cent of the state's grapes and half of Australia's rice production (Murrumbidgee CMA 2008). Outside of the major irrigation districts the dominant agricultural land uses are grazing and dryland cropping.

Supporting a complex range of natural ecosystems, the Murrumbidgee catchment contains many significant wetland habitats such as the extensive Lowbidgee wetlands, and Tuckerbill and Fivebough Swamps, listed under the Ramsar Convention for international ecological importance. Extensive areas of riparian river red gum forest along the middle and lower reaches of the river provide valuable riparian habitat for waterbirds and a variety of threatened fauna species.

Tumut River at Brungle Bridge

Figure 1: The Murrumbidgee catchment

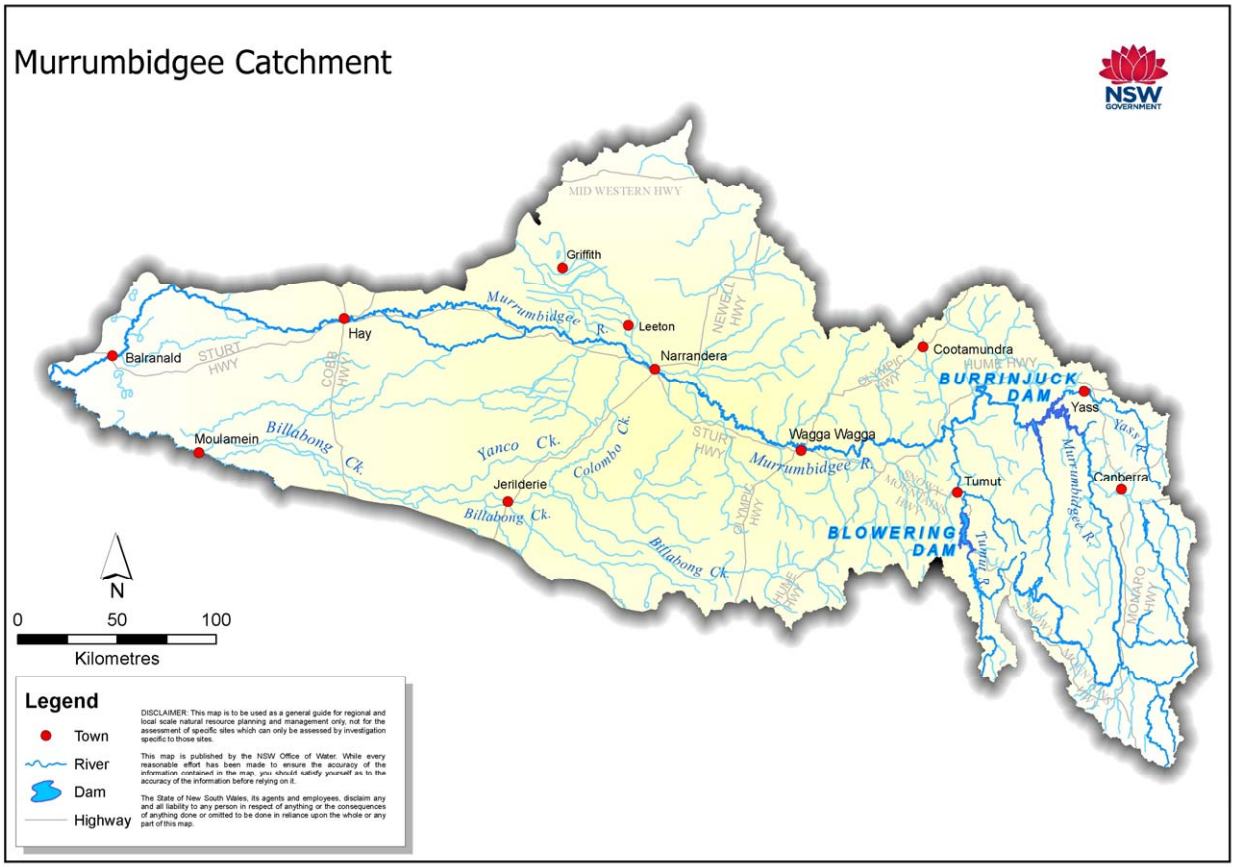
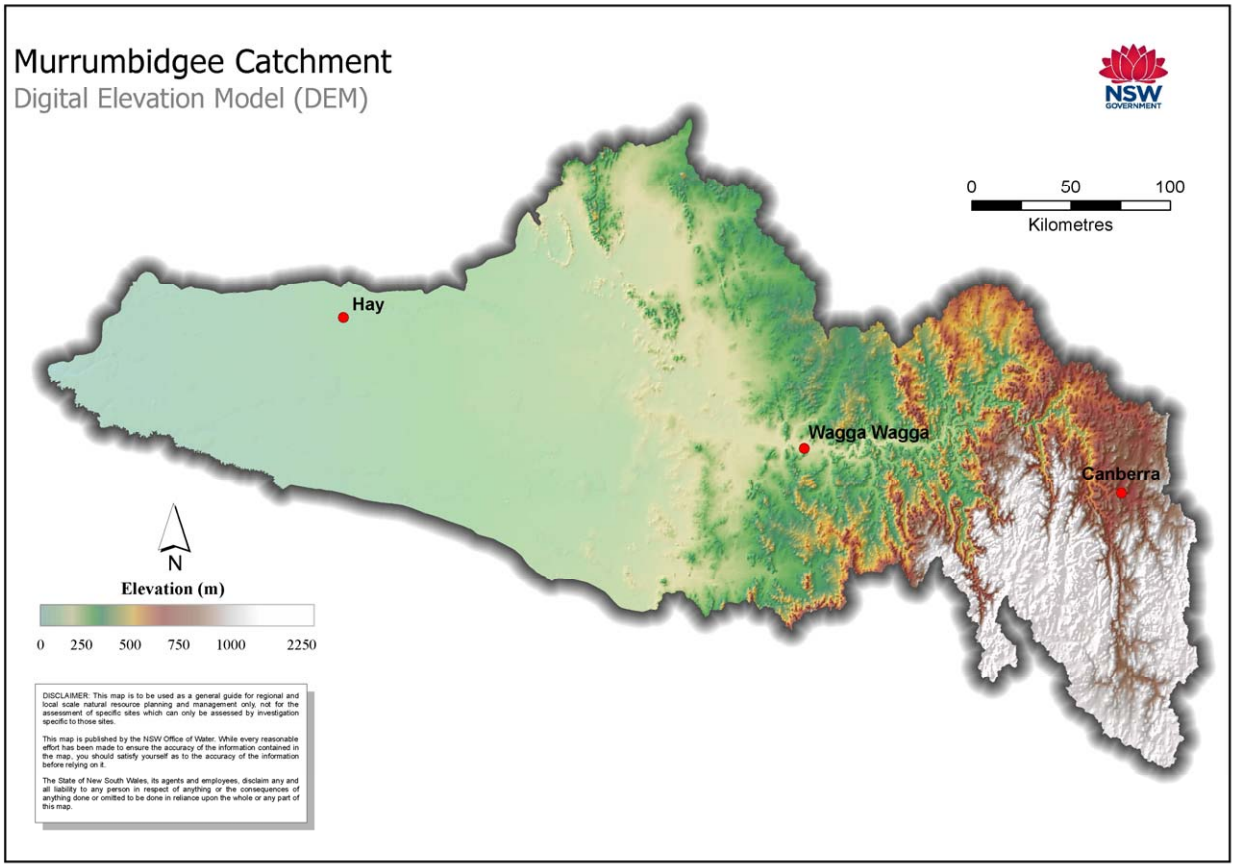


Figure 2: Topography and elevation of the Murrumbidgee catchment



2 Climate

2.1 Rainfall

The average annual rainfall in the Murrumbidgee catchment ranges from over 1,700 millimetres in the higher elevations of the Snowy Mountains, to less than 350 millimetres on the western plains (Figure 3).

Average annual rainfall at Wagga Wagga is 518 millimetres (based on 112 years of data from 1898 to 2010). The wettest year on record was 1950 with 882 millimetres and the driest year was 1914 with just 231 millimetres. On average, rainfall at Wagga is fairly evenly distributed throughout the year with a slight increase during the winter and early spring months when the average monthly rainfall is around 50 millimetres (Figure 4).

2.2 Evaporation

Average evaporation data (Class A pan evaporation, 1921–1995) in the Murrumbidgee catchment demonstrates a strong east-west gradient (Figure 5). Average evaporation varies from less than 1,000 millimetres per year in the south-east, to over 1,800 millimetres per year in the west. Evaporation in the Murrumbidgee is also strongly seasonal, varying from one millimetre per day during July at Wagga Wagga to 9 millimetres per day during January (Figure 6).

Murrumbidgee River at Carrathool

Figure 3: Average annual rainfall in the Murrumbidgee catchment

Source: Hutchinson and Kesteven 1998

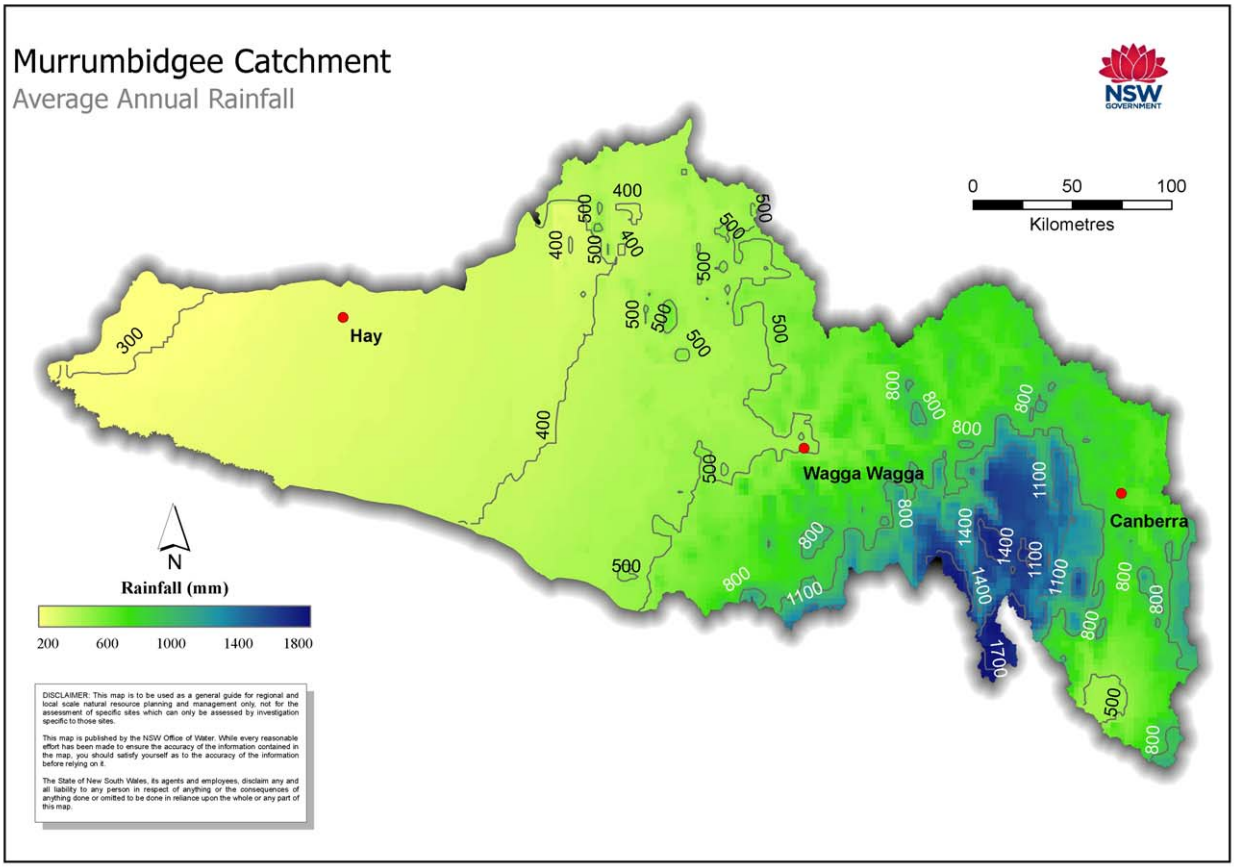


Figure 4: Average monthly rainfall at Wagga Wagga (1898-2010)

Source: Bureau of Meteorology Climate Data Online

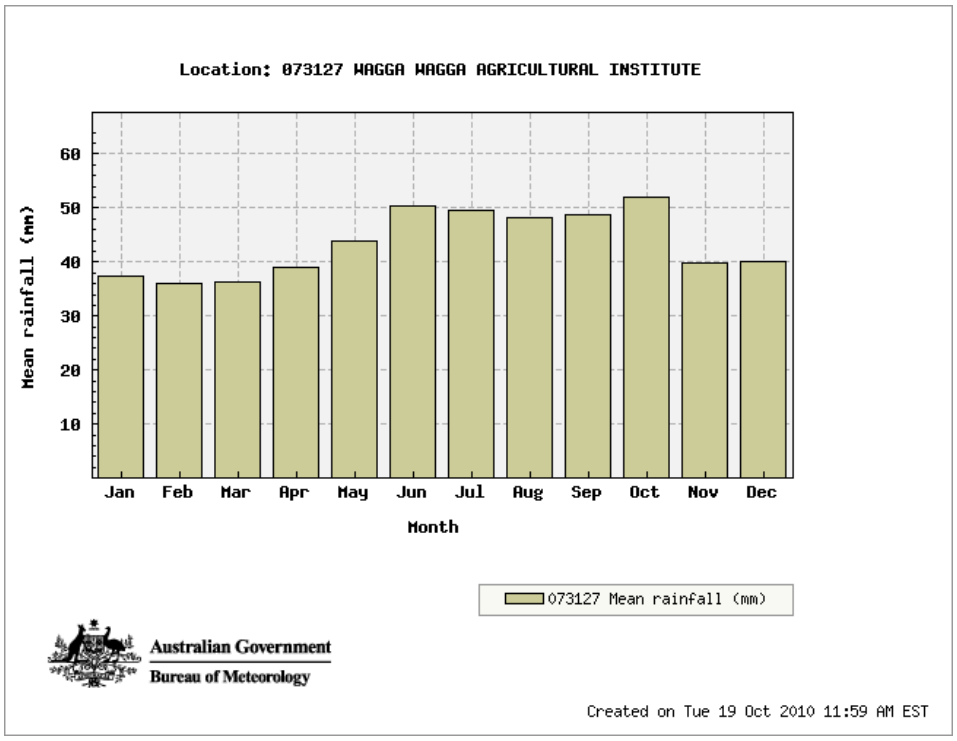


Figure 5: Class A pan annual evaporation in the Murrumbidgee catchment

Source: Hutchinson and Kesteven 1998

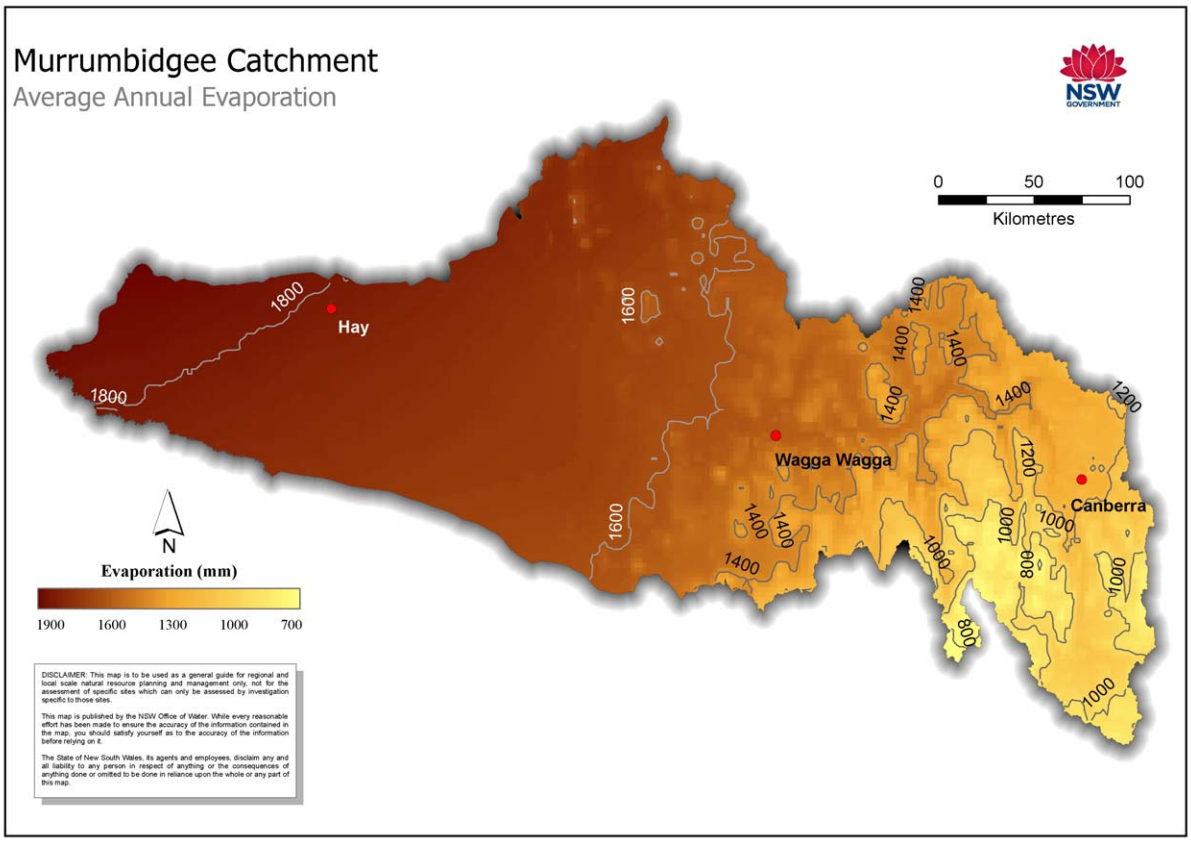
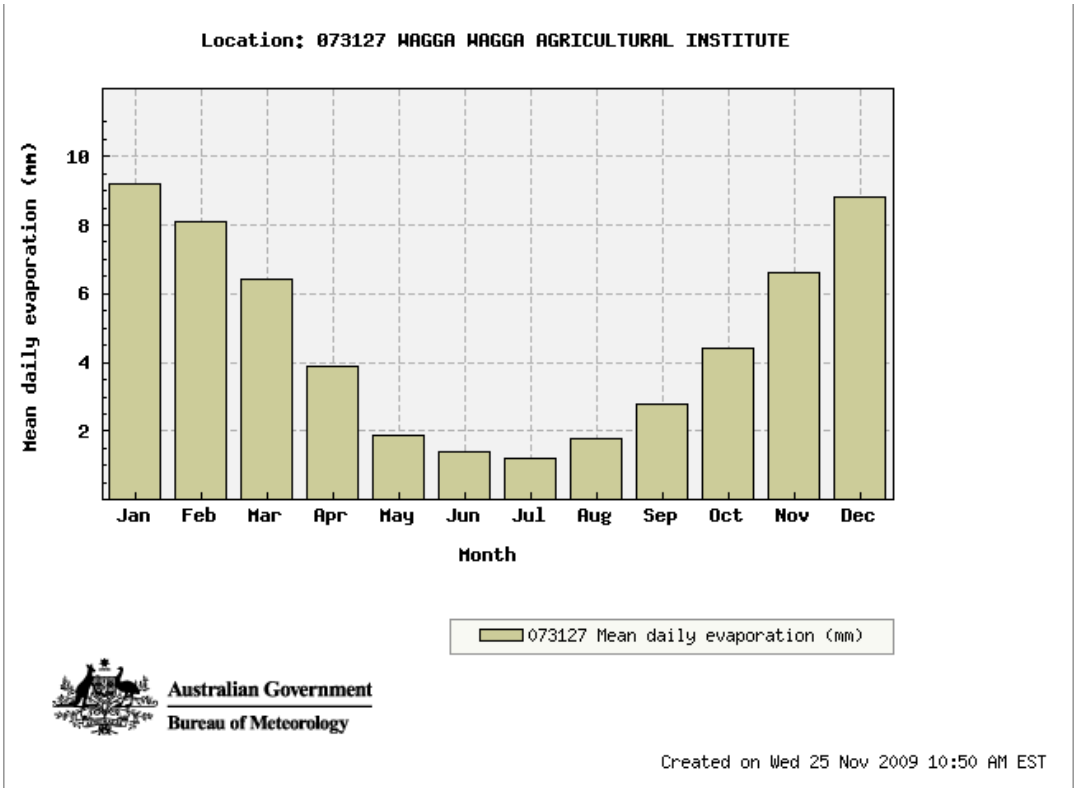


Figure 6: Mean daily evaporation at Wagga Wagga (1958-2007)

Source: Bureau of Meteorology Climate Data Online



3 Land use

Land use in the Murrumbidgee catchment is dominated by extensive agriculture. The largest industry is grazing which occupies 64 per cent of the catchment. Much of the remainder is used for dryland cropping and horticulture. Irrigated crops are economically very important for the catchment and cover 5 per cent of its area. Forests, conservation areas and other native vegetation together cover about 13 per cent of the land use (Table 1, Figure 7).

The grazing land is distributed throughout the catchment and features heavily in all the regions. Dryland agriculture occurs mostly in the mid-Murrumbidgee between Gundagai and Narrandera.

Irrigated cropping occurs within the Murrumbidgee Irrigation Area on the northern side of the river, in the Coleambally Irrigation Area on the southern side of the river, and along the Yanco Creek system. The prominent crops produced in the Murrumbidgee Irrigation Area are rice, corn, wheat, grapes and citrus. In Coleambally Irrigation Area rice, soybeans and corn are grown in summer while wheat, oats and barley are produced over winter. Irrigated pasture for grazing is grown throughout the year. The main irrigated crops along the Yanco Creek system are citrus, stone fruit, wine grapes and rice.

The largest areas of conservation land and commercial forest are in the east of the catchment, upstream of Burrinjuck and Blowering Dams. Kosciusko National Park and Namadgi National Park protect alpine and sub-alpine habitats and represent the largest conservation areas in the catchment.

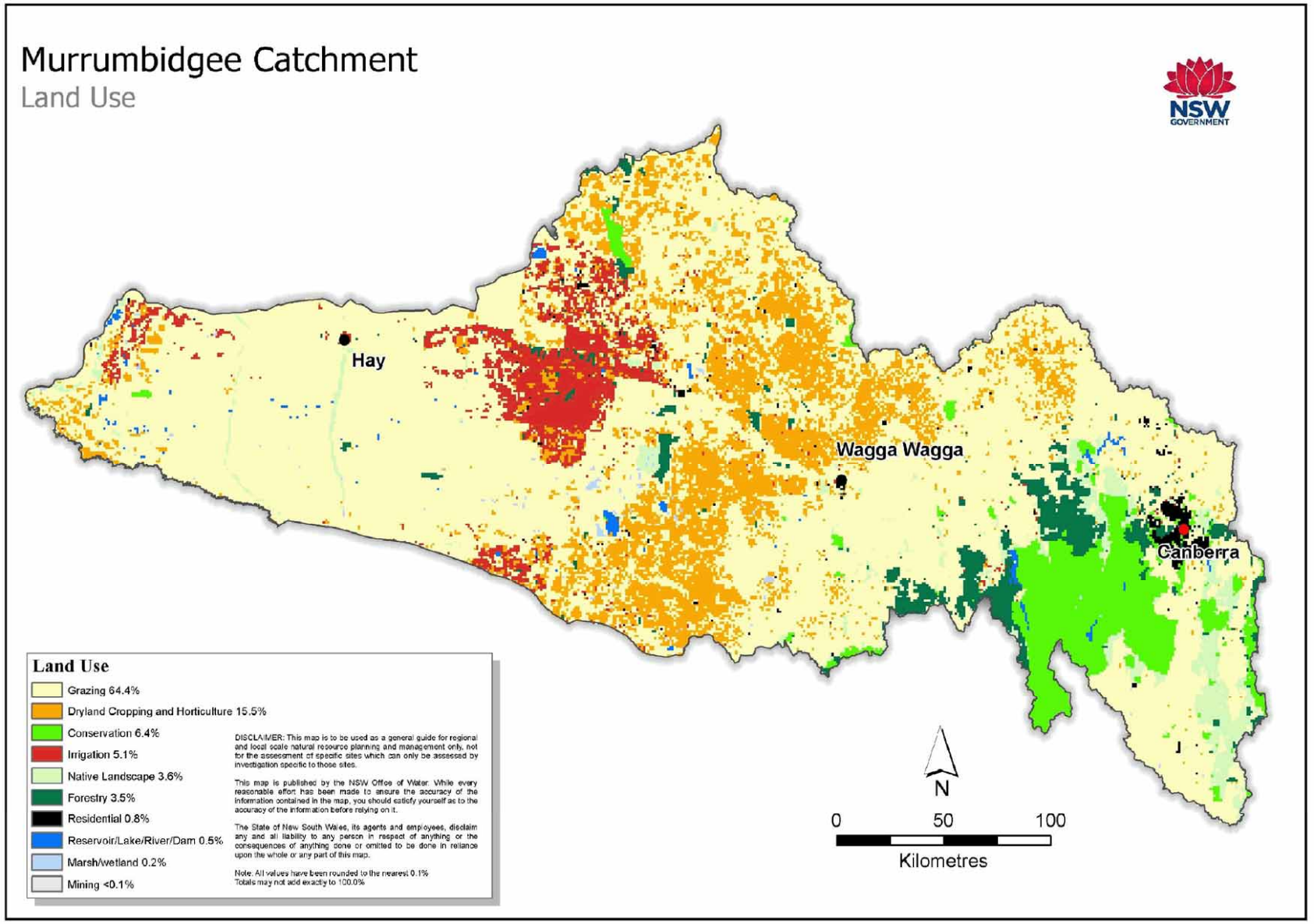
Table 1: Land use in the Murrumbidgee catchment as of 2001

Land use description	Total area (km^2)	Proportion of catchment (%)
Grazing	52,574	64.4
Dryland cropping and horticulture	12,675	15.5
Conservation	5,194	6.4
Irrigation	4,182	5.1
Native landscapes	2,955	3.6
Forestry	2,823	3.5
Residential	612	0.8
Lakes, rivers, dams	377	0.5
Wetlands	196	0.2
Mining	3	<0.1

Source:2001/02 Land use mapping of Australia, Bureau of Rural Sciences

Figure 7: Landuse in the Murrumbidgee catchment

Source:2001/02 Land use mapping of Australia, Bureau of Rural Sciences



4 Environment

4.1 Native vegetation

The Murrumbidgee catchment supports a wide range of native vegetation communities including alpine herb fields, native grasslands, moist forests and woodlands, semi-arid chenopod shrublands, river red gum forests, and box woodlands (Murrumbidgee CMA 2008). Of these, the most extensive along the inland floodplains are the box-red gum and grey box woodlands. It is estimated that approximately 50 per cent of the native vegetation in the Murrumbidgee valley has been cleared (Murrumbidgee CMA 2008).

4.2 Parks and reserves

National parks and nature reserves protect over 5,100 square kilometres of native habitat within the Murrumbidgee catchment. The largest of these is Kosciusko National Park which protects 2,630 square kilometres of the catchment including the headwaters of the Murrumbidgee and Tumut Rivers. Other large parks in the upper catchment are Brindabella and Namadgi National Park which feature mountain and sub-alpine forests.

On the middle and lower floodplain, areas of woodland and riverine habitat are conserved within Narrandera Nature Reserve, Oolambeyan Nature Reserve and Yanga National Park. Narrandera Nature Reserve, near Narrandera features river red gum forests on the banks of the Murrumbidgee River, while Oolambeyan Nature Reserve, 30 kilometres to the south of Carathool, is a former pastoral property that provides woodland and grassland habitat for threatened bird species such as the bush stone curlew, superb parrot and plains wanderer.

Yanga Station, to the south west of Balranald, is another former pastoral station that was gazetted as a National Park in 2007. It covers approximately 760 square kilometres, making it the largest conservation area on the Murrumbidgee floodplain. It forms part of the Lowbidgee floodplain and includes extensive areas of wetlands, lakes and riverine woodlands which provide breeding grounds for many waterbirds.

4.3 Wetlands

The Murrumbidgee catchment contains a diverse range of riverine habitats and wetland types that provide valuable aquatic habitat for a range of native plant and animal species. Some of the important wetland features within the valley include:

The Lowbidgee floodplain is the largest area of floodplain wetland remaining in the Murrumbidgee Valley. Located between Maude and Balranald, the floodplain covers an area of over 2,000 square kilometres. It includes the second largest red gum forest in Australia (along the river downstream of Redbank Weir) and significant black box, lignum and reed-bed communities. The wetlands support large numbers of waterbirds, many of which breed in the extensive lignum swamps, and provide habitat for many threatened species. The Lowbidgee wetlands are included in the Register of the National Estate under the listing for the nearby Great Cumbung Swamp (in the Lachlan Valley) (DEWHA 2009).

The Mid-Murrumbidgee wetlands is a network of riverine lagoons and billabong formations that occur along the river between Narrandera and Carathool. These wetlands rarely dry out completely and provide drought refuge for a wide range of species including many listed as endangered or threatened.

Fivebough Swamp is a permanent fresh to brackish, shallow wetland and Tuckerbil Swamp is a seasonal, shallow, brackish to saline wetland. Both are located on the Riverina plains near Leeton and are of national and international importance because of the abundance and diversity of waterbirds that

they support, including migratory shorebirds and threatened species. Both wetlands are important waterbird habitat and provide refuge within the surrounding agricultural landscapes.

Fivebough and Tuckerbill Swamps are listed as internationally significant under the Ramsar Convention and 16 wetlands are listed as nationally significant in the Directory of Important Wetlands (DEWHA 2009). Table 2 provides a list of the significant wetlands in the valley.

Table 2: Significant wetlands in the Murrumbidgee catchment

Source: Directory of Important Wetlands in Australia (DEWHA 2009)

Wetland	Location	Description
Bethungra Dam Reserve	Wandalybringle Creek, 17 km SW Cootamundra	Artificial pondage supporting large waterbird population
Big Badja Swamp	Big Badja River, 40 km NE Cooma	Subalpine peat swamp
Black Swamp and Coopers Swamp	Delta Creek, 60km E Hay	Terminal swamps of canegrass, lignum and blackbox
Coopers Swamp	Queanbeyan River, 65km SE Canberra	Upland peat swamp
Coree Flats	Coree Creek, Brindabella National Park, 30km W Canberra	Wet tussock swamp with sphagnum bogs.
Doodle Comer Swamp	Henty township	Shallow basin receiving local runoff
Fivebough Swamp	1km NE Leeton	Shallow fresh-brackish basin
Lowbidgee Floodplain	Between Maude and Balranald	Large floodplain of effluent creeks, swamps and lakes
Lower Mirrool Creek Floodplain	Mirrool Creek, 30km NE Griffith	Creek system and floodplain wetlands including Narrabri Swamp and Berangerine Swamp)
Micalong Swamp	Micalong Creek, 29km E Tumut	Large montane peat swamp dominated by sedges
Mid-Murrumbidgee Wetlands	Murrumbidgee River between Narrandera and Carathool	Series of lagoons with river red gum forest
Monaro Lakes	Monaro tablelands 28km N Cooma to 15km S Bombala	Series of ephemeral to permanent upland lakes and swamps (some outside Murrumbidgee catchment)
Snowy Flats	Snowy Flats Creek, 6km SW Corin Dam in Canberra	Mosaic of sphagnum bogs, wet heath, herbfields, and sedgelands
Tomneys Plain	Tomneys Plain Creek, 21km NE Tumbarumba	Upland peat swamp dominated by Sphagnum hummocks
Tuckerbil Swamp	Leeton	Brackish depression surrounded by saline mudflats
Yaouk Swamp	Yaouk Creek, Scabby Range Nature Reserve 60km NW Cooma	Upland peat swamp dominated by tussock grass

4.4 Significant biodiversity

The aquatic and terrestrial environments of the Murrumbidgee catchment provide habitat for a large number of significant species and ecological communities that are listed under the *Threatened Species Conservation Act 1995*.

Eighty threatened animal species are found within the Murrumbidgee catchment, 20 of which are considered endangered. This includes eight species of frogs, seven bats, 43 birds, eight reptiles and eight marsupials. Many of these species are reliant on the riverine forests, woodlands and wetland habitats associated with the Murrumbidgee River. There are 54 threatened plant species, of which 29 are considered endangered.

There are five endangered ecological communities. Most extensive in the Murrumbidgee is the inland grey box woodlands that occur on the riverine plains, and the box-gum woodlands (comprising a mix of white box, yellow box and Blakely's red gum) that occur on the lower slopes and plains. Due to their location on fertile soils, both of these woodland communities have been extensively cleared. Remnants tend to be fragmented or isolated, and a full range of flora and fauna species is rare.

Several fish species that previously occurred in the Murrumbidgee River are listed as threatened under the *NSW Fisheries Management Act 1994* (Table 3). Some of these have not been found in recent surveys and are thought to be locally extinct within the Murrumbidgee River (Murray hardyhead, river snail, olive perchlet, and southern pygmy perch). Breeding and restocking programs are in place for trout cod, purple-spotted gudgeon, silver perch and Murray cod within the Murrumbidgee River and its storages.

The lower Murray River aquatic ecological community includes all natural creeks, rivers, and associated lagoons, billabongs and lakes of the regulated portions of the Murray River below Hume Weir, the Murrumbidgee River below Burrinjuck Dam, and the Tumut River below Blowering Dam. These lowland environments typically have meandering channels and wide floodplains, and provide a range of aquatic habitats including pools, riffles, billabongs, snags and aquatic plants. The ecological community includes all native fish and aquatic invertebrates within these river reaches, and includes 23 native fish species and over 400 recorded native invertebrate species.

Table 3: Threatened aquatic species of the Murrumbidgee catchment

Species	Scientific name	NSW Status
Murray hardyhead	*Craterocephalus fluviatilis*	Critically endangered
River snail	*Notopala sublineata*	Endangered
Trout cod	*Maccullochella macquariensis*	Endangered
Macquarie perch	*Macquaria macquariensis*	Endangered
Southern pygmy perch	*Nannoperca australis*	Endangered
Purple spotted gudgeon	*Mogurnda adspersa*	Endangered
Silver perch	*Bidyanus bidyanus*	Vulnerable
Western olive perchlet	*Ambassis agassizii*	Endangered population
Murray-Darling population of eel tailed catfish	*Tandanus tandanus*	Endangered population
Lowland Murray River aquatic ecological community (includes all regulated reaches of the Murrumbidgee below Blowering and Burrinjuck Dams)		Endangered ecological community

5 Surface water

5.1 Burrinjuck and Blowering Dam catchments

The Murrumbidgee River rises on the Monaro Plateau, an area of elevated plains averaging 1,200 metres with occasional peaks of up to 1,800 metres. The river initially flows southeast then turns abruptly north near Cooma and is joined by the Numeralla and Bredbo Rivers. It then swings north-northwest through the ACT before entering Burrunjuck Dam near Yass which has a total catchment area of 13,100 square kilometres. The major tributaries in this reach are the Cotter, Molonglo and Yass Rivers. Another tributary, the Goodradigbee River, drains the rugged area between the Fiery and Brindabella Ranges before flowing north directly into Burrinjuck Dam.

The Tumut River is the largest tributary of the Murrumbidgee, rising in the Snowy Mountains. Blowering Dam is located on the Tumut River just south of Tumut. It has a relatively small catchment area of only 1,630 square kilometres, but in addition to the inflows from its mountainous and largely forested catchment, the dam also receives water from the Snowy Mountains Scheme via a 22 kilometre tunnel from Lake Eucumbene.

5.2 Downstream of the dams to Wagga Wagga

From Burrinjuck Dam, the Murrumbidgee River flows through a rugged narrow gorge and is joined by Jugiong and Muttama Creeks from the north and the Tumut River from the south, before emerging onto the western plains near Gundagai. Flowing west to Wagga Wagga, it is joined by Adelong, Billabong, Hillas, Tarcutta and Kyeamba Creeks.

The major tributaries of the Tumut River below Blowering Dam are Gilmore, Brungle and Adjungbilly Creeks and the Goobarragandra River.

5.3 Wagga Wagga to Balranald

With the exception of Houlaghans Creek, the few remaining tributaries of the Murrumbidgee are small and ephemeral. The Lachlan River enters the Murrumbidgee just upstream of Redbank Weir but its flows very rarely leave the Great Cumbung Swamp at the end of the Lachlan Valley.

This reach of the river is characterised by a diminishing channel capacity due to the deposition of alluvium. Channel capacity drops from 30,000 ML/d at Hay to 7,000 ML/d at Balranald.

A feature along this section of the Murrumbidgee River are a series of seven weirs which provide the head required to supply water into the major irrigation areas, and creek systems such as Yanco Creek and the Lowbidgee (see section 7.1).

Another water management feature is Tombullen Storage, an off-river storage associated with the Coleambally Canal. Tombullen captures flows in excess of operational requirements. Captured water is released to supply private diverters downstream of Gogeldrie Weir. A large proportion of private diversion takes place within this reach of the Murrumbidgee River, especially between Darlington Point and Maude Weir.

5.4 Yanco Creek system

This system consists of a series of creeks including Yanco, Columbo, Billabong and Forest Creeks on the southern side of the Murrumbidgee, and is the longest network of creeks in Australia. Yanco Creek is as an effluent of the Murrumbidgee which leaves the river near Narrandera and flows 800 kilometres south to Morundah then south-west to join Billabong Creek at Conargo. Flows into the Yanco Creek system are regulated by Yanco Weir on the Murrumbidgee River. At Morundah, Tarabah Weir diverts

some water from Yanco Creek into Colombo Creek which flows south-east through open plains to join Billabong Creek upstream of Jerilderie.

Billabong Creek has its own catchment, rising in the Holbrook/Culcairn region and flowing westward until it is joined by regulated flows from Yanco and Colombo Creeks. These flows are regulated by Hartwood Weir which sends water down Forest Creek as far as Warriston Weir, below which the channel becomes choked by cumbungi before entering Wanganella Swamp. Only high flows pass through the swamp and back into Billabong Creek which eventually joins the Edwards River at Moulamein, which then flows to the Murray River.

The Yanco Creek System supplies water to a number of towns including Morundah, Urana, Oaklands, Jerilderie, Conargo, Wanganella and Moulamein, as well as hundreds of private irrigators. The provision of regulated flows through the creek system for over a century has resulted in the development of a diverse agricultural production base of winter cereals and summer crops.

5.5 Lowbidgee District

The Lowbidgee Flood Control and Irrigation District lies at the end of the Murrumbidgee River near its confluence with the Lachlan River. It encompasses approximately 2,000 square kilometres of natural floodplains, which support productive agricultural land and extensive areas of wetland vegetation.

The capacity of the Murrumbidgee River channel decreases significantly downstream of Hay, with flows breaking out in the vicinity of Maude Weir into an extensive system of floodways and lignum swamps associated with the Nimmie and Caira Creek system. Most of the Lowbidgee's agricultural activity occurs in this area. Cultivation of wheat, barley and safflower is carried out in large constructed bays of up to two square kilometres, while the majority of land not used for cropping carries sheep and cattle (Department of Land and Water Conservation 2001a).

With further reduction in channel capacity beyond Maude, there is overbank flooding on both sides of the river into extensive river red gum forests around Redbank Weir. Landuse in this area is predominantly agroforestry and grazing.

Controlled diversions to Lowbidgee floodplain have been enhanced by the construction of spreader banks throughout the district. This has resulted in alterations to natural flow patterns, with greater areas of inundation and the creation of concentrated wetland areas upstream of the banks. Over time these wetland areas have become significant rookery sites for numerous species of birds, particularly ibis and egrets (Department of Land and Water Conservation 2001a).

Billabong Creek at Jerilderie

5.6 Stream flow

There are approximately 100 active river gauges within the Murrumbidgee catchment recording flows on a continuous basis. Table 4 shows mean daily flows for some key locations throughout the catchment. The figures demonstrate the decreasing channel capacity of the Murrumbidgee River downstream at Hay and Balranald, with mean daily flows decreasing from approximately 9000–10,000 ML/d in the mid-Murrumbidgee to less than 4,000 ML/d below Hay. The Goodradigbee River, with its origins in the alpine areas, is a high yielding tributary to Burrinjuck Dam, with the mean daily flow being four times that of the Yass River (originating from the drier tablelands) despite similar catchment areas.

Many of the gauges located at major towns along the river have been established since the 1880s, including the gauge at Wagga Wagga. Although influenced by the regulation effects of upstream dams since 1928, long term flows at Wagga Wagga provide an insight into how runoff patterns in the Murrumbidgee have varied over time.

The average annual flow at Wagga Wagga is 3,890,000 megalitres. Since 2000 flows have been trending well below the long term mean, with 2008 being one of the lowest years on record (Figure 8). Figure 8 also highlights the dry conditions that existed at the beginning of the 1900s, with the majority of years between 1895 and 1915 being below the long term mean. A similar pattern can be seen in the 1930s and 1940s.

Daily streamflows provide an indication of the variability of flow patterns and the peak height of flood events. There have been several large flood events in Wagga, the largest of these being in 1891, 1925, the 1950s and 1974 (Figure 9).

The cumulative variation from mean curve (Figure 9) provides significant insight into long term streamflow trends. The plot is produced by calculating variations from the long-term mean. It can be interpreted according to the following rules (Burrell and Ribbons 2006):

- Where the slope of the curve is rising the flow exceeds the long term average, indicating wetter periods
- Where the slope of the curve is falling the flow is less than the long term average, indicating generally drier periods
- Relative magnitude can be determined by the steepness of the slope and the y-axis of the plot
- The x-axis represents time in years

The curve shows that the early half of the century was generally dry with long periods of below average flow. A significant shift towards a wet climate occurred in the 1950s which continued up to the late 1990s. Post 2000, the sequence trends back to a dry regime, however this sequence is not yet as prolonged as the big dry in the early half of the century.

Table 4: Mean daily flow for Murrumbidgee gauge sites

Gauge site	Catchment area (km^2)	Mean daily flow (ML)	Period of record
Murrumbidgee River at Gundagai	21,100	9,812	01/07/1886-01/12/2009
Murrumbidgee River at Wagga Wagga	26,400	10,326	01/01/1885-01/12/2009
Murrumbidgee River at Narrandera	34,200	9,039	02/05/1891-01/12/2009
Murrumbidgee River d/s Hay Weir	56,800	3,887	01/01/1981-01/12/2009
Murrumbidgee River d/s Balranald	166,000	2,344	28/02/1979-01/12/2009
Yass River at Yass	1,230	211	24/08/1915-01/12/2009
Tumut River at Tumut*	2,540	4,246	01/11/1900-01/12/2009
Goodradigbee River at Wee Jasper	1,165	828	19/09/1914-01/12/2009
Yanco Creek at Morundah	-	439	13/07/1912-01/12/2009
Colombo Creek at Morundah	-	395	01/01/1978-01/12/2009
Billabong Creek at Conargo	-	744	01/01/1913-01/12/2009
Forest Creek at Warriston Weir	-	174	01/09/1980-01/12/2009

**Subject to transfers from Snowy Mountains Scheme*

Figure 8: Annual stream flow in the Murrumbidgee River at Wagga Wagga

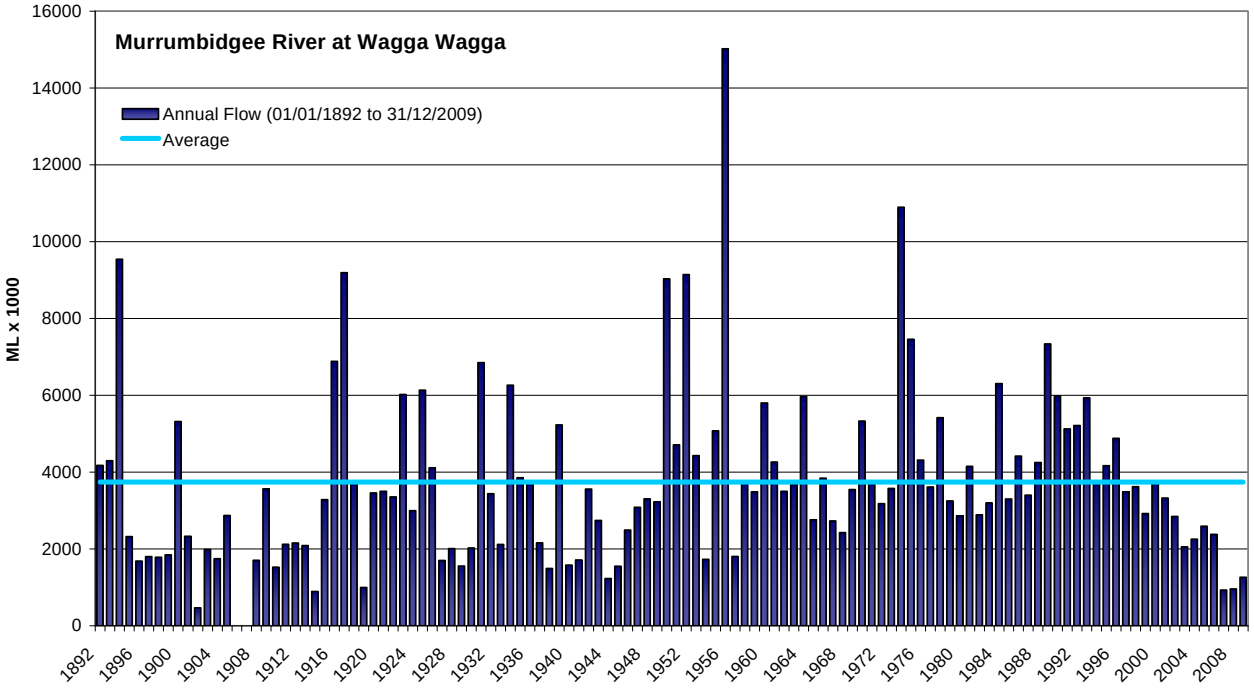
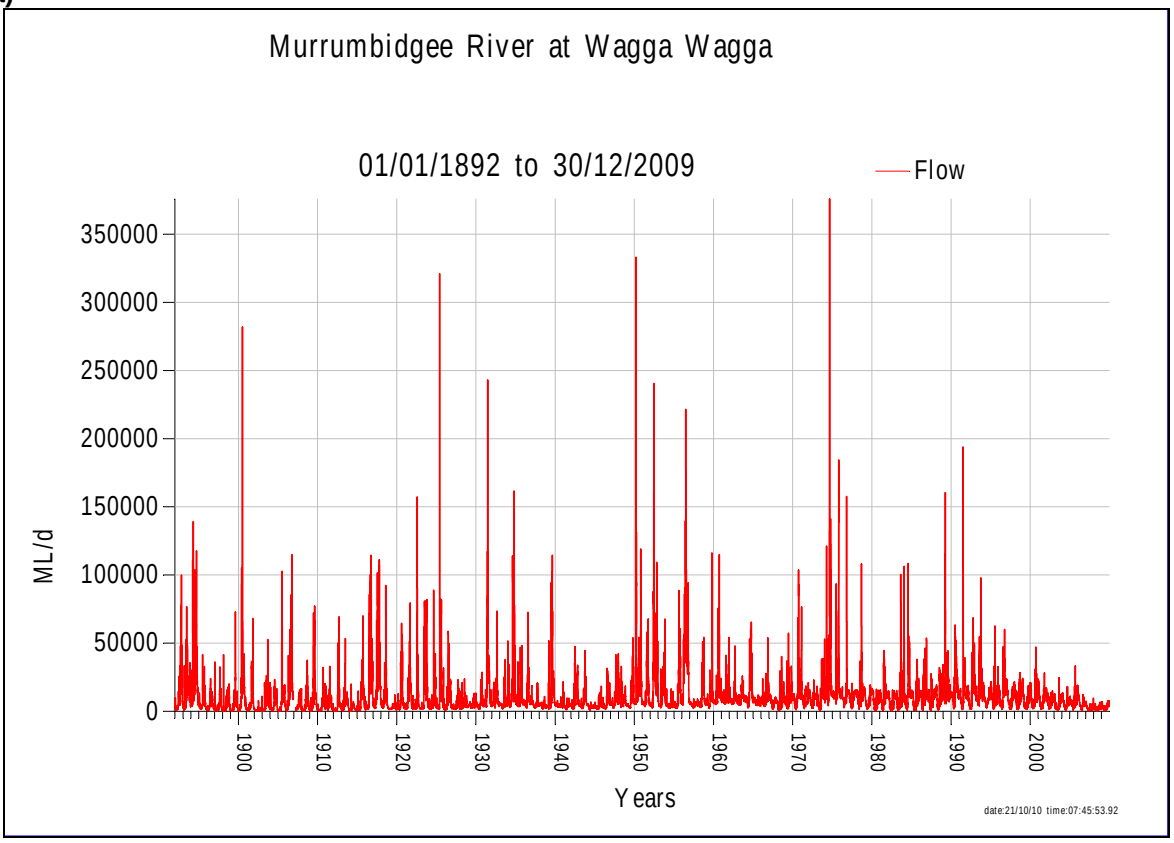
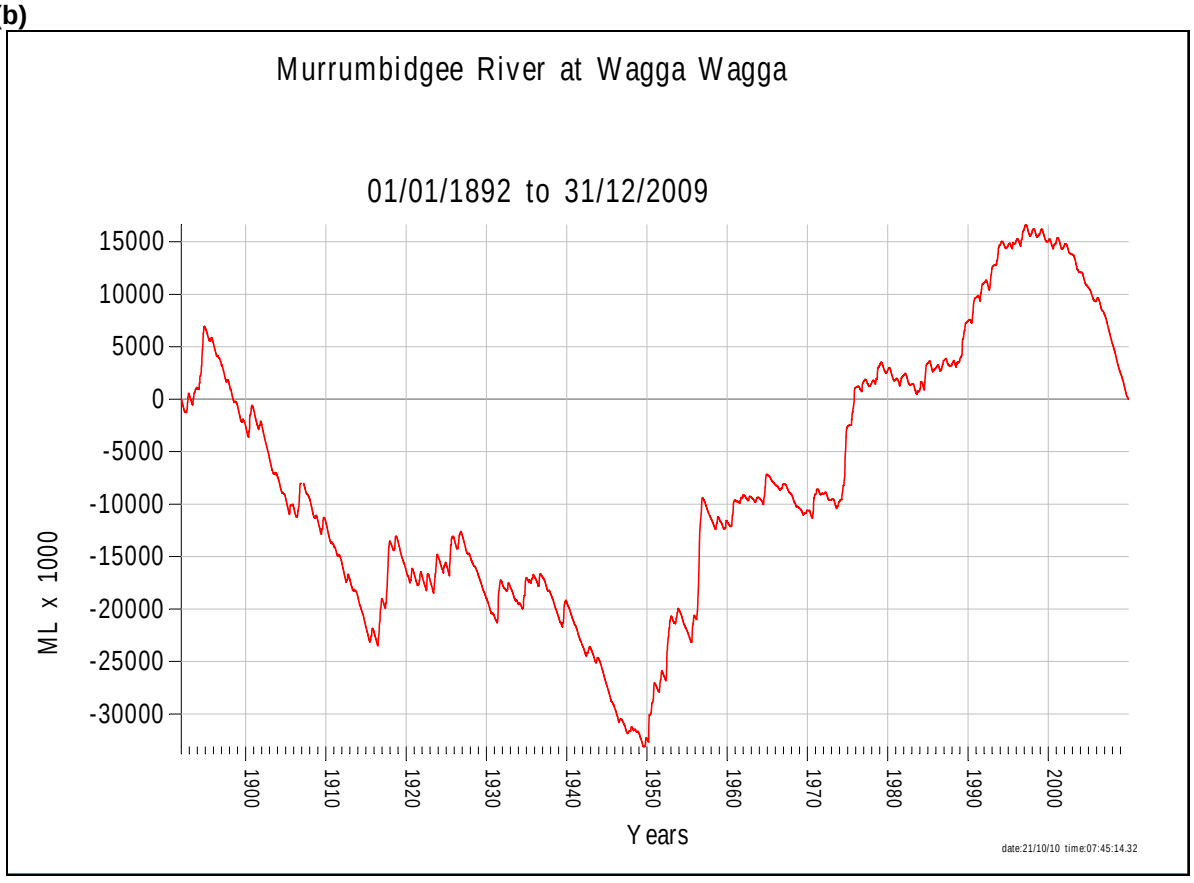


Figure 9: (a) Long term daily flow at Wagga Wagga and (b) Cumulative difference from mean

(a)



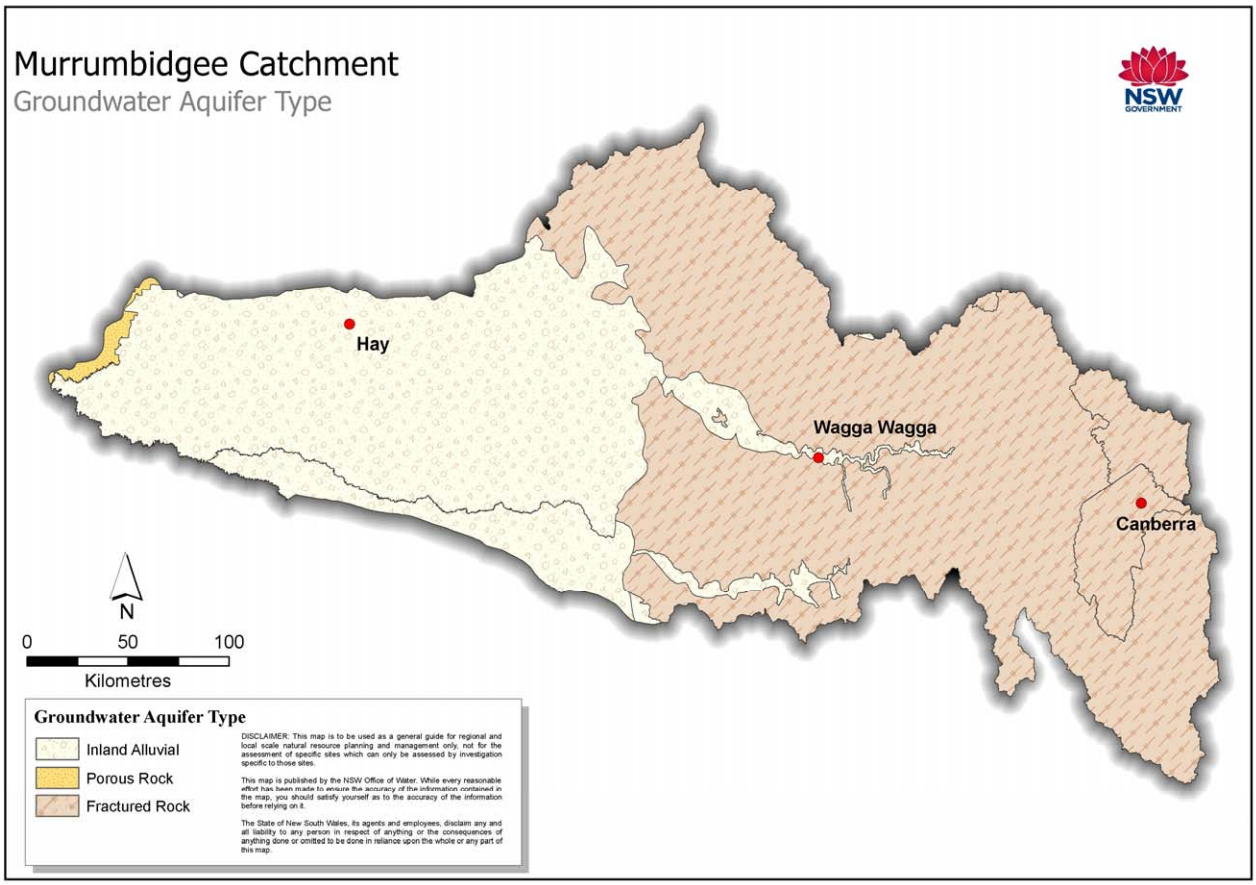
(b)



6 Groundwater

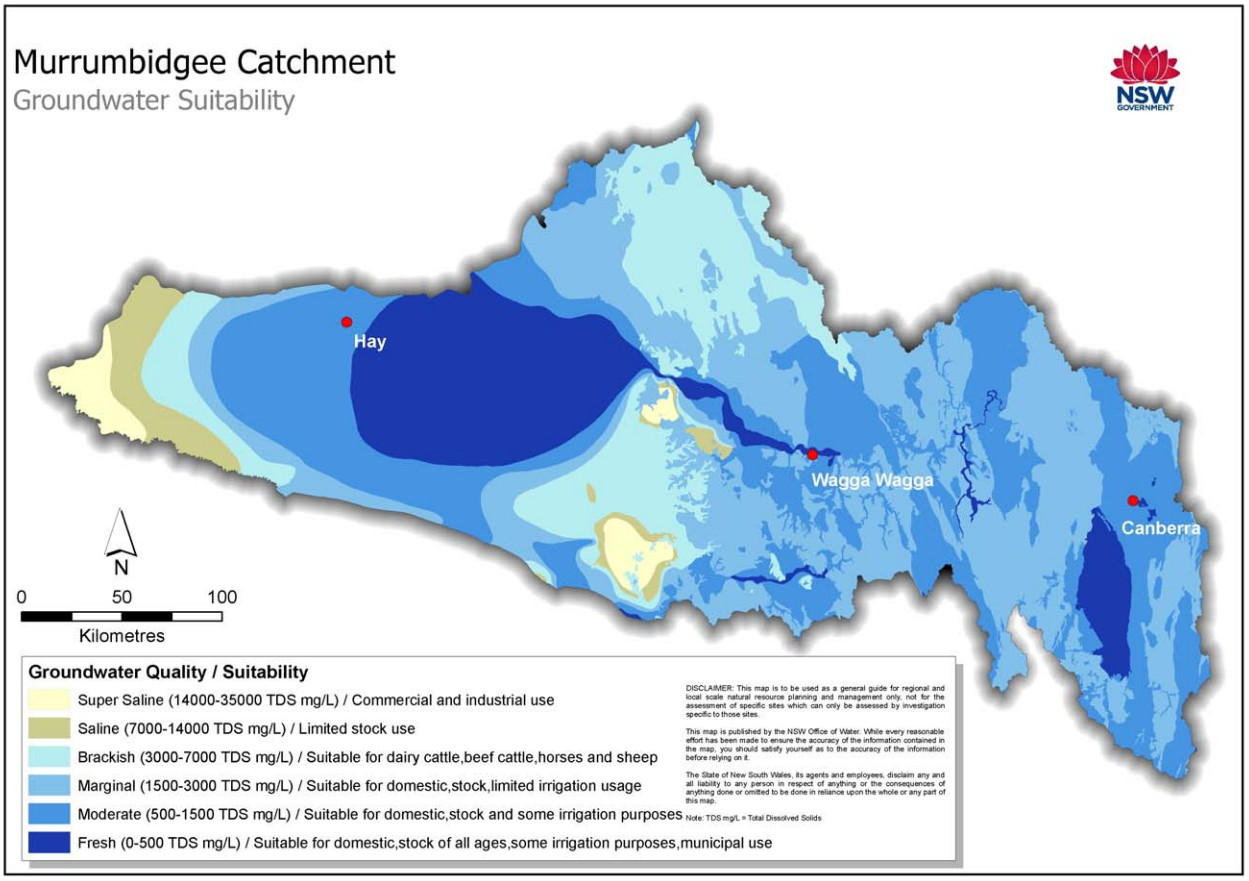
Groundwater is an important source of water for industry and agriculture in the Murrumbidgee catchment. The groundwater and surface water systems in the catchment have a range of connectivity which vary from being highly connected, with the relationship changing seasonally, to longer term variations or permanently disconnected. The interaction is influenced by surface and groundwater use, climate and flood frequency, significance and duration. Most upland streams in the catchment are hydraulically connected, receiving flow from fractured rock aquifers (Figure 10).

Figure 10: Major aquifer types of the Murrumbidgee catchment



Use of groundwater varies across the catchment and is controlled somewhat by the quality and volumes of water available for extraction. Based on drill logging reports, the water in the aquifers of the mid and lower alluvial areas, which is where the majority of licensed entitlement is located, is predominantly fresh, and is suitable for most purposes including irrigation. As a general trend water quality deteriorates from brackish to super saline water westward from Hay and also south of Narrandera (Figure 11). The classification in Figure 11 is based on the maximum concentration of salts for the intended purpose. It provides a general guide for suitability of water for a particular purpose but this may vary according to plant or stock type, the nature and concentration of salt content, climate, duration of use and need (Department of Land and Water Conservation 2001b).

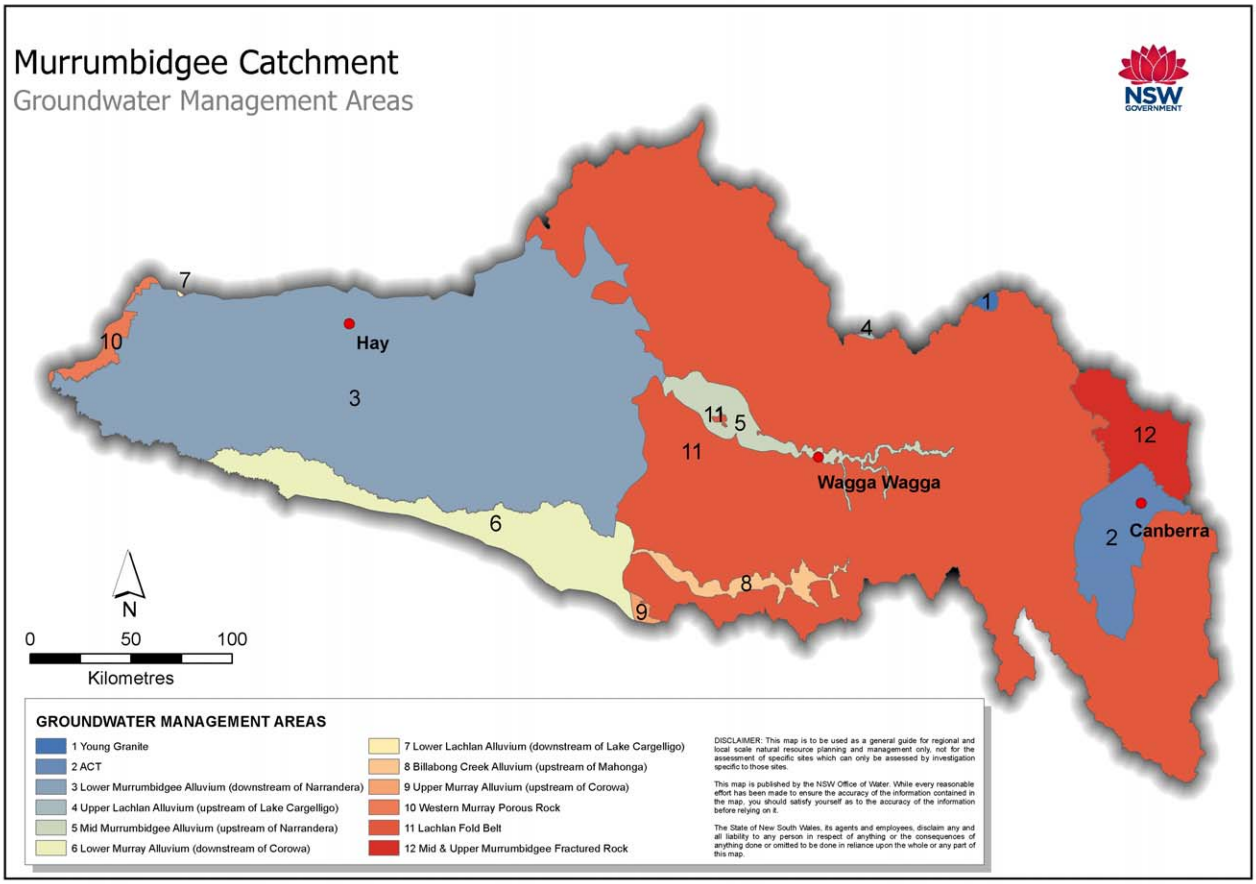
Figure 11: Groundwater quality and suitability



Groundwater management within NSW and the Murrumbidgee catchment is implemented across Groundwater Management Areas (GMA). Figure 12 shows the major Groundwater Management Areas that align with the Murrumbidgee surface water catchment. Of the seven management areas, the Mid Murrumbidgee, and Lower Murrumbidgee contain close to 90 per cent of the total groundwater entitlement for the valley.

In the Mid Murrumbidgee GMA which begins at the foothills of the ranges, narrow floodplains overlying bedrock and relatively high rainfall produce shallow alluvial water tables and strong hydraulic connections between river and aquifer. The direction of flux can vary over time. Water lost from the Murrumbidgee River during floods and periods of high-regulated flow will recharge the aquifer, which may then drain back to the river when the flow is lower. The area gains significant quantities of water from the aquifer for many months following major flood events.

Figure 12: Groundwater Management Areas of the Murrumbidgee catchment



The Mid Murrumbidgee GMA has a long term average extraction limit of 89,000 ML/yr with the share component being approximately 82,500 ML/yr. However, as at the time of this report the historical level of usage has remained much lower at less than 50 percent of the share component. Close to half of all groundwater extraction is for town water supply from bore fields located in close proximity to Wagga Wagga (Department of Water and Energy 2009a).

Within the Lower Murrumbidgee GMA (beginning at Narrandera in the east and extending to the confluence of the Murrumbidgee and Murray Rivers in the west), the basin contains three main regional aquifers that have a maximum combined thickness, in the east, of about 170 metres and about 400 metres at the western extent. The shallowest and least productive of these is the Shepparton Formation. The most significant supplies come from the underlying Calivil Formation and, to a lesser extent, the Renmark Group. The volume of water stored in the Lower Murrumbidgee aquifer system is estimated to be approximately 1.96×10^9 megalitres although much of this water is too saline for productive purposes. The volume of low-salinity groundwater, which occurs predominantly in the eastern part of the GMA is estimated to be 2.8×10^8 megalitres (NSW Office of Water 2009). The lower Murrumbidgee GMA is managed under the *Water Sharing Plan for the Lower Murrumbidgee Groundwater Sources 2003*.

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7 River operations and management

7.1 Major storages and regulating structures

The two largest storages in the Murrumbidgee catchment are Burrinjuck and Blowering Dams (see Table 5). Burrinjuck was completed in 1928 and later enlarged in 1957 to store and regulate water for irrigation and the generation of hydropower. Blowering Dam, on the Tumut River, was completed in 1968, and is the main receiving storage for the transfer of water into the Murrumbidgee from the Snowy Mountains Scheme. Burrinjuck and Blowering Dams are both operated by State Water Corporation.

Burrinjuck Dam

Talbingo Dam is located in the upper reaches of the Tumut River and is the largest dam in the Snowy Mountains Scheme. Water released from Talbingo Dam is used to generate hydroelectricity through the Tumut 3 Power Station before it continues into Blowering Dam. Tantangara Dam, a small dam in the upper catchment of the Murrumbidgee River, is also used by Snowy Hydro Limited for generating hydropower.

Googong Dam on the Queanbeyan River was completed in 1971 to provide town water supplies for Canberra. It is managed by ActewAGL, the ACT's energy and water provider.

A series of seven weirs on the Murrumbidgee River between Wagga Wagga and Balranald provide the head needed to supply major irrigation areas. These are:

- Berembed Weir, 60 kilometres downstream of Wagga Wagga, which supplies the MIA's Main Canal (capacity: 6,700 ML/d)
- Yanco Weir, about 15 kilometres downstream of Narrandera, which controls flows into the Yanco Creek system (capacity: 1,400 ML/d)
- Gogeldrie Weir, about 30 kilometres further downstream, which controls flows into the MIA's Sturt Canal and the Coleambally Canal that supplies the Colleambally Irrigation Area and helps fill the Tombullen off-river storage
- Hay Weir, which buffers downstream users against problems with the timing of supply (water can take up to 30 days to reach Hay from the headwater storages)
- Maude Weir, which facilitates flows into Lowbidgee's Nimmie-Caira Creek system
- Redbank Weir, which facilitates flows into the Redbank Forest system via five regulators
- Balranald Weir, about 30 kilometres upstream of the confluence with the Murray River.

Table 5: Major storage summary

	Burrinjuck	Blowering	Talbingo	Tantangara	Googong
River	Murrumbidgee	Tumut	Tumut	Murrumbidgee	Queanbeyan
Capacity	1,026,000 ML	1,628,000 ML	920,550 ML	254,080 ML	125,000 ML
Purpose	Irrigation, Hydropower	Irrigation, Hydropower	Hydropower	Hydropower	Town Water
Nearest Town	Yass	Tumut	Talbingo	Cooma	Queanbeyan

7.2 Irrigation areas

Murrumbidgee Irrigation Area

The Murrumbidgee Irrigation Area occupies an area of approximately 3,624 square kilometres on the northern side of the Murrumbidgee River downstream of Narrandera. Established in 1912 as a government irrigation scheme it is now privately owned and operated by Murrumbidgee Irrigation. It is fed by two canals receiving diverted water from the river – the Main Canal and the Sturt Canal. The Main Canal receives water diverted at Berembed Weir to serve the Yanco, Leeton and Griffith areas and can accommodate flows of up to 6,500 ML/day while the Sturt Canal receives water diverted at Gogeldrie Weir to supply the Whitton and Benerembah areas, and can accommodate flows of up to 1,700 ML/day.

Excess flows from much of the channel system escape to Mirrool Creek, where they can be pumped by irrigators, diverted back into the channel system or stored in Barren Box Swamp. Virtually all drainage escape flows are directed to Barren Box Swamp to support operational water demands, except for a few which return to the Murrumbidgee River. Barren Box Swamp is used as an on-line storage primarily to provide capacity to supply irrigation, stock and domestic users further to the west in the Wah Wah Irrigation District.

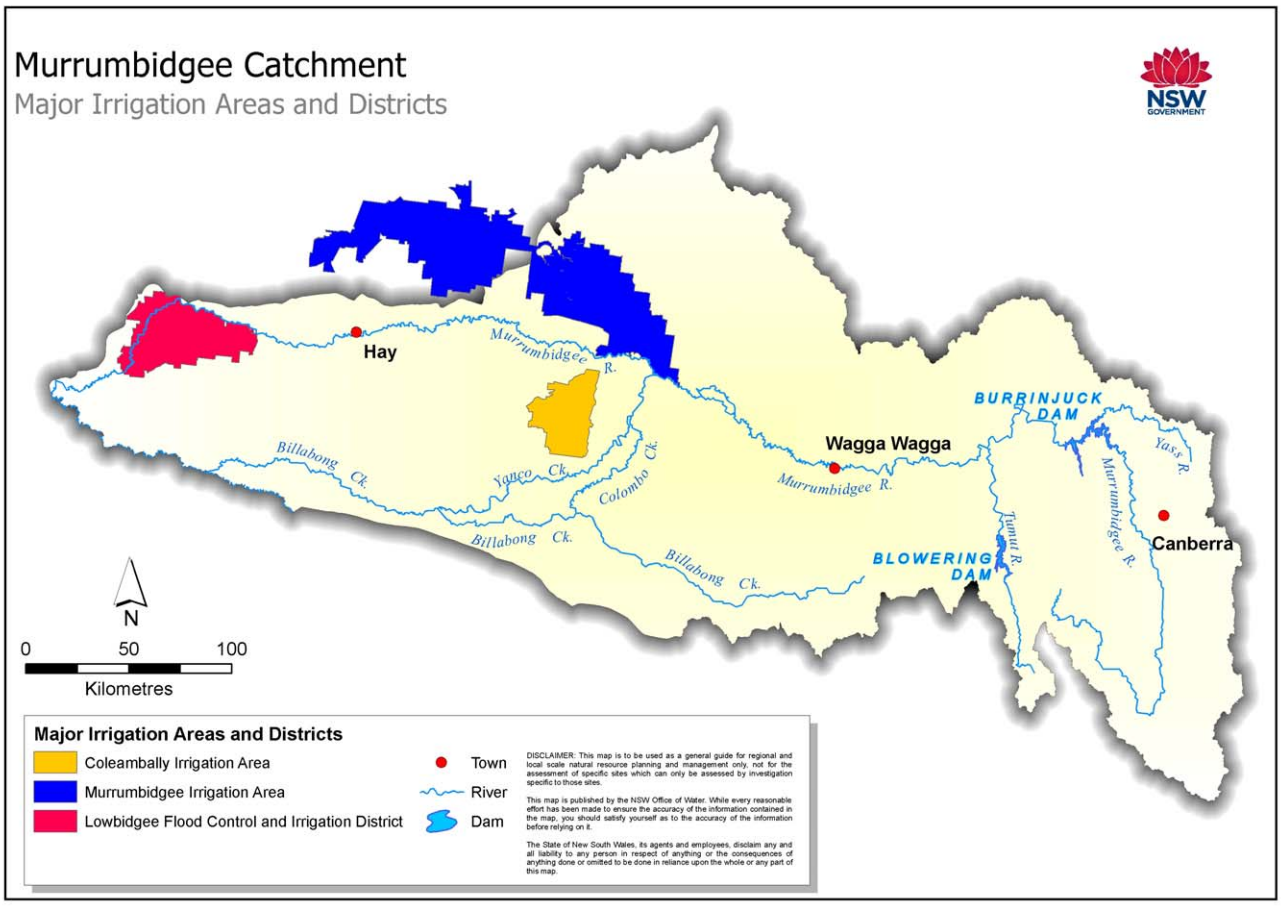
Coleambally Irrigation Area

Coleambally covers an area of over 790 square kilometres on the southern side of the Murrumbidgee River. Originally established as a government scheme in 1960, it is now privately owned and managed by Coleambally Irrigation Corporation which supplies water to irrigators in the Kerabury region and the western Outfall Drain. Water is diverted to the irrigation area from the river through 41 kilometres of main canal and 477 kilometres of supply channels. It is drained by three major drainage channels covering some 734 kilometres: the Coleambally Outfall Drain which heads west to join Billabong Creek just upstream of Darlot; DC800 which heads south to join Yanco Creek; and the Catchment Drain which heads in east to join Yanco Creek. All three drains, but primarily the DC800 and the Catchment Drain, are used by State Water Corporation as supply channels for the water users within NSW Office of Water's area of operation.

Lowbidgee Flood Control and Irrigation District

The Lowbidgee Flood Control and Irrigation District was established in 1945 with the purpose of providing landholders with flood irrigation for pastures on the lower Murrumbidgee. It covers an area of around 1,400 square kilometres including 380 square kilometres of irrigated lands. Approximately 50 properties are included in the scheme which relies on surplus flows delivered from the Murrumbidgee River via Maude and Redbank Weirs.

Figure 13: Major irrigation areas and districts of the Murrumbidgee catchment

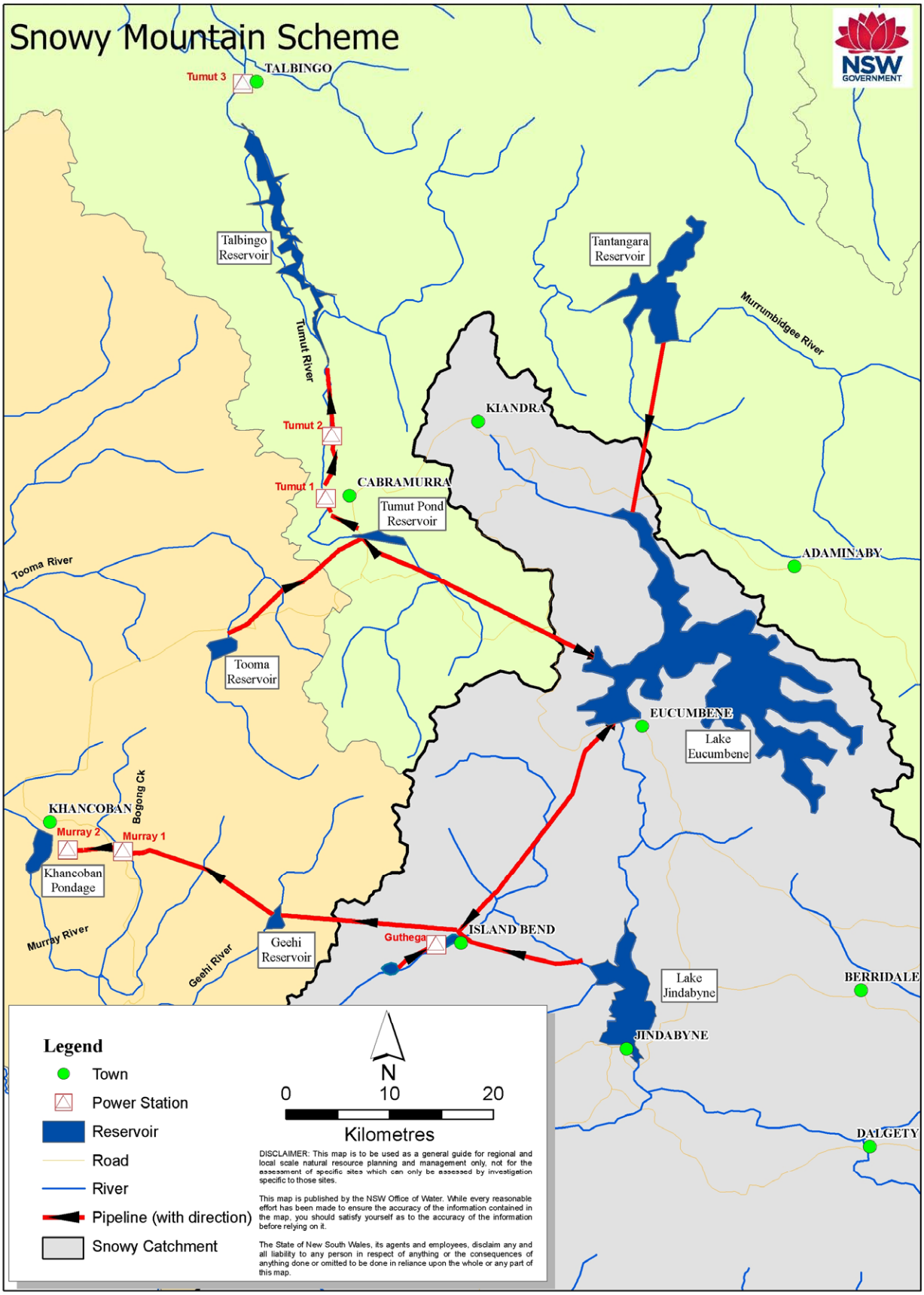


7.3 Snowy Mountains Scheme

The Snowy Mountains Scheme was constructed to impound flows from the major rivers of the Snowy Mountains (which naturally flowed south towards the Victorian coast) and redirect these flows inland via large tunnels through the Snowy Mountains into the western flowing Murray and Murrumbidgee Rivers. In passing through the trans-mountain tunnels and shafts the collected waters fall 750 metres, generating large quantities of hydro-electric power. The water can then be used for irrigation purposes in the Murray and Murrumbidgee valleys.

The Snowy Mountains Scheme consists of two main hydropower developments, these being the Tumut Development and the Murray Development. These are described in more detail below and their connectivity can be seen in Figure 14.

Figure 14: The Snowy Mountains Scheme showing Snowy-Murrumbidgee-Murray connections



The Tumut Development involves the diversion of the Eucumbene, upper Murrumbidgee and Tooma Rivers to the Tumut River, and for the combined waters of these four rivers to generate electricity in four hydropower stations – Tumut 1, Tumut 2, Tumut 3 and Blowering. Water is subsequently released from Blowering Dam to the Tumut River and onto the Murrumbidgee River. The total installed capacity in the four hydropower stations is 2,180,000 kilowatts. The gravity fed main trans-mountain tunnel from Eucumbene Dam to Tumut Ponds can also be used to pump water from Tumut Ponds back to the Eucumbene River if needed in times of high flows in the Tumut River.

The Murray Development involves the diversion of the Snowy River by a trans-mountain tunnel system to the Geehi River and then to the Swampy Plain River via Khancoban Pondage to the Murray River. In passing through the tunnel system electricity is generated in two hydropower stations – Murray 1 and Murray 2. Additional power is generated in Guthega Power Station which makes use of the rapidly falling water of the upper Snowy River on the east side of the Divide before it reaches the main tunnel system. The total installed capacity in the three hydropower stations is 1,560,000 kilowatts (Water Resources Commission 1979).

The other essential part of the Scheme was to utilise the diverted waters of the Snowy River to supplement flows in the inland rivers for the purpose of improved rural production and to minimise the effect of droughts. It was designed to provide approximately one million megalitres of water to the Murray and Murrumbidgee valleys each year through the worst drought on record at the time of design.

It was agreed that Snowy Hydro Limited would provide an annual fixed minimal accountable release, known as the Required Annual Release to the Murray and Murrumbidgee of 1,062,000 megalitres and 1,026,000 megalitres respectively. This release may be adjusted each year for over-release in the previous year, and for water savings in the Murrumbidgee that have been dedicated to Snowy River environmental flows.

7.4 Licensed water use

Surface water

Water management within the Murrumbidgee catchment is quite complex due to its interaction with the Murray and Snowy systems. Adding to the complexity, are multiple classes of licence holders including groundwater users, regulated and unregulated surface water users, and environmental requirements. Detailed information can be found in the gazetted water sharing plans for the Murrumbidgee catchment (see section 7.5). The following is a summary of the major features of the Murrumbidgee regulated system.

The regulated Murrumbidgee Valley operates on an annual accounting system. In annual accounting systems an initial Available Water Determination (AWD) is made at the start of the water year and may increase during the water year. Under annual accounting, balances may be reset to zero at the end of the water year, however in the Murrumbidgee valley there are carry over provisions that allow some of the account water to be carried forward from one water year to the next.

Available water determinations are made by the NSW Office of Water at the start of each water year, and from time to time during the year. An AWD is an announcement of the amount of water available for use in terms of megalitres per share (ML/share). The total number of shares held by a licence holder (as displayed on their access licence) multiplied by the ML/share volume announced determines the volume of water credited to each licensee's account (Department of Water and Energy 2009b).

The *Water Management Act 2000* defines a number of categories of water licence based on the intended use requirements of the licence holder. These categories are assigned different priorities

when the water resources are distributed, with high priority licences being the first to receive water during an AWD. Table 6 lists the current share components and priority for licence categories in the regulated Murrumbidgee River.

Surface water supplementary flows may only be taken by holders of a supplementary category licence. A range of flow triggers outlined in the water sharing plan must occur before a supplementary event is declared and water can be extracted under these licences.

Local water utility licences totalling more than 23,000 megalitres have been issued to meet population requirements throughout the catchment. Some of the towns directly relying on the regulated Murrumbidgee River include Wagga Wagga, Narrandera, Jerilderie, Tumut, Carrathool and Hay (Source: NSW Office of Water Licence Administration System). Since May 2007 water from the unregulated Murrumbidgee River has been used to supplement urban demand in Canberra during the drought conditions (ActewAGL 2009).

Table 6: Murrumbidgee Regulated River share components as at 30 June 2010

Access license category	AWD priority	Total share component (ML)
General Security	Low	1,888,070
High Security	High	356,846
High Security (Aboriginal Culture)	High	500
High Security (Research)	High	320
High Security (Town water Supply)	High	19,769
Murrumbidgee Irrigation Conveyance	Low	243,000
Coleambally Irrigation Conveyance	Low	130,000
Regulated River Conveyance	Low	2,968
Supplementary	Lowest	198,779
Domestic and Stock	Very high	22,266
Domestic and Stock (Domestic)	Very high	261
Domestic and Stock (Stock)	Very high	13,412
Local Water Utility	Very high	23,586

Groundwater

In 2010 the licensed groundwater entitlement in the Murrumbidgee catchment totalled over 410,000 megalitres (Table 7). The Lower Murrumbidgee Groundwater Sharing Plan accounts for 316,728 megalitres, or 77 per cent of this entitlement. The majority of groundwater use is for irrigation and stock use, while town water supplies account for around 28,000 megalitres (seven per cent) of all entitlement within the catchment.

Supplementary licences for groundwater differ to surface water supplementary licences. These were introduced as a way to gradually reduce the share component over the life of the water sharing plan. The volume allowed to be taken under a supplementary groundwater licence is reduced ten per cent each year until the extraction limit is achieved.

Table 7: Murrumbidgee catchment groundwater entitlements (2009–2010)

Licence Category	Entitlement volume (ML)
Lower Murrumbidgee Water Sharing Plan	
	Deep Groundwater Source
Aquifer Access	267,797
Local Water Utility	2,210
Domestic and Stock	324
Supplementary Access	41,196
	Shallow Groundwater Source
Aquifer Access	5,201
Total within WSP area	**316,728**
Areas not managed under a Water Sharing Plan	
Aquaculture	537
Commercial / Industrial / Mining / Dewatering	2,525
Domestic	1347
Drainage / Remediation	11
Farming	129
Feedlot	287
Irrigation	48,537
Recreation	495
Stock	13,711
Town water supply	25,857
Total outside Water Sharing Plan	93,436
Total for catchment	**410,164**

Source: NSW Office of Water Accounting System

7.5 Water sharing plans

A water sharing plan is a legal document prepared under the *Water Management Act 2000*. It establishes rules for sharing water between the environmental needs of the river or aquifer and water users, and also between different types of water users such as town supply, rural domestic supply, stock watering, industry and irrigation.

Water sharing plans provide security for the environment and water users by setting the rules for how water is allocated over a ten year period. This ensures that water is specifically provided for the environment through a legally binding plan, and allows licence holders, such as irrigators who require large amounts of water, to better plan their business activities.

In addition, water sharing plans set rules for water trading, that is, the buying and selling of water licences and also annual water allocations. For most new commercial purposes, water trading remains the only way that water can be obtained as in most areas of NSW all available water is fully allocated.

In NSW a water sharing plan has a lifespan of ten years. The purpose of a water sharing plan is:

- to protect the fundamental environmental health of the water source
- to ensure that the water source is sustainable in the long-term
- to provide water users with a clear picture of when and how water will be available for extraction.

Surface water sharing plans

There are four surface water sharing plans that have been gazetted within the Murrumbidgee catchment. All four plans commenced in July 2004.

The **Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2003** covers some 1,200 kilometres of regulated rivers and creeks below Burrinjuck and Blowering Dams, including the Yanco-Billabong Creek system. The Lowbidgee Flood Control and Irrigation District is excluded, however the plan includes rules regarding when flows may be diverted into the system and the volume of those diversions.

Environmental flow rules were developed for the Murrumbidgee in 1998, and were designed to enhance flow variability, protect low flows, and provide contingent environmental water releases. These rules were amended with the aim of enhancing environmental benefits and incorporated into the regulated water sharing plan. These environmental benefits are delivered via the following environmental provisions:

Daily environmental releases – water released from Blowering and Burrinjuck Dam to deliver environmental benefits downstream of the storages. It is derived daily based on rules outlined in the water sharing plan. These releases are not additional to daily demand but form part of it.

Dam transparency – rules to protect low flows in the river reach immediately downstream of Burrinjuck and Blowering Dams. Transparency rules pass on all inflows entering storage up to a defined limit, being 615 ML/d at Burrinjuck Dam; and 560 ML/d at Blowering Dam.

Dam translucency - ensures that some degree of natural flow variability is restored downstream of Burrinjuck Dam. The translucency rule aims to release a proportion of inflows to Burrinjuck Dam depending on the time of year and the catchment conditions. The proportion of inflows released is based on natural catchment conditions as indicated by flow in the Goodradigbee River (the most natural of the three rivers flowing into Burrinjuck Dam). Translucent releases only occur between 22 April and 21 October when, on average, more water is stored in Burrinjuck than is released.

End of system flows - maintains a flow of water to the end of the Murrumbidgee River ensuring its connectivity with the Murray River. The flow rules provide for a flow of 300 ML/d past Balranald when allocation is at or greater than 80 per cent; and a flow of 200 ML/d past Balranald when allocation is less than 80 per cent.

Environmental water allowances - three water allowances were created to provide direct benefits to the environment. The water is for discretionary environmental management such as wetland inundation, flushes to improve water quality, or providing habitat for waterbird breeding.

Provisional storage volumes – two provisional storage volumes are provided for, to increase the size and frequency of spill events for environmental benefits, and to increase water availability in the following seasons. The provisional storage accounts allow water to be set aside in wet years for future environmental requirements and to reduce the volatility in allocations.

Daily release balance - this account maintains a record of the net difference between the minimum transparent dam release and the water credited to environmental water accounts. The account is credited with the volume of transparent release in excess of 300 ML/day. The daily release balance is calculated as a continuous account.

Under extreme conditions the Minister may suspend the plan. This occurred in November 2006 as a result of the extreme drought that prevailed from 2002 to 2010. However, even with the suspension of

the plan every effort was made to operate in accordance with the plans where feasible. The plan will be reinstated at the Minister's discretion when climatic conditions allow.

There are currently three unregulated river water sharing plans in the Murrumbidgee catchment.

- The **Water Sharing Plan for the Adelong Creek Water Source 2003** covers Adelong Creek and its tributaries, an unregulated catchment that enters the Murrumbidgee River downstream of Gundagai.
- The **Water Sharing Plan for the Tarcutta Creek Water Source 2003** covers the unregulated catchment of Tarcutta Creek which enters the Murrumbidgee River at Borambola, upstream of Wagga Wagga.
- The **Water Sharing Plan for Upper Billabong Creek Water Source 2003** covers the unregulated headwaters of Billabong Creek upstream of Yarra Yarra Creek near Holbrook.

All of these water sources are considered to be highly stressed with a high potential demand for water compared to the available flow. The unregulated plans define various flow classes and extraction limits within these classes, and include cease to pump conditions to protect environmental health during low flow periods.

A copy of the above plans and summary guides can be obtained from www.water.nsw.gov.au

Groundwater sharing plans

There is currently one groundwater sharing plan operating in the Murrumbidgee catchment. The gazetted Lower Murrumbidgee Groundwater Sharing Plan commenced on 1 October 2006 and will cease on 30 June 2017. The plan applies to all water within the Shepparton, Calivil and Renmark unconsolidated alluvial aquifers within the defined water sources (Lower Murrumbidgee Shallow Groundwater Source, and Lower Murrumbidgee Deep Groundwater Source).

The plan:

- shares groundwater sustainably and equitably between users and the environment
- provides for basic landholder rights and priorities of water use
- protects groundwater quality
- maximises the social, economic and environmental benefits of groundwater management strategies
- minimise the negative social and economic impacts of groundwater management strategies

The plan provides access for four different licence categories as shown in Table 7. Access to supplementary water will be reduced by 10 per cent per share component per year until July 2015 when all supplementary access will be cancelled. The plan also sets extraction limits for each Groundwater Source.

Further information and a copy of the plan can be obtained from www.water.nsw.gov.au

Plans in preparation

A number of groundwater sharing plans were in preparation at the time of writing. Two of those that will apply to the Murrumbidgee catchment are:

- The **Draft Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Water Sources** will manage access to groundwater sources of the Murrumbidgee related to the fractured rocks of the Lachlan Fold Belt and Young Granite.
- The **Draft Water Sharing Plan for the NSW Murray-Darling Basin Porous Rock Groundwater Sources** will cover water sources within the Murrumbidgee catchment that are associated with the porous rocks of the Oakland Basin and Western Murray Basin.

These plans were placed on public exhibition in December 2010 and are expected to be finalised in 2011.

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