Department of Primary Industries
Office of Water

Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources

Background document

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1.0 Introduction

Water sharing plans are being progressively developed for rivers and groundwater systems across New South Wales following the introduction of the *Water Management Act 2000*. These plans protect the health of our rivers and groundwater while also providing water users with perpetual access licences, equitable conditions, and increased opportunities to trade water through separation of land and water. In July 2004, 31 plans commenced in NSW, bringing these water sources and some 80 percent of water extracted in NSW under the management and licensing provisions of the *Water Management Act 2000*.

In recent years, plans for the unregulated[1] rivers and groundwater systems have been completed using a 'macro' or broader scale river catchment or aquifer system approach. Approximately 95 percent of the water extracted in NSW is now covered by the *Water Management Act 2000.* The macro planning process is designed to develop water sharing plans covering most of the remaining water sources across NSW. Each macro plan covers a large river basin rather than a single subcatchment, or in the case of groundwater systems, cover a particular type of aquifer (for example fractured rock). These river basin or aquifer macro plans will generally apply to catchments or aquifers where there is less intensive water use.

The *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources* covers both the Barwon-Darling unregulated river water source and the Upper Darling Alluvial groundwater source (refer Appendix 1).

Water sharing rules that the plan focuses on are:

- environmental water rules – the share of the water reserved for the environment
- long-term average annual extraction limits – a growth-in-use assessment and management tool
- access rules – which determine when extraction is allowed (for example above a set river flow rate)
- dealing rules – which control the trade of water, both the transfer of share components of an access licence and assignment of water allocation between access licences, as well as changing the location for water extraction.

In developing environmental water rules, access rules and dealing rules, other water management rules are considered, including:

- rules for granting access licences – what types of licences may be granted
- rules for granting works approvals – what types of rules are required to mitigate impacts

This document provides background to the development of the rules in the plan and includes:

- the purpose of the statutory plan
- a physical description of the Barwon-Darling catchment including land and water use
- the process of plan development including scope, history and basis for decisions
- the relationship between the plan and the Basin Plan
- the use of adaptive management
- the activities associated with implementation, monitoring and review of the plan.

[1] The supply of water in unregulated rivers is typically not controlled by releases of water from dams but rather is dependent solely on rainfall and natural river flows.

The objectives of the plan are to:

- protect, preserve, maintain and enhance the important water dependent ecosystems, Aboriginal cultural and heritage values
- protect basic landholder rights
- manage the water sources to ensure equitable sharing between users
- provide opportunities for market based trading of licences and water allocations
- provide flexibility for licensed water users in how they can use their water
- contribute to the maintenance of water quality
- recognise the connectivity between surface water and groundwater
- allow for adaptive management, that is, to allow changes to the plan to be made as a result of more information that will become available during the life of the plan
- contribute to the environmental and other public benefit outcomes identified under the National Water Initiative.

Note. Socio-economic impacts were a major consideration in the development of the rules in the plan and are reflected in the objective to 'manage the water sources to ensure equitable sharing between users'.

This document is part of a range of material available specifically on the plan including:

- *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources* – a legal instrument written in its required statutory format
- *Water sharing plans – Inland unregulated and alluvial water sources – Overview* – a plain English version of the plan explaining the key sections and rules
- rules summary sheets for each water source detailing the proposed management rules.

In addition, general information on the macro planning process is available in the water sharing plans section of the NSW Office of Water website www.water.nsw.gov.au. Information available for download or viewing includes *Macro water sharing plans – the approach for groundwater. A report to assist community consultation* which explains the method used to classify and set water sharing rules for groundwater across the state.

2.0 Purpose of the plan

2.1 Why are water sharing plans being prepared?

Expansion of water extraction across NSW in the 20th century has placed most valleys at or close to the limit of sustainable water extraction. This has seen increasing competition between water users (towns, farmers, industries and irrigators) for access to water. This has also placed pressure on the health and biological diversity of our rivers and aquifers.

Plans provide a legal basis for sharing water between the environment and consumptive purposes. Under the *Water Management Act 2000*, the sharing of water must protect the water source and its dependent ecosystems and must protect basic landholder rights. Sharing or extraction of water under any other right must not prejudice these rights. Therefore, sharing water to licensed water users is effectively the next priority for water sharing. Among licensed water users, priority is given to water utilities and licensed domestic and stock use, ahead of commercial purposes such as irrigation and other industries.

Plans also recognise the economic benefits that commercial users such as irrigation and industry can bring to a region. Upon commencement, access licences held under the *Water Act 1912* (WA 1912) are converted to access licences under the *Water Management Act 2000* and land and water rights are separated. This facilitates the trade of access licences and can encourage more efficient use of water resources. It also allows new industries to develop as water can move to its highest value use.

In conjunction with the *Water Management Act 2000*, plans also set rules so that commercial users can also continue to operate productively. In general, commercial licences under the *Water Management Act 2000* are granted in perpetuity, providing greater commercial security of water access entitlements. Plans also define the access rules for commercial users for ten years providing all users with greater certainty regarding sharing arrangements.

2.2 Benefits for water users

With the introduction of the plan, a number of benefits will flow to water users including:

- greater certainty – the plan sets out the water sharing arrangements for a ten year period
- clear trading and access rules which will help foster trading
- automatic conversion of licences in the plan area to perpetual water access licences meaning the volumetric water access licences do not have to be renewed, however approvals for the works used to extract water under these access licences will need to be renewed.

The plan recognises the economic benefits to the region that are generated by commercial users such as irrigators and industry. It sets rules so that commercial users can continue to operate productively.

2.3 Environmental considerations

Plans are required to reserve water for the overall health of the river and to protect specific ecosystems that depend on river flows, such as wetlands, lakes, estuaries and floodplains. This share of water reserved for the environment is also intended to sustain the river system's aquatic fauna and flora.

2.3.1 Unregulated river water source

To be healthy and reproduce successfully the plants and animals that live in rivers and streams need floods (very high flows), freshes (high flows) and dry spells (very low flows). The environmental flow rules are designed to ensure the plants and animals in streams continue to experience all these different types of flow events.

In order to protect these flows for the benefit of the environment, the plan establishes five flow classes including; very low, low, A, B and C flows classes.

When the plan commences, all water licences in the unregulated river water source will be subject to the relevant cease-to-pump rules (excluding licences held by town water suppliers, local water utilities and licences used for food safety and essential dairy care[2]).

2.3.2 Alluvial groundwater source

An aquifer is an underground layer of water bearing permeable rock or unconsolidated materials (gravel, sand, silt or clay) from which groundwater can be usefully extracted. Aquifers can store large volumes of water, often accumulated over thousands, or even tens of thousands of years; this is referred to as 'storage'. In the alluvial groundwater source covered by the plan, 100 percent of groundwater storage is reserved as planned environmental water

The volume of water in storage is recharged in a number of ways depending on the type of the groundwater system. Recharge usually comes from rainfall, surface water bodies such as rivers, or via flow from adjacent aquifers. Under the plan, only a proportion of rainfall recharge has been made available for extraction. The remainder of recharge (a proportion of rainfall recharge plus all recharge from other sources) is reserved for the environment. Limiting the volume of use to a proportion of rainfall recharge is intended to reduce the risk of unsustainable groundwater extraction in the long term.

The plan also includes rules on the location of new works and extraction from existing works to protect high priority groundwater dependent ecosystems, high priority karst systems and other environmentally sensitive areas such as rivers or streams.

[2] There are limited exemptions for licensed domestic and stock which allow access to low and no flows. See section "6.2.5.2.2 Access to low flow class" and "6.2.5.2.3 Access to no flow class"

3.0 Scope of the plan

The plan covers two discrete water resources, mostly within what is known as the Western water management area.

The two water resources (located within the Murray-Darling Basin) are:

- the Barwon-Darling unregulated river – this includes the Barwon River from Mungindi weir to the confluence with the Culgoa River and the Darling River from this point to upstream of Lake Wetherell. Reaches of tributaries/ effluents to/of the Barwon-Darling are included in the plan where licences with Barwon-Darling Cap shares nominate works on these streams
- the groundwater in the Upper Darling alluvium associated with the Darling River upstream of Lake Wetherell.

3.1 Water management units

Water sharing plans can include the following hydrological planning units.

Where appropriate, an **extraction management unit** (EMU), consisting of one or several water sources, is specified for the purpose of establishing a geographic area over which the long-term average annual extraction limit (LTAAEL) applies. An available water determination is made for each licence category within the EMU and any growth in extraction above the LTAAEL is managed across the EMU, not at an individual water source level. Where an EMU is not specified, which is in case in this plan, the LTAAEL applies to the **water source** and any growth in extraction above the LTAAEL is then managed at that level.

River sections are specified within the Barwon-Darling unregulated river water source for trading purposes.

Management zones, representing a portion of a river section, are specified within the Barwon-Darling unregulated river water source to allow the refined implementation of access rules. For the Barwon-Darling unregulated river, these management zones are based on the 14 existing river reaches utilised for water licensing, including:

- Mungindi to Boomi River Confluence
- Boomi River Confluence to Mogil Mogil
- Mogil Mogil Weir Pool
- Mogil Mogil to Collarenebri
- Collarenebri to Walgett
- Walgett Weir Pool
- Walgett to Boorooma
- Boorooma to Brewarrina
- Brewarrina to Culgoa River Junction
- Culgoa River Junction to Bourke
- Bourke to Louth
- Louth to Tilpa
- Tilpa to Wilcannia
- Wilcannia to Upstream Lake Wetherell

4.0 Description of the plan area

The Barwon-Darling River is a semi-arid lowland river. Its catchment covers a large area of the northern portion of the Murray-Darling Basin. Major tributaries to the Barwon-Darling include the Intersecting Streams, Border Rivers, Gwydir, Namoi, Castlereagh, and Macquarie rivers. All enter the Barwon-Darling River upstream of the township of Bourke. Downstream of Bourke and further west, the Paroo and Warrego rivers contribute intermittent flows but can provide significant volumes during flood events, raising the duration of high flow events in the Barwon-Darling River (Cooney 1994).

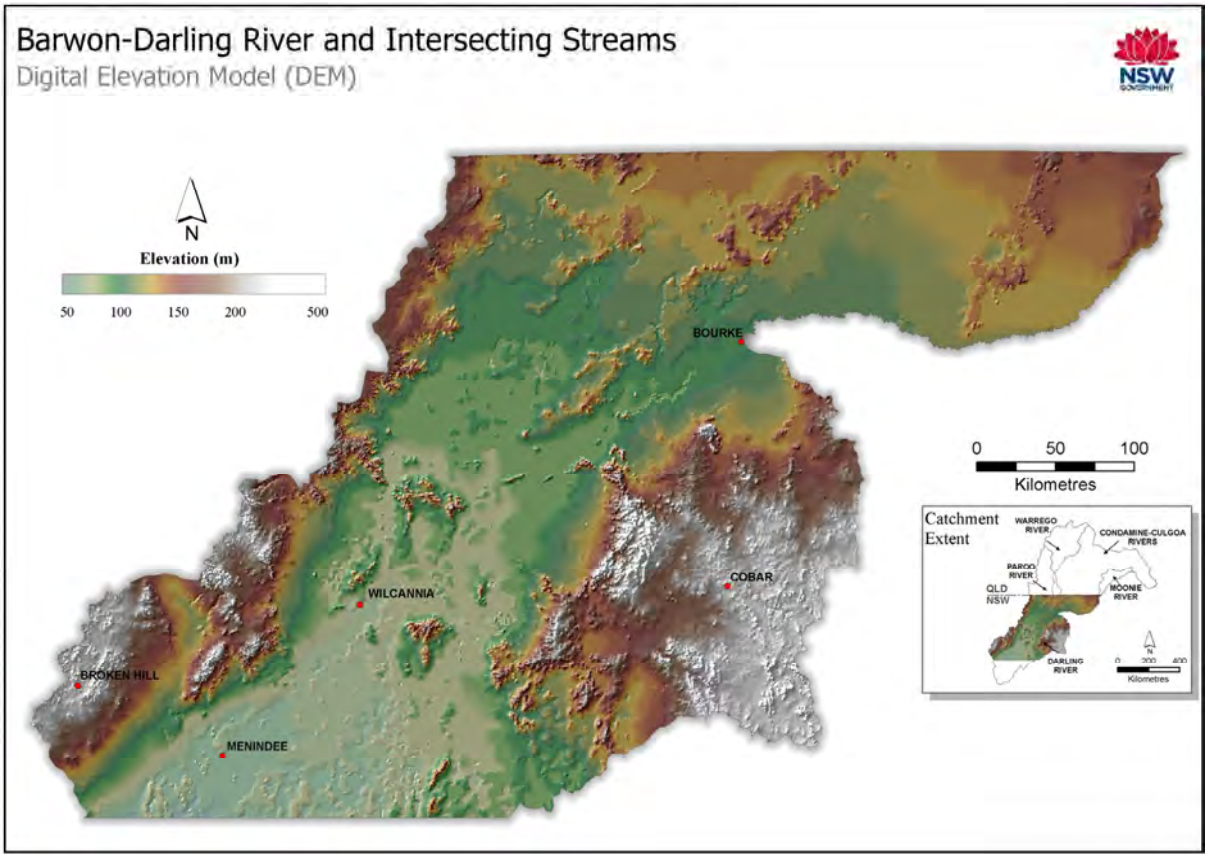
Major service centres within the plan area are Bourke, Brewarrina and Walgett which support populations of 1,000 to 2,500 people.

The Barwon River is formed by the junction of the Weir and Macintyre rivers, 25 kilometres upstream of Mungindi. Between Mungindi and Menindee the Barwon-Darling River can be divided into three distinct geomorphic reaches as described by Thoms et al. (1996).

1. From Mungindi to Walgett the Barwon River has a relatively narrow floodplain with a tightly meandering channel and many in-channel benches. The channel capacity is highly variable, ranging from 4,000 megalitres per day near Mungindi to 50,000 megalitres per day upstream of Walgett. River channel capacity increases dramatically downstream of Collarenebri with inflows from the Boomi, Little Weir, Gwydir, Mehi and Mooni rivers. The channel width varies from 40 to 60 metres and the depth may be up to 10 metres on the channel bends.
2. The floodplain widens downstream of Walgett as it flows unrestricted across alluvial plains with few bedrock outcrops to restrict its path. The floodplain is at its widest between Walgett and Bourke. Within this reach the channel becomes less sinuous, but there are many anabranches and effluent channels, which split from and later rejoin the main channel. Several large tributaries flow into this reach of the river including the Bokhara, Culgoa, Namoi, Castlereagh, Macquarie and Bogan rivers. The channel capacity increases to more than 80,000 megalitres per day near Bourke, while the channel width varies from 60 to 80 metres and the depth may be up to 20 metres.
3. Downstream of Bourke the Darling River is strongly influenced by geological controls which determine its course in a southwest direction. The river flows within a deeply incised channel with few channel benches and a narrow floodplain. The channel width is between 60 to 80 metres and channel depth up to 25 metres. The Darling River enters the Menindee Lakes system at Lake Wetherell, a large artificial storage formed behind the Menindee weir. From here water is diverted into the other main storage lakes of Pamamaroo, Menindee and Cawndilla.

Slopes along the river are relatively low, from 50 to 100 metres above sea level on the floodplain (Figure 1). Combined with highly variable discharges, large adjoining areas of land are inundated during flooding, leading to the construction of extensive floodplain and wetland systems (Reid and Brooks 2000).

Figure 1 Topography and elevation of the Barwon-Darling River and Intersecting Streams



Green and Petrovic (2011) document that riverine vegetation along the Barwon-Darling River is dominated by river red gums, which are found growing along the banks and around lagoons and anabranch channels. Coolibah and black box occur on higher areas of the floodplain, with coolibah woodlands occurring in the northern part of the catchment and black box in the south and west.

There are six broad vegetation communities which are found throughout the northern part of the Darling River basin as described by Westbrooke et al. (2004).

1. The most common vegetation community associated with the Barwon-Darling and its tributaries are the riverine woodlands. Dominated by river red gum, they occur along the banks of the major watercourses, and around associated wetlands, lakes and anabranches. Black box woodlands are found on the higher parts of the floodplain, and these may be mixed with or replaced by coolibah woodlands in the northern parts of the basin.
2. Beyond the floodplains large areas of the catchment are covered in open semi-arid eucalypt woodlands. These are often dominated by poplar box which is one of the most widespread trees of inland eastern Australia. A variety of other species may be present including white cypress pine, silver leaved ironbark, mulga, ironwood and gidgee. This community is particularly extensive in the Paroo and Warrego catchments and the Barwon River north and upstream of Brewarrina.
3. Belah woodlands occur on the sand plains that are adjacent to the floodplain between Louth and Menindee and in the lower Paroo and Warrego catchments. Associated trees include rosewood, sugarwood and wilga.
4. Woodlands and shrublands dominated by a range of acacias occur throughout the west and the north of the catchment. They are most extensive in the catchments of the Culgoa, Warrego and Paroo rivers. Dominant species include mulga, ironwood, gidgee, brigalow and prickly wattle.

5. Chenopod shrublands are found on alluvial plains and dry lakebeds in the south of the Darling basin. They occur on sand plains adjacent to the river in the Wilcannia area and cover extensive areas of the plains between Menindee and Broken Hill. The dominant species are bladder saltbush and copperburrs. Salt tolerant shrubs such as samphires occur on more saline sites while bluebush are found on slightly higher sites such as lunettes and small rises within the alluvial plains.
6. Native grasslands dominated by Mitchell grass cover large areas of the plains in the north of the basin. They are found along the main floodplain between Bourke and Wilcannia, and in the area of the Culgoa, Bokhara and Narran rivers. Extensive areas are associated with the Warrego River in Queensland. Mitchell grass grasslands are the most extensive of the natural tussock grasslands of Australia and a valued pasture component.

The aquatic community of the Barwon-Darling River is part of the endangered ecological community known as the aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River. This includes 21 native fish species and hundreds of native invertebrate species that are found within the Darling River and its associated streams, wetlands and anabranches within NSW.

The Barwon-Darling River has been subject to significant impacts from tributary headwater dams and water extraction, with over one third of its average annual flow being diverted from the river or its tributaries (Thoms et al,. 1996).

Whilst there are no major public irrigation water storages along the river, there are large private off-river storages that store water for irrigation obtained by either pumping during high river flow, harvesting of floodplain run-off, and/or retention of irrigation tailwater. In addition, there are a series of weirs along the length of the Barwon-Darling River, constructed to provide local storage pools for irrigation and town water supplies. The major weirs along the system upstream of Menindee are listed in Table 1.

Table 1 Major weirs along the Barwon-Darling River

Weir	River	Nearest town
Mungindi weir	Barwon	Mungindi
Comilaroy weir	Barwon	Mungindi
Barnaway weir	Barwon	Collarenebri
Weir No. 8	Barwon	Collarenebri
Collarenebri weir	Barwon	Collarenebri
Weir No.10 (Woorawadian)	Barwon	Walgett
Weir No. 11A (Walgett)	Barwon	Walgett
Brewarrina weir	Barwon	Brewarrina
Bourke weir	Darling	Bourke
Weir 19A	Darling	Bourke
Weir 20A	Darling	Louth
Louth weir	Darling	Louth
Tilpa weir	Darling	Tilpa
Wilcannia weir	Darling	Wilcannia

Source Green and Petrovic (2011)

4.1 Land use history

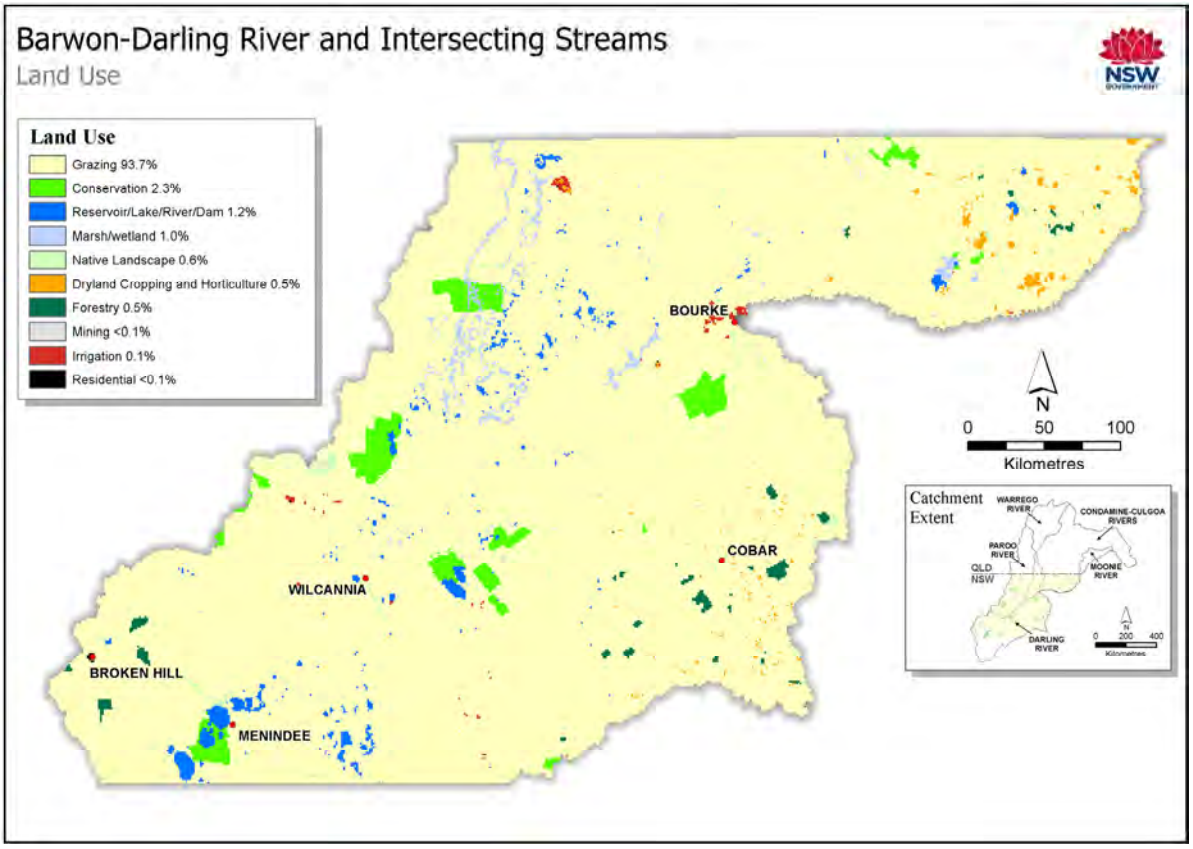
Prior to European settlement, it is acknowledged that the Western catchment was inhabited by various Aboriginal language groups such as the Ngemba, Wilyali, Nawalgu Ngiyampaa, Gurnu, Barundji, Garanggaba, Baranbinya, Walywan, Yuwalari, Murrawari, Wanywalgu, Wadigali, Wangkumara, Malyangaba, Bandjigali, Yawaalaraay, Gamilarray, Barkintji nations and clans. These traditional owners of the land managed and interacted with the landscape and its flora and fauna for over 40,000 years, underpinning the healthy balance of social, economic, environmental and cultural values of pre-European period (Western Catchment Management Authority, 2007).

Flowers (1989) traces a history of settlement around Bourke. In the 1840s white settlers began to move into the western region of NSW, the result was the establishment of an agricultural economy which was owned and controlled solely by white settler families. The Bourke region flourished when its location on the Darling River provided the link between the nearby outback agricultural industries and the east coast trade routes. Bourke became, in the late 19th century, the greatest stock centre in Australia. Despite severe droughts and fluctuations in international primary commodity prices, Bourke district developed a solid agricultural economy based on wool growing and beef, with cotton and citrus fruits providing support.

From the mid 1960s onwards the pastoral industry had declined substantially as a source of employment. This has been brought about by a combination of falling wool prices, rising wages, drought and the introduction of labour saving technology. As trade moved away from river transport routes, Bourke's hold on the inland trade industry began to relax. Bourke’s pastoral economy today is dominated by a small number of large property owners. While the pastoral industry declined, the secondary and tertiary sector of Bourke’s economy significantly expanded. Whilst no longer considered a trade centre, Bourke serves instead as a key service centre for the state’s north western regions.

Green and Petrovic (2011) describe current land use along the Barwon-Darling River and its northern tributaries, where grazing of sheep and cattle is most common, accounting for nearly 94 percent of all land use (Figure 2). Nearly all grazing occurs on native and naturalised pastures, with some improved pastures being grown in the wetter part of the catchment upstream of Bourke. This is also where the majority of dryland cropping occurs, on the Barwon River between Brewarrina and Mungindi. Areas of irrigated cropping occur along the Barwon-Darling River with the main irrigation development occurring at Bourke. The major crops grown are cotton, citrus, grapes, and vegetables. Although economically vital to the region, both dryland and irrigated cropping cover less than one percent of the wider catchment area in total.

Figure 2 Land use along the Barwon-Darling River and Intersecting Streams



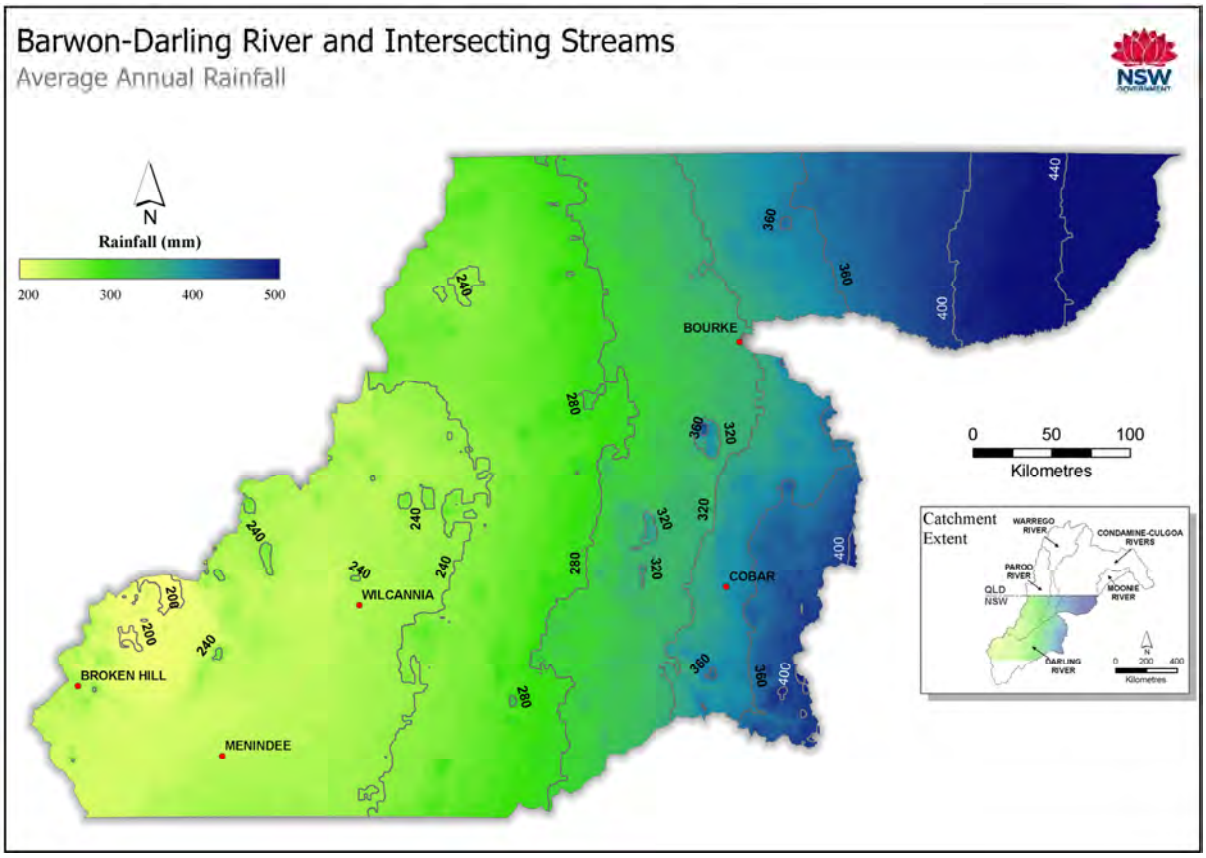
Source: 2001-02 Land use mapping of Australia, Bureau of Rural Sciences

4.2 Climate

The Barwon-Darling River is a semi-arid river characterised by extreme climatic variability with large areas of the catchment often subject to prolonged drought periods.

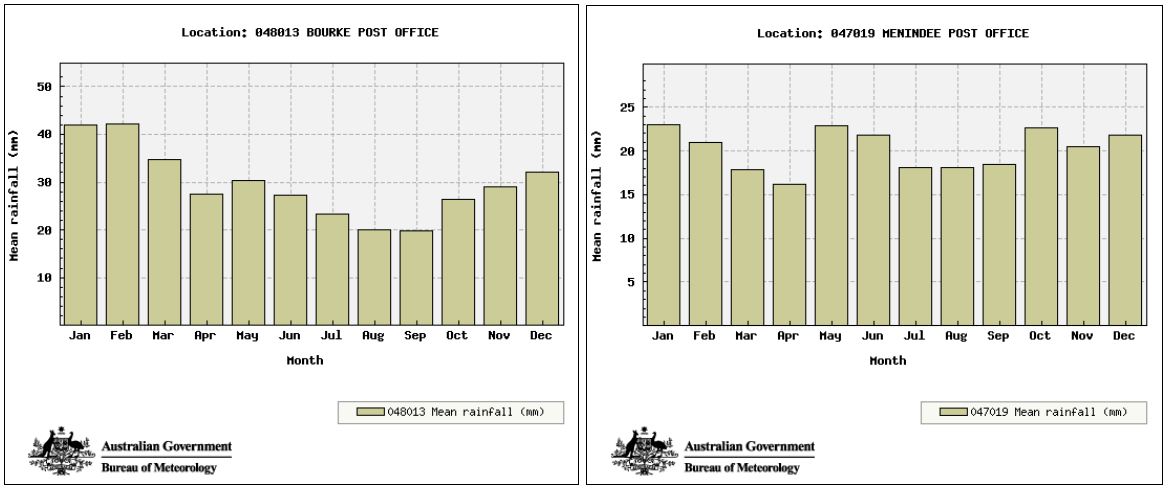
Rainfall is low and highly variable. Green and Petrovic (2011) show that average annual rainfall across the Barwon-Darling region decreases in a gradient from east to west from around 500 millimetres in the north east near Mungindi and Collarenebri to around 200 millimetres near Broken Hill (Figure 3). In the north rainfall tends to be summer dominant. Monthly rainfall at Bourke ranges from 20 millimetres in June to July to 40 millimetres in January to February with the highest falls being recorded from January to March. In the south at Menindee monthly rainfall is much lower, varying from 16 to 23 millimetres, but is more evenly distributed throughout the year (Figure 4).

Figure 3 Average annual rainfall for the Barwon-Darling River and Intersecting Streams



Source: Australian National University 1998

Figure 4 Average monthly rainfall at Bourke (1871–1996) and Menindee (1876–2010)

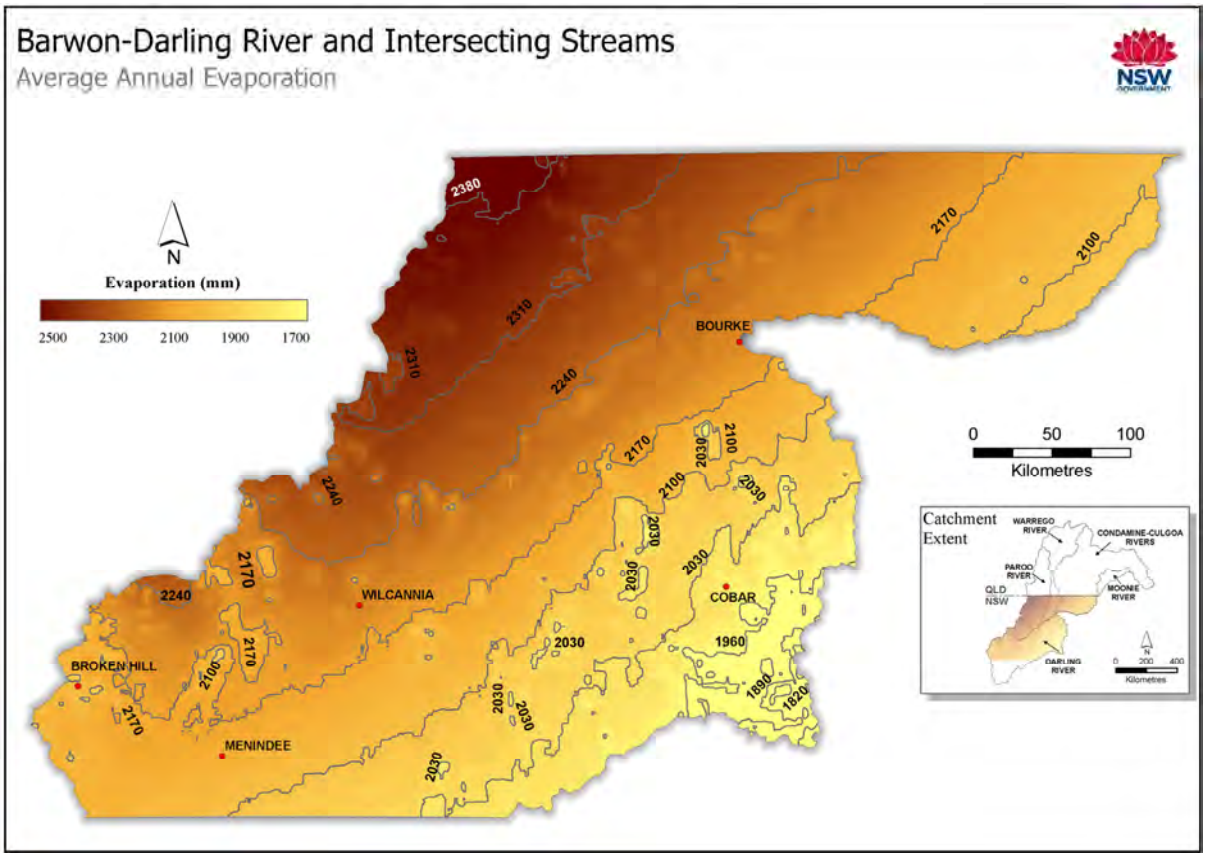


Source: Bureau of Meteorology Climate Data Online

Summers are hot and winters are mild. The semi-arid environment and high summer temperatures result in high evaporation rates across the whole of the catchment. Average annual evaporation ranges around 2,100 to 2,200 millimetres along the length of the river (see Figure 5).

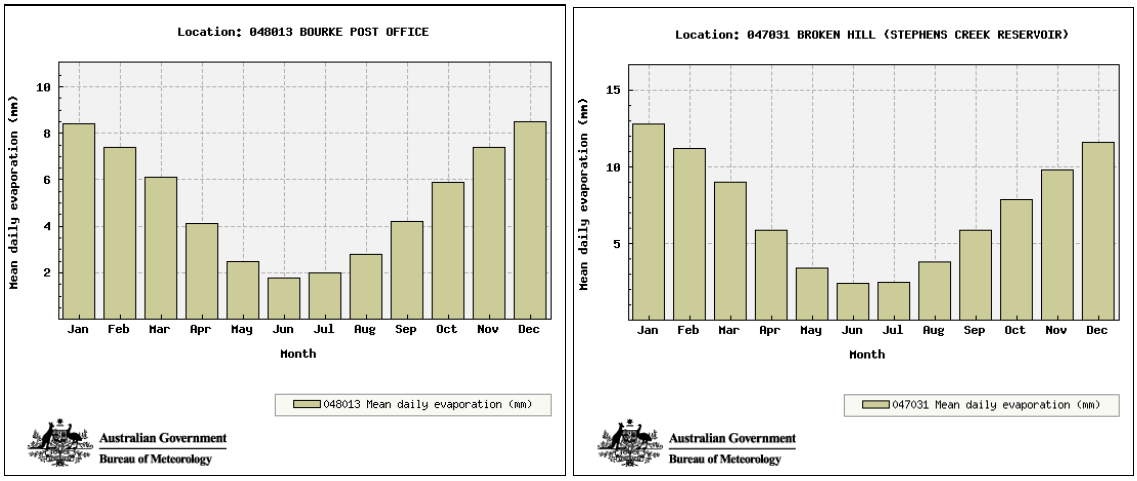
Daily evaporation is strongly seasonal with Class A pan evaporation at Bourke ranging from two millimetres per day in winter to nine millimetres per day in summer (Figure 6). A similar pattern is seen in the south of the catchment at Broken Hill where average daily evaporation in the summer is up to 13 millimetres per day (Green and Petrovic, 2011).

Figure 5 Average annual evaporation for the Barwon-Darling River and Intersecting Streams



Source: Australian National University 1998

Figure 6 Average daily evaporation at Bourke (1967–1994) and Broken Hill (1995–2010)



Source Bureau of Meteorology Climate Data Online

4.3 Streamflows

Brennan et al. (2002) explain climatic variability and low rainfall are important features of the catchment. As a result discharge is highly variable, with a large proportion of average flows occurring in wet years and major flood events. Median annual flow forms less than 30 percent of the mean annual discharge, with maximum flood events orders of magnitude higher. Flows are also usually higher during the summer months (December – April). The largest flows tend to be the result of

summer rainfall, and hence flood events are more likely in summer and autumn (Thoms et al. 2004). Discharges decrease downstream of Bourke due to a lack of contributions from tributaries and high rates of evaporation (Thoms and Sheldon 2000).

Green and Petrovic (2011) find that, of all the river's tributaries, the Border Rivers catchment is the largest contributor of flow, producing 35 percent of the long-term flow in the river at Menindee (Table 2). The Namoi and Culgoa-Condamine system are the next largest contributors. Together these three eastern catchments account for 80 percent of the Darling River's flow.

Table 2 Contributions to long-term average flow in the Darling River at Menindee

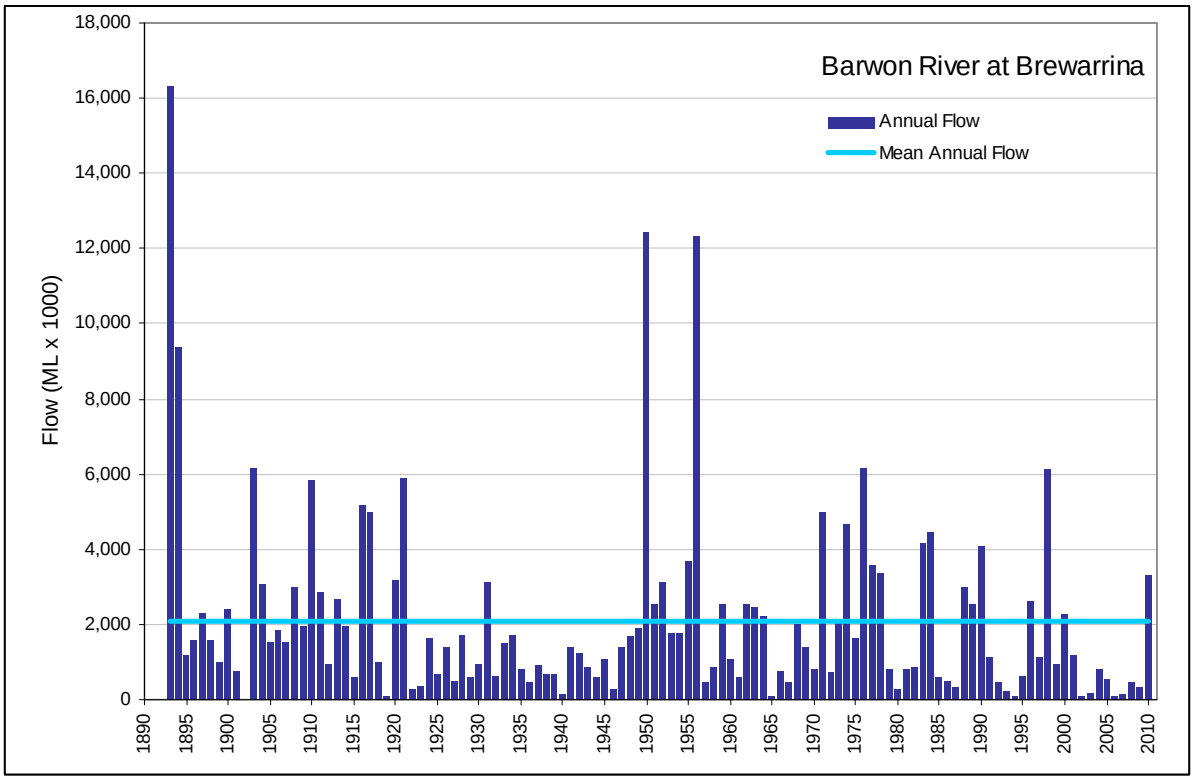
River system	Flow contribution (%)
Border Rivers	35
Namoi River	25
Condamine-Culgoa rivers	20
Gwydir River	10
Castlereagh-Macquarie-Bogan rivers	5
Warrego-Paroo rivers	5

Daily streamflows provide an indication of the variability of flow patterns and the peak height of flood events, as described by Green and Petrovic (2011). The flow regime is characterised by a series of flood events and intervening recessions which can last a few months, or occasionally, a few years. Despite the semi-arid nature of the river, the daily hydrograph shows that minor flow events can be expected at least once or twice a year, and that long periods of no flow are generally the exception.

Flows have been recorded in the Barwon River at Brewarrina since 1892. This gauge provides one of the longest and most complete periods of flow data available for the river. Over the long-term, the river has stopped flowing only four percent of the time. The mean annual flow at Brewarrina exceeds 2,100 gigalitres with annual flow ranging from just 1,700 megalitres in 1902 to more than 16,000 gigalitres in 1892 (Figure 7). The drought in the 2000s resulted in below average annual flows in the Barwon River for nine consecutive years; however figure 7 shows that longer periods of drought have been experienced at Brewarrina. For 28 years from 1922 until 1949 there was only one year of above average flow in the Barwon River.

The largest flood at Brewarrina was recorded in July 1893, reaching a peak height of over 377,000 megalitres per day. Major flood peaks exceeding 100,000 megalitres per day (such as those during the 1950s and 1970s) have occurred every 20 to 30 years, while medium sized floods of up to 50,000 megalitres per day have occurred once or twice per decade.

Figure 7 Annual flow in the Barwon River at Brewarrina 1892 – 2009



Streamflow is measured along the length of the Barwon-Darling, with major gauging stations included in Table 3 below. Table 4 shows that mean daily flows increase with increasing channel capacity between Collarenebri and Bourke and then decrease again downstream of Bourke, with the average daily flow being 9,464 megalitres at Bourke.

Table 3 Stream gauging stations in the plan area

Station name	Station no.	Drainage area (km^2)	Period of record	
			Start	Finish
Barwon River upstream of Presbury weir	416050	24,070	1987	Ongoing
Barwon River at Mogil Mogil	422004	64,800	1944	Ongoing
Barwon River at Collarenebri	422003	85,500	1944	Ongoing
Barwon River at Tara	422025	88,500	1999	Ongoing
Barwon River at Walgett	422001	132,200	1986	Ongoing
Barwon River at Boorooma	422026	134,000	1999	Ongoing
Barwon River at Geera	422027	208,000 [1]	1999	Ongoing
Barwon River at Brewarrina	422002	297,850 [1]	1892	Ongoing
Barwon River at Beemery	422028	300,000 [1]	1999	Ongoing
Darling River at Warraweena	425039	385,000	1999	Ongoing
Darling River at Bourke	425003	386,000	1880	Ongoing
Darling River at Louth	425004	489,300	1904	Ongoing
Darling River at Tilpa	425900	502,500	1995	Ongoing
Darling River at Wilcannia	425002	569,800	1886	Ongoing

Note: Water levels at all stations are logged at frequent intervals of around 30 minutes or more frequently as required. Data is telemetered once a day or more frequently as required.

1: These areas are very subjective as water enters Barwon River from multiple effluent streams draining the large Condamine-Culgoa and Macquarie-Bogan catchments

Source: NSW Office of Water real-time data – Rivers and streams

Table 4 Mean daily flow for selected gauges on the Barwon-Darling River

Gauge site	Catchment area (km^2)	Mean daily flow (ML)	Period of record
Barwon River at Collarenebri	85,500	3,283	1944 to 2012
Barwon River at Dangar Bridge (Walgett)	132,200	6,351	1886 to 2012
Barwon River at Brewarrina	297,800	5,921	1892 to 2012
Darling River at Bourke	386,000	9,464	1895 to 2012
Darling River at Louth	489,000	8,660	1904 to 2012
Darling River at Wilcannia	569,800	6,374	1913 to 2012

Source: NSW Office of Water real-time data – Rivers and streams

4.4. Historical droughts

The Barwon-Darling, located in the far west of the state, is exposed to a harsh and arid climate that has produced prolonged droughts throughout the valley.

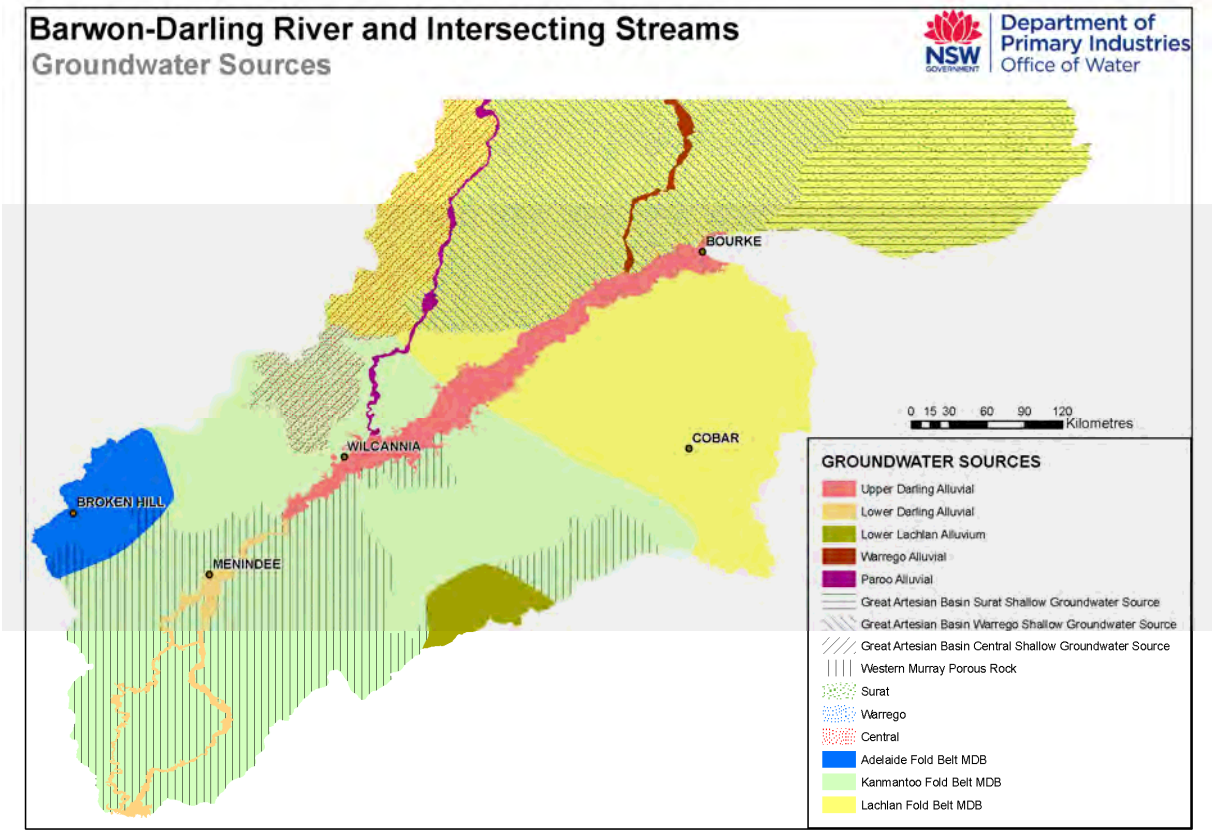
Flow data for the Darling River at Bourke town gauge from 1943 to present shows that the longest duration of no flow was 153 days between 2 July 1943 and 2 December 1943, followed by 139 days from late August 1994 to January 1995. The longest period of low flows (below 350 ML/day) at Bourke was between 5 May 2002 and 15 March 2003 (314 days), followed by 265 days of low flows from late April 1994 to January 1995.

Due the current level of irrigation development, it is likely that the recent drought (2002 to 2009) has had the largest impact on water use.

4.5 Groundwater

Groundwater in the Barwon-Darling and Intersecting Streams catchments encompass nine groundwater sources as shown in Figure 8. The alluvium associated with the Paroo and Warrego rivers are included in the *Water Sharing Plan for the Intersecting Streams Unregulated and Alluvial Water Sources 2011*, whilst the alluvium associated with the Darling River as shown in Figure 8, is covered by this plan.

Figure 8 Groundwater management units of the Barwon-Darling and Intersecting Streams



The Upper Darling Alluvial groundwater source is located along the Darling River, from upstream of Bourke to Lake Wetherell. The alluvial sediments are comprised of clay, sands and gravels and generally become finer closer to the surface. The alluvial deposits are generally around 40 to 50 metres thick, with piezometric heads of groundwater generally at 10 to 20 metres depth below ground level.

The aquifers of the Upper Darling Alluvial groundwater source are formed in three alluvial lithological units, namely the Narrabri, Gunnedah and Cubbaroo formations. The Narrabri formation overlies the Gunnedah formation that in turn overlies the Cubbaroo formation. Perched fresh water aquifers are common in the Narrabri formation where there is direct recharge from the rivers. The main aquifers are associated with the Gunnedah and Cubbaroo Formations, but most are saline. The only exception is near Wilcannia where these formations produce fresh groundwater. The aquifers in the Narrabri, Gunnedah and Cubbaroo formations are believed to be hydraulically connected to each other. The aerial extent of each unit within the groundwater source is not fully understood due to insufficient drilling information.

The water from Upper Darling Alluvial groundwater source is mainly used for domestic and stock purposes and also for Wilcannia town water supply. The majority of extraction from the Upper Darling Alluvial groundwater source is currently for the Upper Darling salt interception scheme (SIS), which is located 25 kilometres south west of Bourke along the Darling River. The SIS is intended to reduce the salinity of the Darling River by intercepting saline groundwater flow before it enters the river.

The Office of Water has 40 groundwater monitoring sites in the Upper Darling Alluvial groundwater source. Monitoring bores at nine sites near the Upper Darling SIS are equipped with telemetered data loggers for real time groundwater monitoring and the information is available in the public domain. The monitoring bores at eight sites are equipped with data loggers for continuous groundwater level monitoring. At the remaining 23 sites, groundwater levels are monitored at three monthly intervals.

Monitoring groundwater levels near the river shows that the Upper Darling Alluvial groundwater source gains water from the river during the flood events and loses water to the Darling River during the low flows in some river sections. The salinity of groundwater is monitored every three months in a few sites which are adjacent to the Upper Darling SIS.

4.6 Climate change and variability

Following the November 2006 water summit on the southern Murray-Darling Basin, the then Prime Minister and basin state premiers commissioned CSIRO to report on sustainable yields of surface and groundwater systems within the basin. The CSIRO Murray-Darling Basin Sustainable Yields Project assessment was undertaken for 18 regions including the Barwon-Darling. The CSIRO (2008) report made the following conclusions for the Barwon-Darling:

- Current average surface water availability (assessed at Bourke) is 3,515 gigalitres per year and a high proportion (39 percent) of this water is used in this catchment. Groundwater use is low and poses no major concerns.
- The recent climate (1997 to 2006) was not significantly different to the long-term average climate.
- The best estimate of climate change by 2030 would reduce average surface water availability by 8 percent and increase surface water diversions by 2 percent due to increased evaporation from storages.
- Likely future development of farm dams (14 percent growth) and groundwater would reduce average river inflows by 3 percent. Projected increase in regional groundwater extraction (24 fold) would increase streamflow leakage to groundwater by 37 gigalitres per year.

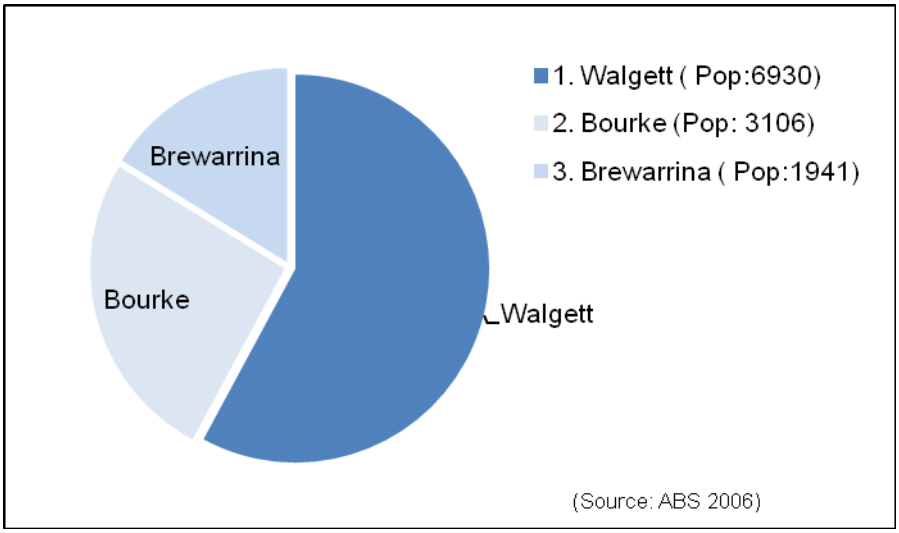
However, CSIRO also report that the hydrological impacts of climate change in the basin remain very uncertain. Rainfall run-off modelling with climate change projections from global climate models indicates that future run-off in the Barwon-Darling region is more likely to decrease than increase. The 2008 report suggests that the best estimate 2030 climate scenario is a 2 percent reduction in mean annual run-off. The extreme estimates (from different climate models under high global warming) range from a 22 percent reduction to a 50 percent increase in mean annual run-off.

Under the best estimate 2030 climate, there would be an 8 percent reduction in water availability, a 10 percent reduction in end of system flows and a 2 percent increase in surface water diversions overall. Under the wet extreme 2030 climate there would be increases of 31 percent in average water availability, 47 percent in end of system flows and 3 percent in surface water diversions. Under the dry extreme 2030 climate there would be decreases of 27 percent in average water availability, 35 percent in end of system flows and an increase of 5 percent in surface water diversions (CSIRO, 2008).

4.7 Socio-economic context

The graph in Figure 9 shows a distribution of the population by local government area across the plan area. There are approximately 12,000 people in the local government areas associated with the plan in total, with the urban centers providing the population hubs (ABS, 2006a). Indigenous Australians comprise 33 percent of the population, compared to two percent of the total population across NSW.

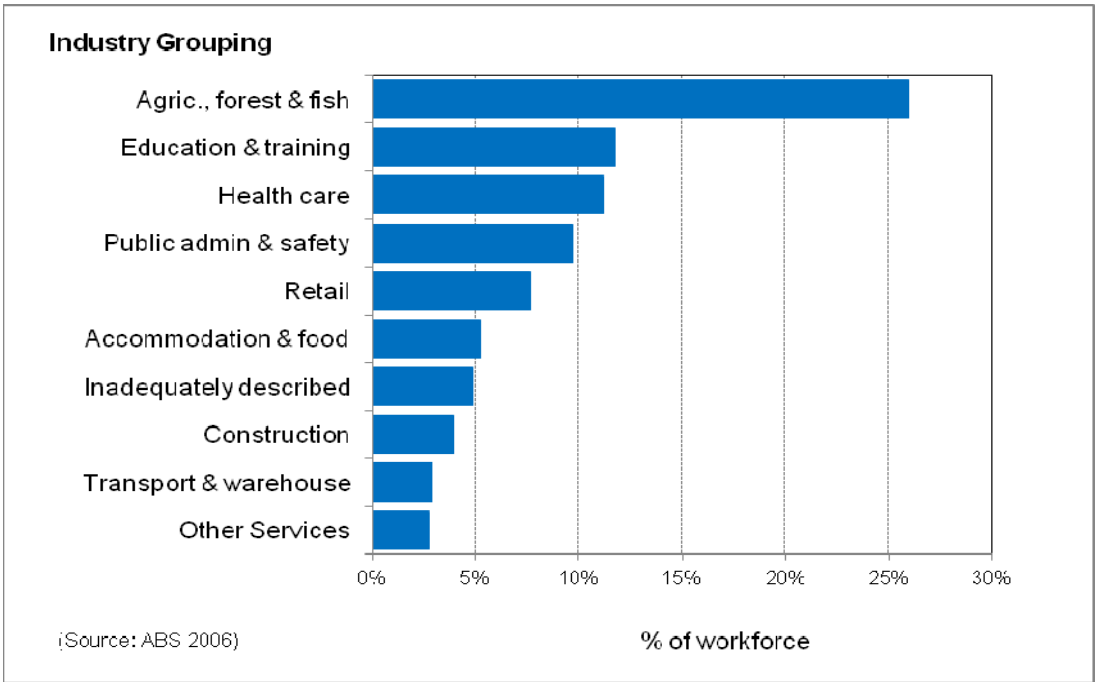
Figure 9 Distribution of population for Barwon-Darling local government areas



In 2006 approximately 38 percent of the population within local government areas spanning the plan area, were in the labour force. The labour force participation rate, at 55 percent, was marginally lower than the NSW average of 59 percent. The unemployment rate of 11.1 percent was higher than the NSW average of 6.3 percent (ABS, 2006a).

Figure 10 shows that across the plan area the agricultural industry employs approximately 27 percent of the labour force. Education and training, health care, public administration and safety and retail trade employ a total of 40.3 percent (ABS, 2006a).

Figure 10 Workforce description by major sector type



The index of relative socio-economic advantage and disadvantage can be used to represent household economic and social resources within an area. The average Australian score is 1,000. Two thirds of the Australian population score between 900 and 1,100.

The average score for the Barwon-Darling area is 905. This indicates that the area falls within the same range as two thirds of the Australian population but below the Australian average and below the

NSW average of 1,003. There is some variation within the plan area. Bourke has a higher score at 958, indicating the area is marginally less disadvantaged. Brewarrina and Walgett both have scores lower than Bourke indicating they are marginally more disadvantaged.

4.8 Entitlement and use

There are over 200 water licences in the area covered by the plan, totaling 184,322 shares. This entitlement is divided between unregulated surface water and, to a lesser extent, alluvial groundwater. The majority of licences are used for irrigation, with a proportion used for town water supply and domestic and stock purposes. Current water entitlement across the water sources within the plan area is listed in Table 5. The share components for unregulated river A, B and C class licences are based on shares in the modeled 173 GL Cap (irrigation component). The plan allows for amendment to these share components as a result of an updated long-term model estimate for irrigation diversions.

Table 5 Total entitlement for each river section and water source

Water source / River section	Unregulated access			Local water utility	Salinity and water table mgt	Stock and domestic
	A class	B class	C class			
River Section 1	850	27,893	6,389	479	N/A	-
River Section 2	724	17,382	31,743	1,000	N/A	-
River Section 3	6,015	50,939	1,542	3,500	N/A	-
River Section 4	1,407	23,074	5,080	425	N/A	-
Barwon-Darling unregulated river	**8,996**	**119,288**	**44,754**	**5,404**	**N/A**	**2,660**
Upper Darling Alluvial	**0**	**0**	**0**	**220**	**3,000**	**0**

Note: .at the time of writing this document stock and domestic entitlement for the Barwon-Darling Unregulated River Water Source had not been broken down by river section.

Water is also extracted from watercourses and aquifers within the plan area through basic landholder rights (not requiring a licence).

4.8.1 Embargoes under the *Water Act 1912*

Under section 113A of the WA 1912 an embargo order on applications for Part 5 water licences was first gazetted during November 2006 for the Upper and Lower Darling alluvial groundwater management areas (note that the Upper Darling Alluvial groundwater source includes a section of the Lower Darling alluvial groundwater management area). The order was remade as part of an embargo on Part 5 water licences across all inland groundwater in highly committed aquifers outside water sharing plan areas. The remade order also replaced a number of specific exemptions for the Upper and Lower Darling alluvials with a single set of exemptions across all areas covered by the embargo.

Similarly, an embargo order under section 22BA of the WA 1912 was made for Part 2 water licences in the unregulated areas across a large section of Western NSW including those of the Barwon-Darling on 14 July 1995. This order was remade on 21 October 1998 and then again on the 12 May

2000 and finally on the 16 May 2005. The exemption changed each time a new order was made, with the original order including an exemption for a licence to irrigate ten hectares. Subsequent orders did not include this and generally contained standard exemptions, including irrigation if it was for research or teaching, domestic and stock (not for piggeries and feedlots and not more than five megalitres per year) and town water supply.

4.8.2 Agricultural water extraction from the Barwon-Darling unregulated river

As flows in the Barwon-Darling River are not regulated, large scale irrigation developments, that is, irrigated areas in excess of about 20 hectares are normally based on extraction during high river flow events and supported by water supplies held in privately owned on-farm storages. CSIRO (2008) model the total capacity of these large private off-river storages as 283 GL.

Detailed statistics from the 2006 Agricultural Census reported by local government area (ABS, 2006b) are used below to describe the main agricultural activities in the local government areas (Walgett, Brewarrina and Bourke) along the Barwon-Darling River.

Agricultural production occurs on 7,191,547 ha in the local government areas associated with the Barwon-Darling River. Irrigation production accounts for 25,000 ha and represents less than 1 percent of the total area devoted to agriculture. The gross value of irrigated agriculture was estimated at $61 million which represented approximately 24 percent of the total value of agricultural production.

In 2005-06 approximately 171,043 ML of water was extracted for irrigation in the Barwon-Darling catchment by 634 businesses. The gross value of irrigated agriculture was $355 per megalitre. Cotton was the main crop grown in the irrigated sector accounting for $56 million or 92 percent of the gross value of irrigated agricultural production. Dryland production occurred on 7,166,547 ha. The main output from the non irrigated sector was cereals and grain as well as production from sheep and other livestock and meat cattle accounting for $178 million.

Approximately 63 percent of irrigation water use and 76 percent of irrigated area occurs in the Walgett Shire. Significant irrigation also occurs in the Bourke Shire.

4.8.2.1 Walgett Shire

In Walgett Shire the total gross value of agricultural production was $196 million. This comprised $44 million from irrigated agriculture and $152 million from non irrigated agriculture.

Approximately 108,565 ML of water was extracted for irrigation use. Irrigated agriculture occurred on 19,000 ha and accounted for 22 percent of the total value of agriculture. The gross value of irrigated agriculture was $405 per megalitre. Cotton was the main crop grown in the irrigated sector accounting for $44 million or 99 percent of the gross value of irrigated agricultural production.

Dryland production occurred on 2,002,105 ha. The main output from the non irrigated sector was cereals and grain accounting for $92 million.

4.8.2.2 Bourke Shire

In Bourke Shire the total gross value of agricultural production was $35 million. This comprised $17 million from irrigated agriculture and $18 million from non irrigated agriculture.

Approximately 62,478 ML of water was extracted for irrigation use. Irrigated agriculture occurred on 6,000 ha and accounted for 47 percent of the total value of agriculture. The gross value of irrigated agriculture was $269 per megalitre. Cotton was the main crop grown in the irrigated sector accounting for $12 million or approximately 72 percent of the gross value of irrigated agricultural production.

Dryland production occurred on 3,823,656 ha. The main output from the non irrigated sector was production from sheep and other livestock accounting for $11 million.

4.8.2.3 Brewarrina Shire

In Brewarrina Shire the total gross value of agricultural production was $26 million an estimate for the gross value of irrigated agriculture for this region is not available.

Dryland production occurred on 1,340,786 ha. The main agricultural output was production from meat cattle sheep and other livestock accounting for $23 million.

4.8.3 Water extraction from the Upper Darling Alluvial groundwater source

The construction of Upper Darling salt interception scheme was completed in 2010. At the commencement of the plan, the scheme was the largest entitlement issued in this groundwater source.

Most aquifers found in the alluvial groundwater source are saline; the only exceptions are the alluvial aquifer near Wilcannia and isolated shallow aquifers, which produce fresh groundwater. The alluvial groundwater source is mainly used for domestic and stock purposes and Wilcannia town water supply.

Detailed water use is not available in this alluvial groundwater source because there is not yet broad scale metering. NSW is exploring this issue through the Water Use Monitoring Program.

4.9 Local water utility requirements

There are six town water supplies located along the length of the Barwon and Darling rivers. These town water supplies, their location and entitlement volume are listed below in Table 6. Descriptions of each scheme follow the table.

Some towns have two separate reticulated water systems; one for potable or treated water suitable for drinking, the other for raw or untreated water. Raw water is typically used for gardens and other uses outside the home, including council parks, and is not metered at individual premises.

On the 23 November 2006, an order under the *Water Management Act 2000* was placed on basic landholder rights users to restrict water extraction upstream of weirs in the Barwon-Darling system at Collarenebri, Walgett, Brewarrina, Bourke and Wilcannia. The temporary water restriction order was placed, in the public interest, because of the water shortage being experienced at that time. The effect of this order was to restrict all landholders that access water directly from those weir pools to the same restriction being imposed in the relevant town. In future droughts it is likely a similar temporary restriction will be utilised again.

Table 6 Town water supplies, location and entitlement volume in the plan area

Water supply	Management zone / water source	Entitlement (ML/year)
Collarenebri town water supply	Mogil Mogil to Collarenebri	416
Walgett town water supply	Mogil Mogil to Collarenebri	63
Brewarrina town water supply	Boorooma to Brewarrina	1000
North Bourke town water supply	Culgoa River Confluence to Bourke	300
Bourke town water supply	Culgoa River Confluence to Bourke	3200
Louth town water supply	Bourke to Louth	25
Wilcannia town water supply	Tilpa to Wilcannia	400

Water supply	Management zone / water source	Entitlement (ML/year)
Wilcannia town water supply	Upper Darling Alluvial	220

4.9.1 Collarenebri town water supply

Water for Collarenebri town is sourced from a weir pool on the Barwon River and pumped to a reservoir, which supplies both the raw water reticulation network and a membrane water filtration plant. Peak demand is in the order of 0.9 megalitres per day and annual consumption is around 170 megalitres of treated water and 250 megalitres of raw water.

There are 6 levels of water restrictions in Walgett Council's drought management plan, ranging from 'permanent water conservation measures' through to level 5 (emergency) restrictions. Under level 5 (emergency) restrictions, the target daily consumption for Collarenebri town is 0.2 megalitres per day. Each of these restrictions is triggered by a volume of water remaining in the weir pool.

4.9.2 Walgett town water supply

Walgett town has a licence to extract water from the Namoi River and normally obtains water from this source. Peak daily demand has historically been in the order of 1.5 megalitres per day (treated) and 4.5 megalitres per day (raw). Annual consumption is around 480 megalitres (treated) and 800 megalitres (raw), although this is expected to decrease following the introduction of water conservation measures by Walgett Council, including 'user-pays' water pricing.

Walgett town water supply is at risk during extended droughts due to a lack of flow in the Namoi River. Although the Namoi River is a regulated river supplied by Keepit dam near Gunnedah, it takes around two weeks for the water released from the dam to reach Walgett town. When the dam is low and the river is not flowing, around 90 to 95 percent of releases from Keepit Dam do not reach Walgett due to evaporation and seepage. The river stopped flowing in 1982, 1994, 1995 and several times in the 2000s.

Water is generally available in the Walgett weir pool on the Barwon River, which has a capacity of 800 megalitres; however there are constraints to Walgett accessing this water, both due to licensing requirements and a lack of infrastructure. During past droughts, Walgett has obtained a temporary WA 1912 licence to pump water from the Walgett weir pool into a series of temporary earth weirs on the Namoi River so that the existing Namoi River pumps can supply the town. This is not seen as a satisfactory long-term arrangement and Walgett Council have been encouraged to obtain a permanent licence from the Barwon River with appropriate conditions so that it can access this water when water deliveries are not available from Keepit dam.

4.9.3 Brewarrina town water supply

Brewarrina township draws its water from the Brewarrina weir pool, on the Barwon River. The volume of the weir pool is not known precisely, but a survey was carried out by Brewarrina Shire Council in 1994, which estimated a volume of approximately 6,000 ML.

Brewarrina township has two reticulated water systems. The reticulated raw water supply was constructed from 1952, with the majority of the network constructed in 1960. In 1970 treated water was supplied to Brewarrina. There are two pumps that take water from the weir pool (270 L/s and 40 L/s capacity) and transfer it to a 2.27 ML raw water reservoir located at the water treatment plant site. The water treatment plant has a capacity of 1.0 ML/day. Waste water from the water treatment plant is processed through two large lagoons and returned to the raw water system.

Brewarrina township has a licence to extract up to 1,000 ML/year. In recent years, usage has varied from 987 ML in 2006-07 to 726 ML in 2007-08.

Brewarrina has a reasonable period of storage in its weir pool, but there are other users of the weir pool in addition to the Brewarrina residents. The only strategy available during drought for Brewarrina township is to maintain the town water supply in storage for as long as possible. Water restriction triggers at Brewarrina are directly related to water levels measured at the weir.

Brewarrina does not have an available groundwater source. Test drilling for alluvial groundwater beside the river at Brewarrina was undertaken in 2007 without success. The Great Artesian Basin is a considerable distance (about 50 km) from Brewarrina; so is not considered a likely source for an alternate piped supply.

4.9.4 Bourke town water supply

Bourke township draws its water from the Bourke weir pool, on the Darling River. Both Bourke and North Bourke are serviced by the water treatment plant for potable water; however the much smaller North Bourke has a separate raw water pumping station with a licensed volume of 300 ML.

Bourke township has the highest per person urban water consumption in NSW. Potable water production is relatively consistent, at approximately 1.5 ML/day. Raw water, by contrast, varies with the seasons; it can be 7 to 8 ML/day during summer and as low as 2 ML/day during winter.

Town water supply 'drought' is defined when water ceases to flow over the Bourke weir. The weir pool storage provides approximately 6 months of town water supply for Bourke town. Due to the extensive periods of no flow in the Darling River, works have been proposed to provide an alternate supply to Bourke during drought. Work has commenced for stage 1 of the project. A new bore has been drilled into the Great Artesian Basin and 6 km of 100 mm PVC pipe installed. The project proposes to build some infrastructure at the bore head (aerator, chlorinator, balance tank and pump station, telemetry) and complete the 20 km pipeline to the Bourke water treatment plant. The project, when completed, will not provide a full alternate town water supply for Bourke, but if it can provide about 1 ML/day from the Great Artesian Basin, then the need for water carting should be alleviated.

Bourke currently has 6 levels of water restrictions, which are directly related to water levels measured at the weir. They are shown below in Table 7.

Table 7 Bourke town water restriction levels

Water level (m)	Weir pool capacity	Description	Water restriction level
3.9	100 %	Cease to flow	1
3.5	75 %	0.4 m below full capacity	2
2.7	50 %	1.2 m below full capacity	3
2.1	35 %	1.8 m below full capacity	4
1.6	25 %	2.3 m below full capacity	5
1.1	15 %	2.8 m below full capacity	6

4.9.5 Louth town water supply

Louth is a small community (35 people, 25 houses, 1 hotel) on the Darling River. Houses have rainwater tanks for their drinking water. Louth has a raw water scheme, licensed for 25 ML to take water from the Darling River. It can also access raw water from a bore, adjacent to the Darling River, which was drilled during the blue-green algal crisis in the early 1990s. During a severe drought, if

rainwater tanks run dry then it is expected that emergency drinking water supplies would be carted from alternate locations (e.g. Bourke).

4.9.6 Wilcannia town water supply

Wilcannia township draws its water from the Wilcannia weir pool, on the Darling River. The weir pool breaks up into two pools when the water level is lowered approximately 600 mm below the weir crest. The first pool is 5 km long, and the second is 22 km long. There is a natural rock bar between the pools and they are relatively independent about 2 months after flow ceases over the weir. A study calculated that the first weir pool had a volume of 296 ML and the second weir pool has a calculated volume of 2,018 ML (NSW Public Works Department, 1987).

Wilcannia township has two reticulated water systems. The reticulated town water supply from the river was constructed and then a 2.5 ML raw water reservoir was added in 1974. The water treatment plant and 1 ML potable water reservoir were constructed in the mid 1980s, and the filtered water mains were installed. The water treatment plant can treat up to 6 L/s (or about 0.5 ML/day) of potable water.

There are no accurate figures for town water usage for Wilcannia, as it does not have a bulk water meter, but a meter is planned to be installed shortly. The NSW Public Works Department (1987) report estimates the 1984 consumption at 400 ML. Wilcannia town probably uses between 300 and 400 ML per year.

The Darling River has ceased to flow over the weir pool at Wilcannia on many occasions in recorded European history; so often that this is not considered an aberrant event. Historical records (NSW Public Works Department, 1987) show no flow for up to 362 days (January 1902 to January 1903) and similarly NSW Office of Water data over the past decade show no flows for up to 354 days (31 August 2006 to 20 August 2007).

When the Darling River ceases to flow over Wilcannia weir, there is sufficient storage for approximately four months town water supply for Wilcannia. Water restriction triggers at Wilcannia are directly related to water levels measured at the weir. During no flows, Council's strategy is to pump some water from the larger upstream weir pool and maintain a minimum volume in the downstream weir pool (about 70 ML), as the town water supply pumps can't operate if the water level falls one metre below the weir crest.

Due to extensive periods of cease to flow in the Darling River, one groundwater production bore has been constructed to provide an alternate water supply to Wilcannia. The bore is located at Union Bend, about 3 km south of Wilcannia. It was constructed in 2003 and can supply about 6 L/s, fed directly to the water treatment plant and then the potable water supply. During the recent drought, increased pumping from groundwater induced salinity into the aquifer from lower aquifers. A second and third bore were sunk in 2007, but these are yet to be equipped and connected to the town's supply system.

5.0 Developing the plan

5.1 Project groups

5.1.1 State Interagency Panel

The State Interagency Panel (SIP) has overall responsibility for the statewide strategic direction of water sharing planning, to ensure that adequate resources are available from each agency and that the varying policy and statutory requirements of the relevant NSW Government agencies are met. The SIP also has the role of making water sharing decisions in cases where an interagency regional panel, see below, cannot reach agreement or where the issue has statewide significance.

The SIP is chaired by the NSW Office of Water and comprises representatives from the Office of Water, the NSW Office of Environment and Heritage (OEH), catchment management authorities (CMAs), and agriculture, fisheries and aquaculture specialists from the NSW Department of Primary Industries (DPI). The Office of Water is responsible for the overall project management.

5.1.2 State Groundwater Panel

The State Groundwater Panel (SGP) provides a senior level forum for discussing and resolving a wide range of water planning and policy issues specific to groundwater. The SGP plays a specific role in reviewing and, where appropriate, modifying the outcomes of the regional groundwater assessments and the proposed groundwater sharing rules to ensure consistency across the state for aquifer types.

The group is chaired by the Office of Water and has representatives from OEH and agriculture specialists from DPI.

5.1.3 Interagency Regional Panel

The plan rules were developed by the Office of Water based on recommendations from the Barwon-Darling Interagency Regional Panel (IRP), which consists of representatives from the Office of Water, OEH, DPI and the Western, Namoi and Border Rivers-Gwydir catchment management authorities (as observers). Appendix 2 lists the names of panel representatives and their areas of expertise, and also lists the NSW Office of Water working group who provided specific technical and scientific information.

The key responsibilities of the IRP are to:

- review the hydrological (water management) units provided by the Office of Water
- review existing water sharing rules as to their applicability[3]
- make recommendations on the water access and dealing (trading) rules for each water source
- assist the CMA with consultation on the proposed rules
- review submissions, from targeted consultation and public exhibition, and recommend changes where necessary to the draft water sharing rules.

IRPs work under the guidance of the SIP, as described above.

[3] This includes reviewing water access conditions imposed on users through announcements or orders under the *Water Act 1912* during low flow conditions.

The Barwon-Darling IRP used local knowledge and expertise in developing and recommending the water sharing rules through a consensus decision-making approach.

5.2 Policy context

There are a number of national and state policies that impact on and direct the development of plans.

5.2.1 Murray-Darling Basin Cap management

Water diversions from rivers in NSW progressively increased throughout the last century, but most rapidly in the 1980s. Growth in water diversions:

- takes more water away from the river and may threaten its environmental health
- reduces water available to other legitimate businesses thus increasing competition and the potential for inequitable access
- reduces flows from upstream river systems into downstream systems.

In 1994, the Murray-Darling Basin Ministerial Council (MDBMC) undertook an assessment of water diversions across the basin. This found that the levels of diversions at that time were placing stress on both the environmental health of our river systems and the reliability of supply to water users; and that diversions were continuing to increase. In response, the MDBMC introduced a diversion limit – the Cap – in 1995.

The definition of Cap for each of the basin states and territories is formalised in Schedule E of the Murray-Darling Basin Agreement. In NSW, the Cap is defined as the average yearly volume of water that would have been diverted under 1993-94 levels of development and management rules.

The Murray-Darling Basin Authority runs the Schedule E register of cumulative cap credits and debits for each of the designated cap valleys. Under Schedule E, the diversions in each designated river valley are compared with the diversions that would have occurred under Cap conditions each year. The difference between these two numbers is the Cap credit (or debit), and these are cumulated since the commencement of Cap accounting in 1997/98 to determine the net credit or debit for each valley. Should a valley be above the trigger thresholds provided by Schedule E, the relevant state or territory is then required to conduct a special audit assessment against their definition of Cap in the Agreement, to determine if there has been systemic growth in extraction. The findings of the special audit are then reviewed by the Independent Audit Group of the Murray-Darling Basin Ministerial Council and if necessary the Murray-Darling Basin Ministerial Council then requires the relevant state or territory to rectify the breach of Cap within what they consider to be an acceptable period of time.

Under the agreement, water sharing plans are required to be developed to ensure consistency with the Cap. This means that the long-term average annual extraction limit must be equal to or less than the Cap.

5.2.2 National Water Initiative

The NSW Government is a partner to the National Water Initiative (NWI) which was signed by the Council of Australian Governments in June 2004. The NWI recognises the continuing imperative to increase the productivity and efficiency of Australia's water use, the need to service rural and urban communities, and to ensure the health of river and groundwater systems by establishing clear pathways to return all systems to environmentally sustainable levels of extraction.

The NWI has a number of relevant requirements for water planning in Clauses 23, 25, 35 to 40, 52, 78, 79 and Schedule E (refer to the National Water Commission website www.nwc.gov.au in the

Water Reform section for details). This intergovernmental agreement contains provisions on water planning including:

- settling the trade-offs between the competing uses must be based on the best available science and socio-economic analysis, as well as consultation with the community
- ensuring that environmental and other public-benefit outcomes are provided for through planned and adaptive environmental water on a statutory basis and achieved, including actions to sustain high conservation value rivers, reaches, and groundwater areas
- providing for water trading to enhance water markets
- recognising and addressing surface and groundwater connectivity
- managing local impacts in groundwater areas as well as protecting groundwater dependent ecosystems
- providing for indigenous consultation and aboriginal cultural and commercial entitlements,
- assessing and addressing interception
- monitoring and reporting on implementation.

The Intergovernmental Agreement on a National Water Initiative sets out guidelines, outcomes and timelines for water plans and planning processes. The National Water Commission is an independent statutory body responsible for providing advice to Council of Australian Governments on the implementation of the NWI and national water issues and undertakes a biennial assessment of each state's progress with implementing the NWI for this purpose.

5.2.3 Natural Resources Commission

Water sharing plans also comply with the Natural Resources Commission (NRC) statewide standards and contribute to the relevant statewide targets such as Targets 5 and 6 (see www.nrc.gov.au for details) which is a requirement of the State Plan, Goal 22 (see www.nsw.gov.au/stateplan for details). The NRC was established in 2003 to provide the NSW Government with independent advice on natural resource management issues. To achieve this it has developed and recommended a Standard for Quality Natural Resource Management and 13 statewide targets for natural resource management in NSW, which have been embedded in the NSW State Plan. Table 8 lists the state targets and how these are met within the plan. As with the NWI, the components of the State Standard focus on the use of the best available knowledge, use of appropriate information management systems, delivery of integrated outcomes, engagement of the community and regular monitoring, measuring, evaluation and reporting to specify how delivery of the targets is progressing. The NRC reviews plans against this Standard and its associated targets.

Table 8 Contribution of the plan to the relevant NRC statewide targets

Relevant statewide target	Plan contribution
By 2015 there is an improvement in the condition of riverine ecosystems (Target 5)	- sets a defined share of water for riverine ecosystems - protection of very low flows - trading rules to maintain or reduce authorised extraction by river sections - adaptive management, giving the ability to adjust rules once information becomes available or at the end of plan period.
By 2015 there is an improvement in the ability of groundwater systems to support their groundwater dependent ecosystems and designated beneficial uses (Target 6)	- sets distance rules to GDEs for new bores - trading rules designed to protect groundwater sources - local area impact management rules

Relevant statewide target	Plan contribution
By 2015 there is an improvement in the condition of important wetlands, and the extent of those wetlands is maintained (Target 8)	- no new works permitted on off-river pools - defined access rules for each flow class
Natural resource decisions contribute to improving or maintaining economic sustainability and social well-being (Target 12)	- plans provide a defined share to water and defined certainty of access - separation of land and water enhances trading and value of licences - establishment of perpetual and compensable water access licences provides security for business investment - water markets encourage movement of water licences to high value uses

5.2.4 Basin Plan

The Commonwealth *Water Act 2007* requires the Murray-Darling Basin Authority (MDBA) to prepare and oversee a Basin Plan. This plan is a legally enforceable document that provides for the integrated management of all the basin's water resources. Some of the main functions of the Basin Plan will be to:

- set and enforce environmentally sustainable limits on the quantities of surface water and groundwater that may be taken from basin water resources
- set basin-wide environmental objectives, and water quality and salinity objectives
- develop efficient water trading regimes across the basin
- set requirements that must be met by state water resource plans
- improve water security for all uses of the basin water resources.

The Basin Plan will provide the new foundation for managing the basin's water resources in accordance with any rules and plan accreditation criteria established by the MDBA. At the heart of the Basin Plan will be limits on the quantities of surface water and groundwater that can be taken from basin water resources. These are known as 'sustainable diversion limits'. As the sustainable diversion limits come into effect, they will replace the current Murray-Darling Basin Ministerial Council Cap on diversions and will set limits on the taking of both groundwater and surface water from the basin.

Further details can be found on the MDBA website www.mdba.gov.au in the Basin Plan section.

5.2.5 Catchment action plans

The plan is consistent with and contributes to the catchment action plans for the Western, Border Rivers-Gwydir and Namoi catchments. The action plans can be found on the relevant catchment management authority (CMA) websites:

- Western CMA: www.western.cma.nsw.gov.au under 'ten year catchment plan'
- Border Rivers-Gwydir CMA: www.brg.cma.nsw.gov.au in the publications section.
- Namoi CMA: www.namoi.cma.nsw.gov.au in the publications section.

The Western Catchment Action Plan rivers and groundwater theme has two catchment targets, relating to improving or maintaining water system health at monitoring sites and salinity targets at Wilcannia. More specifically, management target six states 'flow sharing arrangements including water sharing plans implemented by DNR for all priority streams by 2010, with advice from the Western CMA on water management issues which affect the catchment community'.

The Border Rivers-Gwydir Catchment Action Plan water theme has a catchment target which is 'by 2015 maintain or improve the condition of all subcatchments across the catchment based on the scores from the 2001 Riverine Condition Assessment index'. The action plan explains that 'no target is included for hydrology (the amount of extraction and extent of regulation). The Border Rivers-Gwydir CMA is currently involved in the development of macro water sharing plans and these will govern the extraction and regulation of water based on sustainable yields that consider the economic and environmental constraints of the water source'.

The Namoi Catchment Action Plan water theme has a catchment target for the region's rivers and aquifers which is 'from 2006, there is an improvement in the condition of surface and ground water ecosystems'. Management target four is 'from 2006, oversee and review water management planning and other processes under the *Water Management Act 2000*, so that Water Management Plans, including Water Sharing Plans (WSPs), result in fair and reasonable access to surface and ground water sources for the environment (water dependant ecosystems), economic uses (agricultural, industrial, town water supply) and social values (recreation, cultural).'

Similar to the statewide targets on improvement in riverine ecosystems and the ability of aquifers to support groundwater dependent ecosystems, the plan will contribute to achieving the above targets by:

- setting a defined share of water for riverine ecosystems
- protecting very low flows
- implementing trading rules to maintain or reduce entitlement in river sections
- adopting an adaptive management approach, giving the Minister the ability to adjust rules once information becomes available, or upon remake of the next plan.

One of the CMA responsibilities, as observers, is to provide the IRP with advice on the alignment of the proposed water sharing rules with the priorities in their catchment action plan.

5.3 Other considerations

There are a number of policies and water related issues that require consideration with the development of the plan and the associated water sharing rules.

5.3.1 Protecting Aboriginal values

Aboriginal people have a spiritual, customary and economic relationship with land and water that provides an important insight into 'best practice' for natural resource management. The NSW Government is determined to ensure that Aboriginal culture is maintained across the state and that Aboriginal communities benefit from the new opportunities that the water market will bring.

Water sharing plans recognise the importance of rivers and groundwater to Aboriginal culture. The plans will allow Aboriginal communities to apply for a water access licence for cultural purposes such as manufacturing traditional artifacts, hunting, fishing, gathering, recreation, and for cultural and ceremonial purposes. An Aboriginal cultural licence can also be used for drinking, food preparation, washing, and watering domestic gardens.

Aboriginal cultural licences allow communities to access water for important cultural purposes and the plan provides for them to be granted, throughout the plan area. These cultural licences are limited to ten megalitres per year per application.

The plan also allows supplementary water (subcategory Aboriginal environmental) access licences to be granted to Aboriginal persons or communities in the Barwon-Darling unregulated river water source. These access licences are intended to allow Aboriginal persons and communities to extract

water to fill lagoons and billabongs to improve or restore their Aboriginal cultural and environmental value. Further information on these licences is found in the section '6.2.4 Rules for granting access licences' under water sharing rules for the Barwon-Darling unregulated river water source.

An amendment clause is now included in all water sharing plans, allowing that the plan may be amended after year five to provide rules for the protection of water dependent Aboriginal cultural assets, including:

- the identification of water dependent Aboriginal cultural assets in a schedule,
- amending the access rules to protect water dependent Aboriginal cultural assets,
- restricting the granting and amendment of water supply works to protect water dependent Aboriginal cultural assets, and/or
- amending the dealing rules to protect water dependent Aboriginal cultural assets.

For more information, see the fact sheet *Macro water sharing plans – Information for Aboriginal water users*, which is available on the Office of Water website www.water.nsw.gov.au.

5.3.2 Protecting basic landholder rights

Under the *Water Management Act 2000*, extraction of water for **basic landholder rights** (BLR) are made up of domestic and stock rights, harvestable rights and native title rights. Water may be extracted under these rights without the need for a water access licence, although in the case of accessing groundwater under a domestic and stock right the bore must still be approved by the Office of Water.

The principles of the *Water Management Act 2000* also require that water sharing must protect BLR. The plan does this by identifying the water requirements for domestic, stock and native title rights at the start of the plan and taking these requirements into consideration when designing rules for licensed water extractions. As the access rules for water access licences do not apply to BLR users this provides BLR users with a higher level priority of water access. The requirements of harvestable rights have been inherently considered as the design of access rules is also based on river flows that result after harvestable rights extractions have occurred. There are currently no extractions for native title rights. However, these rights may be activated during the plan's ten year term.

Domestic and stock rights can be restricted by the Minister to protect the environment or public health, or to preserve existing basic landholder rights. These restrictions are outside the framework of the plan.

The plan provides an estimate of the water requirements for domestic and stock rights within each of the water sources, noting that these rights may increase during the life of the plan. The plan cannot limit or restrict these rights, but the *Water Management Act 2000* itself provides for restrictions on basic landholders rights, through the development of mandatory guidelines.

In estimating the requirements for domestic and stock rights, Consideration has been given to both surface and groundwater simultaneously, effectively reducing the double counting of these requirements. The method is summarised as follows:

- Areas of significant reliance on groundwater and surface water are determined.
- 2005 land use data held by NSW Office of Water is used to determine grazed area and a consequent volume determined by applying a stock consumption allowance (megalitres per hectare), to estimate stock watering use in each water source.
- ABS Population and Housing Census data by collector districts is used to calculate the number of houses in each water source and a domestic consumption allowance (megalitres per 'house') is applied to estimate the total domestic water use for each water source.

5.3.3 Protecting town water supply access

Towns have a higher priority for access to water than commercial licences. Water sharing plans recognise this priority by ensuring that a full share of water is allocated for annual town water supplies except where exceptional drought conditions prevent this. The annual share for every town water supply will be specified on the town's licence. Towns may be able to sell part of their annual account water to other towns but, unlike commercial users, will not be able to sell the licence outright.

In unregulated surface water and groundwater sources, towns will not need to change their existing water access arrangements unless their current infrastructure is unable to meet their water needs and requires upgrading. In this case, when a major augmentation of the works occurs, town water utilities will need to meet conditions specified in the plan to ensure that there is enough water flowing to protect the environment and consider any potential impacts on other consumptive users.

Outside of the plan, section 324 of the *Water Management Act 2000* allows the Minister to make an order declaring temporary water restrictions over a water source. An order can be made under section 324 to restrict B and/or C class access on the Barwon-Darling unregulated river and supplementary access on the Namoi, Gwydir and Border Rivers to help maintain two years town water supply for Broken Hill in Menindee Lakes. It is intended that an order under section 324 of the *Water Management Act 2000* would also be made to enact the provisions of the Interim Unregulated Flow Management Plan for the North-West (see section '6.6.1 Interim Flow Management Plan for the North-West').

5.3.4 Managing surface water and groundwater connectivity

A key objective of the 2004 Intergovernmental Agreement on a National Water Initiative is 'recognition of the connectivity between surface and groundwater resources and connected systems managed as a single resource'.

For the purposes of developing plans for inland aquifer systems in NSW, the Office of Water has defined a highly connected surface-groundwater system as one in which '70 percent or more of the groundwater extraction volume is derived from stream flow within a single irrigation season'. This is a simplified version of, but still reasonably consistent with, the key findings and conclusions circulated for discussion amongst state jurisdictions by the Murray-Darling Basin Commission in their 2008 report '*Evaluation of the connectivity between surface water and groundwater in the Murray-Darling Basin'*.

Using the above definitions of connectivity, the Upper Darling Alluvial groundwater source will be treated as 'less highly connected'. This approach is applied consistently to all inland water sources.

5.3.5 Granting new access licences

Plans make provision for the application for new access licences in addition to those prescribed by the *Water Management (General) Regulation 2011*. If additional licences are granted in a water source and usage is assessed to have exceeded the LTAAEL, then growth management provisions in the plan are implemented.

Each of the water sources in the plan area have been embargoed under the WA 1912 for the application of new licences (see section '4.8.1 'Embargoes under the *Water Act 1912'*).

The regulation prescribes a number of different types of specific purpose access licences for which applications may be made. Clause 19 of the regulation allows for applications to be made for the following specific purpose access licences:

- a local water utility [domestic and commercial] access licence, for the purpose of domestic consumption and commercial activities

- a domestic and stock [domestic] access licence, for the purpose of domestic consumption
- an unregulated river [town water supply] access licence, for the purpose of supply to communities for domestic consumption and commercial activities
- an aquifer [town water supply] access licence, for the purpose of supply to communities for domestic consumption and commercial activities
- any category of specific purpose access licence that has a subcategory ‘Aboriginal cultural’, for Aboriginal cultural purposes.

Under the plan, applications for specific purpose access licences may be made in accordance with clause 19 of the regulation, an access licence may be granted in accordance with a dealing or an access licences may be granted in accordance with the specific rules for the unregulated river water source or alluvial groundwater source (see section ‘6.2.4 Rules for granting access licences’ for each water source).

5.3.6 Mandatory conditions

The plan sets out a number of provisions that will be applied as mandatory conditions to water access licences and water supply work approvals, developed by other rules contained within the plan. These mandatory conditions are designed to protect the rights of all users in the water source and the environmental water rules of the plan. They cannot be removed or altered unless the plan itself is amended.

6.0 Rules for the Barwon-Darling unregulated river

6.1 Background

6.1.1 Interim Unregulated Flow Management Plan for the North-West

The Interim Unregulated Flow Management Plan for the North-West of NSW (the interim plan) was released in February 1992.

The primary objective of the interim plan was to better manage unregulated flows to provide water quality and fish passage outcomes for the Barwon-Darling without significantly impacting on water users.

The interim plan established:

- target flows at key locations along the Barwon-Darling
- priorities for river health and riparian flows
- a framework for sharing unregulated flows between irrigators
- better management of extractions
- improved monitoring and research programs.

The interim plans target flows include:

1. Riparian flows

The flow targets at each town along the Barwon-Darling will vary depending upon the inflows from tributaries downstream of Mungindi. If no such inflows exist the targets are shown in Table 9.

Table 9 Riparian flow targets under the interim north-west unregulated flow plan

Location	Target (ML/day)
Mungindi	850
Collarenebri	760
Walgett	700
Brewarrina	550
Bourke	390
Louth	280
Wilcannia	150

2. Algal suppression

Access to uncontrolled or unregulated flows is managed to achieve a flow of at least 2,000 megalitres per day for five days at Wilcannia in the period October to April inclusive, unless a flow of at least this size has occurred within the preceding months.

Some restriction to supplementary access in the major tributaries and/or to B and C class access on the Barwon-Darling, prior to three months of below algal suppression flows at Wilcannia may be required to allow for the time it takes for flow to travel from the tributaries to the lower Barwon-Darling.

3. Fish migration flows

Access to uncontrolled or unregulated flows is managed to achieve a target flow of at least 14,000 megalitres per day at Brewarrina and/or 10,000 megalitres per day at Bourke for five days in the

months September to February inclusive, unless two such flows have occurred within this period. These rules were intended to apply until appropriate fishways are installed at Bourke and Brewarrina weirs.

Although the interim plan has been in place since 1992, difficulties with flow forecasting across such a large geographical area with varying antecedent conditions has to date significantly limited its application.

6.1.2 Barwon-Darling River Management Committee

6.1.2.1 Development of environmental flow rules for the Barwon-Darling

6.1.2.1.1 Indicative environmental flow rules for the Barwon-Darling

A panel of independent scientists (Thoms et al 1996) conducted assessments on the Barwon-Darling River between Mungindi and Menindee in 1995 and observed evidence of habitat degradation throughout the system. The panel considered it to be particularly severe in the reaches Collarenebri to Walgett and Bourke to Louth and less severe between Louth and Wilcannia and Brewarrina and Bourke. In all cases, in-channel habitat availability and access to important food sources was found to have declined due to hydrologic changes.

In recognition of the declining river health of the major irrigation rivers in NSW (including the Barwon-Darling), the NSW Cabinet on 19 August 1997 endorsed recommendations from the then Minister for Land and Water Conservation and Minister for the Environment that would see environmental flow rules applied to each of these systems.

Prior to these cabinet deliberations, officers from the then Department of Land and Water Conservation, Environmental Protection Agency and other state agencies with interests in water management were asked to develop indicative flow rules for each of these systems. These rules were intended to address river health needs related to water flows in the valley, but were not to have an impact on water users exceeding ten percent of average annual diversions. Note that average annual diversions were benchmarked using the Barwon-Darling Cap Integrated Quantity and Quality Model.

The Barwon-Darling indicative environmental flow rules were based on the scientific panel's assessment into the impact of tributary and Barwon-Darling development on river flows and water dependent environments and ecosystem processes. The panel identified a number of flow related issues, expressed a number of environmental objectives and made a number of recommendations for future actions.

The single greatest catalyst for change to licence access conditions was the environmental objective to improve in-channel habitat availability. Further, the panel recommended that flows equal to or less than ten percent of river channel capacity were essential to maintain the river environment. Estimates based on cross sectional area and flow data indicate that this equates to flow in the 50th to 60th percentile range of flows throughout the river. Therefore, it was proposed to increase pumping thresholds to the 60 percentile for B class and the 50 percentile for C class licences, thus meeting this requirement while preserving the distinction between these classes of licence.

The Barwon-Darling indicative environmental flow rules were then submitted to cabinet who agreed that these rules should be considered by the Barwon-Darling River Management Committee. The committee was given until March 1998 to review the rules and, if they so agreed, propose variations.

6.1.2.1.2 Environmental flow rules for 1998/99

On 1 April 1998, the Barwon-Darling River Management Committee submitted advice to the then Minister for Land and Water Conservation for the setting of environmental flow rules on the Barwon-Darling in the 1998/99 water year. Included in this advice was the analysis of five different options (including the indicative environmental flow rules) considered by the committee in their deliberations.

The decision was not unanimous, however the majority of members favoured the below option, broken down as three rules:

1. Pumping thresholds for all B class licences above the Namoi junction to be set at the 60th percentile natural flow.
2. Pumping thresholds for all B class licences below the Namoi junction to be raised:
   - by 200 megalitres per day from Namoi junction to Brewarrina;
   - from 390 to 1150 megalitres per day at Bourke; and
   - from 280 to 1000 megalitres per day at Louth.
3. Introduce limits on diversions below the Namoi junction for flows between those set out in rule two and the 60th percentile natural flow. At this point, these limits were a notional concept and had not been quantified.

These rules were subsequently endorsed by the Minister for application in the 1998/99 water year.

Importantly, the committee placed the following caveat on its advice to the Minister that 'rules may require some adjustment or refinement as the operational aspects are developed for proposed thresholds, for example workable gauge heights, whether single or dual gauge triggers and the location and installation of additional gauges (at least 2 to 3 needed)'.

Subsequent meetings of the committee and its working groups attempted to resolve the rules (and licence conditions) for A, B and C class licences, the appropriate thresholds below Louth and the operational aspects of rule three.

At meeting 5 (13-14 May 1998), the committee agreed

- 'that in relation to rule three, a 50/50 flow sharing model should be adopted as the most straight forward way to manage to Cap levels of extraction in this range. This will be subject to review as more information becomes available'
- 'that the Walgett to Brewarrina and Brewarrina to Bourke river sections would be subdivided'
- 'stream gauges upstream and downstream of the Macquarie and Culgoa confluences would be required'.

The introduction of the 1998/99 rules meant that A class licences above the Namoi River junction now had thresholds that were above the B class thresholds. To resolve this problem, the committee agreed that A class licences above the Namoi River junction should be lowered below B class licences, with a parity maintained similar to that between the two classes in other reaches. Further, it was agreed that A class licences below the Namoi junction should remain the same.

It is noted that all A class thresholds fall well short of the base environmental flow, that is the 60th percentile, however, it is assumed that the effect of this A class pumping has a comparatively negligible impact on the river system.

Additionally, the committee advised that it was inappropriate to standardise C class access conditions, as upon issue, they had been intentionally tailored for each individual licence. The basis on which these new access conditions were devised was essentially to ensure that each new licence did not compete for the same water as existing downstream irrigators, often this involved negotiations with the

downstream users. The view of the committee was that as these access conditions represented a mutually acceptable solution, they should not be undermined. Consequently, it was agreed that as a general rule 'pumping thresholds for C class licences now falling below the new B class thresholds will be raised, by the same amount as the B class licences in those reaches, to maintain the relativity between these licences. If the C class licence threshold is above the new B class threshold, the threshold will remain the same'. There were however, two C class licences upstream of Namoi junction, which were assessed a little differently. The access conditions for these two licences were instead resolved by a working group, involving one of the irrigators in question.

By meeting 6 (29-30 July 1998), the access thresholds for all classes of irrigation licences had been agreed on and there was a need for the [five] new river gauging stations to be established as reference points for implementing licence conditions. At this meeting it was agreed 'that the new licence conditions would not be implemented until all required gauges are operational'.

At meeting 7 (17-18 November 1998), the committee was advised 'that the 1998/99 environmental rules endorsed by government in April this year have not been implemented because necessary river gauges could not be installed before the winter – spring floods; and that these gauges, to be located upstream of the Namoi junction, upstream and downstream of the Culgoa junction and upstream and downstream of the Macquarie junction, will be installed by the end of January 1999'.

6.1.2.1.3 Environmental flow rules for 1999/00

On November 17 1999, the committee advised the Minister that the environmental flow rules for the 1999-2000 water year would be essentially those previously recommended for 1998/99. In its advice the committee noted 'unfortunately, the 1998-99 rules have not been implemented because required river gauges were not installed. Water users continue to adhere to their old licence conditions, although the Bourke water users association has voluntarily adopted the higher access thresholds and trialed the 50/50 sharing rule for a period over last summer'.

By mid December 1999, the installation and calibration of required stream gauges was completed.

These gauges are:

- Barwon at Tara 42205 (upstream of Namoi River junction)
- Barwon at Boorooma 422026 (upstream of Macquarie River junction)
- Barwon at Geera 422027 (downstream of Macquarie River junction)
- Barwon at Beemery 422028 (upstream of Culgoa River junction)
- Darling at Warraweena 425039 (downstream of Culgoa River junction)

6.1.2.1.4 Environmental flow rules for 2000/01

In June 2000, the Barwon-Darling River Management Committee submitted what would be their final advice on environmental flow rules to be implemented in the 2000/01 water year. This advice was identical to rules one and two of the 1999/2000 water year, but proposed changes to rule three. The changes followed the acceptance by the committee of the threshold alternative to the 50/50 sharing rule. This threshold alternative was determined through the analysis of several Integrated Quantity and Quality Model runs, aiming to achieve an average annual diversion equal to that yielded by the 50/50 flow sharing rule. The threshold set providing the best match was one in which thresholds were reset to the existing environmental flow rules thresholds plus 15 percent of the difference between the environmental flow rules thresholds and the 60th percentile flow. These thresholds are shown in Table 10.

Table 10 Threshold equivalents to 50/50 flow sharing rule (flows in megalitres per day)

Station	Walgett	Upstream Macquarie	Brewarrina	Upstream Culgoa	Downstream Culgoa	Bourke	Louth	Wilcannia
'B' class threshold alternative to 50/50 rule	900	870	840	760	1330	1250	1130	850
Existing 'B' class threshold	900	825	750	670	1230	1150	1000	774

6.1.2.2 Barwon-Darling Cap Management Strategy

The Barwon-Darling Valley was initially subject to Special Audit, and declared in breach of Cap, by the Independent Audit Group (IAG) in 2000 (MDBMC, 2000). NSW subsequently proposed to combine the Barwon-Darling and Lower Darling Valleys for reporting purposes under Schedule F (now Schedule E) of the Murray-Darling Basin Agreement (hereafter 'the Cap'). At that time, NSW gave an undertaking to ensure that the Barwon-Darling sub-valley would still be managed to ensure compliance with the Cap.

The combined Barwon-Darling/ Lower Darling Cap Valley was then declared in breach of the Cap following the 2003-2004 Review of Cap Performance by the IAG. In response, the (former) NSW Department of Natural Resources, in consultation with key stakeholders, developed Cap management arrangements for the Barwon-Darling that were considered by the IAG in 2005.

These arrangements included reducing the total licensed entitlement for the Barwon-Darling river valley from 524 GL to 173 GL, the latter figure being the estimate at the time of the long-term average annual diversions at 1993-94 levels of development and management (Cap), based on river basin modelling.

Another feature of these arrangements was the ability for individuals to continuously carry forward their share in the long-term average Cap from year to year with the only limit on the use of this accrued account water being the original entitlement volume (referred to as Annual Volumetric Limit) of that licence. Central to the concept was that by distributing annual shares in the long-term average Cap for the valley, Cap would not be exceeded in the long term. Implicit to this strategy was that short term average annual diversions could be significantly larger than the longer term Cap, reflecting the boom-bust nature of Barwon-Darling flows and hence extraction opportunity.

In 2005, the Independent Audit Group reported to the MDBMC that 'The IAG accepts that a fixed licence allocation of the type proposed by NSW will ensure the Cap will be kept over the long term…..' (MDBMC, 2005).

Consistent with this independent assessment, in 2006 the Minister for Natural Resources signed a Heads of Agreement for a Barwon-Darling Cap Management Strategy (the Strategy), with the NSW Water Administration Ministerial Corporation, the Mungindi-Menindee Advisory Committee, Bourke Shire Council, Clyde Agriculture, Darling Farms and NSW Irrigators Council.

A copy of the Cap Management Strategy is included as appendix 3.

6.1.3 Barwon-Darling Cap Integrated Quantity and Quality Model

6.1.3.1 Recent refinements

Since announcing the Cap management strategy in 2006, NSW has made revisions in three main areas to the original Barwon-Darling Cap Integrated Quantity and Quality Model (IQQM) 2001 version

(Model run number 93940001.sys) that generated a long-term average annual diversion of 173 gigalitres for irrigation:

1. Inclusion of updated inflow data

The original Barwon-Darling Cap IQQM utilised tributary inflows from 1922 to 2000. Most of these inflows which are provided by the upstream tributary Cap models have been revised and the Barwon-Darling Cap IQQM now incorporates the improved estimation of these tributary inflows and a longer modeling period (1895 to 2009).

2. Refinement of the model to include recent drought behaviour of individual irrigators

Irrigators in the original Barwon-Darling Cap IQQM were calibrated in 2001 using infrastructure and diversion data from 1995 to 2000. A whole valley comparison of observed annual diversions versus current development modelled annual diversions showed that for the years 1999/2000 to 2007/08 modelled diversions were less than the observed in two thirds of years and that this difference had accumulated to about 110 gigalitres. The difference between observed and modelled diversions is caused by deficiencies in the model's ability to replicate on-farm processes that affect diversions during the predominately drier period that occurred post calibration.

These deficiencies were identified in the two major parameters that influence irrigator behaviour, irrigation efficiency and rainfall run-off harvesting efficiency. Irrigators were recalibrated using extended infrastructure and diversion data from 1995-2005. Appropriate changes were made to both irrigator efficiency parameters to more closely match modeled and observed diversions. Changes were also made to the capacities of some on-farm storages in the Culgoa to Louth reach. These changes were based on observed LiDAR survey data, recently obtained and analysed for this purpose.

3. Inclusion of occasional pumping restrictions applied in times of drought

These changes were included at the request of the Independent Auditor appointed by the Murray-Darling Basin Authorities Independent Audit Group (IAG), who is responsible for the peer review of the Barwon-Darling Cap IQQM. In effect, the changes were designed to replicate the past practice of 'embargoing' B and C class access within the Barwon-Darling in order to allow a sufficient volume of water to pass through to the Menindee Lakes for Broken Hill Town Water Supply. For modelling purposes, these restrictions have been based on critical water levels being maintained in the Menindee Lakes. Importantly, the revised Barwon-Darling Cap IQQM (Model Run Number Adt LT17.sqq) when run over the 1895 to 2009 simulation period now reveals a long-term annual average diversion of 190 gigalitres.

These model revisions and most particularly the changes to efficiency parameters have also had a significant effect on the Barwon-Darling Cap performance as measured by Schedule E (see section '5.2.1 Murray Darling Basin Cap Management'). Prior to the above changes the accumulated debit under Schedule E for the Barwon-Darling sub-valley was 346 gigalitres at the end of the 2009/10 water year and now (at the end of the 2010/11 water year) it is 2 gigalitres in credit.

Further details of the Barwon-Darling IQQM can be found in Appendix 4.

6.1.3.2 Metering data correction

The Cap management strategy envisaged that the concurrent installation of (new) Mace meters with (old) time and event meters would provide a means to improve the accuracy of the historical 'time and event' pump data dating back to 1995.

It has since been identified that there are issues with the Mace data highlighted by the comparison of diversions from identical pump setups. This problem is exacerbated by a number of pump

replacements from those that existed in 1993/94 and that the remaining pumps are now considerably worn.

If the 'time and event' data can be corrected (particularly the data 1995-2005) and the Cap IQQM can be re-calibrated against it, this will produce a revised Cap IQQM. The corrected data will also provide more reliable individual and valley historical extraction that can be used (as agreed in the Cap management strategy) to redistribute revised Cap shares.

The plan allows for an amendment to be made to the LTAAEL and share components of unregulated river access licences to incorporate the required management actions arising from this meter data review.

6.1.4 Short term Cap management actions

Despite the introduction of a long-term Cap Management Strategy for the Barwon-Darling Unregulated River in 2006, the Schedule E Cap debit for the Barwon-Darling sub valley continued to grow and was reported by the IAG as being 346 GL after the 2009/10 water year.

In response, various announcements during the development of the plan were made by the NSW Government following representations from the then Murray-Darling Basin Ministerial Council (now Murray-Darling Basin Legislative and Governance Forum) regarding short-term Cap management actions to respond more quickly to the cumulative Cap debit under Schedule E for the Barwon-Darling sub-valley.

During November 2011, in response to a revised Cap model (see section '6.1.3.1 recent refinements') that was indicating a significant reduction in the Schedule E cumulative Cap debit for the Barwon-Darling sub-valley, the NSW Commissioner for Water announced an interim Cap management action for 2011/12 that included distributing shares in 198 GL (the interim long-term Cap estimate at that time from the revised Cap model) with no access to accrued account water. The purpose of this action was to constrain water use to a maximum of 198 GL as an interim strategy to allow time for the revised model to be peer reviewed and accredited by the IAG for Cap auditing purposes.

In January 2012, the Commissioner for Water announced 'borrow forward arrangements' that would apply in addition to the arrangements announced in November 2011. These borrow arrangements allowed water users, through an expression of interest process, to gain access to their 2012/13 Cap share in the 2011/12 water year.

6.1.5 Water Shepherding

In July 2010, the Commonwealth and NSW Governments signed a bilateral Memorandum of Understanding (MoU) in relation to shepherding water for the environment. The MoU defines water shepherding as the delivery of a calculated volume of water that was created by the non-activation/reduced extraction at a nominated licence location to a more downstream location with consideration of losses and without causing adverse third party impacts on stakeholders, where it will be made available for extraction or use for the environment.

The implementation of water shepherding in the Barwon-Darling and its tributaries is being developed in two stages. Presently, Implementation Plan (Stage one) which is developing the proposed arrangements for water shepherding is due to be completed by September 2012. Following endorsement of Implementation Plan (stage two) by both the NSW and Commonwealth governments, a project will commence to enable water shepherding to be implemented.

The Plan can be amended to allow for the implementation of water shepherding in the Barwon-Darling.

6.1.6 Comparison with macro approach

The 'macro' planning process is the current approach of the Office of Water to developing plans and for unregulated water sources is described in the manual *Macro water sharing plans – the approach for unregulated rivers. A report to assist community consultation* (Office of Water, 2010). The approach was designed to develop broader scale plans covering a large river basin, not a single water source. In this process, a risk and value assessment results in a classification for each water source which is used to assist in determining the optimal balance between extraction and retention of water in-stream. These broad scale relative assessments show where water sharing rules need to strongly protect valuable natural assets by limiting extraction or to provide for extraction by water users where there is significant community dependence on extraction.

The macro planning classification process was not used for the development of the rules for the Barwon-Darling unregulated river as the history of management in this water source necessitated the development of more complex rules.

6.2 Water sharing rules

Water sharing rules included in the plan are:

- access rules – which determine at what flows or river heights extraction is allowed
- extraction limits – which set the total volume of water that can be extracted on a long-term average annual basis from the water source
- rules for granting new entitlement – what types of access licences may be granted
- dealing rules – which control the trade of water (permanent transfer of access licence entitlements and assignment of water allocations between access licences, the change of water sources and the location for extraction).

Notes in the plan also foreshadow the use of 'temporary water restrictions' afforded by section 324 of the *Water Management Act 2000* in order to enact the provisions of the Interim Flow Management Plan for the North West (see section '6.1.1 Interim Unregulated Flow Management Plan for the North-West') and/or to maintain two years security of supply in Menindee Lakes for Broken Hill's town water supply. Note also that the Minister's powers under section 324 of the *Water Management Act 2000* cannot be limited by a water sharing plan.

6.2.1 Protecting environmental values

6.2.1.1 General

Plans are required to reserve water for the overall health of the river and aquifers and to protect specific ecosystems that depend on river flows, such as wetlands, lakes, estuaries and floodplains and groundwater dependent ecosystems. This share of water reserved for the environment is also intended to sustain the river and groundwater system's aquatic fauna and flora.

6.2.1.2 Evaluating the adequacy of the 2000/01 cease to pump rules for protecting instream values

The only available evaluation of the adequacy of these access rules for the protecting instream values is the algal suppression work carried out by Mitrovic et al in 2006, using the Integrated Quantity and Quality Model to detect the long-term effect that the current thresholds may have on algal bloom

development. Analysis of these modelling results indicates that the current thresholds may have significant environmental benefits mitigating against algal bloom development on the Barwon-Darling, by up to one third at some sites.

Further analysis of modelling of critical flow thresholds by Mitrovic *et al* (2006) was undertaken with the Integrated Quantity and Quality Model by Foster and Cooke (2011) to determine the potential impact of water sharing plans on the contributing tributaries upstream. Results in Appendix 5 show that the number of flow events that exceed the critical flow threshold for the suppression of algal blooms at Brewarrina, Bourke and Wilcannia increase with the application of the water sharing plans and resource operation plans in the tributary valleys and significantly more frequently with the application of access rules on the Barwon-Darling. Modelling shows that despite the increase in frequency, there is a significant reduction in the mean total volume of events exceeding the thresholds and a significant reduction in the mean maximum flow and maximum flows. The mean number of days since a previous event exceeding the critical threshold has reduced from 38 to 28 days at Brewarrina, from 35 to 19 days at Bourke, however an increase from 42 days to 62 days is observed at Wilcannia.

It is acknowledged that the 2000/01 access rules were developed before many aquatic ecological values within the water source were recognised by legislation. The Barwon-Darling Unregulated River water source now includes:

- 6 species listed as threatened or vulnerable under the *Fisheries Management Act 1994* or the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth),
- the endangered aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River listed under *the Fisheries Management Act 1994.*

Over the last decade, Fisheries NSW (and its predecessor organisations) has been undertaking research into the water requirements of native species of threatened fish within the water sharing plan area. Unfortunately, this research was not in a form that could be considered by the IRP during the development of this plan.

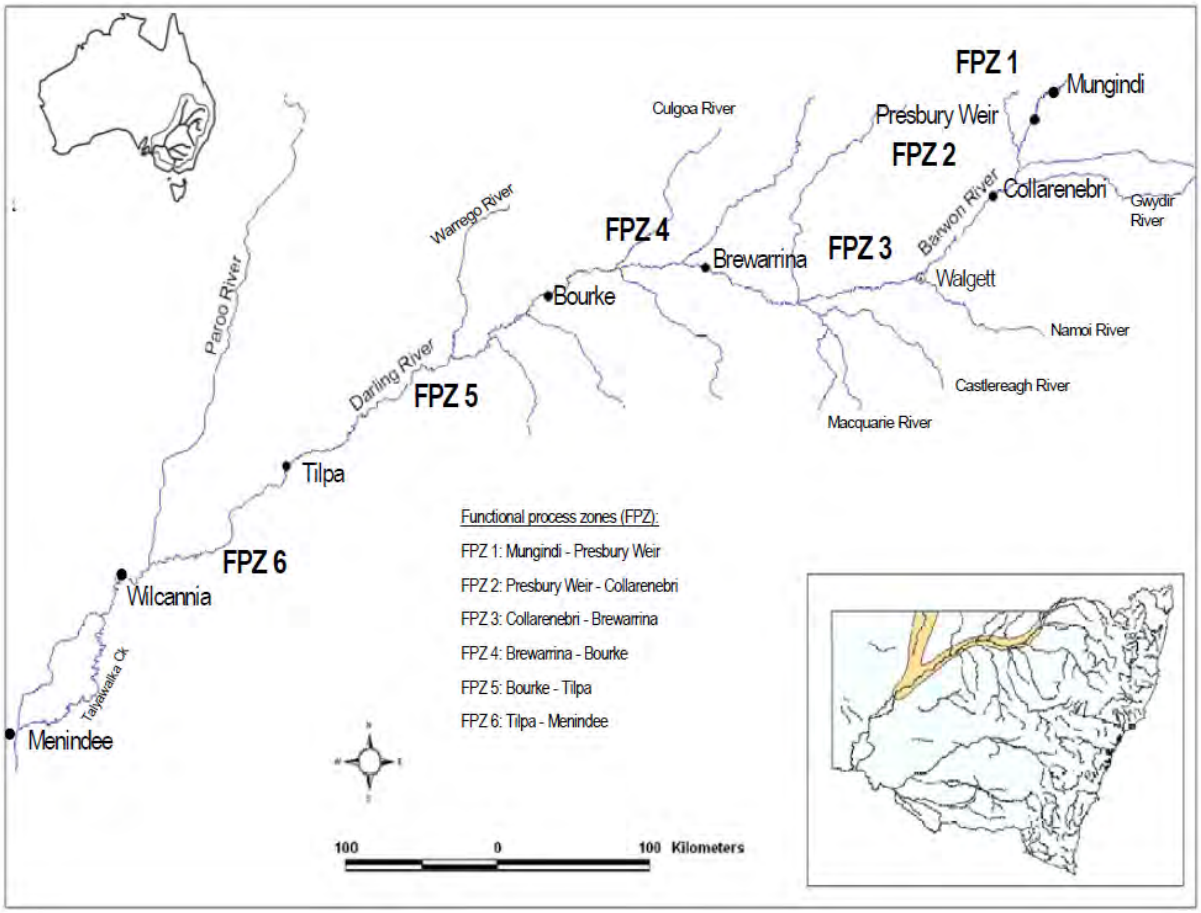
Using best available science, the IRP recommended that the existing 2000-01 environmental flow rules were adequate for protecting in-stream values within the Barwon-Darling Unregulated River water source, however, the IRP also recommended that the plan provide for amendment to the access rules where it can be demonstrated by future studies that the current access rules are having an adverse impact on the endangered aquatic ecological community, or an individual listed threatened species of fish within that community (see section ‘6.2.5.2.1 Amendment to access rules’).

6.2.1.3 Evaluating the adequacy of the 2000/01 environmental flow for protecting floodplain values

When makings its final recommendations on environmental flow rules for 2000-01, the Barwon-Darling River Management Committee reiterated that the environmental water requirements of the Barwon-Daring floodplain remained a significant information gap. In response, an investigation into the commence-to-fill heights of Barwon-Darling wetlands was commissioned. Further, it was intended that the findings of this report would be used to re-examine the adequacy of the current thresholds in achieving environmental benefits for the Barwon-Darling floodplain.

Brennan *et al* (2002) undertook an analysis of the physical character of the Barwon-Darling River between Mungindi and Menindee. The river was broken up into six functional process zones based on geomorphological and hydrological character (see Figure 11). In each of these zones the geomorphic diversity and hydrological connectivity of floodplain wetlands was evaluated. Overall 583 wetlands were identified and assessed.

Figure 11 Location of functional process zones within the Barwon-Darling

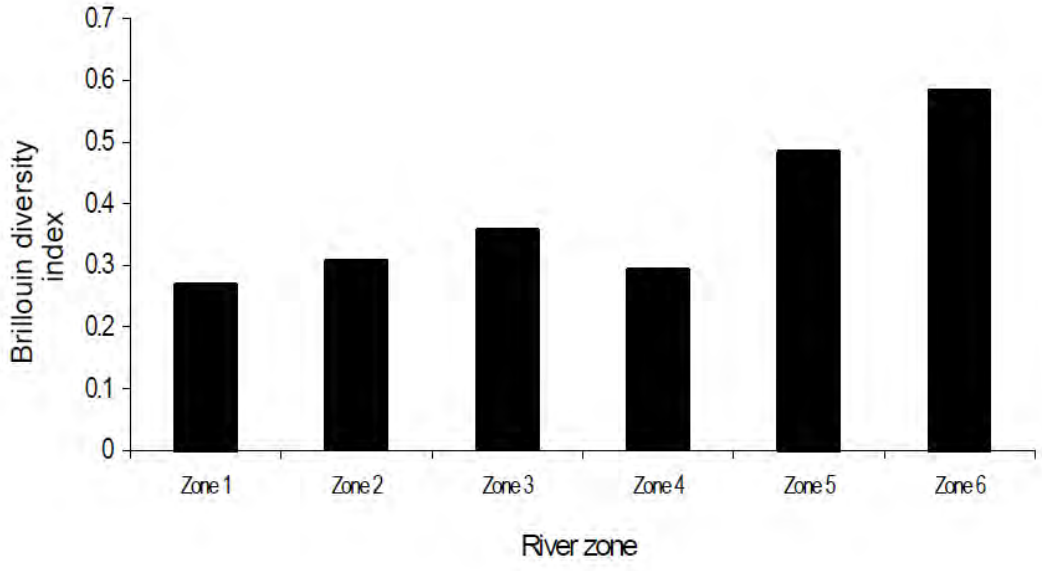


Source Brennan et al 2002

Commence to fill discharges were estimated for approximately 20 percent of the wetlands identified between Mungindi and Menindee (see Table 11). These wetlands consisted of anabranches and billabongs. These systems provide critical habitat for many aquatic organisms and woodland and water birds.

Figure 12 shows that the diversity of geomorphic diversity (i.e. structural complexity important for aquatic organism habitats) is highest in zone 6 and increases with distance downstream.

Figure 12 Wetland morphology diversity index for functional process zones in the Barwon-Darling River



Source Brennan *et al* 2002

Table 11 Critical flow volumes required to fill the wetlands identified within the respective zones between Mungindi and Wilcannia

Functional Process Zone	Critical flow groups (MLD)	Percent of wetlands in each group
Zone 1		
(Mungindi - Presbury Weir)	0 - 4000	**78***
	9000-17,000	22
Zone 2		
(Presbury Weir - Collarenebri)	1000-12,000	**30***
	19,000-30,000	**60***
	60,000	10
Zone 3		
(Collarenebri -Brewarrina)	2000-5000	6
	9000-32,000	**86***
	38,000-40,000	8
Zone 4		
(Brewarrina - Bourke)	0-4000	6
	11,000-32,000	**82***
	47,000-60,000	12
Zone 5		
(Bourke – Tilpa)	14,000-50,000	**77***
	59,000-82,000	17
	106,000	3
	177,000	3
Zone 6		
(Tilpa - Wilcannia)	8000-26,000	**23***
	29,000-35,000	**54***
	37,000-42,000	15
	46,000-48,000	8

Source Brennan *et al* 2002

Cooney (1994) has also undertaken a comprehensive evaluation of the commence to fill volumes required to inundate wetland systems within the Barwon-Darling on behalf of the working group of the interim plan for the management of unregulated flows in the north west of NSW. Cooney found that in each of the three reaches investigated, the estimated discharge required to inundate 50 percent of the wetlands to be:

- Reach 1: Mungindi to Brewarrina 19,000 megalitres per day
- Reach 2: Brewarrina to Louth 30,000 megalitres per day
- Reach 3: Louth to Menindee 21,000 megalitres per day

Using the findings of Brennan et al 2002, Foster and Cooke (2011) evaluated the potential change in frequency and duration of meeting commence to fill heights in various Barwon-Darling floodplain wetlands, under three different IQQM scenarios:

1. no tributary or Barwon-Darling development
2. NSW water sharing plan and Queensland resource operation plan levels of tributary development and no Barwon-Darling development
3. NSW water sharing plan and Queensland resource operation plan levels of tributary development and Cap baseline conditions for the Barwon-Darling.

Not surprisingly, these results (see Appendix 6) show that there has been approximately a 45 to 50 percent reduction in the frequency of commence to fill thresholds being exceeded where 'natural' flows occur and where water sharing plans and resource operation plans are operating on the tributaries. Interestingly, the difference between scenarios two and three was in most cases less than two percent, suggesting that whilst the impact of water resource development on the Barwon-Darling is significant, only minor environmental gains for floodplain wetlands could be expected from changes made to the commence-to-pump thresholds on the Barwon-Darling alone.

Using best available science, the IRP recommended that floodplain wetland cannot be meaningfully protected by changing the 2000-01 access rules and hence proposed no change.

6.2.1.4 Protecting pools, lagoons and lakes

Pools in NSW can provide an important source of water for access licence holders, basic landholder rights holders and communities. Pools also have a key ecological function as a critical refuge and habitat for flora and fauna. Pools include lentic water bodies (standing water) in or associated with unregulated rivers across NSW, including anything falling within the definition of a 'lake' found in the Dictionary of the *Water Management Act 2000*, except for tidal pools and estuaries.

Dealings rules in the plan protect off-river pools from the impacts of extraction by prohibiting the nomination of new works located on off-river pools for any access licence that does not already nominate works located within that off-river pool (see section '6.2.8 Restriction to nomination of works').

6.2.2 Managing extraction

6.2.2.1 Long-term average annual extraction limit

The volume of the long-term average annual extraction limit (LTAAEL) for the Barwon-Darling unregulated river water source is set equal to the long-term average annual extraction that would occur under Cap baseline conditions as agreed under the Murray-Darling Basin Agreement, that is, the sum of:

- the modelled long-term average annual irrigation diversion under Cap baseline conditions
- the estimated average annual diversions under Cap conditions for non-irrigation WA 1912 entitlements
- an estimate of basic landholder rights under Cap conditions.

At the commencement of the plan, the LTAAEL is calculated to be 210 gigalitres, of which irrigation contributes 197 gigalitres.

The LTAAEL recognises the effect of past climatic variability on the availability of water, in accordance with section 20 (2) (c) of the *Water Management Act 2000,* as historic climate and river flow information is used in its determination.

The LTAAEL includes the following:

- all water extractions by holders of all categories of access licences in accordance with the rules used for accounting of Cap diversions for Schedule E of the Murray-Darling Basin Agreement.
- domestic and stock rights and native title rights extractions
- any floodplain harvesting extractions determined to be taken for use in conjunction with extractions from the water source
- water allocations assigned from access licence water allocation accounts in the water source to access licence water allocation accounts in any other water source (if permitted).

An assessment of compliance with the LTAAEL will be carried out annually by comparing long-term diversions for a model configured to represent 'current conditions' with the LTAAEL model and a growth-in-use response will be triggered if this modeling indicates that long-term diversions under 'current conditions' exceed the LTAAEL by more than three percent.

6.2.2.2 Management to the Cap over the short-term

Although long-term Cap compliance is assured by the Cap Management Strategy (see section '6.1.2.2 Barwon-Darling Cap Management Strategy') and the associated restructure of entitlements, modelling demonstrates that future periods of significant cumulative Cap debit (as per Schedule E) are likely if the plan consists only of the Cap Management Strategy rules. These periods of modelled cumulative Cap debits are primarily the result of annual water use patterns under current development and management practices that are significantly different to the annual water use patterns that would have occurred under 1993/94 levels of development and management conditions i.e. Cap. Modelling of the efficacy of various plan mechanisms for reactively responding to a future breech of Schedule E (a cumulative cap debit that exceeds 20 percent of the long-term average annual diversions under Cap conditions) shows that an individual take limit of 300 percent of share component applying over three consecutive water years would be the optimal approach to employ in the Barwon-Darling. Consequently, the plan allows the Minister the discretion to introduce an individual take limit for unregulated A, B and C class licences of 300 percent of share component applying over three consecutive years as a reactive approach to address any future breach of Schedule E for the Barwon-Darling sub-valley. Note that recent refinements to the Barwon-Darling Cap model have resulted in the Barwon-Darling sub-valley being within the trigger thresholds of Schedule E at the commencement of the water sharing plan (see section '6.1.3.1 recent refinements') and hence this additional management action will not apply at the commencement of the plan.

6.2.3 Available water determination

Available water determinations credit water into the water allocation account of each water access licence. Specific purpose access licences such as domestic and stock or local water utility access licences, will generally always receive 100 percent of their share component, although in years of exceptional drought, daily access rules may limit extraction so that the full annual entitlement cannot be realised.

The maximum available water determination for unregulated river licence categories within the water source is used to manage growth in extractions above the long-term average annual extraction limit (LTAAEL). That is, if growth occurs then the maximum available water determination for unregulated river A, B and C class access licences will be reduced.

The maximum available water determination permitted in the plan for unregulated river A, B and C class access licences is the estimated long-term average annual extractions for irrigation under the LTAAEL, divided by the sum of share components of all unregulated river A, B and C Class access licences at that time. This allows an available water determination of greater than one megalitre per unit share if the estimate of irrigation extractions under the LTAAEL is increased without or prior to a redistribution of shares.

6.2.4 Rules for granting access licences

Supplementary (Aboriginal environmental) access licences can be granted to Aboriginal persons or communities to extract water to fill lagoons and billabongs in the Barwon-Darling unregulated river water source to improve or restore their Aboriginal cultural value. Supplementary (Aboriginal environmental) access licences can be granted up to a total volume of 2,000 ML/year across the water source; although water made available for extraction under this category across the water source through an order under section 70 of the *Water Management Act 2000* is limited to 500 ML in any one year. The extraction of this water is to be tagged as licensed environmental water under the *Water Management Act 2000* to be accounted for outside the LTAAEL.

The supplementary licence category was proposed by the NSW Office of Water so that:

- different Aboriginal individuals or groups may have the opportunity to use part or all of the water made available for this licence category
- unique access rules could be devised for these licences
- there are no ongoing fees associated with the licence, only usage charges.

An order made under section 70 of the *Water Management Act 2000* is required to authorise the take of water under a supplementary water access licence. Expressions of interest to take water under a supplementary (Aboriginal environmental) access licence are required to be lodged by licence holders at least one week, but no more than 12 months before water is proposed to be taken. If expressions of interest received by the NSW Office of Water exceed the total volume of water that may be made available, authorisations to take water under section 70 will be given first to applicants who have less frequent historical access, and then in chronological order of receipt.

The plan allows for the granting of supplementary (Aboriginal environmental) access licences in acknowledgement that water resource development both within the Barwon-Darling and upstream tributaries has resulted in a decreased frequency of flows required to fill lagoons and wetlands with significant cultural value within the water source. Therefore, access rules for the taking of water under these supplementary access licences are defined for each management zone to reflect the frequency of the lowest level of floodplain breakout under a long-term ‘natural’ model simulation of flows.

The plan allows for amendment of the rules governing supplementary (Aboriginal environmental) water access licences, should they not achieve the intended sharing of access among Aboriginal groups.

Feedback from recent Aboriginal consultation throughout NSW suggests that there is significant interest within the Aboriginal community in the notion of 'cultural flows' i.e. leaving water in-stream to maintain or improve cultural value. It should also be noted that supplementary (Aboriginal environmental) access licences cannot currently be used to enhance in-stream cultural values in unregulated rivers. Ultimately, in-stream cultural values are protected by the access rules. The plan allows for the amendment of access rules for the protection of water dependent Aboriginal cultural assets (as outlined in section '5.3.1 Protecting Aboriginal values').

6.2.5 Rules for managing access licences

6.2.5.1 Carryover and water accounts

A water allocation account will be established for each water access licence. Water is credited to the account when an available water determination is made, and debited when water is extracted. A licence holder's account is not permitted to go into debit.

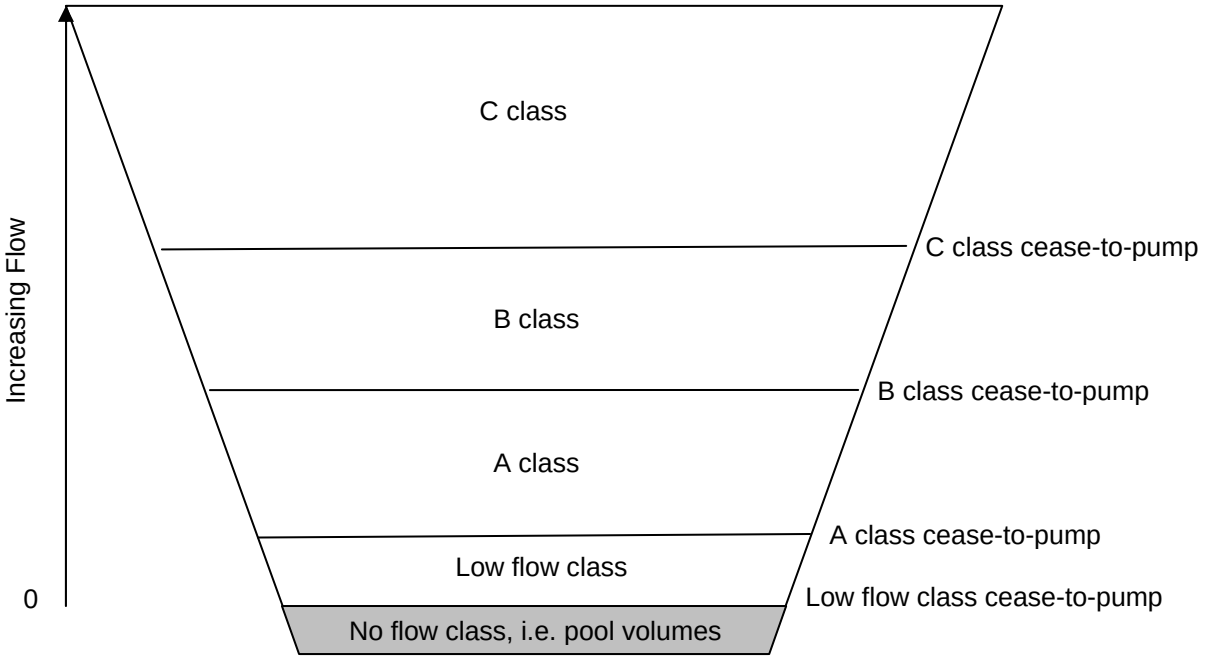
Unregulated rivers have enormous variation in annual flow volumes between years. Accordingly, Barwon-Darling unregulated river access licence accounts will operate under continuous accounting rules, subject to compliance with the daily access rules, take limits and extraction limits where applicable. There is no maximum amount of unused water allocation that can be carried over from one water year to the next.

Specific purpose access licences such as town water supply, supplementary (Aboriginal environmental), Aboriginal cultural and domestic and stock access licences are subject to annual accounting, with no carryover of unused water allocation permitted.

6.2.5.2 Access rules

The plan establishes five flow classes for each management zone; namely the no flow, low flow, A, B and C classes, as displayed in Figure 13.

Figure 13 Representation of flow classes in a typical river cross-section



Unregulated river access licences within the Barwon-Darling may access flows at or above their relevant flow class only, e.g. A class access licences can access A, B and C class flows. This reserves the low and no flow classes for the environment, with limited exemptions defined below. For A and B class licences, access conditions remain as per the 2000-01 environmental flow rules (see section '6.2.1 Protecting environmental values'). The plan also establishes a uniform flow class for C class licences above all existing C class conditions, but the existing access rules for C class licences continue to apply, as defined in schedule 2 of the plan. The purpose of establishing uniform flow classes that were above all existing conditions was to protect existing C Class users i.e. new licences as a result of some trades will receive the uniform C flow class conditions and so will not compete for the same physical water as existing users. These uniform C flow class conditions will have the effect of moving extraction pressure into higher flows, where that same extraction has less environmental significance.

6.2.5.2.1 Amendments to access rules

The Barwon-Darling River is considered by Fisheries NSW as a key fish asset. It contains a highly diverse native fish community with large areas of connected, quality habitat. The water source also encompasses the endangered aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River and 6 vulnerable or threatened species listed under the *Fisheries Management Act 1994* or the *Environment Protection and Biodiversity Conservation Act 1999*.

The access rules included in the plan are based on the 2000/01 environmental flow rules, created before the endangered aquatic ecological community and many of the threatened species were determined and listed. Based on the recommendations of the IRP, the plan includes provisions to amend the existing flow classes and access rules, establish new or additional flow classes and flow reference points after year five of the plan for any management zone in the Barwon-Darling unregulated river water source following a study that shows to the satisfaction of the Minister that the current access rules are having an adverse impact on an endangered aquatic ecological community in the Barwon-Darling unregulated river water source, or an individual listed threatened fish species within that community, provided that:

- such amendments do not apply to domestic and stock access licences and local water utility access licences
- in the Minister's opinion, such amendments do not substantially alter the long-term diversions under A Class, B Class and C Class access licences in the Barwon-Darling unregulated river water source
- the socio-economic impacts of the proposed rules have been taken into account, and
- the Minister has consulted with relevant Government agencies and stakeholders.

The IRP considered that it is critical to acknowledge and provide for the needs of the environment, consistent with the priority of the environment over extractive use in the *Water Management Act 2000.* Equally, the plan aims to ensure certainty for water users over its term, so the plan needs to define limits of change possible under any amendment.

During targeted consultation, Aboriginal stakeholders suggested the Brewarrina fish traps were an important Aboriginal cultural asset that could be managed by the plan. The fish traps are designed to operate on a falling river. As such, the IRP recommended that an amendment clause be included in the plan to change the access rules for any class in the Macquarie Junction to Brewarrina management zone, should a study show that these rules are having an adverse impact on the Aboriginal cultural value of the fish traps at Brewarrina, provided that:

- such amendments do not apply to domestic and stock access licences and local water utility access licences
- in the Minister's opinion, such amendments do not substantially alter the long-term diversions under A Class, B Class and C Class access licences in the Barwon-Darling unregulated river water source
- the socio-economic impacts of the proposed rules have been taken into account, and
- the Minister has consulted with relevant Government agencies and stakeholders.

6.2.5.2.2 Access to low flow class

There are a number of licences for domestic and stock purposes that currently have no flow conditions. Under the plan, domestic and stock licences will receive the 'low flow class' access conditions. In effect, these licensees must cease to pump when there is no flow at a relevant gauging station. Domestic and stock purposes also have limited access to the no flow class (see section '6.2.5.2.3 Access to the no flow class'). Precedents have been set in the past where a dedicated two inch pump was required for access to water during periods of no flow. The IRP recommended that domestic and stock licensed extraction for stock watering from the low flow class be limited to 0.6 ML/day (average pumping rate for a two inch pump).

The Plan also includes limited access to the low flow class for the survival watering of permanent plantings and when a flow event is imminent (see section '6.2.5.2.4 Recognising historical notwithstanding access').

6.2.5.2.3 Access to no flow class

Those activities that are considered critical human needs or animal health requirements are permitted to access the no flow, that is, water below the cease-to-pump defined in the access rules. Although the volume of extraction is relatively small, it is in direct competition for environmental water requirements at its most critical time. Licences with access to no flows include those used for:

- town water supply, until major augmentation of the schemes infrastructure occurs
- fruit washing
- cleaning of dairy plant and processing equipment for the purpose of hygiene
- poultry washing and misting
- cleaning of enclosures used for intensive animal production for the purposes of hygiene.
- stock and/or domestic purposes (see details below)
- survival watering of permanent plantings and when flows are imminent (see section '6.2.5.2.4 Recognising historical notwithstanding access')

The SIP has endorsed a policy position that applies across NSW for domestic and stock access to the very low flow class (equivalent to the no flow class in the Barwon-Darling unregulated river). This includes access to the very low flow class for domestic purposes at a maximum rate of 1 kilolitre per dwelling per day for the life of the plan and access to the very low flow class for stock watering at a maximum rate of 14 litres per hectare of grazeable land for the first five years of the plan. This policy position will be reviewed before year five of the plan to inform whether or not the exemption should continue beyond year five. The IRP can endorse more stringent rules for domestic and stock access to the very low flow class, but not less stringent.

Based on historical precedents where a dedicated two inch pump was required for access to water during periods of no flow and to limit impacts on other high priority water users and the environment

during this critical period, the IRP recommended that access to the no flow class for licensed stock use be limited to:

- 14 litres per hectare of grazeable area per day
- 0.6 ML/day (average pump rate of a two inch pump)
- pipe and trough reticulation systems

6.2.5.2.4 Recognising historical 'notwithstanding' access

All WA 1912 access licences in the Barwon-Darling unregulated river water source have had, upon application, historical access to water when the cease-to-pump rule is in place. This access has been granted through what is known as the 'notwithstanding' condition[4].

6.2.5.2.4.1 Historical access

A review of approvals to access water below cease-to-pump conditions under the notwithstanding condition in the Barwon-Darling water source was compiled from available records for the IRP to consider. In summary, this review showed that:

- in excess of 200 separate approvals for access under notwithstanding condition were granted from 1991 to 2006;
- the reasons for this access were typically to maintain permanent plantings and/or for livestock fodder production;
- the duration and volumes of access were variable; and
- the majority of notwithstanding applications were approved in drought years (1991-95 and 2002-04).

Since 2007, several applications for access under the notwithstanding condition have been received by the Office of Water, but access below the cease-to-pump (CtP) during this time has not been granted due to likely environmental and/or third party impacts.

6.2.5.2.4.2 Environmental implications

Environmental water needs are most critical during periods of low and no flows. There is a significant amount of literature on the environmental risks that extraction during periods of low and no flow poses; however, little work has been completed on ecosystem and species resilience thresholds to guide decisions on what would be 'acceptable' levels of access to low and no flows.

Whilst it could be argued that allowing access to water below the CtP has environmental implications, historically water users have had the ability to apply for access below the CtP so any tightening of this position should be seen as an overall gain for the environment.

6.2.5.2.4.3 Application in the plan

The IRP agreed that, in principle, reliance on access to flows below the CtP should be discouraged through the rules in the plan because of the risk it poses to environmental values and other high priority users, but considered options for permitting access in defined circumstances based on

[4] The notwithstanding licence condition as it reads in most licences: *(11) Notwithstanding anything contained in the foregoing limitations and conditions –application may be made to the Department of through its office at Dubbo from time to time for permission to use the licensed work during any limited period otherwise than in accordance with the said limitations and conditions. If any such application be granted in whole or in part by the said Department, then the licensed work may be operated for the period and in accordance with the conditions to be specified by the said Department in granting the application. The application and the granting thereof by the said department shall be in writing.*

historical approvals under the notwithstanding condition as well as feedback received through the public exhibition process on this issue.

As a result, the circumstances in which approval to access flows below the CtP may be considered under the plan, which are detailed below, are:

- access for A class licences for the survival watering of permanent plantings
- access for A class licences when flows are imminent
- access for B class licences when flows are imminent.

Note that the plan also allows for amendment to incorporate additional rules for access below the CtP for any reason that written approval was previous given under WA 1912 licence conditions. Before amending the plan to incorporate additional rules for access below the CtP the Minister must consult with relevant Government agencies and stakeholders.

Consistent with the intention to discourage reliance on access to flows below the CtP, the IRP recommended that access to imminent flows be only permitted for WA 1912 licences existing immediately prior to commencement of the plan and access for survival watering be only permitted for areas of permanent plantings existing at commencement of the plan. Permitting access only to existing WA 1912 licences (and in the case of survival watering, areas of permanent plantings) existing immediately prior to the commencement of the plan means that any new licences granted through trading activity or new areas of permanent plantings developed after commencement of the plan will not be able to apply for access below the CtP.

a) Access for survival watering

A class licences may apply to access the low flow class, or no flow class from Bourke weir pool (i.e. the pool in direct connection to the Bourke weir face), during the first five years of the plan on application for the survival watering of permanent plantings (table grapes, citrus, wine grapes, dried fruit, nuts and fruit trees), provided that:

- the licence to which the application relates is included in schedule 4 to the plan. The schedule lists licences arising from WA 1912 licences at commencement of the plan and their associated defined areas of permanent plantings
- water is to be extracted at a defined rate (kL/ha/day), direct to crop, for survival watering of defined areas of permanent plantings provided in schedule 4 (note that these rates assume other cultural practices are being used to reduce water requirements, e.g. radical canopy pruning)
- written approval of an application remains at the discretion of Minister,
    - who may deny access based on unacceptable downstream or local impacts on the environment, high priority or other water users
    - who may deny access if the applicant has breached their licence conditions in the past or if they have failed to pay their water licence fees
    - who may require specific records of extraction to be kept and provided
    - who must consult with relevant Government agencies and stakeholders prior to giving written approval.

A class licensees with permanent plantings are encouraged to investigate alternative reliability measures during the first five years of the plan, where feasible, such as capacity sharing of a joint off-river storage or connection to reticulated town water supplies.

The IRP recommended that access below the cease-to-pump (at the cost of the environment and other high priority water users) cannot be justified for the survival watering of lucerne as lucerne has

an investment timeframe more akin to annual crops than permanent plantings, which generally have investment timelines beyond 25 years.

b) Access when flows are imminent

(i) Access for A class licences

A class licences may be given written approval from the Minister to access the low flow class or the no flow class on application when flows are imminent provided that:

- the licence to which the application relates arose from a WA 1912 entitlement at commencement of the plan
- the Minister has consulted with relevant Government agencies and stakeholders
- the Minister considers that
    - an A class flow is expected within three weeks
    - the granting of the application would not cause any unacceptable impacts on downstream higher priority users (i.e. the environment, local water utilities, licensed domestic and stock and basic landholder rights), with due recognition for any other existing or pending applications for access to the low flow class or no flow class
    - the applicant has operated in accordance with licence conditions
- the applicant has paid all water licence fees
- the water is to be pumped direct to crop
- for access to the no flow class, the capacity of the artificial pool (i.e. a pool in direct connection to a weir face) remains greater than 50 percent
- after water has been extracted from the low or no flow class, water is not permitted to be taken in A class until flows have been in A class for a defined number of hours, equivalent to the number of hours that water was taken from the low or no flow class
- access to the low or no flow class is subject to any other restrictions imposed by the Minister, e.g. that water is to be extracted
    - to a maximum total volume
    - at defined rates (e.g. number of pumping hours per day), and/or
    - for a defined period of time, to a maximum of ten days

A class licences typically do not have the off-river storages to provide a buffer during times of low or no flow. The Office of Water is confident in the precision of predictions for A class flows at a given location within the water source to arrive within a period of three weeks. As extractions by domestic and stock access licences from the no and low flow class will be limited to a maximum rate, the IRP agreed that any access by A class licences to the no and low flow class should also be limited to minimise impacts on higher priority water users including the environment. A maximum rate of 0.6ML/d is equivalent to the maximum rate imposed on licensed stock access during periods of low and no flow.

(ii) Access for B class licences

B class licences may be given written approval to access the no flow class on application when flows are imminent provided that:

- the licence to which the application relates arose from a WA 1912 entitlement at commencement of the plan
- the Minister has consulted with relevant Government agencies and stakeholders

- the Minister considers that
    - a B class flow is expected within two weeks
    - the granting of the application would not cause any unacceptable impacts on local higher priority users (i.e. the environment, local water utilities, licensed domestic and stock and basic landholder rights), with due recognition for any other existing or pending applications for access to the no flow class
    - the applicant has operated in accordance with licence conditions
- the applicant has paid all water licence fees
- the water is to be used for the last or second last watering of a crop, to be pumped direct to crop
- the capacity the artificial pool (i.e. a pool in direct connection to a weir face) remains greater than 50 percent
- after water has been extracted from the no flow class, water is not permitted to be taken in B class until flows have been in B class for a defined number of hours, equivalent to the number of hours that water was taken from the no flow class
- access to the no flow class is subject to any other restrictions imposed by the Minister, e.g. that water is to be extracted
    - to a maximum total volume
    - at defined rates (e.g. number of pumping hours per day, or a maximum volume per day), and/or
    - for a defined period of time, to a maximum of ten days

B class access below the cease-to-pump is restricted to the no flow class from artificial pools so that there is no additional competition for A class flows, low flows, or natural pool volumes. Allowing B class access to A class flows could distort the A class water market and extraction rates could have significant impacts on flows. B class licence off-river storages should provide supply when flows are in A class or the low flow class, alternatively B class licensees could use the water market to access A class flows if required. Predictions of imminent B class flows at Bourke have a high degree of precision for flows arriving within two weeks and this is thought to be a reasonable allowance for the rest of the water source.

(iii) Justifications for permitting access when flows are imminent

The key advantage of limiting access to flows below the CtP when a flow event is imminent is that any environmental impacts will be short-term only. The delayed commence-to-pump from the next flow event and requirement to pump direct to crop provide disincentive from exploitation of this allowance. Further, access to the no flow class is permitted from artificial pools only and 50 percent of the pool volume is reserved for refugia and supply for high priority users. Extraction rates, volumes and/or periods of access may also be limited by the Minister to minimise the daily impact on other users.

If written approval to access water below the CtP is given when a flow is imminent, water is not permitted to be taken above the CtP by that licence until flows have been above the CtP for a defined number of hours, equivalent to the number of hours that water was taken below the CtP by that licence. This delayed commence-to-pump rule provides physical reparation as soon as possible after extraction below the CtP.

Access to the no flow class when flows are imminent is from artificial pools only. During extended periods of no flow, weir pools can be drawn down such that a full pool can break into smaller component pools. The IRP agreed that access to artificial pools would mean only those pools that

were in direct contact with a weir face covered by a water supply work approval. Access to the artificial weir pool is permitted as long as the pool is not drawdown below 50 percent of capacity. This drawdown rule would be implemented through a height restriction below the sill on the crest of a weir.

6.2.6 Extraction components

Extraction components can be used to further define a licence holder's right to water by limiting the rate and timing of extractions under a licence and/or a group of licences in a reach or class.

Although not implemented, all unregulated river water sharing plans allow total daily extraction limits and individual daily extraction limits to be imposed. This is most commonly intended as a way to share water between licensees and the environment within a flow class on a daily basis, although they are proposed for a different reason in the Barwon-Darling (see section '6.2.6.1 Establishing individual daily extraction limits in the Barwon-Darling'). These extraction components are a tradable right under section 71Q of the *Water Management Act 2000*.

6.2.6.1 Establishing individual daily extraction limits in the Barwon-Darling

In the Barwon-Darling Unregulated River water source, individual daily extraction limits (IDELs) are intended to provide a mechanism to limit extraction rates to those currently permitted through authorised pumps, thereby allowing a free and opening trading regime whilst limiting:

- third party, and
- environmental impacts.

The administrative and management systems required to successfully implement IDELs are not currently in place, however it is expected that they will be in place within the first few years of this plan's term.

6.2.6.1.1 Defining extraction rates of authorised pumps

WA 1912 licensed entitlements in the Barwon-Darling do not specify the pumping rates of the authorised pumps attached to the licence, rather their maximum size. Further, there are significant variations in the 'true' pumping rate of two identically sized pumps at different locations on the Barwon-Darling, primarily due to head differences (difference in elevation between the water surface and the pump discharge), but also the age and design of the respective pumps. Notwithstanding this, 'average' pump capacities are recorded for various sizes and types of pumps in the NSW Office of Water Licensing Administration System and these rates were historically used for assessing environmental impacts for new licence applications. Unique to the Barwon-Darling, all active metered pumps have an 'agreed pumping rate' with State Water Corporation as a consequence of time and event metering.

Within the water source, the number of installed pumps is less than the number of authorised pumps and so the IRP intended from the outset that individual daily extraction limits could be established within the Barwon-Darling in a manner which did not impinge on the rate of extraction from current pumps.

6.2.6.1.2 Feedback on methods to establish IDELs received during consultation

Targeted consultation

During targeted consultation of the draft plan in November 2010, the NSW Office of Water proposed to establish total daily extraction limits (TDELs) for each reach and class at the commencement of the plan, based on the sum of average pump capacities for authorised pumps and allow individual daily

extraction limits (IDELs) to be established when management systems are in place if it is assessed that the TDEL for any reach and class has been exceeded.

Closer analysis of authorised and installed pump capacities per reach by the Office of Water following targeted consultation revealed that establishing TDELs and IDELs in this manner may lead to some unacceptable outcomes. There were two main issues arising:

- some classes and reaches have no or very little licensed pump capacity, and therefore under the model proposed no or very little extraction could ever exist in those reaches and classes, and
- some average pump capacities are less than the 'agreed pumping rates' for a specified pump size.

In light of this, the Office of Water asked water users via email correspondence post the targeted consultation meetings to consider a slight variation to the original proposal for establishing IDELs and TDELs in an attempt to resolve the above two issues. The slight variation included:

- Calculating IDELs by:
    - summing the average pump capacities for all authorised pumps in all licence classes for each river section and
    - distributing this total authorised pump capacity to licences based on Cap share for each river section (to provide the same active-inactive weighting as the Cap share distribution).
- Calculating TDELs by summing the IDELs for each class in four river sections

It was still proposed that TDELs be created at the commencement of the plan and IDELs established when management systems were in place.

Public exhibition

The method for establishing IDELs included in the draft plan placed on public exhibition in October 2011 was the result of redistributing the total authorised average pump capacity based on Cap share per river section as proposed in email communication to water users post targeted consultation. It included:

- Allowing IDELs to be established during the life of the plan at the below rates:
    - 0.118 ML/day per megalitre of Cap share in the Mungindi-Walgett section
    - 0.061 ML/day per megalitre of Cap share in the Walgett-Brewarrina section
    - 0.086 ML/day per megalitre of Cap share in the Brewarrina-Bourke section
    - 0.123 ML/day per megalitre of Cap share in the Bourke-Menindee section.
- Establishing TDELs at commencement of the plan for each section and class based on the sum of IDELs calculated at the above rates.

The differences in the proposed IDEL rates between sections were most notably due to:

- the volumetric conversion at differential rates along the Barwon-Darling, i.e. 15 ML/ha starting at Mungindi through to 20 ML/ha at Bourke, and
- the history of usage weighting applied through the Cap Management Strategy (see appendix 3).

For public exhibition, an appendix was included in the draft plan so that individual licence holders could check their proposed IDEL as a result of this method. The appendix included a few cases where multiple IDELs were issued against the same licence number, due to the one licence relating to multiple purposes or multiple classes. An updated table was provided at public exhibition meetings

and was uploaded onto the NSW Office of Water website on 14 November 2011 with only one IDEL per licence per class.

6.2.6.1.3 Changes to the method for establishing IDELs post public exhibition

In response to various comments from public exhibition that the proposed IDELs were insufficient for some current operations, the NSW Office of Water investigated alternate methods for establishing IDELs, with the intention to at least match existing extraction rates. To match existing extraction rates, both the State Water agreed pumping rates and the number, type and size of authorised works, need to be considered.

The final method for establishing IDELs under the plan matches the maximum of any recorded extraction requirements at commencement of the plan for each licence that converted from the WA 1912. Any licence that did not arise from a WA 1912 entitlement on commencement of the plan is to be assigned an IDEL of 0 ML/day. The plan permits the Minister to amend an IDEL during the plan term if it is proven, on application, that the sum of pump capacities for works authorised by the *WA 1912* entitlement that the water access licence arose from (as defined in Appendix 7) is greater than the IDEL defined by the maximum of:

- the sum of average pump capacities as determined by the Office of Water for all authorised pumps attached to each WA 1912 entitlement on commencement of the plan, excluding 85SL105065, or
- the sum of State Water Corporation agreed pumping rates for any installed pumps attached to the WA 1912 entitlement on commencement of the plan.

An IDEL for the water access licence arising from 85SL105065 will be based on the sum of average pump capacities as determined by Office of Water for all authorised pumps that were attached to WA 1912 licences; 85SA000852, 85SA001091, 85SA001705, 85SL033742, 85SL036564, 85SL036666, 85SL039847, 85SL040124 and 85SL045977 as at 1/12/2010. This distinction is necessary for 85SL105065 as it was created on 5/12/2010 as the result of amalgamating licensed entitlement from the licences listed above; however this amalgamation did not preserve the number of previously authorised works as it was intended that the licensed entitlement would be primarily used for non-extractive environmental purposes, rather than water extractions. Allowing an IDEL to be created for the water access licence arising from 85SL105065 in the manner described above will allow formal protection of the notional daily extraction rights historically attached to this licence.

The clause permitting the Minister to amend an IDEL means that the plan does not have to be amended if new pumps that were previously authorised under the WA 1912 are installed, existing pumps refurbished or agreed pumping rates for installed pumps are changed, e.g. due to meter data correction.

6.2.6.2 Trade of extraction component

A Minister's note was included in the draft plan placed on public exhibition requesting feedback on options for assigning nominal individual daily extraction limit (IDEL) rights when dealings occur before IDELs are established under the plan. Under the draft plan, new access licences that result from a dealing would not receive an IDEL. Where an access licence holder reduces the share component of an access licence to zero as part of a dealing, the access licence holder should continue to hold the access licence with a zero share component in order to receive an IDEL when management systems are in place. Where an access licence is cancelled as the result of a dealing, the IDEL associated with that access licence would also be cancelled. Two further options were included in the Minister's note:

- adjusting the IDELs that will be issued where share component is traded within a river section in proportion to the amount of share component that is bought or sold, but not for dealings between river sections, and
- not permitting share component to be bought or sold until after IDELs have been established.

The IRP found no reason to change the rules as proposed in the draft plan as response to the Minister's note in the draft plan was limited and mixed. Further, the rules in the plan do not prevent alternate arrangements being made through private sale contacts before IDELs are established and there were no environmental or third party impacts to consider for any option.

The implications for nominal IDEL rights will be communicated by Office of Water licensing staff to any licensee involved in a dealing prior to the trade being processed.

During public exhibition of the draft plan, water users indicated that they would like time to discuss IDELs, as they are a relatively new concept. IDELs, as well as other changes that the IRP had recommended for the draft plan, were discussed at a meeting between staff from the NSW Office of Water and water users in Bourke in March 2012.

6.2.7 Water interception activities

A change in land use activities can potentially result in the interception of significant quantities of water. Examples of activities that can impact on water quantity include increased farm dam capacity or the development of significant areas of new forestry plantations in a catchment. Under the National Water Initiative, significant interception activities should be accounted for within a plan's extraction limit.

6.2.7.1 Exemptions for farm dams

Farm dams currently require an access licence only when:

- they are located on a third order (or greater) river, irrespective of the dam capacity or purpose;
- they are located on first or second order streams and their combined capacity exceeds the maximum harvestable right dam capacity for the property, which enables the capture of ten percent of the mean annual run-off from the property in the Central division of NSW, or 100 percent in the Western division, or
- they are on a permanent (spring fed) first or second order stream.

Unlicensed extraction from farm dams that doesn't match any of the above criteria is permitted as a component of the basic landholder rights, called the harvestable right. The full activation of harvestable rights within the area of the plan is considered highly unlikely. The plan cannot actually limit these rights. The provisions relating to harvestable rights are unaffected by any of the rules identified in the plan.

6.2.7.2 Acknowledgement of floodplain harvesting activities

Floodplain harvesting is the collection, extraction or impoundment of water flowing across floodplains, excluding the following types of water extraction:

- taking of water under any other type of water access licence that is not a floodplain harvesting access licence or an applicable water access licence exemption
- taking of water under a basic landholder right, including the harvesting of rainwater run-off

- capture of run-off of irrigation water and stormwater in tailwater return systems or other means in accordance with licence conditions or methods which have been approved by the Office of Water.

Floodplain harvesting works can generally be put into two categories:

- Purpose-built works specifically built to facilitate floodplain harvesting, including pumps, structures or other works that divert water into or from storages, supply channels or depressions or otherwise impound flows.
- Works built for multiple purposes that have the effect of facilitating floodplain harvesting, such as:
  - levees, conveying works and off-river storages constructed in billabongs or depressions
  - below-ground level channels from which the water is delivered into storages.

Floodplain flows can originate from local run-off that has not yet entered the main channel of a river, or from water that has overflowed from the main channel of a stream during a flood.

In most unregulated river water sources, floodplain harvesting has generally already been recognised and licensed as part of the process that converted area based water licences to volume based licences. However, in the Barwon-Darling, further volumetric entitlements and measurement for floodplain harvesting may be established in the future under the NSW Floodplain Harvesting Policy.

6.2.7.3 Risk of interception through forestry expansion

The projected growth in commercial forestry plantations in the Barwon-Darling is considered negligible (CSIRO, 2008).

6.2.8 Rules for water supply works approvals

6.2.8.1 Restriction to nomination of works

Off-stream pools, including those on ox-bows, warrambools and billabongs, are considered to be of high environmental value. Currently, there are a number of licences that nominate authorised works which are located on off-stream pools and not allowing this practice to continue would cause unacceptable impacts on these individual users as it would in most cases trigger the redesign and construction of new irrigation infrastructure. In contrast, the rule in the plan which protects these pools through the prohibition of new works can be achieved with minimal impacts. This rule does not preclude a replacement work with the same specifications being installed in one of these off-stream pools.

6.2.8.2 Rainfall run-off harvesting dams

Capture of water in a rainfall run-off harvesting dam requires no licence if the dam is within the maximum harvestable right dam capacity for the property on which it is located (see section ‘6.2.7.1 Exemptions for farm dams’). Capture of water in a rainfall run-off harvesting dam beyond the permissible harvestable right requires a water supply works approval and a licence nominating this work that has a share component (entitlement), with a volume equal to or greater than the capacity of the dam. Extraction from these dams is not subject to the access rules for the water source or management zone.

The plan does not prohibit the construction of on-farm storages (turkey’s nests) which will not intercept overland flow, that is, they do not harvest rainfall run-off.

6.2.8.3 In-river dams

The plan does not prohibit a water supply work approval for a new in-river dam being granted in this water source. However the granting of any water supply work approval must be consistent with the NSW Weirs Policy, the principles of the *Water Management Act 2000* and the *Fisheries Management Act 1994*.

6.2.9 Dealings rules

The Barwon-Darling Cap Management Strategy (see appendix 3) foreshadowed that a free and open permanent and temporary trading system would be introduced and that 'concessional conversions' would also be permitted (see section '6.2.9.1 concessional conversions'). The dealing rules in the plan have been constructed to maintain this intent whilst mitigating against potential third party and localised environmental impacts that would otherwise result from increased competition. Dealings are not permitted into the water source. In general, dealings are not permitted from an access licence with a more stringent access condition to an access licence with a less stringent access condition. The exception to this rule is where dealings are permitted to a C class licence with a less stringent access condition in order to reinstate the pre-Cap average history of extraction attached to that particular C class licence. The volumes allowed to be traded to these licences arising from WA 1912 C class licences with history of extraction greater than their share component are defined in schedule 7 of the plan.

6.2.9.1 Concessional conversions

As many licence holders have insufficient Cap share to pursue their pre-Cap conversion average history of extraction, concessional conversion rules enable licence holders to seek reinstate their previous extraction at specified access conditions. For example, shares in C class can be converted to B class, in order to reinstate a pre-Cap average history of extraction at B class access conditions.

Dealings under section 71O of the *Water Management Act 2000* allow the conversion of an access licence category. The only conversions of category permitted under the plan are those to reinstate existing history of extraction through a concessional conversion. The concessional conversion limits (i.e. the number of shares allowed to be converted) for licences arising from existing WA 1912 licences are defined in schedule 7 of the plan.

Comments from water users during public exhibition requested that no time limit is placed on concessional conversions. The risk in permitting concessional conversions for the life of the plan is that the water market will remain distorted, that is, there can be no stable price for a particular class if water can still be traded between classes. As a compromise, the IRP recommended that concessional conversions be permitted for the first five years on the plan, consistent with the period originally envisaged under the Cap Management Strategy.

6.2.9.2 Trades between management zones and river sections

The Barwon-Darling unregulated river displays enormous temporal and spatial variation in flows due both to climate and location. Flow travel times and volumes from Mungindi to Menindee vary exponentially due to the range of seepage and evaporative losses experienced. Further, many of the non-standard access conditions have been settled by land board hearings to resolve disputes over the competition for water within a flow class. Together, these unique characteristics make it difficult to allow for dealings that involve either the assignment of rights or allocations between management zones whilst effectively mitigating against third party impacts. The IRP discussed some potential solutions for permitting trades between management zones whilst mitigating potential third party impacts and protecting environmental values, including:

- allowing trade up to the annual volumetric limit that existed within a management zone,
- allowing trade into management zones at higher flow thresholds (e.g. A class may become A+ class, with higher flow thresholds),
- grouping several management zones into a section and allowing trade within that river section, and
- using individual extraction components (which would be the most ideal, but management systems are not currently in place).

Prior to public exhibition, the NSW Office of Water proposed that, consistent with the IRPs intention to open up trade whilst preventing third party impacts, trades would be permitted from year two of the plan between river sections up to existing annual volumetric limit totals. The trades subject to these restrictions include 71Q dealings – assignment of rights or share component, 71T dealings – assignment of allocation or account water and 71W dealings – nomination of works. The dealing rules included in the draft plan placed on public exhibition can be summarised as follows:

- Year one
    - No trades permitted [concessional conversions (71O) only]
- After year one, prior to IDELs being established
    - No restrictions on trades within a river section or management zone
    - Trades permitted between river sections provided it does not cause total account water or share component held in a river section and class to exceed total annual volumetric limit for that river section and class
- Once IDELs are established
    - No restriction for nomination of works, assignment of allocation or share component
    - Trades in extraction component (71S) only permitted within a river section

At public exhibition meetings, the Office of Water highlighted that under the draft plan dealings other than concessional conversions were not permitted in year one and proposed that alternatively the plan could in year one:

- allow other dealings (71Q, 71T, 71W) within river sections only, or
- allow other dealings (71Q, 71T, 71W) between river sections, making both concessional conversions and trades subject to the total annual volumetric limit for a river section and class.

Comments were sought in submissions on these alternatives for trade in the first year of the plan.

6.2.9.3 Feedback from public exhibition and final rules

The majority of feedback from public exhibition requested that the plan permit trades (including concessional conversions) between sections. As trades are permitted between sections from year two of the plan, these comments were assumed to relate to the proposed rules for year one of the plan and the interim trading rules (in place before the plan commences). Submissions also requested that assignment of allocations (71T) were permitted to a higher class.

Under the provisions of the draft plan there was potential for assignment of rights or share component (71Q) between river sections, but the volume of water in accounts effectively prohibited any trades in allocation (71T) or nomination of works (71W) between sections. The IRP considered this issue as well as feedback from submissions when recommending the final rules for dealings between sections:

- Prior to IDELs being established

- No restrictions on trades within a river section or management zone
- Trades permitted between river sections provided it does not cause total share component held in a river section and class to exceed a volume equivalent to the total annual volumetric limit for that river section and class for concessional conversions (71O*), nomination of works (71W), or share component (71Q)
- No restrictions on trades in allocation (71T)

- Once IDELs are established
  - No restriction for concessional conversions (71O*), nomination of works (71W), allocation (71T) or share component (71Q)
  - Trades in extraction component (71S) only permitted within a river section

* Note: Concessional conversions under 71O are only permitted for the first five years of the plan.

7.0 Rules for the Upper Darling Alluvial groundwater source

7.1 Background

The Upper Darling Alluvial groundwater source is defined as the alluvial deposits associated with the Darling River, extending from upstream of Bourke to Lake Wetherell. It is comprised of basal sands and gravels and generally becomes finer closer to the surface. The thickness of the alluvial deposits is generally around 40 to 50 metres, with water levels generally 10 to 20 metres below ground level.

The aquifers are formed in all three alluvial lithological units; the Cubbaroo, Narrabri and Gunnedah formations. Perched fresh water aquifers are common in the Narrabri formation when there is direct recharge from the rivers. The main aquifers are associated with the Gunnedah and Cubbaroo Formations, but most are saline. The only exception is near Wilcannia where these aquifers produce fresh groundwater.

The Upper Darling Alluvial groundwater source is recharged by rainfall and streamflow. There is limited extraction from the groundwater source. Water is mainly used for domestic and stock purposes and also for Wilcannia town water supply. The Upper Darling salt interception scheme is located on the Glen Villa reach of the Darling River, 25 kilometres south of Bourke. The scheme is intended to reduce the salinity of the Darling River by diverting groundwater flowing from saline springs before it reaches the river.

7.1.1 Method for managing extraction

In February 2010, the SGP endorsed that all alluvial and highly connected groundwater sources within the NSW portion of the Murray-Darling Basin would have long-term average annual extraction limits (LTAAELs) set at an estimate of current average annual usage. This decision was based on the premise that groundwater pumping from any alluvial or highly connected aquifer will decrease flows in connected surface waters, and that the current level of impact on surface waters is acceptable.

The alternate method, commonly applied for hard rock aquifers across the state is the macro planning risk assessment approach (see section ‘7.2 Risk assessment’). Using the groundwater macro planning risk assessment approach to determine a sustainability index and hence the LTAAEL results in a significantly larger LTAAEL than one set at an estimate of current average usage for systems with low entitlement and usage, like the Upper Darling Alluvial.

The higher LTAAEL set using the macro plan risk assessment approach is very unlikely to result in any measurable impact on connected surface waters due to the poor water quality, low yields and the fact that new licences (excluding those permitted by the *Water Management (General) Regulation 2011*) can only be issued following the release of water by the Minister as a controlled allocation under section 65 of the *Water Management Act 2000*. Rather, a LTAAEL set by the groundwater risk assessment process will allow new and existing schemes such as the Upper Darling salt interception scheme that generate significant environmental outcomes to develop and continue.

Therefore, in June 2010, the SGP endorsed that the groundwater risk assessment process be used to determine the LTAAEL for the Upper Darling Alluvial groundwater source.

7.2 Risk assessment

The groundwater risk assessment process is the current approach of the Office of Water to developing plans for less highly connected groundwater sources and is described in *Macro water sharing plans – the approach for groundwater. A report to assist community consultation* (Office of Water, 2011). The macro approach is a risk based approach based on best available information that gives a relative assessment for groundwater sources across the state and provides rules for water access and for managing water supply works that relate to groundwater extraction. The process uses simple assessments ('high', 'medium' and 'low') to indicate different levels of risk. The adopted approach helps to clarify a range of values and risks, indicating where an optimal balance between extraction and retention of groundwater in an aquifer might be. In some areas, natural assets need strong protection; in others there is more socio-economic reliance on groundwater for extraction. The broad scale relative assessments allowed the most appropriate provisions to be developed for inclusion in plans.

The aquifer risk assessment considers the risk that groundwater extraction places on the groundwater source and its high priority groundwater dependent ecosystems and identifies risks to ecological, water quality and aquifer integrity assets. The socio-economic risk assessment looks at the dependence of local communities on groundwater extraction in terms of the risk to financial and sociological assets. An overall risk valuation is attained for the groundwater source, which is equal to the highest value attained on any criterion. Mitigation measures, applied through rules in the water sharing plan, can reduce the impact of extraction on a groundwater source. For example, a groundwater source which is at high environmental risk may have its risk reduced to medium or low if the effect of extraction can be successfully mitigated. The Upper Darling Alluvial groundwater source did not have mitigation measures applied because infrastructure to manage mitigation is not expected to be available in the medium term, as current extraction pressure indicates that it is not a priority.

The risk assessment was completed for the Upper Darling Alluvial groundwater source and is shown in Appendix 8. The assessment shows a high risk to both aquifer and socio-economic assets. As a result of the risk assessment, the 'sustainability factor' was determined for the groundwater source. This factor determines the proportion of average annual recharge which is reserved as environmental water, with the remainder available for extraction. Recommended groundwater sharing rules were also then developed for the groundwater source and endorsed by the IRP.

7.2.1 Recharge calculations

Recharge is the volume of water that infiltrates into an aquifer. It is expressed as a volume in megalitres per year. Recharge usually comes from rainfall and from surface water, such as river flows. The recharge calculation for the alluvial groundwater source is the basis for determining the volume of groundwater reserved as planned environmental water and the volume that is potentially available for extraction.

Recharge is calculated on long-term average annual figures. Depending on available information it may include a number of sources of recharge; in this case it is based on rainfall only, that is, the calculation does not include river recharge, side slope or upward recharge. It is calculated based on a percent of infiltration of average annual rainfall over the groundwater source area.

The average annual rainfall recharge for the Upper Darling Alluvial groundwater source is as displayed in Table 12. The recharge figure for high conservation value areas within the groundwater source is treated separately from the rest of the recharge, in that 100 percent of this recharge is reserved as planned environmental water, while the recharge from the remainder of the groundwater source is

shared between the environment and water potentially available for extraction, as determined by the sustainability factor.

High conservation value areas include national parks, nature reserves, historic sites, Aboriginal sites, state conservation areas and karst conservation areas.

Table 12 Average annual rainfall recharge for the Upper Darling Alluvial groundwater source

Upper Darling Alluvial	Area (ha)	Mean annual rainfall (mm)	Average annual rainfall (ML/year)	Infiltration (%)	Average annual rainfall recharge (ML/year)
High conservation value area	88,234	261	229,875	2	4,598
Non-high conservation value area	657,130	261	1,712,021	2	34,240
Total	745,364	261	1,941,896	2	38,838

Average annual rainfall (megalitres per year) = groundwater source area (hectares) x mean rainfall (millimetres) / 100
Average annual rainfall recharge (megalitres per year) = average annual rainfall x percentage infiltration

7.2.2 Sustainability factor

For the non-high conservation areas of the groundwater source, the calculated recharge is split between water reserved for the environment and water potentially available for extraction, based on the sustainability factor. The Upper Darling Alluvial groundwater source has a sustainability factor of 50 percent which means that 50 percent of the rainfall recharge for the non-high conservation areas in the groundwater source will be planned environmental water and 50 percent will potentially be available for extraction. Appendix 9 shows the sustainability factor matrix and the Upper Darling Alluvial groundwater source position on this matrix.

7.3 Water sharing rules

7.3.1 Protecting environmental values

Plans are required to reserve water for the overall health of the river and aquifers and to protect specific ecosystems that depend on river flows, such as wetlands, lakes, estuaries and floodplains and groundwater dependent ecosystems. This share of water reserved for the environment is also intended to sustain the river and groundwater system's aquatic fauna and flora.

The water set aside for the environment, or 'planned environmental water' is calculated by adding all of the recharge to high conservation value areas to the component of recharge from non-high conservation areas set aside for the environment. The planned environmental water for the Upper Darling Alluvial groundwater source is set out in Table 13.

Table 13 Planned environmental water for the Upper Darling Alluvial groundwater source

Upper Darling Alluvial	Average annual rainfall recharge (ML/year)	Proportion reserved for environment	Planned environmental water (ML/year)
Non-high conservation value area	34,240	50 %	17,120
High conservation value area	4,598	100 %	4,598
TOTAL	38,838		21,718

Planned environmental water (megalitres per year) = Non-high conservation value area recharge x (100 percent – sustainability factor) + 100 percent of recharge to high conservation value areas

Additional protection for environmental assets is also afforded through specific rules for granting or amending water supply works approvals and managing existing works within these groundwater sources which take into account any key features such as groundwater dependent ecosystems. The distance rules (see the section '7.3.6 Rules for water supply works approvals') cover new or amended bores, stipulating a buffer zone around high priority groundwater dependent ecosystems. Existing bores are not affected by the buffer zones and are able to continue operating within the existing conditions of their access licences.

7.3.1.1 Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are ecosystems which have their species composition and natural ecological processes determined to some extent by the availability of groundwater. GDEs can include cave systems, springs, wetlands and groundwater dependent endangered ecological communities.

The methodology utilised for the identification and scheduling of high priority GDEs in the macro planning process involves two stages, consistent with the NSW Groundwater Dependent Ecosystem Policy (DLWC, 2002).

7.3.1.2 Stage 1 prior to the commencement of the plan

Stage 1 occurs during the initial development of a water sharing plan. It involves a desktop exercise assembling all known records of high priority GDEs. The desktop assessment in stage 1 allows the plan to protect GDEs of known high conservation value from year 1 of the plan where time and resources are not available to conduct detailed field studies and analysis. GDEs that have been identified through other processes as having important conservation significance are listed in a schedule to the plan and rules are developed to protect them. For example, GDEs listed under the Directory of Important Wetlands, Ramsar listed wetlands, communities listed under the *Threatened Species Act 1995* and karst conservation reserves listed under the *National Parks and Wildlife Act 1974* are added to the GDE schedule for the commencement of the plan.

The IRP then has the opportunity to review and amend the GDE list as well as the rules that have been developed to protect them based on their expertise. If the rules vary substantially from the standard rules that have been developed to protect GDEs, then the proposed rules may be submitted to the State Groundwater Panel for endorsement.

The list of high priority GDEs compiled at this stage can either be amended after year five of the plan as further GDEs are identified or during the life of the plan on submission to and approval by the Minister.

7.3.1.3 Stage 2 during the life of the plan

Stage 2 occurs during the life of the plan and is a comprehensive assessment of the individual GDEs listed through a collation process. Records of other GDEs are collated from interrogating government databases, GIS records and other studies. Stage 2 involves a significantly more detailed analysis of GDEs to build upon the desktop assessment undertaken at Stage 1 based on the *Groundwater Dependent Ecosystems: Assessment, Registration and Scheduling of High Priority: Manual to Assist Groundwater Macro planning*, (DNR, 2006). This involves undertaking a comprehensive assessment of all records of known GDEs to determine their ecological value. High ecological value for an ecosystem is defined as an ecosystem in a natural or near natural condition, health and integrity assessed in terms of four criteria, which are:

- ecosystem condition/level of disturbance

- rarity of the dependent biota or physical features
- diversity
- special features.

The GDE manual sets out the process for scoring the ecological values to achieve an overall ranking of high, medium and low priority for each GDE. Those determined to be of high priority are then listed in the NSW GDE records and included in schedules to the plans. Changes to the rules that protect the GDEs will also be made, where appropriate.

7.3.2 Managing extraction

7.3.2.1 Long-term average annual extraction limit

The volume of water potentially available for extraction is termed the long-term average annual extraction limit (LTAAEL) and is expressed in megalitres per year (megalitres per year). The LTAAEL for the Upper Darling Alluvial groundwater source is as expressed in Table 14.

Table 14 Long-term average annual extraction limit for the Upper Darling Alluvial groundwater source

Water source	Average annual rainfall recharge from non-high conservation value areas (ML/year)	Sustainability factor	LTAAEL (ML/year)
Upper Darling Alluvial	34,240	50 %	17,120

LTAAEL = average annual rainfall recharge to non-high conservation value areas (megalitres per year) x sustainability factor

Note that the Upper Darling Alluvial groundwater source contains water locations of variable yield and quality and there is no guarantee of individual works accessing sufficient yields of adequate quality for production purposes.

7.3.2.2 Compliance with extraction limits

Extractions are managed to the LTAAEL. Should growth in use above the LTAAEL be assessed to have occurred, an appropriate growth-in-use response will be taken. A growth-in-use response will be triggered if average annual usage over three years from the Upper Darling Alluvial groundwater source exceeds the LTAAEL by more than five percent. This is the NSW default growth-in-use trigger for ‘less highly connected’ groundwater systems.

7.3.3 Available water determination

The maximum available water determination (AWD) for a water source is used to manage growth in extractions above the LTAAEL. If growth is assessed to have occurred, then maximum AWDs will be reduced to respond to this growth, that is, the maximum AWD will be less than 1 megalitre per unit share.

Available water determinations are primarily used to credit water into a licence’s water allocation account. The AWD for aquifer access licences in the Upper Darling Alluvial groundwater source will be 1 megalitre per unit share, unless a growth-in-use response is required.

7.3.4 Rules for granting access licences

The sum of entitlements within Upper Darling Alluvial groundwater source is less than the LTAAEL, which may indicate that this groundwater source has unassigned water. A portion of this water may be made available for new access licences through a controlled allocation order made under section 65

of the *Water Management Act 2000*, should a decision be made by the Minister to do so. Definition of the portion of the unassigned water that may be considered to be made available will be in accordance with state policy (currently under development).

7.3.4.1 Aquifer interference

Activities which intersect, or 'interfere with', an aquifer may involve:

- the extraction of groundwater that flows into a void to allow the activity to operate safely. This is often called dewatering, and the water extracted is often referred to as 'incidental groundwater'; and
- other impacts resulting from the intersection of the aquifer, such as changes to groundwater flow paths and gradients, subsidence and cracking of riverbeds, river bank collapse, destruction/removal of the aquifer structure, and artificial aquifer recharge.

Volumes of water incidentally taken in the course of aquifer interference activities, such as the water intercepted during mining operations, have in the past required a licence under the WA 1912.

Operators of these activities will continue to be required to hold an access licence and sufficient account water to account for incidental water taken. This includes activities where extraction associated with aquifer interference activity was occurring at the commencement of the plan.

7.3.5 Rules for managing access licences

7.3.5.1 Carryover and water accounts

As the Upper Darling Alluvial groundwater source contains many discrete aquifers with small storages and available water determinations are unlikely to be less than 1 megalitre per unit share, no carry over of entitlement from one year to the next is allowed. The maximum amount of water permitted to be taken from this groundwater source in any one water year is the water allocation accrued in the water access licence account for that water year.

7.3.5.2 Access rules

Under NSW Office of Water policy, daily flow access conditions can be applied to highly connected alluvial groundwater sources which are linked to river flow in the relevant unregulated water source/ management zone. As the Upper Darling Alluvial groundwater source is defined as 'less highly connected', daily access rules will not be applied.

7.3.6 Rules for water supply works approvals

In accordance with the principles of the *Water Management Act 2000*, the plan sets rules to minimise the cumulative impacts resulting from groundwater extraction. To do this, the plan specifies rules which prohibit new or amended works from extracting water within certain distances of other water users, contaminated sites, groundwater dependent ecosystems and groundwater dependent culturally significant sites. This is to prevent unacceptable or damaging levels of drawdown of water occurring in the local vicinity of these users and sites.

7.3.6.1 Statewide distance rules

Standard distance rules were developed for the macro plans through internal meetings of regional and state panels consisting of regional groundwater experts and representation from the NSW Department of Primary Industries and the Office of Environment and Heritage to incorporate a socio-economic and

environmental perspective. These panels compiled sets of distance criteria based on previous studies, substantial local knowledge and experience. This experience included knowledge of analytical and numerical models and their results, such as those used in dryland salinity studies until the late 1990s. A consistent set of rules for common groundwater aquifer types (for example fractured rock, alluvial, coastal sands and porous rock) was then produced by comparing the various rules proposed by the regional panels based on what has worked in the past in similar geological provinces.

Groundwater flow modelling with representative aquifer parameters was used to calculate water balances and also provided watertable drawdowns at different distances under a 24 hour per day pumping regime for one year. The modelling was undertaken to test the distance criteria produced by the regional panels to protect regulated streamflow and base flow in the unregulated systems. For high priority groundwater dependent ecosystems such as karst groundwater dependent ecosystems, the distances were set so that overall ecosystem health would remain the same and resulting impacts on drawdown would be within seasonal water level movements. For other groundwater dependent ecosystems, water users and significant sites, only a minimal level of impact was permitted.

The standard set of distance criteria then went to the State Groundwater Panel for approval. The groundwater panel, when negotiating the final rules, weighed the social, environmental and economic impacts of extraction on groundwater sources to set an acceptable level of drawdown near critical sites and other water users. Since then, the standard rules have been further tailored for the macro plans through the development of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*.

As the distances are based on a combination of experience and modelled estimates of drawdown, the macro plans allow for these distances to be altered in some cases. For example, the distances to minimise interference with other works may be reduced if a proponent can demonstrate in a hydrogeological study that no more than minimal impact will occur on existing extraction at a lesser distance. The distances to protect groundwater dependent ecosystems may be reduced if the proponent provides hydrological evidence that no drawdown of water will occur at the outside edge of the perimeter of any high priority groundwater dependent ecosystem listed in the plan.

This process has resulted in consistent rules across aquifer types that are considered to reflect the most current thinking in terms of managing local impacts of extraction and protecting groundwater dependent ecosystems. However, the plan development process allows for changes to the rules to cater for local conditions. The distance criteria may be altered due to a number of different factors, such as lot size where property sizes may lead to different interference distance criteria, aspects of the local hydrology and town dependence on groundwater.

7.3.6.2 Application in the plan

In developing the plan, regional Office of Water staff made draft recommendations on rules for the plan which were then compared against the standard rules. The IRP then made a final decision as to which rule would be adopted, striving to remain consistent with the standard rules where possible while being sensitive to any unique attributes of the groundwater sources in the plan area.

For new works there are rules to:

- minimise interference between neighbouring works
- locate works away from contaminated sites
- protect water levels in groundwater dependent ecosystems
- protect groundwater dependent culturally significant sites
- manage surface and groundwater connectivity

- manage temporary local impacts that may affect water levels, water quality and aquifer integrity.

For details about all of the distance rules for the groundwater source, refer to Part 9, Division 2 of the plan.

7.3.7 Trading of access entitlement

The water market is an effective and equitable way to reallocate water between users. The National Water Initiative sets out guidelines for water trading, although these will be largely superseded in the Murray-Darling Basin once the Basin Plan commences. Trading can currently occur either on a permanent or temporary basis. Trading of water entitlement needs to be addressed in the plan within a framework that maximises the flexibility for users to be able to use water to its highest value but does not adversely impact on groundwater sources or existing users.

In most groundwater sources covered by macro plans trading is allowed within a groundwater source, but no trading is allowed into or out of the groundwater source. This is to ensure that any groundwater source cannot be further degraded as a result of trading into that source.

For the Upper Darling Alluvial groundwater source, no trades are allowed into the groundwater source, based on lack of hydrologic connection. There are no restrictions on trade within the groundwater source; however each trade application undergoes a minimal harm assessment.

8.0 Consultation

The IRP's recommended rules underwent targeted consultation with specific interest groups and water users[5] where significant changes in management were proposed before the plan was drafted. Formal public exhibition[6] of the draft plan ensured wider public consultation.

While developing the plan, the participating agencies (the Office of Water, OEH, DPI and the CMAs) identified areas where better data was needed for making future water planning decisions. Similarly, the community might have suggested areas where further analysis or data gathering is required. This local input was essential in the finalisation of the plan.

CMAs manage the public consultation process, and ensure that all stakeholders and interested parties have an opportunity to examine and comment on the proposed water sharing rules. In particular, the Western, Border Rivers-Gwydir and Namoi CMAs looked for stakeholders to provide:

- local knowledge and expertise – for example identification of local assets or values that have not yet been considered by the IRP
- feedback on the practical elements of the proposed water sharing rules – to make certain they are easily implemented by the licence holders
- confirmation that there are no unintended outcomes from the plan – it is essential that this be given due consideration before the plan is finalised
- specific comments on the Minister's notes included in the draft plan.

8.1 Targeted consultation on the draft rules

Targeted consultation on the proposed rules for the draft plan was carried out in November 2010 (see Table 15).The objectives of this consultation were:

- to provide background as to why the plan was developed, how it was developed, what rules were proposed in the various areas and how stakeholders could provide feedback; and
- to provide a 'first opportunity' to informally consult with key stakeholders to test the suitability of the proposed management rules

Table 15 Key groups consulted as part of targeted consultation

Date	Group	Location
9 Nov 2010	Environmental groups – Darling River Action Group and Inland Rivers Network	Parramatta
16 Nov 2010	Western CMA Aboriginal reference group	Cobar
17 Nov 2010	Border Rivers-Gwydir CMA Aboriginal reference group	Inverell
22 Nov 2010	Mungindi-Menindee Advisory Council	Bourke

[5] Targeted consultation refers to informal consultation held with key stakeholders to test the suitability of the proposed water sharing rules and provide feedback on the rules potential impacts.

[6] Public exhibition is the formal exhibition of a draft Plan where the Minister invites submissions on the draft Plan and in particular will seek comment on a range of key issues.

8.2 Refining water sharing rules as a result of targeted consultation

The Barwon-Darling IRP reviewed matters raised at the targeted consultation meetings and consequently made some changes to the initial water sharing rules. During this review process, if updated data became available, it was incorporated into the assessment process. Table 16 outlines the changes to the proposed rules as a result of this consultative process.

Table 16 Changes to water sharing rules as a result of targeted consultation and updated data

Water source	Changes to water sharing rules	Justification
Barwon-Darling unregulated river	Individual take limit over three water years for A,B and C class licences changed from 375% to 450%	Intent of rule was to prevent users from becoming more opportunistic. The IRP believed 375% would cause a significant immediate financial impact. Instead, 450% was suggested as an alternative at consultation with water users.
	Add an amendment clause in the plan to change the access rules for any class in the Macquarie Junction to Brewarrina management zone, should a study show that these rules have an adverse impact on the performance of the fish traps at Brewarrina.	Feedback from Aboriginal groups requested that the IRP allow for the amendment of A class access rules in this zone upstream of the fish traps, but the IRP elected to apply the amendment to all classes as the fish traps are designed operate on a falling river, not low flows
	Individual daily extraction limits (IDELs) for A, B and C class licences to be issued in proportion to Cap share based on the sum of authorised average pump capacities for each section and class. Total daily extraction limits to be the sum of IDELs for each river section and class	IDELs based on authorised pump capacity were in some cases less than agreed pumping rates for a specified pump size. Redistributing on Cap share should give a weighting to historically active users. Setting limits for management zones means no or very little extraction could ever exist in some zones, so management zones were grouped into sections.
Upper Darling Alluvial	New figures for the LTAAEL, planned environmental water	Updated rainfall data across the state resulted in new recharge estimates in April 2011.
All	New estimates for basic landholder rights	Updated ABS housing data informed new estimates across the state in June 2011

8.3 Public exhibition of the draft water sharing plan

Public exhibition of the draft water sharing plan was held across the plan area from 10 November and extended to 18 December 2011, with three public information sessions held, as shown in Table 17.The objectives of this consultation were:

- to provide background to stakeholders as to why the water sharing plan was being developed, how it had been developed to date, what rules were proposed and how stakeholders could provide feedback
- to formally consult with a broad range of stakeholders to explain the proposed water sharing rules and how they will be implemented
- to seek feedback from stakeholders and the general community about the proposed water sharing rules.

Submissions were required to be made in writing on the applicable form. Comments and enquiries made at the public meetings were also noted.

Table 17 Public information sessions during public exhibition

Date	Location	Main issues raised
1 November 2011	Walgett	Notwithstanding access, take limits, trading, Cap management, metering
2 November 2011	Bourke	Notwithstanding access, take limits, trading, concessional conversions, Cap management, metering
3 November 2011	Wilcannia	Low flows to end of system, notwithstanding access, trading

8.4 Refining water sharing rules as a result of public exhibition

The NSW Office of Water reviewed all the issues raised during public exhibition, in submissions as well as matters raised at the information sessions. The Office of Water consequently highlighted the key issues from public exhibition to the IRP, who then recommended changes to the draft water sharing rules. During this review process, if updated data became available, it was incorporated into the plan. Table 18 outlines the changes to the draft rules as a result of this consultative process.

Table 18 Changes to water sharing rules as a result of public exhibition

Water source	Change to water sharing rules	Justification
Barwon-Darling unregulated river	Access below the cease-to-pump permitted in limited circumstances for survival watering of permanent plantings and when flows are imminent for A and B class licences. Amendment provision to incorporate new rules based on any written approval to access water below CtPs under *Water Act 1912* licence conditions.	Recognising historical notwithstanding access in the Barwon-Darling unregulated river water source
	Access to the low flow class for domestic and stock and A class access licences at a maximum rate of 0.6 ML/day. Access to the no flow class for domestic and stock at a maximum rate of 0.6 ML/day and must use pipe and trough reticulation systems.	Historical precedents have limited extraction to that possible through a 2 inch pump, i.e. 0.6 ML/day.
	Amendment to access rules after year five of the plan for protection of endangered aquatic ecological communities.	The Lower Darling endangered aquatic ecological community and some threatened species have been listed since the 2000-01 environmental flow rules were developed. If studies show these access rules are adversely affecting these species, the plan allows the access rules to be amended.
	Amendments to access rules: -do not apply to domestic and stock and local water utility access licences, -must not substantially alter long-term diversions under A, B and C Class access licences -must undergo consultation and -must take into account any socio-economic impacts.	The boundaries of change for amendment clauses have been defined to minimise uncertainty for water users during the plan term.

Water source	Change to water sharing rules	Justification
	Individual daily extraction limits (IDELs) are to be established based on the sum of average pump capacities or agreed pumping rates of authorised works attached to *Water Act 1912* licences, rather than distributed based on share component	IDELs now match the maximum of any recorded extraction rates for each licence, based on various comments from exhibition that IDELs based on share component were insufficient. The Minister may amend an IDEL on application if average pump capacities or agreed pumping rates are proven insufficient.
	Supplementary (Aboriginal environmental) access licences may be granted up to 500 ML each, to a 2,000 ML total for the water source. Water will only be allocated to a maximum of 500 ML each year for the water source after individual written expressions of interest. These licences are subject to access rules and have no carryover.	The total volume of licences allowed in this category has been limited to allow a reasonable frequency of access for individual users. The plan allows for amendment if the rules do not achieve the intent of sharing this water between different Aboriginal groups.
	Changes to dealings rules: -concessional conversions will be permitted for the first five years of the plan	Submissions requested concessional conversions be permitted for the life of the plan, but this distorts market values. The five year term is consistent with the 2006 Cap management strategy.
	-no restrictions on assignment of allocations (account water) within a licence class or to a higher class (e.g. B to C) -assignment of rights (share component) is permitted to a C class licence with lower access conditions up to that access licence's concessional conversion limit	Current volumes of water in accounts prohibited trades in allocation between sections under the draft rules. This restriction was removed to open temporary trade, acknowledging that there were restrictions on permanent trades. The draft plan allowed for concessional conversions to A and B class, but not C class – this was amended post exhibition.
	Removal of the individual take limit applying over three consecutive water years which limited water use to 450% of share component.	Modelling post public exhibition showed that this rule would not improve compliance with Cap under schedule E of the MDB Agreement (Schedule E).
	Removal of the ability for the Minister to reduce AWDs in order to respond to a breech of schedule E for the Barwon-Darling sub-valley.	Modelling post public exhibition demonstrates that this rule would not be effective in responding to a breech of Cap according to schedule E in a timely fashion.
	Specify that the Minister may introduce an individual take limit of 300% of share component applying over three consecutive water years to address a future breech of Cap, according to schedule E of the MDB Agreement.	Modelling post public exhibition showed that an individual take limit of 300% of share component applying over three consecutive water years would address any future breech of Cap (schedule E) within an acceptable period of time.
Upper Darling Alluvial groundwater source	A new licence category, for water table and salinity management, will be included. Licences may be granted in this category, including a licence for the existing Upper Darling Salt Interception Scheme.	This is a newly created specific purpose licence category. These licences are granted for the sole purpose of reducing or preventing an increase in salinity levels in a water source.

9.0 Adaptive management

Adaptive management is an important part of a water sharing plan. Adaptive management refers to the process of ongoing data collection monitoring, evaluation and review during the life of the plan that either enables plan amendment or remaking of a better plan after ten years. Adaptive management is a requirement of both the *Water Management Act 2000* and the National Water Initiative, and has been allowed for during the life of the Plan through amending provisions and establishment of 'limits of change' to the Plan.

Where adaptive management is identified further studies may be undertaken within agencies or by external organisations which may assist in informing the review of plan provisions.

9.1 Evaluation of plan performance

The evaluation framework for water sharing plans is currently being developed. The objectives of the project are:

- Inform the community of the results from the 10 year operation of water sharing plans
- Collate the results of the various legislatively-required evaluations, along with other relevant learnings to inform the remake of water sharing plans.

The evaluation framework will use a system of 'program logic' to organise the inputs, outputs and outcomes from water sharing plans and their operation. Evaluation questions and monitoring indicators allow assessment of these steps to rate a water sharing plan for its:

- Process of development (appropriateness)
- Performance during operation (efficiency)
- Socio-economic environmental and cultural outcomes (effectiveness).

The Office of Water's approach conforms to NSW and Commonwealth government guidelines for monitoring, evaluation and reporting, and demonstrates the adaptive management approach to water planning required under the principles of the *NSW Water Management Act, 2000*. The Office has also chosen to organise the evaluation questions and monitoring indicators using the NSW Natural Resource Commission's auditable standard for natural resource management.

9.2 Performance indicators

The Plan includes a number of performance indicators that will be monitored over the 10 year life of the Plan.

It is not practicable to monitor all issues in all water sources. The performance indicators identify that monitoring will be undertaken for specific issues in key water sources. The actual procedure for monitoring each indicator may change over the period of the Plan as improved methods are developed.

The water sharing plan Environmental Flows Monitoring and Modelling program has been designed to make the results of environmental flows studies more transferable between water sources and to develop more generic relationships between flow, hydraulics and ecological responses. In adopting this approach it enables a more efficient and effective evidence-based approach to support monitoring

and evaluation requirements of NSW water sharing plans and identifies specific knowledge gaps to allow further investigative work to be prioritised.

9.3 Plan review

Under the *Water Management Act 2000*, the Natural Resources Commission is required to undertake a review of this Plan prior to any decision to extend its term or to make a new plan.

The Evaluation framework developed will consider the statutory requirements for the different types of evaluation:

- An audit of the Plan, at intervals of no more than five years, for the purpose of ascertaining whether its provisions have been given effect to. This audit is to be carried out by the State Interagency Panel, which has now been appointed by the Minister (for Water).
- An audit of the Plan by the Natural Resources Commission to assess to what extent the water sharing provisions have contributed to the relevant state wide targets, and natural resource standards and targets in the relevant catchment management area. The Natural Resources Commission will call for public submissions when undertaking its review.
- An annual review of Implementation Programs.

10.0 Implementation

10.1 Implementation programs

An implementation program may be established that sets out the means by which the objectives of the plan are to be achieved. The process for monitoring of the performance indicators will be outlined in the implementation program.

Should an implementation program be established, an annual review of the implementation program will be conducted to determine whether the implementation program is being effective in implementing the water sharing provisions. The results of this review will be included in the Office of Water's annual report.

10.2 Monitoring water extractions

Each water sharing plan establishes the relevant mandatory conditions for extraction, including that all licences undertake measurement of extraction. The Office of Water will develop a measurement of extractions strategy to meet the objectives of the NSW Water Extraction Monitoring Policy.

Measurement of extractions may be via meters or other forms of monitoring devices fitted to approved works, or via alternate monitoring systems, in order to provide water extraction estimates. Different types of devices will be required depending on the nature of the water supply work installation, the size of the work, and the effect that the operation of the work may have on the water source and other water users.

Under the Water Use Monitoring Program assessment of water sources is being undertaken across the state to identify priority areas of measurement of extractions and to determine the most suitable measurement options. It is likely that this will be implemented in high priority areas initially, with roll out to all water sources over time, as appropriate.

Note: Decisions regarding the timetable for introduction of measurement of extractions are still under consideration. In the interim, water users are encouraged to use other forms of self measurement to assist them to extract water in compliance with their licence conditions, which will be developed from the relevant plan provisions. Water users may install flow meters of their own volition. Meters need to meet new national water meter standards and be installed in accordance with the manufacturer's specifications.

10.3 Compliance

The Office of Water will undertake compliance activities as necessary to enforce the conditions on each individual's licence and combined work and use approval, which are developed based on the provisions of the plan once it is implemented. Some reliance is placed on local water users to identify inappropriate or unlawful behaviour and report this to the Office of Water. Reports may be made by calling 1800 633 362 or emailing watercompliance@water.nsw.gov.au (refer to the Office of Water website www.water.nsw.gov.au)

11.0 Acronyms

ABS	Australian Bureau of Statistics
AWD	Available Water Determination
BLR	Basic landholder rights
CMA	Catchment management authority
CSIRO	Commonwealth scientific and industrial research organisation
CTF	Commence-to-fill
CTP	Commence-to-pump
DPI	Department of Primary Industries
EMU	Extraction Management Unit
GAB	Great artesian basin
GDE	Groundwater dependent ecosystem
IAG	Independent Audit Group to the Murray-Darling Basin Authority
IDELs	Individual daily extraction limits
IQQM	Integrated quantity quality model
IRP	Interagency regional panel
LTAAEL	Long-term average annual extraction limit
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority
MDBMC	Murray-Darling Basin Ministerial Council
MOU	Memorandum of understanding
NRC	Natural resources commission
NWI	National Water Initiative
OEH	Office of environment and heritage
SDL	Sustainable diversion limit
SGP	State groundwater panel
SIP	State interagency panel
SIS	Salt interception scheme
UFMPNW	Interim unregulated flow management plan for the north-west
WAL	Water access licence
WSP	Water sharing plan

12.0 Glossary

Many of the terms in this document are defined in the *Water Management Act 2000* and are therefore not redefined here. However, there are some terms that are not and have therefore been defined below to assist with understanding the water sharing plan.

Account water: The balance in an access licence water allocation account at a particular time. An access licence water allocation account records water allocations accrued under the licence as well as water allocations taken, assigned or re-credited. The operation of the account is also governed by rules for the carrying over of credits from one accounting period to the next and rules for the maximum credit that may be allowed to accumulate in the account as established in a water sharing plan.

Allocation assignment: The transfer of credited water between water allocation accounts.

Alluvial, alluvium: Sediment deposited by a stream of running water, in particular along riverbeds or flood plains.

Aquifer: An underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt or clay) from which groundwater can be usefully extracted. The volume of water stored in an aquifer, the rate at which water can recharge, the volume of water extracted from it, and the rate at which water can move through the aquifer are all controlled by the geologic nature of the aquifer.

Assignment of share component: The transfer of licensed entitlement between water access licences.

Beneficial use category: Categories defined within the 1995 National Water Quality Management Strategy that reflect the quality of groundwater present as well as the potential values of the groundwater in the long-term.

Ecological values: The intrinsic or core attributes associated with naturalness, diversity, rarity and special features, but excluding representativeness used to classify water sources for apportioning water management rules.

Endangered ecological communities: Ecological communities listed in Schedule 1 of the *Threatened Species Conservation Act 1995* or Schedule 4 of the *Fisheries Management Act 1994*.

Extraction of water: Removal of water from a river for off-stream storage or consumptive use.

Extraction management unit (EMU): A group of water sources; defined for the purpose of managing long-term annual average extraction.

Flow classes: The range of daily flow rates in a river which provides the framework for sharing water on a daily basis.

Flow duration curve: A plot that shows the percentage of time that flow in a stream is likely to equal or exceed some specified value of interest.

Flow gauging station: A device used to measure the height of a river, from which the flow in the river can be calculated.

Flow reference point: The site from which the flow data is calculated to determine the rates associated with a flow class and then to implement the daily access rules during the life of the plan.

Groundwater: The water beneath the earth's surface that has filtered down to the zone where the earth or rocks are fully saturated.

Groundwater dependent ecosystems (GDEs): Ecosystems that rely on groundwater for their species composition and their natural ecological processes.

Long-term average annual extraction limit (LTAAEL): The target for total extractions (under all water access licences plus an estimate of basic landholder rights within an EMU) which is used to assess whether growth in use has occurred. The actual annual extractions (metered plus estimated) are averaged over a fixed period of time defined by the water sharing plan when comparing with the LTAAEL. If the fixed period of time is greater than one water year, then in any one water year, extractions can exceed the LTAAEL without triggering a growth-in-use response.

Macro water sharing plans: Plans which apply to a number of water sources across catchments or different types of aquifers. The macro planning process is designed to develop broader scale plans covering most of the remaining water sources in NSW.

Management zone: An area within a water source used for defining the location of applicability of water sharing rules, but secondary to the water source. A management zone is more likely to be designated where local dealing restrictions are in place or where 'cease-to-pump' rules for works approvals apply.

Pools: Lentic water bodies (standing water), including anything falling within the definition of a 'lake' found in the Dictionary of the *Water Management Act 2000,* except for tidal pools and estuaries.

Regulated river: A river that is declared by the Minister, by order published in the Gazette, to be a regulated river. Typically rivers where state owned storages catch water during wetter periods and the river is used to supply stored water to meet downstream users' orders during dry times are regulated rivers.

Riparian: Relating to or living or located on the bank of a natural watercourse, such as a river or stream.

Water sharing plan: A plan made under the *Water Management Act 2000*, which sets out the rules for sharing water between the environment and water users within whole or part of a water management area or water source.

Water year: The 12 months running from 1 July to 30 June.

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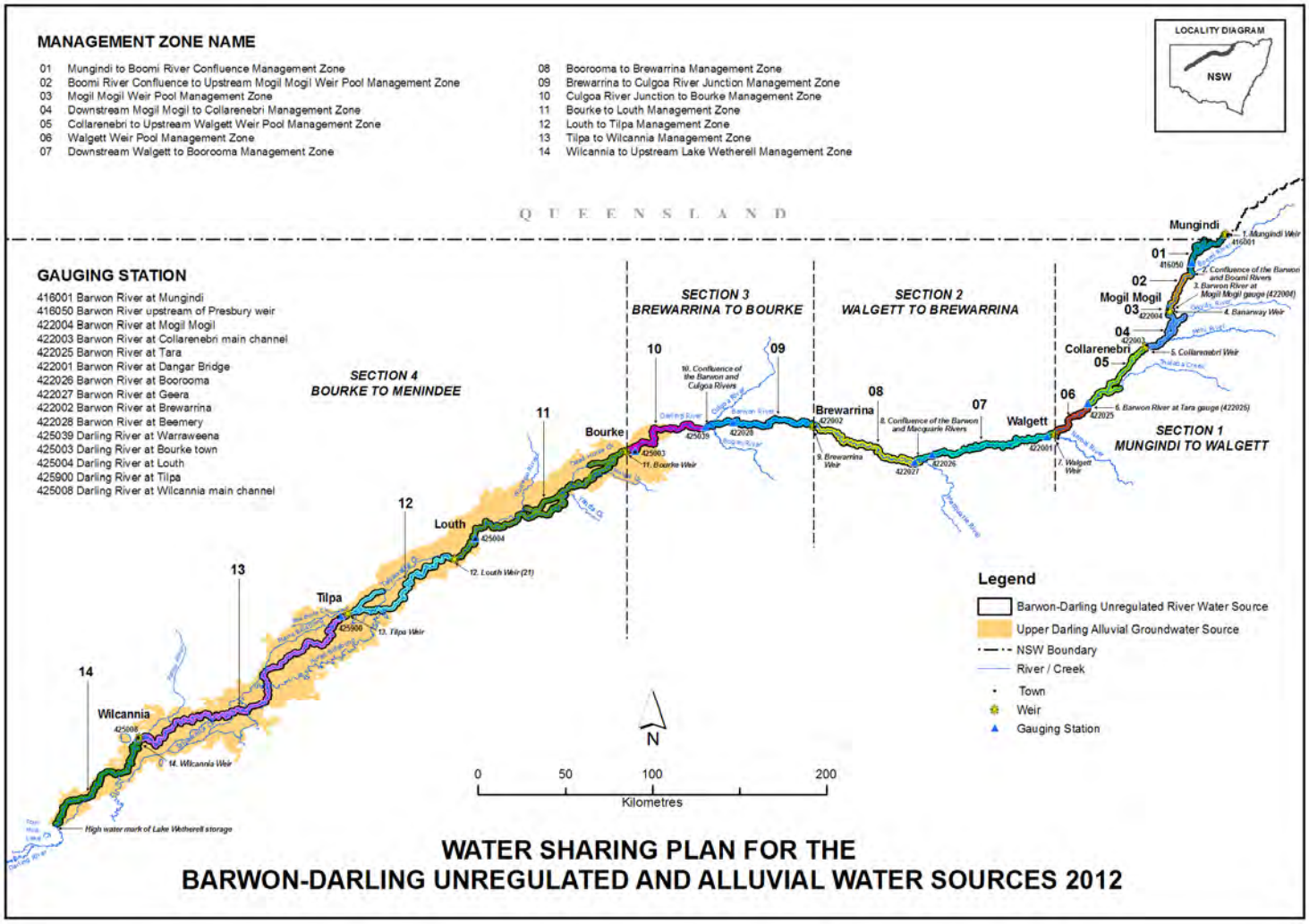
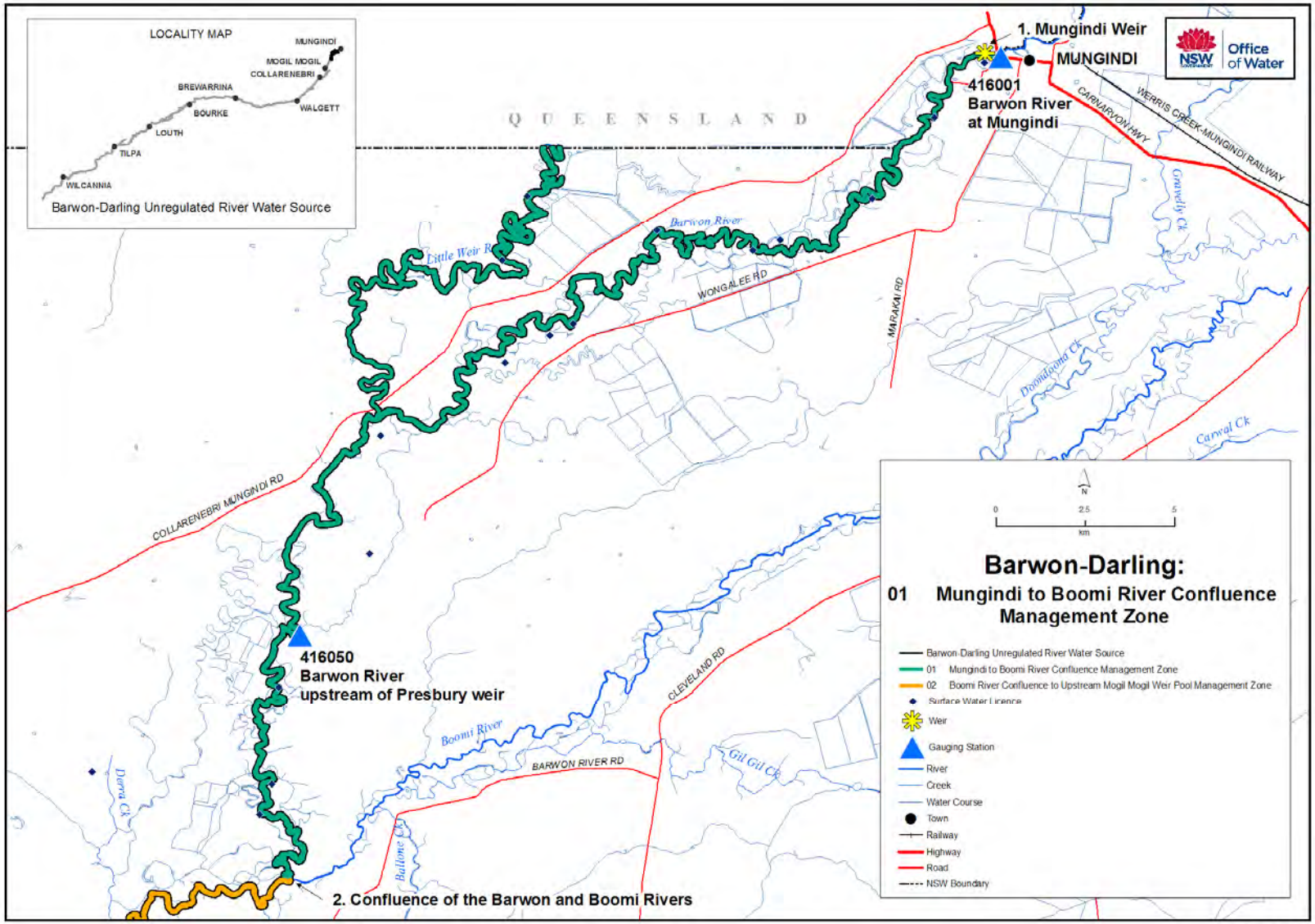
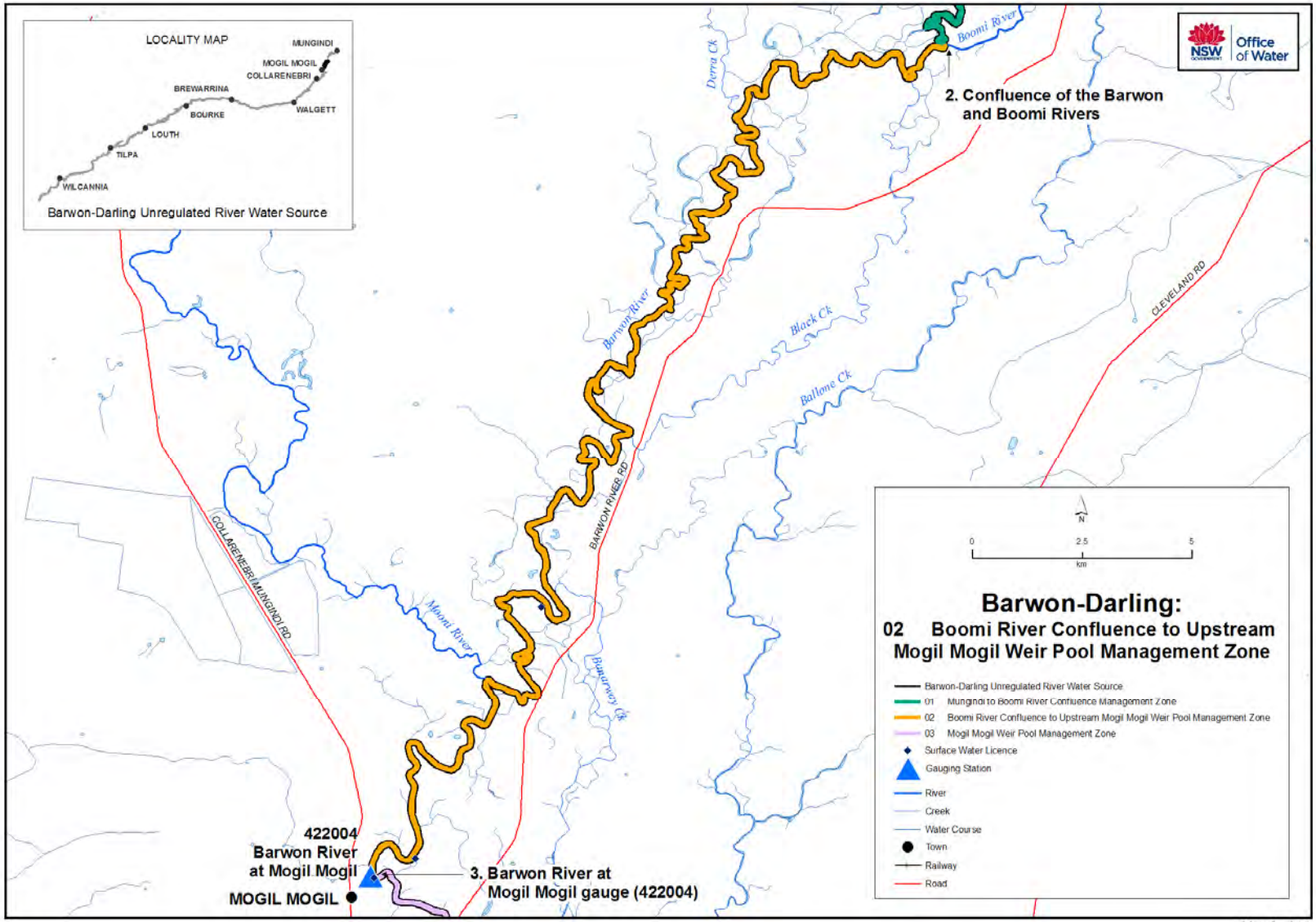
Appendix 1: Water sharing plan maps

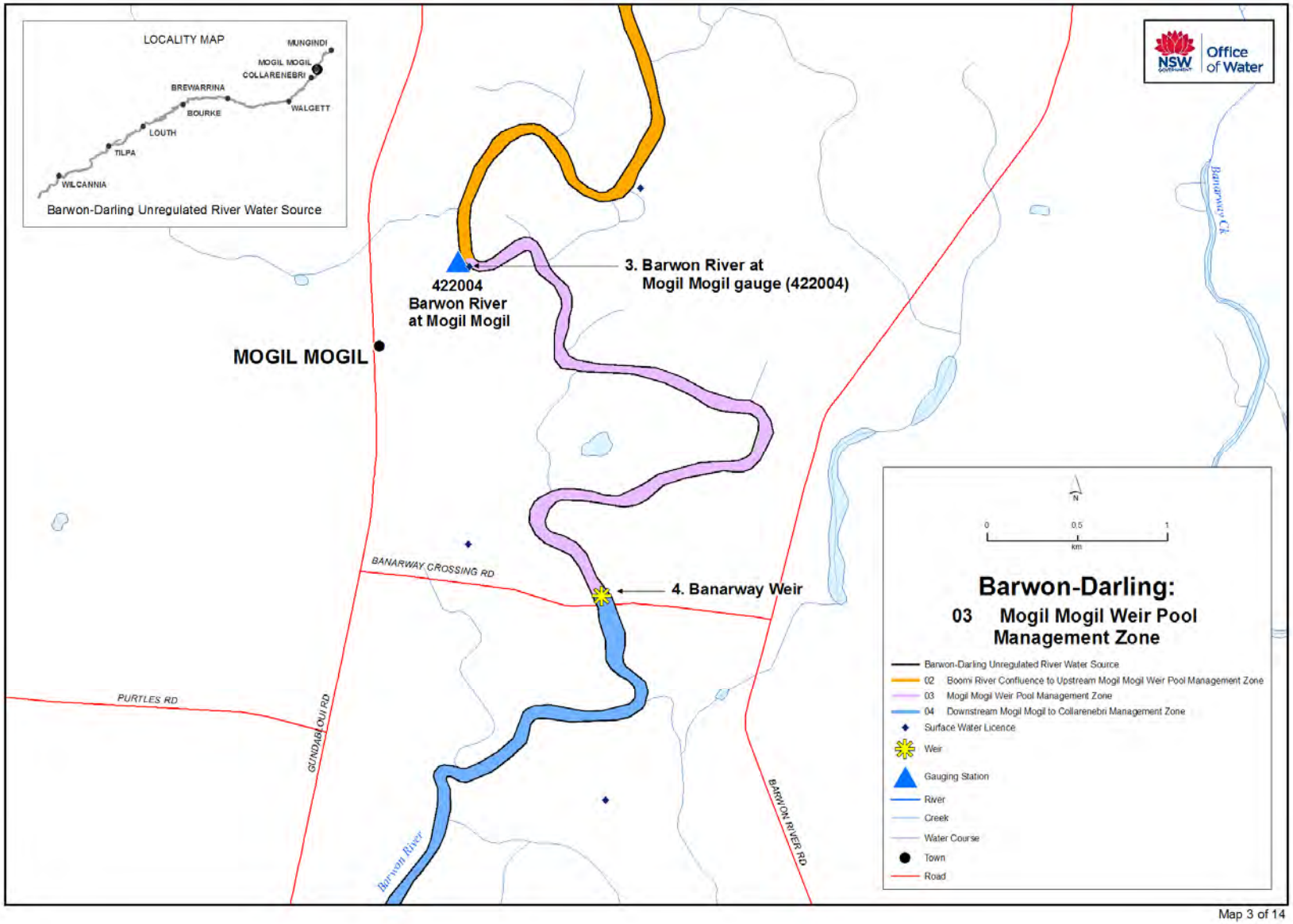



LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
QUEENSLAND
1. Mungindi Weir
MUNGINDI
416001
Barwon River
at Mungindi
NSW Office of Water
CARNARVON HWY
WEIRRIS CREEK-MUNGINDI RAILWAY
Barwon River
Little Weir R
WONGALEE RD
MARAKAI RD
Grawdy Ck
Doondoona Ck
Carwal Ck
COLLARENEBRI MUNGINDI RD
416050
Barwon River
upstream of Presbury weir
CLEVELAND RD
Boomi River
BARWON RIVER RD
Gil Gil Ck
Dewa Ck
Ballone Ck
2. Confluence of the Barwon and Boomi Rivers
N
0
2.5
5
km
Barwon-Darling:
01 Mungindi to Boomi River Confluence Management Zone
Barwon-Darling Unregulated River Water Source
01 Mungindi to Boomi River Confluence Management Zone
02 Boomi River Confluence to Upstream Mogil Mogil Weir Pool Management Zone
Surface Water Licence
Weir
Gauging Station
River
Creek
Water Course
Town
Railway
Highway
Road
NSW Boundary

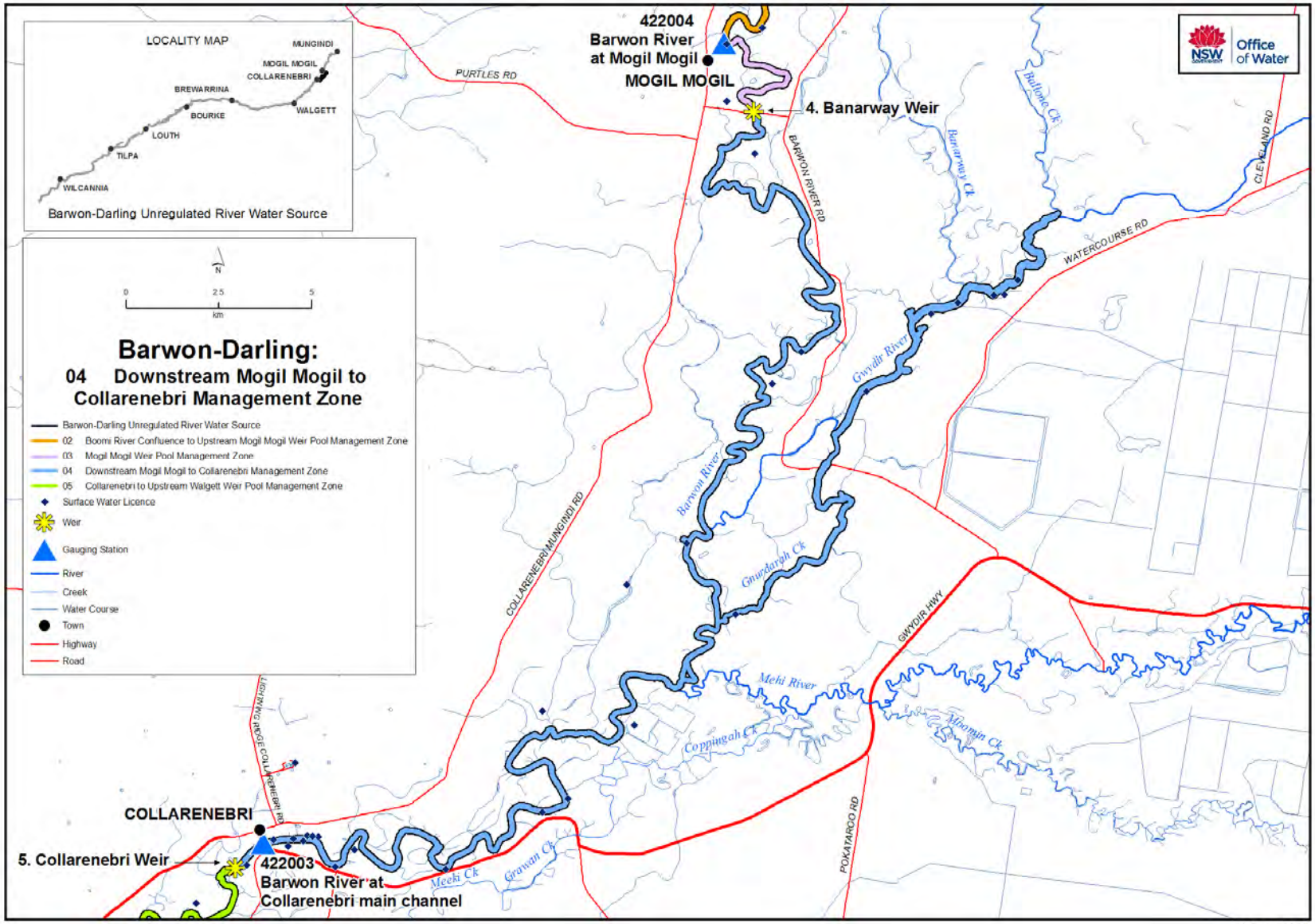
Map 1 of 14

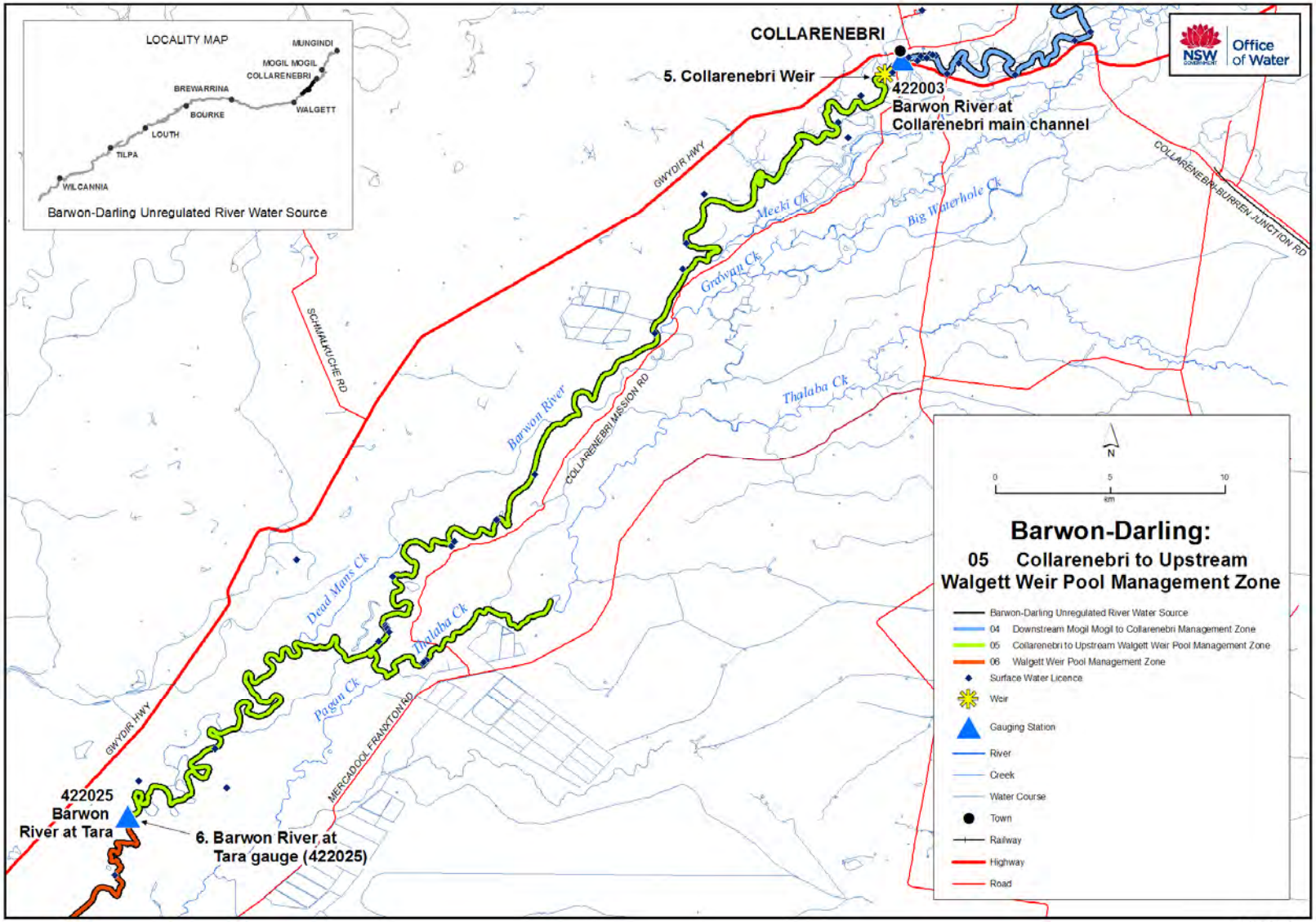

LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
NSW Office of Water
2. Confluence of the Barwon and Boomi Rivers
Boomi River
Derra Ck
Barwon River
Black Ck
Ballone Ck
CLEVELAND RD
BARWON RIVER RD
COLLARENEBRI/MUNGINDI RD
Moonii River
Bungunya Ck
422004
Barwon River
at Mogil Mogil
MOGIL MOGIL
3. Barwon River at Mogil Mogil gauge (422004)
N
0
2.5
5
km
Barwon-Darling:
02 Boomi River Confluence to Upstream Mogil Mogil Weir Pool Management Zone
Barwon-Darling Unregulated River Water Source
01 Mungindi to Boomi River Confluence Management Zone
02 Boomi River Confluence to Upstream Mogil Mogil Weir Pool Management Zone
03 Mogil Mogil Weir Pool Management Zone
Surface Water Licence
Gauging Station
River
Creek
Water Course
Town
Railway
Road

Map 2 of 14

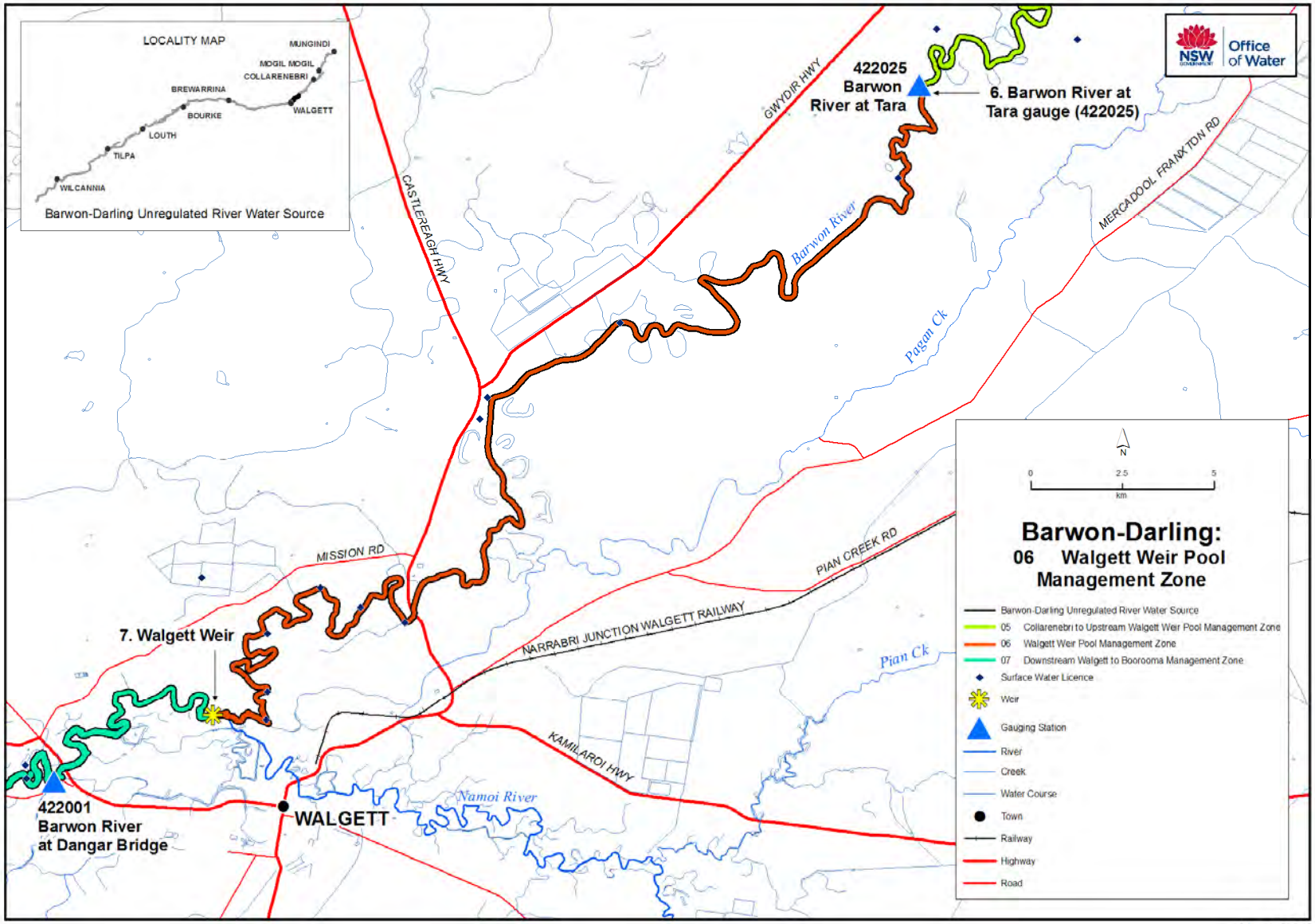

LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
NSW Office of Water
3. Barwon River at Mogil Mogil gauge (422004)
422004
Barwon River
at Mogil Mogil
MOGIL MOGIL
Banarway Ck
BANARWAY CROSSING RD
4. Banarway Weir
PURTLES RD
GUNDABLOUI RD
Barwon River
BARWON RIVER RD
N
0
0.5
1
km
Barwon-Darling:
03 Mogil Mogil Weir Pool Management Zone
Barwon-Darling Unregulated River Water Source
02 Boomi River Confluence to Upstream Mogil Mogil Weir Pool Management Zone
03 Mogil Mogil Weir Pool Management Zone
04 Downstream Mogil Mogil to Collarenebri Management Zone
Surface Water Licence
Weir
Gauging Station
River
Creek
Water Course
Town
Road

Map 3 of 14

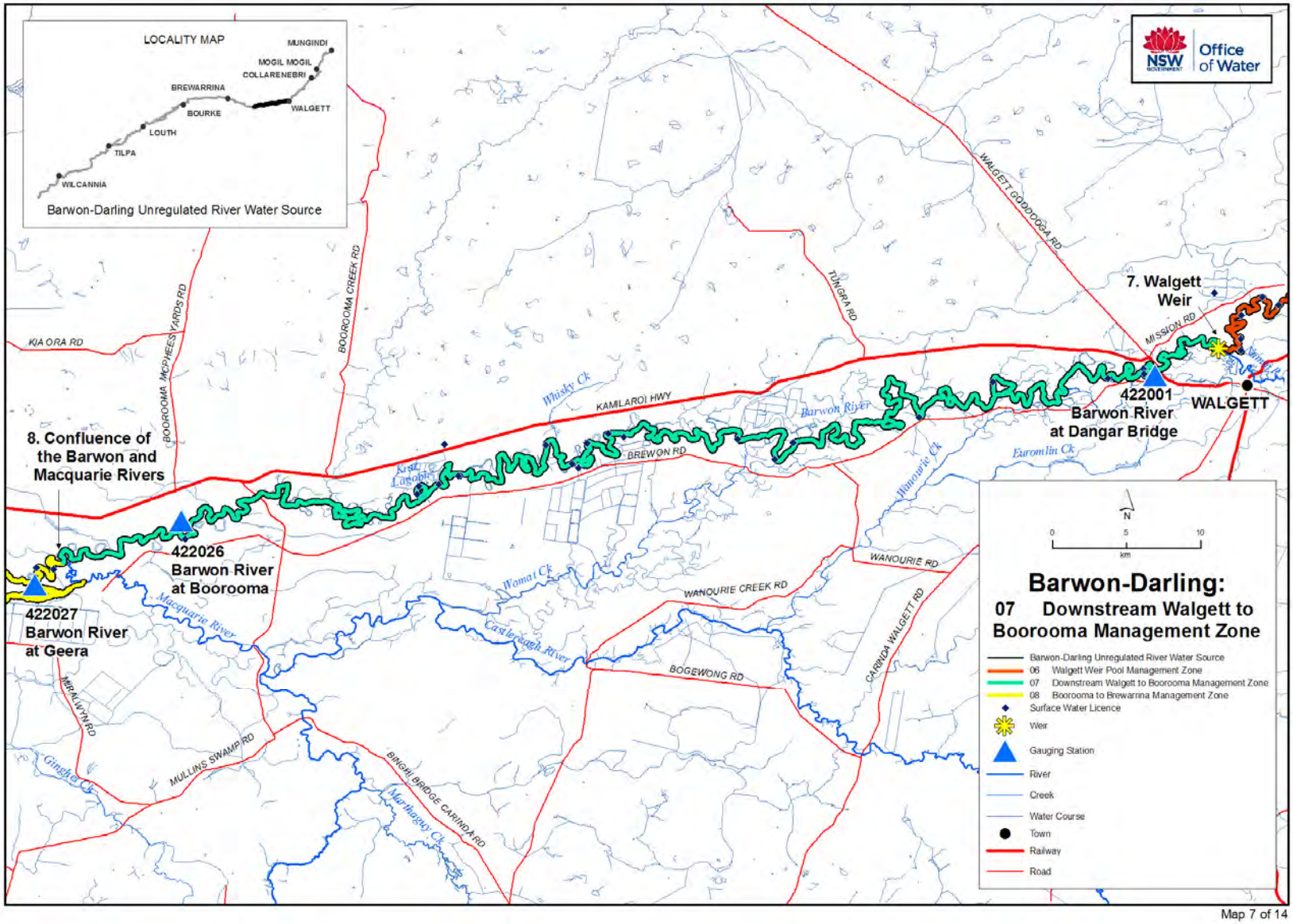

LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
N
0
2.5
5
km
Barwon-Darling:
04 Downstream Mogil Mogil to Collarenebri Management Zone
Barwon-Darling Unregulated River Water Source
02 Boomi River Confluence to Upstream Mogil Mogil Weir Pool Management Zone
03 Mogil Mogil Weir Pool Management Zone
04 Downstream Mogil Mogil to Collarenebri Management Zone
05 Collarenebri to Upstream Walgett Weir Pool Management Zone
Surface Water Licence
Weir
Gauging Station
River
Creek
Water Course
Town
Highway
Road
422004
Barwon River
at Mogil Mogil
MOGIL MOGIL
4. Banarway Weir
PURTLES RD
BARWON RIVER RD
Banarway Ck
Ballandool Ck
CLEVELAND RD
WATERCOURSE RD
Gwydir River
Barwon River
COLLARENEBRI/MUNGINDI RD
Gnardargh Ck
GWYDIR HWY
Mehi River
Coppingah Ck
Mboomin Ck
POKATARCO RD
LIGHTNING RIDGE COLLARENEBRI RD
COLLARENEBRI
5. Collarenebri Weir
422003
Barwon River at
Collarenebri main channel
Meeki Ck
Grawan Ck
Office of Water
Map 4 of 14


LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
COLLARENEBRI
5. Collarenebri Weir
422003
Barwon River at
Collarenebri main channel
Office of Water
GWYDIR HWY
Mecki Ck
Big Waterhole Ck
Graham Ck
COLLARENEBRI BURREN JUNCTION RD
SCHMALKUCHE RD
Barwon River
COLLARENEBRI MISSION RD
Thalaba Ck
Dead Mans Ck
Thalaba Ck
Pagan Ck
MERCADOOL FRANKTON RD
GWYDIR HWY
422025
Barwon
River at Tara
6. Barwon River at
Tara gauge (422025)
N
0
5
10
km
Barwon-Darling:
05 Collarenebri to Upstream
Walgett Weir Pool Management Zone
Barwon-Darling Unregulated River Water Source
04 Downstream Mogil Mogil to Collarenebri Management Zone
05 Collarenebri to Upstream Walgett Weir Pool Management Zone
06 Walgett Weir Pool Management Zone
Surface Water Licence
Weir
Gauging Station
River
Creek
Water Course
Town
Railway
Highway
Road

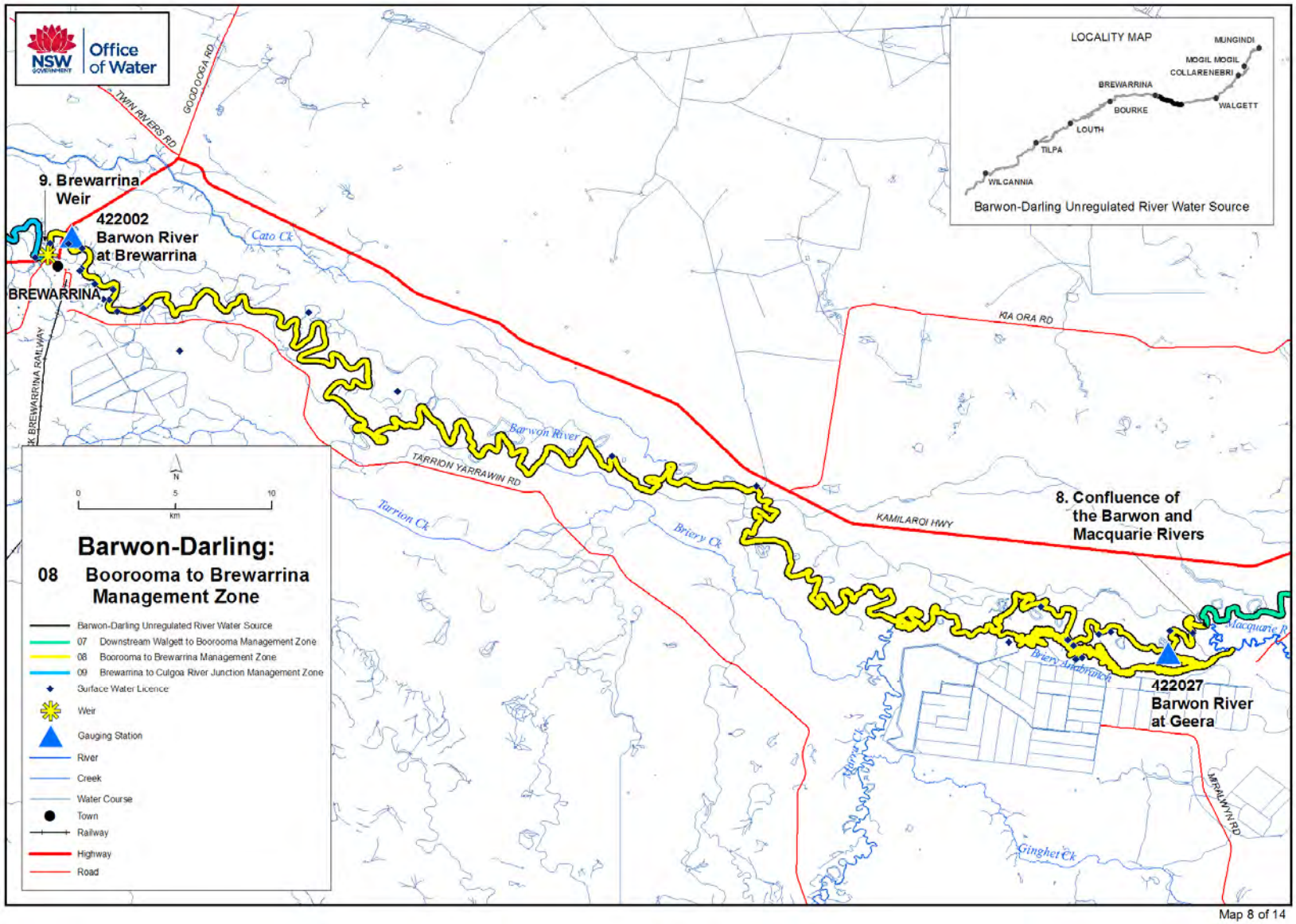
Map 5 of 14


LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
Office of Water
422025
Barwon
River at Tara
6. Barwon River at
Tara gauge (422025)
GWYDIR HWY
CASTLEREAGH HWY
MERCADOOL FRANKTON RD
Barwon River
Pagan Ck
MISSION RD
PIAN CREEK RD
NARRABRI JUNCTION WALGETT RAILWAY
7. Walgett Weir
Pian Ck
KAMILAROI HWY
Namoi River
422001
Barwon River
at Dangar Bridge
WALGETT
N
0
2.5
5
km
Barwon-Darling:
06 Walgett Weir Pool
Management Zone
Barwon-Darling Unregulated River Water Source
05 Collarenebri to Upstream Walgett Weir Pool Management Zone
06 Walgett Weir Pool Management Zone
07 Downstream Walgett to Boorooma Management Zone
Surface Water Licence
Weir
Gauging Station
River
Creek
Water Course
Town
Railway
Highway
Road

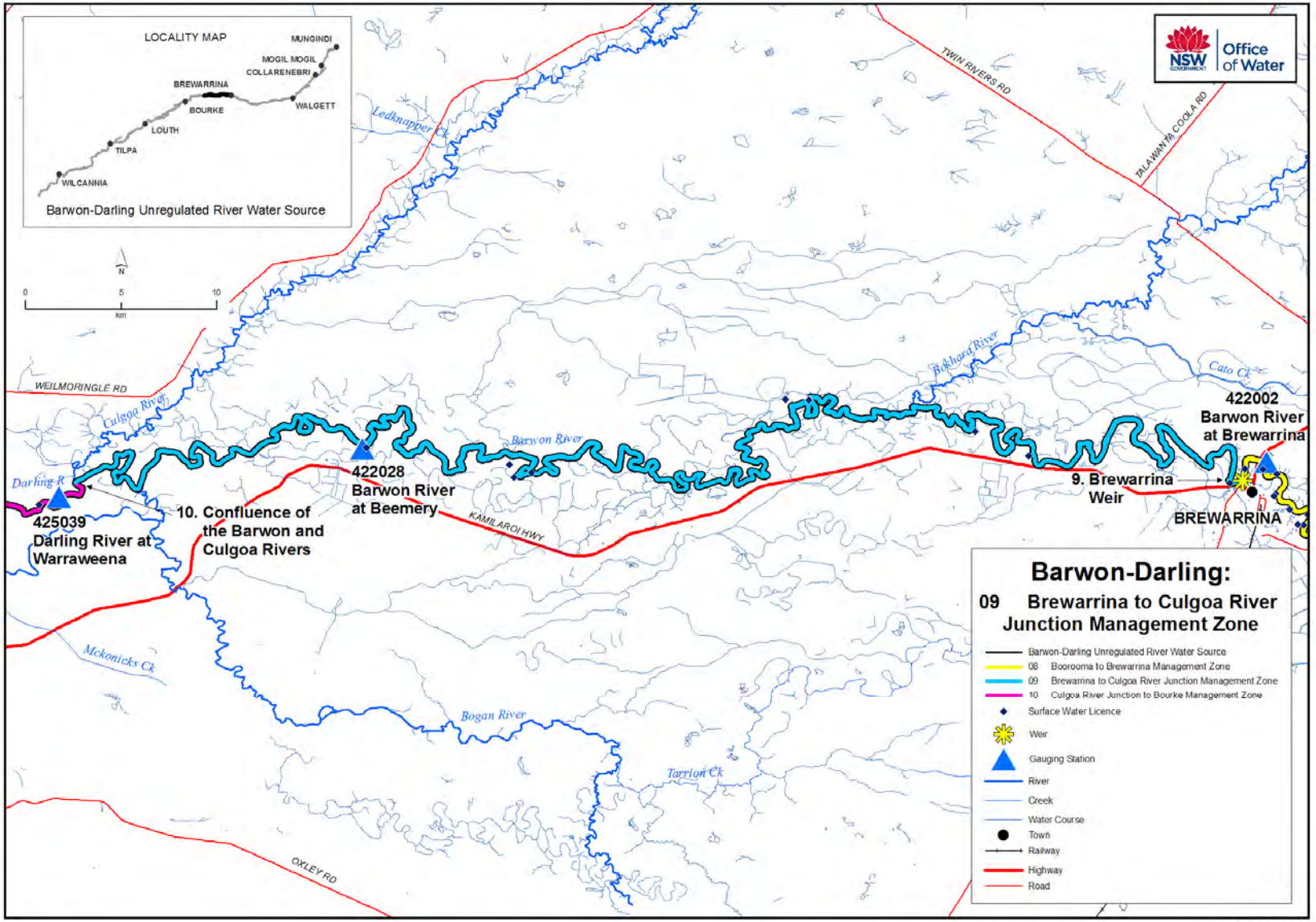
Map 6 of 14

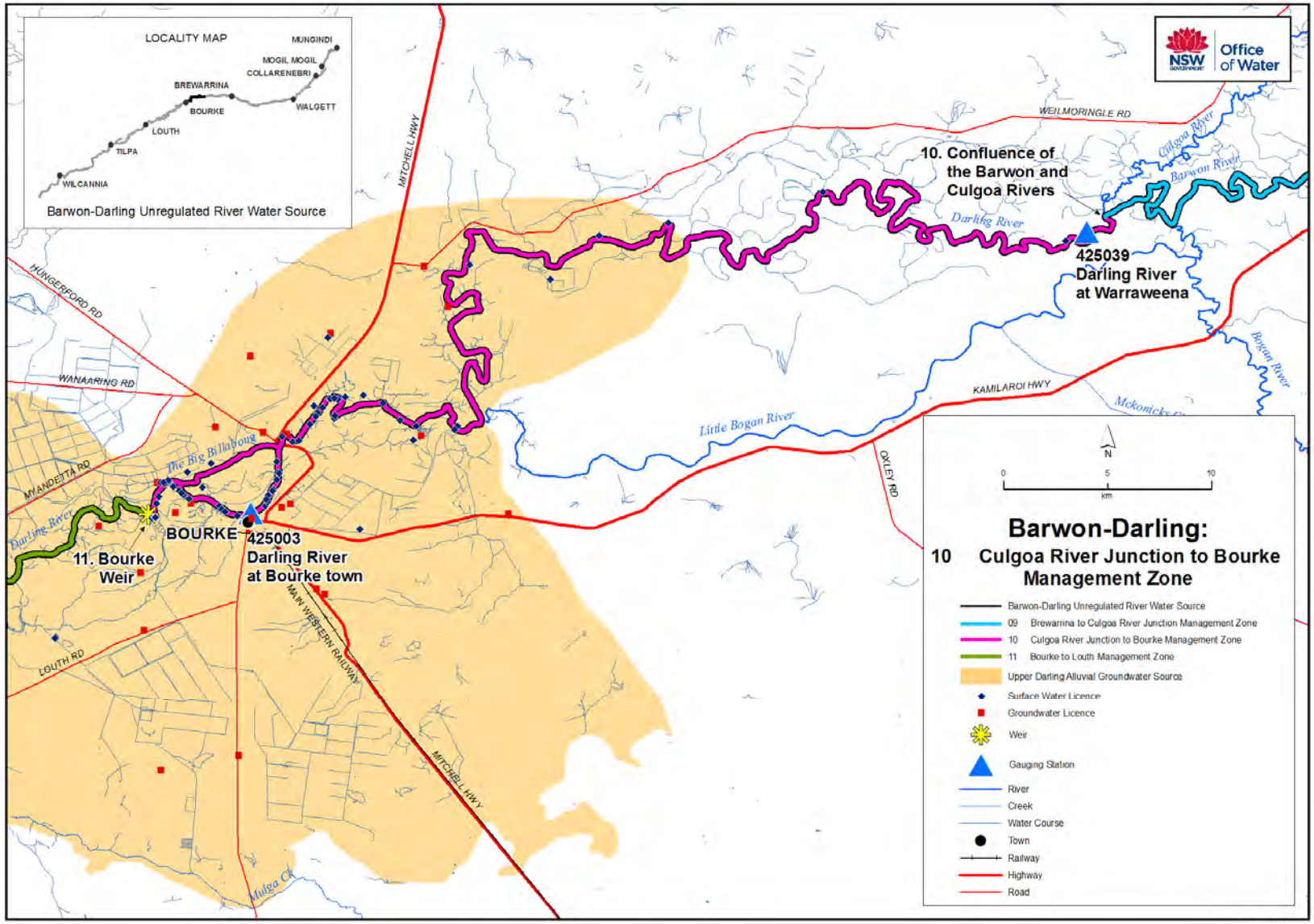

LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
NSW GOVERNMENT Office of Water
7. Walgett Weir
422001 Barwon River at Dangar Bridge
WALGETT
8. Confluence of the Barwon and Macquarie Rivers
422026 Barwon River at Boorooma
422027 Barwon River at Geera
KAMILAROI HWY
BREWON RD
WANOURIE RD
WANOURIE CREEK RD
BOGEWONG RD
CARINDA WALGETT RD
BINGHI BRIDGE CARINDA RD
MULLINS SWAMP RD
MERALIVYN RD
KIA ORA RD
BOOROOMA MCPHEESYARDS RD
BOOROOMA CREEK RD
TUNGRA RD
WALGETT GOODOOGA RD
MISSION RD
Barwon River
Whisky Ck
Womat Ck
Castlereagh River
Macquarie River
Euromlin Ck
Marthaguy Ck
Ginghet Ck
N
0 5 10
km
Barwon-Darling:
07 Downstream Walgett to Boorooma Management Zone
Barwon-Darling Unregulated River Water Source
06 Walgett Weir Pool Management Zone
07 Downstream Walgett to Boorooma Management Zone
08 Boorooma to Brewarrina Management Zone
Surface Water Licence
Weir
Gauging Station
River
Creek
Water Course
Town
Railway
Road

Map 7 of 14

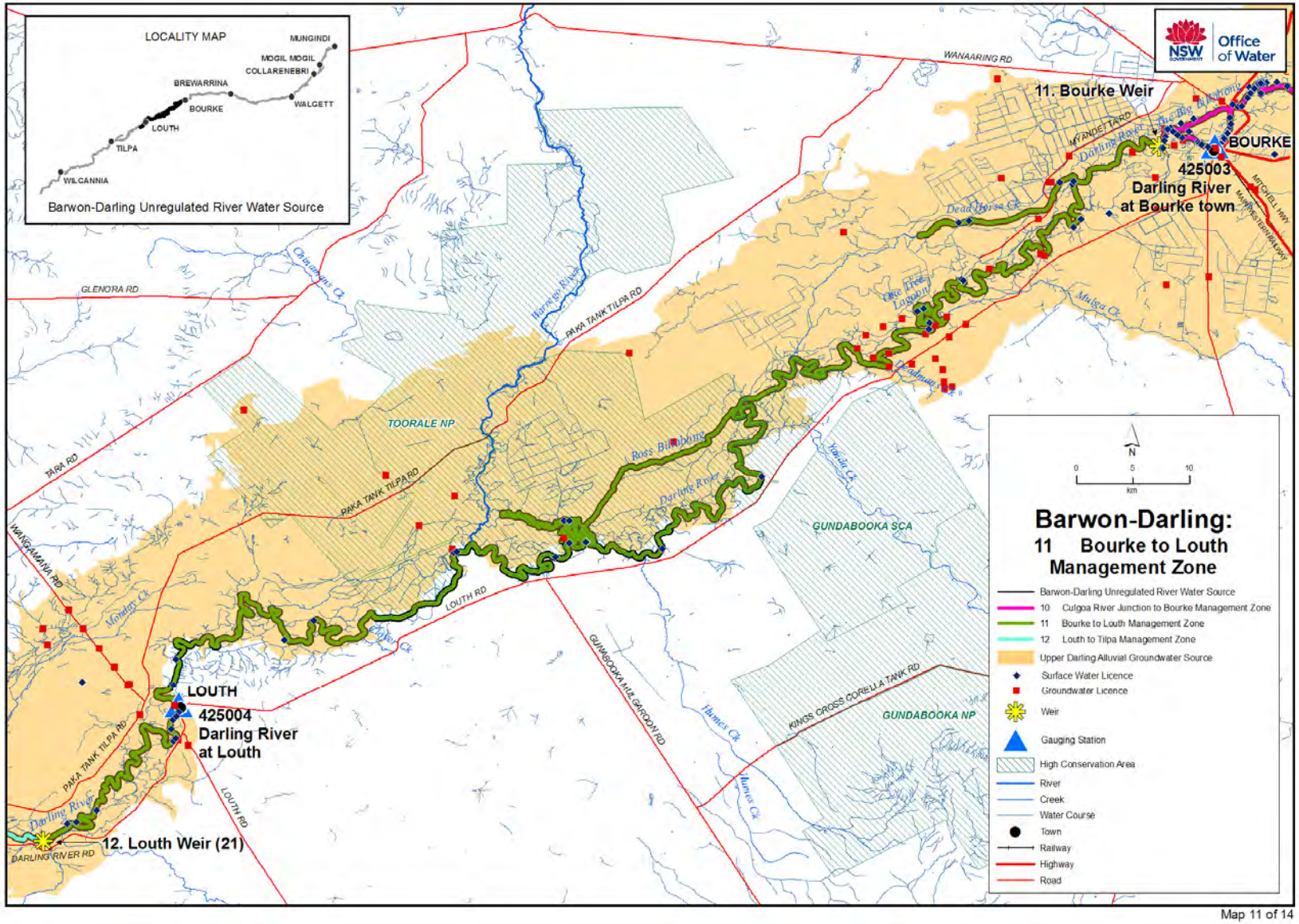

Office of Water
NSW GOVERNMENT
LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
9. Brewarrina Weir
422002 Barwon River at Brewarrina
BREWARRINA
TWIN RIVERS RD
GOGO OOGA RD
Cato Ck
BREWARRINA RAILWAY
KIA ORA RD
Barwon River
TARRION YARRAWIN RD
Tarrion Ck
Briery Ck
KAMILAROI HWY
8. Confluence of the Barwon and Macquarie Rivers
Macquarie R
Briery Junction
422027 Barwon River at Geera
Hurra Ck
Ginghet Ck
MIRRALWYN RD
N
0
5
10
km
Barwon-Darling:
08 Boorooma to Brewarrina Management Zone
Barwon-Darling Unregulated River Water Source
07 Downstream Walgett to Boorooma Management Zone
08 Boorooma to Brewarrina Management Zone
09 Brewarrina to Culgoa River Junction Management Zone
Surface Water Licence
Weir
Gauging Station
River
Creek
Water Course
Town
Railway
Highway
Road

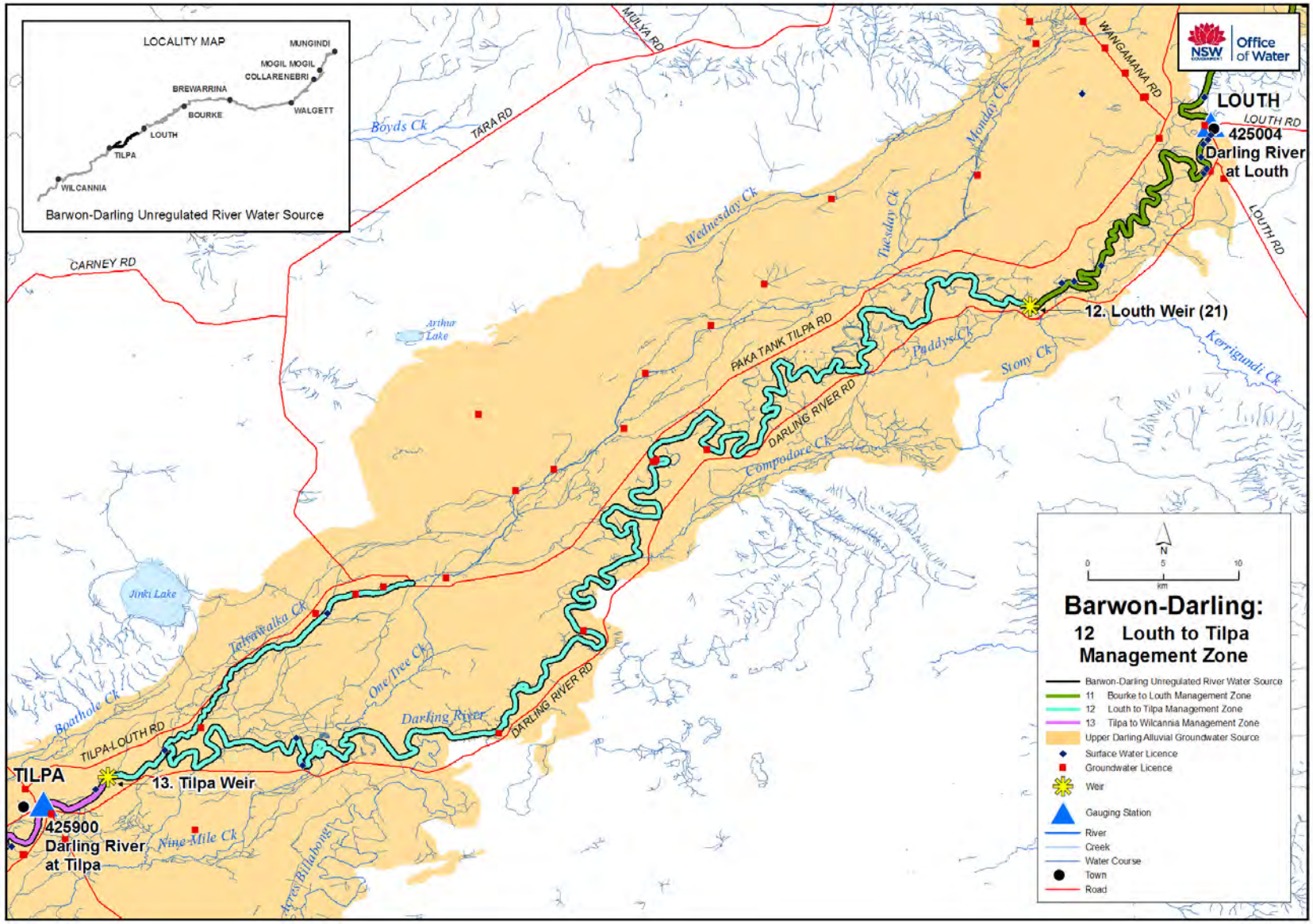
Map 8 of 14


LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
N
0
5
10
km
NSW GOVERNMENT
Office of Water
TWIN RIVERS RD
TALAWANTA COOLA RD
Ledknapper Ck
WEILMORINGLE RD
Culgoa River
Darling R
Barwon River
Bokhara River
Cato Ck
422002
Barwon River
at Brewarrina
422028
Barwon River
at Beemery
9. Brewarrina
Weir
BREWARRINA
425039
Darling River at
Warraweena
10. Confluence of
the Barwon and
Culgoa Rivers
KAMILAROI HWY
Mckonicks Ck
Bogan River
Tarrion Ck
OXLEY RD
Barwon-Darling:
09 Brewarrina to Culgoa River
Junction Management Zone
Barwon-Darling Unregulated River Water Source
08 Boorooma to Brewarrina Management Zone
09 Brewarrina to Culgoa River Junction Management Zone
10 Culgoa River Junction to Bourke Management Zone
Surface Water Licence
Weir
Gauging Station
River
Creek
Water Course
Town
Railway
Highway
Road
Map 9 of 14

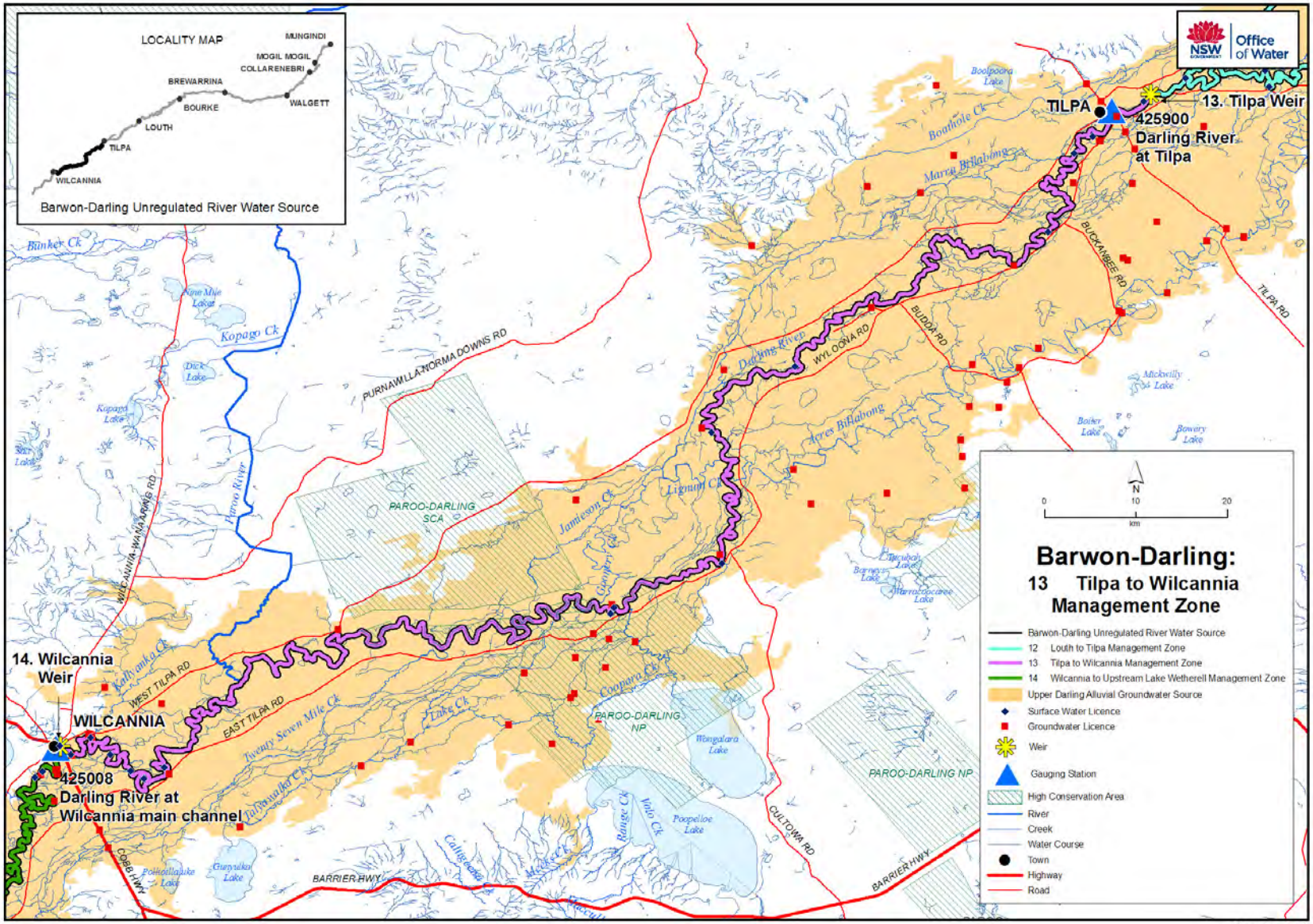

LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
Office of Water
10. Confluence of the Barwon and Culgoa Rivers
425039 Darling River at Warraweena
425003 Darling River at Bourke town
11. Bourke Weir
BOURKE
Barwon-Darling:
10 Culgoa River Junction to Bourke Management Zone
Barwon-Darling Unregulated River Water Source
09 Brewarrina to Culgoa River Junction Management Zone
10 Culgoa River Junction to Bourke Management Zone
11 Bourke to Louth Management Zone
Upper Darling Alluvial Groundwater Source
Surface Water Licence
Groundwater Licence
Weir
Gauging Station
River
Creek
Water Course
Town
Railway
Highway
Road
MITCHELL HWY
WEILMORINGLE RD
HUNGERFORD RD
WANAARING RD
MYANDETTA RD
LOUTH RD
KAMILAROI HWY
OXLEY RD
MAIN WESTERN RAILWAY
Darling River
Little Bogan River
Bogan River
Barwon River
Culgoa River
The Big Billabong
Mulga Ck

Map10 of 14

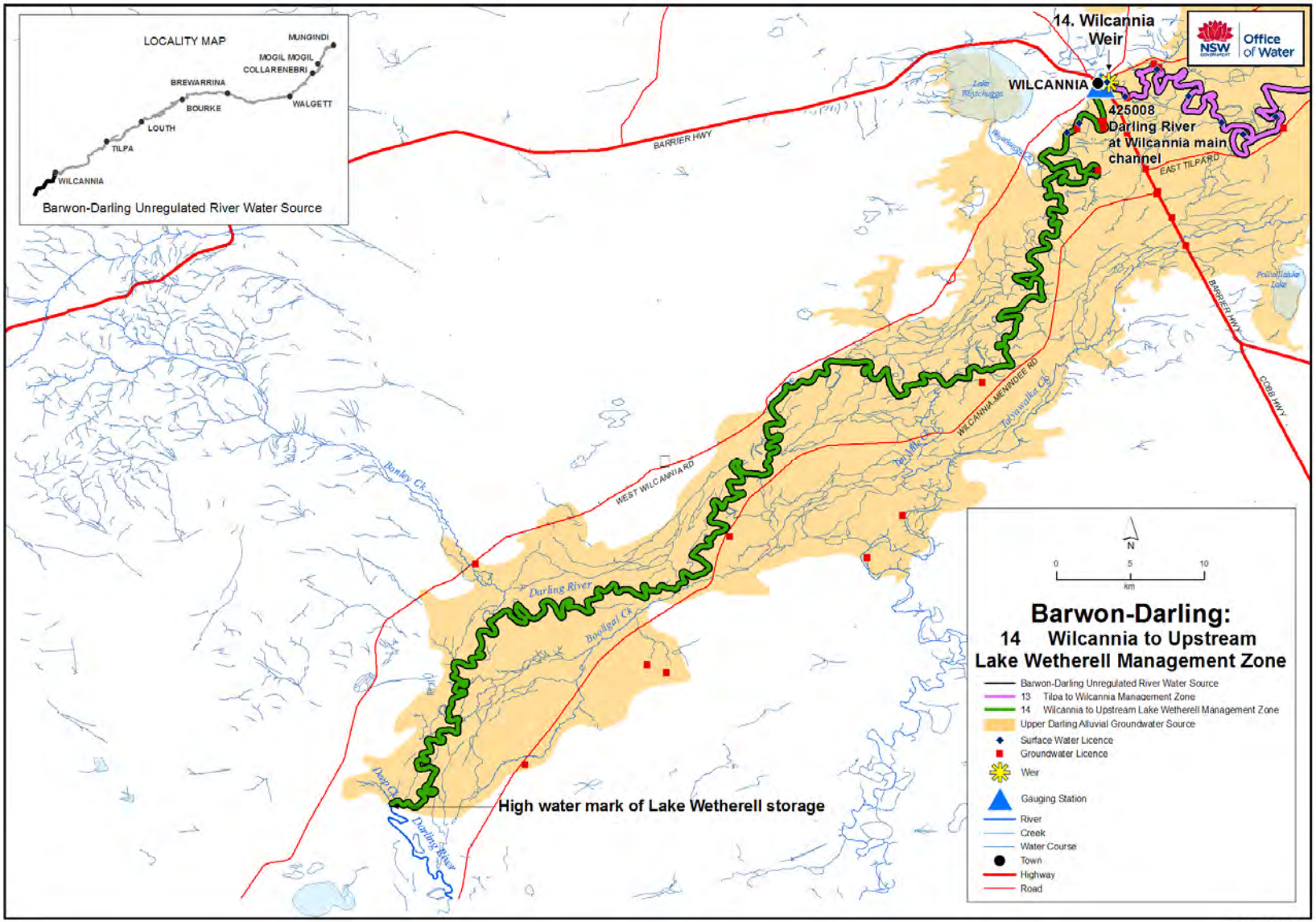

LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
NSW Office of Water
11. Bourke Weir
BOURKE
425003
Darling River
at Bourke town
LOUTH
425004
Darling River
at Louth
12. Louth Weir (21)
WANAARING RD
GLENORA RD
PAKA TANK TILPA RD
TARA RD
WANGAMANNA RD
LOUTH RD
DARLING RIVER RD
TOORALE NP
GUNDABOOKA SCA
GUNDABOOKA NP
KINGS CROSS CORELLA TANK RD
GUNAGOOKA MILE GARDOW RD
MITCHELL HWY
MANNUS TERRAMUNGA HWY
Barwon-Darling:
11 Bourke to Louth
Management Zone
Barwon-Darling Unregulated River Water Source
10 Culgoa River Junction to Bourke Management Zone
11 Bourke to Louth Management Zone
12 Louth to Tilpa Management Zone
Upper Darling Alluvial Groundwater Source
Surface Water Licence
Groundwater Licence
Weir
Gauging Station
High Conservation Area
River
Creek
Water Course
Town
Railway
Highway
Road
Map 11 of 14


LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
NSW Office of Water
LOUTH
LOUTH RD
425004
Darling River at Louth
12. Louth Weir (21)
MULYA RD
WANGAMANA RD
Boyds Ck
TARA RD
Monday Ck
Wednesday Ck
Tuesday Ck
CARNEY RD
Arthur Lake
PAKA TANK TILPA RD
Paddys Ck
Stony Ck
Kerrigundi Ck
DARLING RIVER RD
Compodore Ck
Jinki Lake
Tatawalka Ck
Boathole Ck
One Tree Ck
Darling River
TILPA-LOUTH RD
TILPA
13. Tilpa Weir
425900
Darling River at Tilpa
Nine Mile Ck
Acres Billabong
N
0
5
10
km
Barwon-Darling:
12 Louth to Tilpa Management Zone
Barwon-Darling Unregulated River Water Source
11 Bourke to Louth Management Zone
12 Louth to Tilpa Management Zone
13 Tilpa to Wilcannia Management Zone
Upper Darling Alluvial Groundwater Source
Surface Water Licence
Groundwater Licence
Weir
Gauging Station
River
Creek
Water Course
Town
Road

Map 12 of 14


LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
NSW Office of Water
TILPA
13. Tilpa Weir
425900
Darling River at Tilpa
14. Wilcannia Weir
WILCANNIA
425008
Darling River at Wilcannia main channel
PAROO-DARLING SCA
PAROO-DARLING NP
PAROO-DARLING NP
PURNAWILLA NORMA DOWNS RD
WYLOONA RD
BUDDA RD
BUCKANBEE RD
TILPA RD
WEST TILPA RD
EAST TILPA RD
COBB HWY
BARRIER HWY
BARRIER HWY
CULTOWA RD
Barwon-Darling:
13 Tilpa to Wilcannia Management Zone
Barwon-Darling Unregulated River Water Source
12 Louth to Tilpa Management Zone
13 Tilpa to Wilcannia Management Zone
14 Wilcannia to Upstream Lake Wetherell Management Zone
Upper Darling Alluvial Groundwater Source
Surface Water Licence
Groundwater Licence
Weir
Gauging Station
High Conservation Area
River
Creek
Water Course
Town
Highway
Road
N
0
10
20
km

Map 13 of 14


LOCALITY MAP
MUNGINDI
MOGIL MOGIL
COLLARENEBRI
BREWARRINA
BOURKE
WALGETT
LOUTH
TILPA
WILCANNIA
Barwon-Darling Unregulated River Water Source
14. Wilcannia Weir
WILCANNIA
425008
Darling River at Wilcannia main channel
BARRIER HWY
EAST TILPARD
WEST WILCANNIA RD
WILCANNIA-MENINDEE RD
COBB HWY
Darling River
Boolgal Ck
High water mark of Lake Wetherell storage
N
0
5
10
km
Barwon-Darling:
14 Wilcannia to Upstream Lake Wetherell Management Zone
Barwon-Darling Unregulated River Water Source
13 Tilpa to Wilcannia Management Zone
14 Wilcannia to Upstream Lake Wetherell Management Zone
Upper Darling Alluvial Groundwater Source
Surface Water Licence
Groundwater Licence
Weir
Gauging Station
River
Creek
Water Course
Town
Highway
Road

Map 14 of 14

Appendix 2: Interagency regional panel and support staff – membership and expertise

Name	Agency	Role	Expertise
Interagency Regional Panel			
Anna Bailey (to Oct 2010)	NSW Office of Water	Agency Representative	Surface water and groundwater management, planning/ policy development and implementation, across the state with particular emphasis on northern inland areas.
Mark Harris (post Oct 2010)	NSW Office of Water	Agency Representative	Extensive experience in water management policy and planning, water sharing plan development and implementation
Greg Markwick	Department of Primary Industries	Agency Representative	Thirty years experience 15 years as a Regional Director with Primary Industries in the Western region. Regional experience in water reform programs, water quality problems, inland agricultural industries, catchment management and interagency coordination.
Peter Terrill	Office of Environment and Heritage	Agency Representative	Water management and water environmental specialist since 1987. Several roles within the NSW water and environment departments as well as with the former MDBC. Currently an environmental water manager responsible for the unregulated river systems of north-western NSW. Extensive experience with water reform in the Barwon-Darling.
Ken Harrison	Western CMA	CMA Observer	Natural resource management in Far Western NSW, including: program development and implementation, project management, soil conservation, and land and water management. Community liaison and engagement.
Sally Egan	Namoi CMA	CMA Observer	Broad experience in catchment management, program development/ implementation and project management, including, soil conservation, land/ biodiversity management and riparian restoration. Community liaison and engagement.
Jeremy Cape	Namoi CMA	CMA Observer	Catchment management, community liaison and engagement
Liz Savage	Border Rivers-Gwydir CMA	CMA Observer	Catchment management, community liaison and engagement
Sarah Foot	Border Rivers-Gwydir CMA	CMA Observer	Catchment management, community liaison and engagement
Support staff			
Daniel Connor	NSW Office of Water	Plan coordinator	Natural resource management, water management and planning.
Emily Turner	NSW Office of Water	Planning support	Water planning, support documentation
Ashleigh Jones	NSW Office of Water	Plan writer, policy support	Water policy and planning, environmental science, environmental law
Richard Wheatley, Mark Campbell	NSW Office of Water	Technical support - Licensing	Western NSW licensing officer, extensive local knowledge of water sharing issues, users, WUAs

Name	Agency	Role	Expertise
Eva Ciecko	NSW Office of Water	Technical support – Spatial data	Spatial data systems, mapping
Seevaratnam Haridharan	NSW Office of Water	Technical support - Hydrogeology	Hydrogeology, local knowledge
Neal Foster	NSW Office of Water	Technical support - Ecology	Aquatic ecology, local knowledge
Noel Flavel, Brinta Nandy, Graham Carter	NSW Office of Water	Technical support – Socio-economics	Socio-economic data, impacts of water sharing rules
Richard Cooke	NSW Office of Water	Technical support - Hydrology	Hydrology, IQQM
Anne Brook	NSW Office of Water	Planning support - Media	Community relations and media
Janine Lonergan, Emma Solomon	NSW Office of Water	Planning support - Legal	Environmental law
Paul Simpson	NSW Office of Water	Planning support - Implementation	NSW Water Management, Hydrology, IQQM.

Appendix 3: Barwon-Darling Cap Management Strategy

HEADS OF AGREEMENT

for the Barwon-Darling River System
regarding proposed management actions to comply with
the Murray-Darling Basin Cap on Diversions

BETWEEN
Minister for Natural Resources
Water Administration Ministerial Corporation
Mungindi-Menindee Advisory Council Inc
Bourke Shire Council
Clyde Agriculture
Darling Farms
NSW Irrigators' Council

HEADS OF AGREEMENT dated the day of 2006

BETWEEN:

The Hon. Ian Macdonald, MLC, Minister for Natural Resources of Level 33, Governor Macquarie Tower, 1 Farrer Place, Sydney NSW 2000 (the ***Minister***);

AND

Water Administration Ministerial Corporation of 23-33 Bridge Street, Sydney NSW 2000 (the ***Ministerial Corporation***);

AND

Mungindi-Menindee Advisory Council Inc. of 109 Wee Waa Street, Walgett NSW 2832 (the ***Council***).

AND

Bourke Shire Council of 29 Mitchell Sreet, Bourke, NSW 2840 (***Bourke***)

AND

Clyde Agriculture of Swire House, 8 Spring Street, Sydney NSW 2000 (***Clyde***)

AND

Darling Farms of Wanaaring Rd, Bourke, NSW 2840 (***Darling***)

AND

NSW Irrigators Council, Level 6, 139 Macquarie Street, Sydney NSW 2000, (***Irrigators***)

RECITALS:

A. The Minister represents the New South Wales Government.

B. The Ministerial Corporation licences water extractions on water sources to which the ***Water Act 1912*** applies.

C. The Council is the peak body representing irrigators along, and consulted to advise on, the Barwon-Darling River System.

D. The Bourke Shire Council is the locally elected Government body located along the Barwon Darling River System.

E. Clyde Agriculture and Darling Farms are two of the most significant irrigators in the Barwon Darling region.

F. NSW Irrigators Council is the peak body representing all irrigators in all the strategic decisions concerning the use of water in NSW.

THE MATTERS OF PRINCIPLE AGREED ARE AS FOLLOWS:

1. DEFINITIONS AND INTERPRETATION

1.1 Definitions

The following definitions apply unless the context requires otherwise:

Annual Volumetric Limit or ***AVL*** means the licensed maximum volume that can be extracted in any one water year.

Barwon-Darling Cap means the long term average annual diversions modelled at 1993/94 levels of development.

Barwon-Darling Cap Model or ***BDCM*** means the existing Integrated Quality Quantity Model used for determining the long term Cap along the Barwon-Darling River System.

Barwon-Darling River System means the unregulated reaches of the Barwon River and the Darling River between Mungindi and Menindee Lakes.

DNR means the ***NSW Department of Natural Resources.***

MDBC means ***Murray Darling Basin Commission.***

1.2 Interpretation

The following rules of interpretation apply unless the context requires otherwise:

a) The ***singular*** includes the plural number and visa versa.

b) A ***gender*** includes all genders.

c) Where a ***word*** or ***phrase*** is defined its other grammatical forms have a corresponding meaning.

d) ***Headings*** are for convenience only and do not affect the interpretation.

e) A reference to any ***party*** to this Agreement or any other agreement or document includes the party's legal personal representative, successor in title, and permitted assigns.

f) A reference to a ***company*** includes a person, a corporation an unincorporated body or other entity and visa versa.

2. PURPOSE

2.1 Purpose

The Parties enter into this Heads of Agreement in a spirit of cooperation and with the determination to progress the arrangements outlined below.

2.2 Heads of Agreement non binding

This Heads of Agreement is a statement of intention only. It is not intended to, and does not impose any legally binding obligations upon, or create any legally binding obligations between, the Parties.

3. ARRANGEMENTS

3.1 Adjustment to the Barwon-Darling Cap Model

3.1.1 The Parties agree that DNR will review the BDCM as per the following Tasks:

1. DNR will establish a working group composed of an independent hydrologist, a person nominated by the ***Council,*** and a staff member of DNR.
2. DNR will endeavour to engage Mr. Drew Bewsher (Bewsher Consulting), who is contracted by MDBC to accredit the models used by NSW for Cap determinations, or another independent hydrologist as agreed between the parties.
3. Assess DNR report tentatively titled: "Barwon Darling IQQM implementation summary report" and any modelling issues by the ***Council.***
4. Identify key tasks of modelling and calibration that require further work.
5. Develop a project plan for implementing the tasks at 2. Including:
    - Required data collection;
    - Model recalibration and validation.
    - The technical process required for the amendment of the "Cap" volume.
6. Prepare and publish the report.

3.1.2 The Parties acknowledge that the MDBC will be the accreditor of the BDCM and that DNR will use its best endeavours to gain accreditation of the final BDCM in accordance with accepted MDBC procedure, and will publish the accreditation report.

3.1.3 The Parties agree that DNR will determine and distribute a new Cap as per the following Tasks:

1. The upgraded BDCM will be run to produce a revised 1993/94 long-term average annual diversion – the new Cap.
2. The distribution of individual shares in the new Cap will be consistent with the conversion rate in 3.2 below. The new share entitlements will take effect in the water year subsequent to the year in which the determination is made.
3. Wherever necessary, existing water accounts will be converted to reflect a new volume consistent with the changeover to new extraction meters. *(**Note:** Subject to this Task, existing water accounts held at the time of the new Cap determination will not be adjusted, either up or down, as a consequence of a new Cap determination. The carryover credit at 3.3 provides a buffer to the uncertainty of the accuracy of the Cap figure. Amendments to water accounts will only occur with the changeover to new meters.)*

3.2 Range of Annual Cap Volume

It is agreed that the long-term Barwon Darling Cap, is estimated to be in the range of 173 – 250 Gl based on existing metering. This will be confirmed following the analysis and upgrade of the IQQM as per 3.1.1.

Initially starting on July 1, 2006 the Barwon Darling Cap is assumed to be the notional figure of 173 Gl. This is a notional figure only, and the final figure will only be determined once the review noted in 3.1.1 is implemented.

3.3 Conversion of licence entitlements to comply with the Barwon-Darling Cap

The Parties agree that:

a) the conversion from current licensed AVL to new Barwon-Darling Cap-compliant shares will be based on a formula that will bias active AVL over inactive AVL by a weighting ratio of 2.25:1, where:

- ***active*** is defined by the average annual extraction between 1995/96 and 2004/05 (with appropriate adjustment for "nil" extraction years);
- ***inactive*** is the difference between AVL and active;
- ***annual extraction*** is based on individual diversion records held by DNR.

b) prior to conversion, DNR will seek advice from licence-holders as to the accuracy of the extraction records intended to be relied upon.

c) the Council will encourage prompt responses by licence-holders to the extraction records provided.

3.4 Barwon-Darling River System continuous accounts

The current Annual Volumetric Limits that apply to licences will be removed. Individual water accounts will be established. Each year these individual water accounts will be *credited* with a volume equivalent to each individual's share of Cap, as calculated at 3.2 above. Individual water use will be *debited* from the account. Any unused account water will remain in the account and be carried over for use in subsequent years.

3.5 Trading Rules

Appropriate trading rules for both permanent and temporary trade, will be agreed between the parties and introduced upon commencement of the Cap.

3.6 Initial Barwon-Darling River System water accounts

To determine the carryover volume going into the first year of the new water management regime, a theoretical "valley" water account dating back to 1997/98 (the first year of formal reporting to the Independent Audit Group of the Murray-Darling Basin Ministerial Council) was established and credited with twice the Cap volume in the first year and the Cap volume each year thereafter. Total water extractions from and including 1997/98 up to and including 2005/06 will be debited from the valley account yielding a positive or negative carryover. Based on recorded extractions to date, this carryover volume is estimated at 150GL (subject to verification of total extractions this current water year (2005/06)).

The Parties agree that:

a) a carryover credit or debit will exist going into the first year of the new arrangements, subject to the total extraction volume for this current water year;

b) a carryover *credit* will be distributed amongst active AVL only.

THIS HEADS OF AGREEMENT IS DULY AUTHORISED BY:

SIGNED by **IAN MACDONALD** on behalf of the **STATE OF NEW SOUTH WALES** in the presence of:

Minister's Signature

Signature of Witness

Print Witness' Name

SIGNED by **WATER ADMINISTRATION MINISTERIAL CORPORATION** by its authorised officer **RICHARD SHELDRAKE** Director General in the presence of:

Director General's Signature

Signature of Witness

Print Witness' Name

SIGNED by **MUNGINDI-MENINDEE ADVISORY COUNCIL INC.** by its Chairman **IAN COLE** in the presence of:

Chairman's Signature

Signature of Witness

Print Witness' Name

Ado ZANELLA, Premier's Department

SIGNED by **WAYNE O'MALLEY** on behalf of **BOURKE SHIRE COUNCIL** in the presence of:

Mayor's Signature

Signature of Witness

Print Witness' Name

SIGNED by **CLYDE AGRICULTURE** by its authorised officer **DAVID BOYD** in the presence of:

Mr. Boyd's Signature

Signature of Witness

Print Witness' Name

SIGNED by **DARLING FARMS** by its authorised officer **STEVE BUSTER** in the presence of:

Mr. Buster's Signature

Signature of Witness

Print Witness' Name

SIGNED by **NSW IRRIGATORS COUNCIL** by its Chairman **COL THOMSON** in the presence of:

Chairman's Signature

Signature of Witness

~~Print Witness' Name~~

Ado ZANELLA, Premier's Department

Appendix 4 Integrated Quantity and Quality Model

The Barwon-Darling Integrated Quantity and Quality Model (IQQM) relies on calibration against historical stream flow, rainfall, evaporation, on-farm storage (ofs) behaviour and water extraction activities. The model can then be used to:

- create 'natural' stream flow sequence by removing any irrigation developments and using 'natural' inflows from the tributaries,
- assess reliability for different categories of licences under current and full development,
- assess the likely improvement to the environment and impact on users of proposed flow sharing rules.

The IQQM cannot forecast flows or flood levels, or determine the state of the catchment in the future.

NSW Office of Water developed and calibrated an initial IQQM for the Barwon-Darling River in 1995. The recent re-calibration of individual irrigator behaviour using extended data has created the latest version available to simulate streamflows and water extractions for irrigation use. The model assesses long-term behaviour over 114 (1895 to 2009) years of daily historical climate and simulated inflow data. It also outputs data on a daily time step. The major hydrologic processes modelled by the IQQM include:

- gauged inflows (simulated and historical data gap filled and extended)
- ungauged over-bank inflows (estimated)
- routing of flows along the Barwon-Darling River
- river losses or unexplained differences (lumping seepage, unmeasured extractions and over bank inflows and measurement errors)
- irrigator behaviour of large individual enterprises and grouped small farms; areas cropped for irrigation, crop demands, pumped diversions and on-farm storage behaviour
- flow sharing management amongst irrigators
- NSW Office of Water License controls on irrigators.

Major hydrologic processes not modelled are land use changes (ie crop types) and on-farm management changes (i.e. planting risk - in the form of water that is stored in ofs relative to the water requirements of the planted area).

The model represents the River systems using nodes and links. Nodes represent locations along the river where flow enters, leaves, extracted by irrigators, lost or measured; while links are used to model the movement of water between nodes (see below).

Types of input data collected for the IQQM consisted of:

- rainfall (BOM data gap filled and extended)
- evaporation (BOM data gap filled and extended)
- inflows (simulated by upstream tributary models and gauged Office of Water streamflow data gap filled and extended)
- crop type, irrigated area, ofs capacities and on-farm water management decisions (SW data from surveys)
- pumped irrigation water diversions (observed Time and Event metered diversions)
- Barwon-Darling streamflow data (Office of Water data)

The aim is to achieve the best match possible between the modelled outputs and the observed data over a given period of record. The model calibration is performed over a period when data is available and there is sufficient climatic variability. Recent improvements include the recalibration of irrigation

and rainfall-runoff harvesting efficiencies to incorporate the impacts of a more significantly diverse climate period.

The Cap IQQM has been independently audited and effectively accredited (waiting final sign off) by the Murray-Darling Basin Authority for undertaking auditing of the Murray-Darling Basin Cap

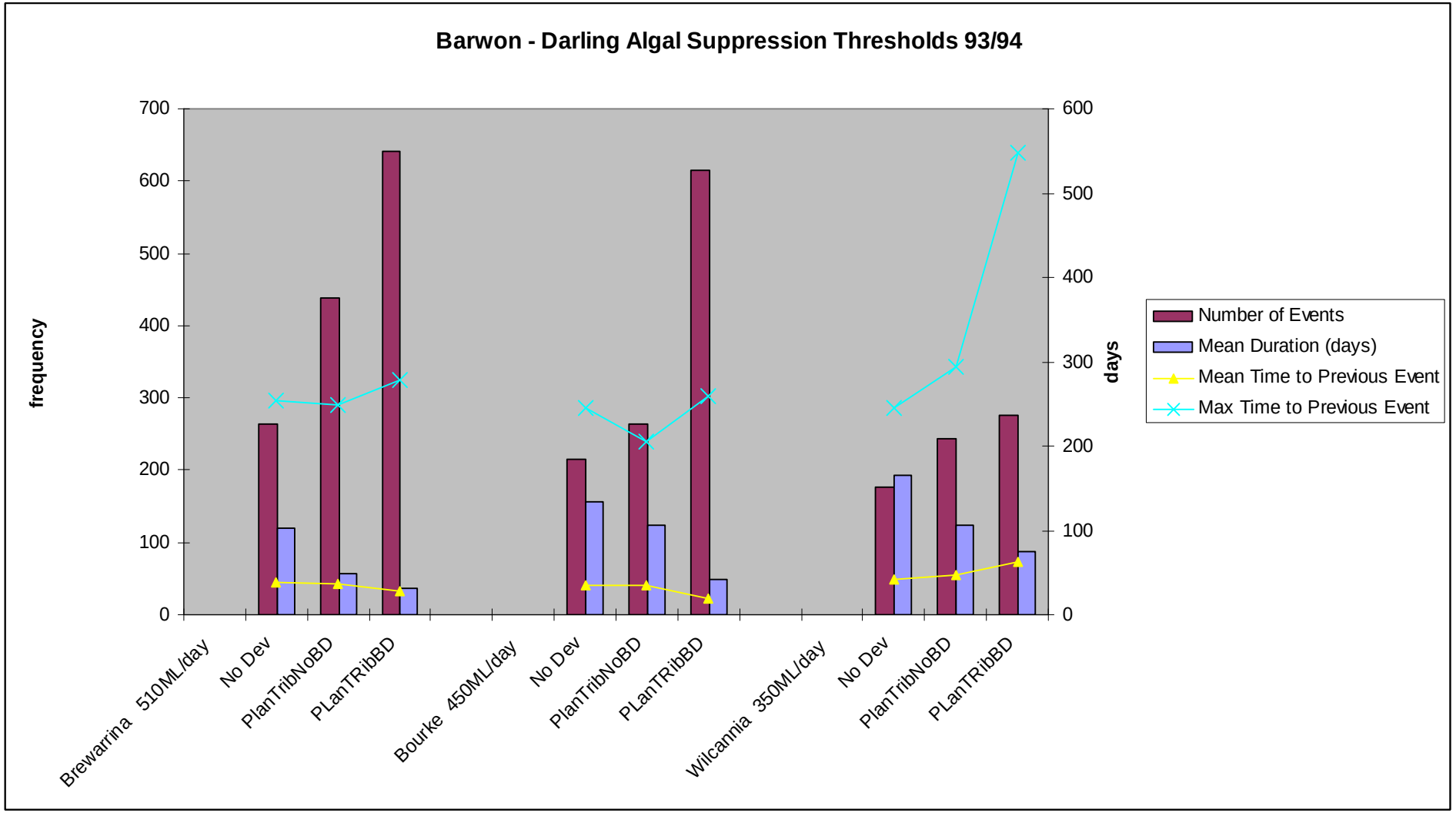
Appendix 5: Modelling of algal suppression thresholds

Table: Comparison of (i) no development, (ii) water sharing plan and resource operation plan development on tributaries, with no Barwon-Darling development and (iii) water sharing plan and resource operation plan development on tributaries plus Barwon-Darling development

	Number of events	Mean duration (days)	Mean volume (GL)	Mean max flow (ML/day)	Max flow (ML/day)	% change from 'natural'	Mean time to previous event (days)	Max time to previous event (days)
Brewarrina 510 ML/day								
No development	263	119.6	1059.2	20188.6	258214		38	254
Plan development only on tributaries (no B-D)	439	57.6	364.7	8417.8	179061	30.65	37	248
Plans on tributaries and B-D development	641	36.3	238.4	6176.8	178988	30.68	28	278
Bourke 450 ML/day								
No development	215	157.2	2151.9	33077.9	582207		35	246
Plan development only on tributaries (no B-D)	263	122.9	982.1	15625.4	353219	39.33	35	205
Plans on tributaries and B-D development	614	48.5	393.3	8091.3	352996	39.37	19	259
Wilcannia 350 ML/day								
No development	176	193.4	2218.3	17850.8	231708		42	246
Plan development only on tributaries (no B-D)	244	123.8	888.7	9150.8	143334	38.14	46	294
Plans on tributaries and B-D development	276	87.6	712.3	8837.6	142890	38.33	62	547

Source IQQM – Foster and Cooke (unpublished)

Figure: Comparison of Barwon-Darling IQQM scenarios and impact on frequency of exceedance of critical flow thresholds and duration of exceedance



Source Foster (unpublished)

Appendix 6: Modelling of commence to fill thresholds for wetlands

Table: Comparison of IQQM runs to evaluate relative impact on commence to fill thresholds after Brennan et al (2002)

Feature	CTF	Natural	Plans on tributaries, not on BD	% change from 'natural'	Plans on tributaries and BD	% change from 'natural'	Further % change based on BD dev
Zone 2							
Collarenebri Node							
Unnamed	19244	2.15	1.13	47.4	1.12	47.9	0.5
Butti Lagoon	30000	0.7	0.42	40.0	0.415	40.7	0.7
Long Swamp	60394	0.145	0.007	95.2	0.007	95.2	0.0
Weerabilla Lagoon	21184	1.74	0.91	47.7	0.9	48.3	0.6
Grawan Creek	6800	12.5	5.8	53.6	5.7	54.4	0.8
Meeki Creek	1990	30.3	16.1	46.9	14.9	50.8	4.0
Thalaba Creek	19600	2	1.1	45.0	1.05	47.5	2.5
Pagan Creek	20500	1.88	0.985	47.6	0.97	48.4	0.8
Zone 3							
Walgett Node							
Ulah Lagoon	27000	6.3	3.1	50.8	3.05	51.6	0.8
Ulah Lagoon	18000	9.4	4.6	51.1	4.5	52.1	1.1
Herding Yard Lagoon	22421	7.75	3.75	51.6	3.7	52.3	0.6
Canary Lagoon	18426	9.1	4.5	50.5	4.45	51.1	0.5
Canary Lagoon	18664	9.05	4.46	50.7	4.41	51.3	0.6
Canary Lagoon	4513	28.5	15.75	44.7	15.2	46.7	1.9
Toothia Billabong	9977	16	8	50.0	7.8	51.3	1.3
Toothia Billabong	31230	5.3	2.65	50.0	2.64	50.2	0.2
Toothia Billabong	25217	6.7	3.31	50.6	3.29	50.9	0.3
Toothia Billabong	13247	12.4	5.9	52.4	5.84	52.9	0.5
Toothia Billabong	25200	6.7	3.32	50.4	3.29	50.9	0.4
Yambie Lagoon	38520	4.2	2.1	50.0	2.095	50.1	0.1
Yambie Swamp	24817	6.82	3.39	50.3	3.36	50.7	0.4
Cato Creek	27130	6.21	3.06	50.7	3.02	51.4	0.6
Tarrion Billabong	19092	8.83	4.38	50.4	4.32	51.1	0.7
Yambacooma Billabong	17094	9.8	4.76	51.4	4.69	52.1	0.7
Dead Horse Creek	177076	0.45	0.25	44.4	0.25	44.4	0.0
Zone 4							
Bourke Node							
Piono Creek Lagoon	21000	14	6.5	53.6	6	57.1	3.6

Feature	CTF	Natural	Plans on tributaries, not on BD	% change from 'natural'	Plans on tributaries and BD	% change from 'natural'	Further % change based on BD dev
Warraweena Lagoon	28362	9.5	4.5	52.6	4.3	54.7	2.1
Turee Lake	315000	0.159	0.02	87.4	0.02	87.4	0.0
Polygonum Swamp	31219	8.2	3.8	53.7	3.7	54.9	1.2
Polygonum Swamp d/s	27800	9.6	4.4	54.2	4.3	55.2	1.0
Big Billabong	59360	3.2	1.75	45.3	1.7	46.9	1.6
Zone 5							
Bourke Node							
Duck Egg Swamp	40000	5.9	2.9	50.8	2.8	52.5	1.7
Yanda Ck Anabranch	36800	6.6	3.2	51.5	3.1	53.0	1.5
Yanda Ck Anabranch	33820	7.3	3.5	52.1	3.4	53.4	1.4
Ross Billabong	59270	3.2	1.75	45.3	1.7	46.9	1.6
Ross Billabong	27248	10	4.6	54.0	4.4	56.0	2.0
Ross Billabong	28228	9.5	4.4	53.7	4.2	55.8	2.1
Taloula Billabong	45000	4.8	2.5	47.9	2.4	50.0	2.1
Boolpara Lake	65000	2.8	1.6	42.9	1.6	42.9	0.0
Acres Lagoon	48305	4.5	2.3	48.9	2.2	51.1	2.2
Zone 6							
Wilcannia Node							
Cultowa Billabong	30403	7.6	3.68	51.6	3.54	53.4	1.8
Talyawalka Creek	34292	4	2.45	38.8	2.4	40.0	1.3
27 Mile Creek	32334	4.35	2.81	35.4	2.75	36.8	1.4
Unnamed	8600	30.95	16	48.3	14.9	51.9	3.6
Lake Wotychugga	30678	7.25	3.54	51.2	3.42	52.8	1.7
Lake Wotychugga	25963	11.51	5.41	53.0	5.15	55.3	2.3
Lake Wotychugga	29609	8.3	3.99	51.9	3.8	54.2	2.3
Lake Wotychugga	33994	4.1	2.5	39.0	2.35	42.7	3.7
Talyawalka Billabong	11321	25.5	12.68	50.3	11.88	53.4	3.1
Teryaweynya Lake	32976	4.6	2.66	42.2	2.62	43.0	0.9
Eucalyptus Lake	34730	3.8	2.38	37.4	2.34	38.4	1.1
Victoria Lake	37848	3.08	1.92	37.7	1.88	39.0	1.3
Brummeys Lake	41356	2.68	1.61	39.9	1.59	40.7	0.7
Gum Lake	40694	2.75	1.64	40.4	1.61	41.5	1.1
Boola Boolka Lake	38745	2.95	1.89	35.9	1.85	37.3	1.4
Ratcatchers Lake	46424	2.29	1.41	38.4	1.39	39.3	0.9
North Lake	47242	2.21	1.38	37.6	1.37	38.0	0.5
Unnamed	15895	20	9.7	51.5	9.1	54.5	3.0
Unnamed	16709	19.1	9.1	52.4	8.7	54.5	2.1
10 Mile Creek	33110	4.54	2.64	41.9	2.6	42.7	0.9

Feature	CTF	Natural	Plans on tributaries, not on BD	% change from 'natural'	Plans on tributaries and BD	% change from 'natural'	Further % change based on BD dev
Unnamed	32098	5.65	2.99	47.1	2.93	48.1	1.1
Unnamed	34267	3.97	2.47	37.8	2.42	39.0	1.3

Figure: Impact on CtF thresholds in zone 2

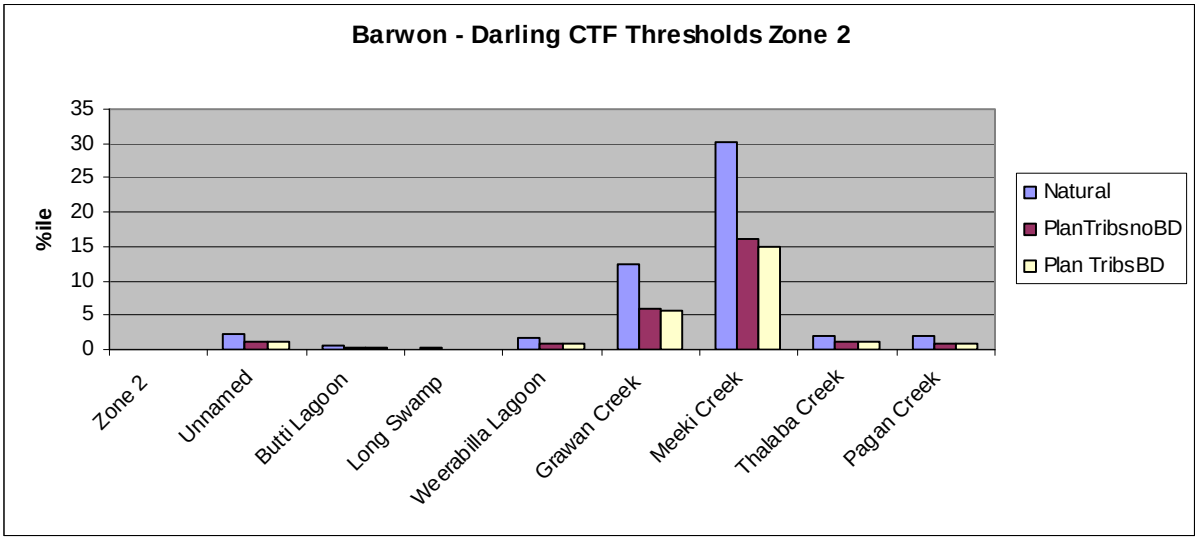


Figure: Impact on CtF thresholds in zone 3

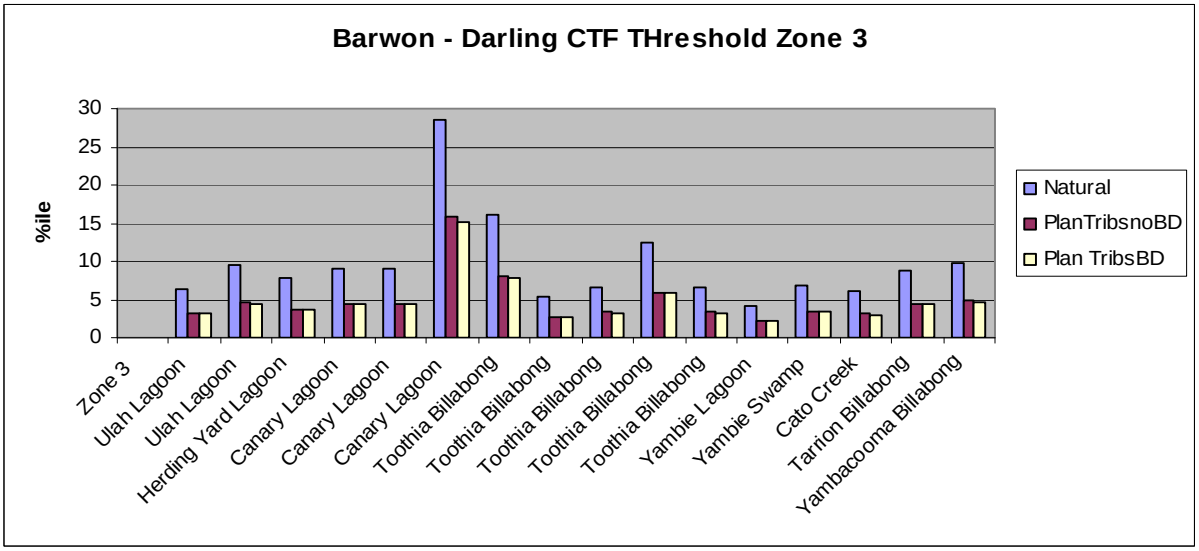


Figure: Impact on CtF thresholds in zone 4

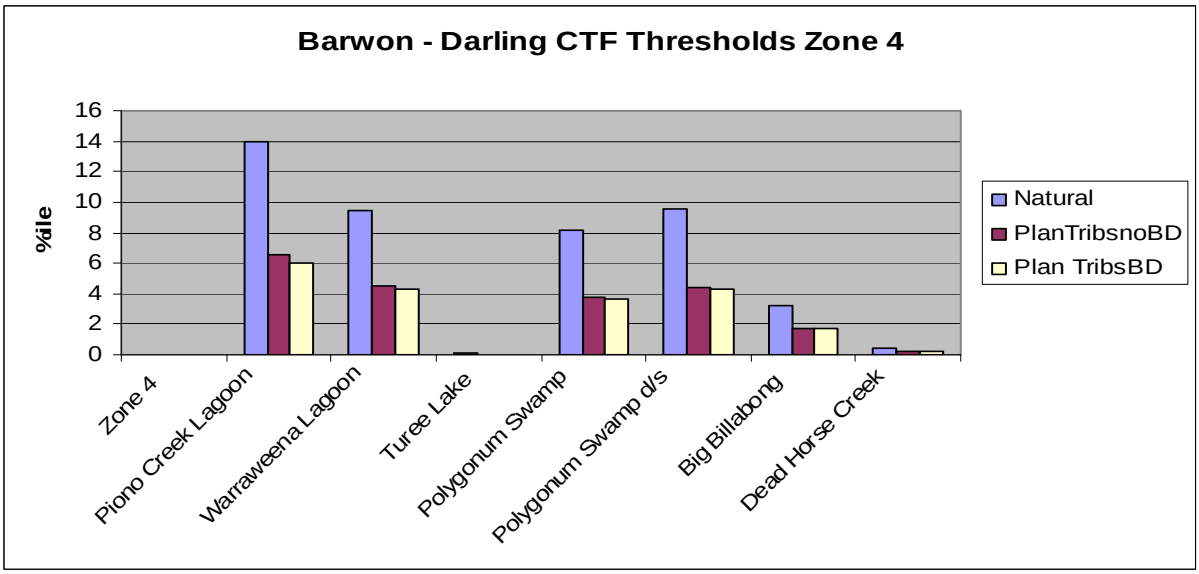


Figure: Impact on CtF thresholds in zone 5

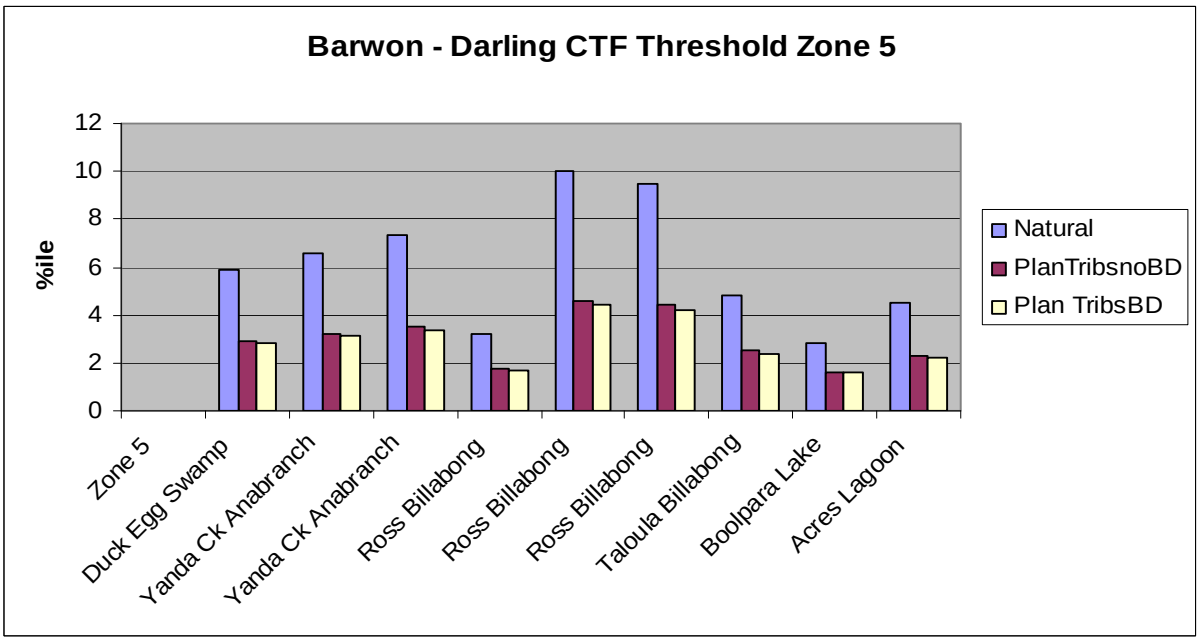
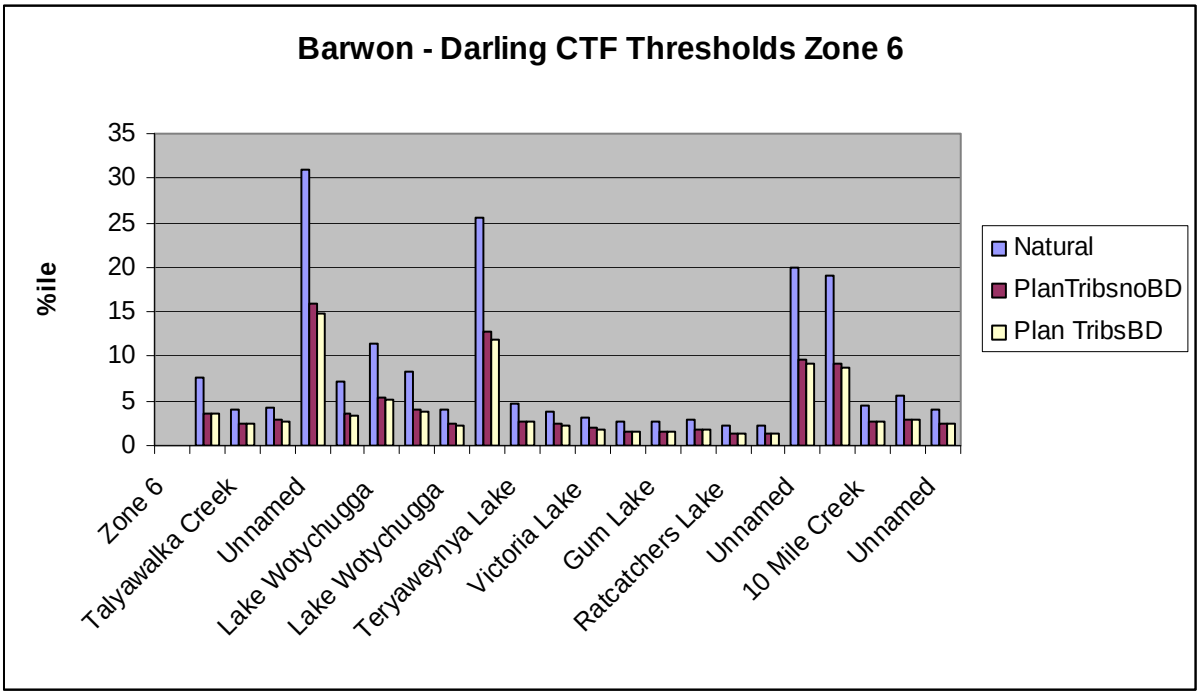


Figure: Impact on CtF thresholds in zone 6



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Appendix 7: Works authorised to extract Barwon-Darling unregulated water at commencement of the plan

Table: Works authorised by *Water Act 1912* licences at commencement of the plan extracting unregulated water

***Water Act 1912* licence**	**Class**	**Authorised works**
85SA001653	C	2 610 mm Axial Flow Pump
85SA001710	B	1 610 mm Centrifugal Pump, 2 510 mm Centrifugal Pump
85SA001836	B	4 610 mm Axial Flow Pump
85SA010578	B	7 610 mm Axial Flow Pump, 4 660 mm Axial Flow Pump
85SA011579	B	1 660 mm Mixed Flow Pump
85SA011581	B	5 660 mm Axial Flow Pump
85SA012502	B	3 600 mm Axial Flow Pump, 2 400 mm Axial Flow Pump, 1 250 mm Centrifugal Pump
85SA012503	A	1 150 mm Axial Flow Pump, 1 150 mm Centrifugal Pump, 6 100 mm Submersible Pump, 1 80 mm Submersible Pump
85SL006615	A	1 80 mm Centrifugal Pump
85SL015549	A	1 80 mm Centrifugal Pump
85SL017358	A	1 100 mm Centrifugal Pump
85SL017395	A	1 150 mm Centrifugal Pump
85SL017910	A	1 80 mm Centrifugal Pump
85SL018386	A	1 150 mm Centrifugal Pump
85SL018906	B	1 150 mm Centrifugal Pump
85SL019431	A	1 50 mm Centrifugal Pump
85SL019830	A	1 125 mm Centrifugal Pump
85SL019833	B	1 250 mm Centrifugal Pump
85SL019891	A	1 38mm Centrifugal Pump
85SL019980	A	1 80 mm Submersible Pump
85SL020122	A	1 100 mm Centrifugal Pump
85SL020562	A	1 100 mm Centrifugal Pump
85SL021298	A	1 100 mm Centrifugal Pump
85SL021400	B	1 150 mm Centrifugal Pump, 1 200 mm Centrifugal Pump
85SL021645	A	1 80 mm Centrifugal Pump
85SL021766	B	1 200 mm Centrifugal Pump
85SL022057	A	1 80 mm Centrifugal Pump
85SL022063	A	1 65 mm Centrifugal Pump
85SL022896	A	1 80 mm Centrifugal Pump
85SL022947	B	1 150 mm Centrifugal Pump

***Water Act 1912* licence**	**Class**	**Authorised works**
85SL023367	A	1 100 mm Centrifugal Pump
85SL023809	B	1 100 mm Centrifugal Pump
85SL023943	A	1 80 mm Centrifugal Pump
85SL024052	A	1 80 mm Centrifugal Pump
85SL024550	B	1 200 mm Centrifugal Pump, 1 100 mm Centrifugal Pump
85SL025591	B	1 300 mm Centrifugal Pump
85SL026335	A	1 80 mm Centrifugal Pump
85SL026717	A	1 150 mm Centrifugal Pump
85SL026850	A	1 100 mm Centrifugal Pump
85SL026894	B	1 400 mm Axial Flow Pump
85SL026985	B	1 200 mm Centrifugal Pump
85SL027276	B	1 200 mm Centrifugal Pump
85SL027632	B	1 400 mm Axial Flow Pump
85SL028028	A	1 100 mm Centrifugal Pump
85SL028056	A	1 80 mm Centrifugal Pump
85SL028178	B	1 400 mm Axial Flow Pump
85SL028410	B	1 80 mm Centrifugal Pump, 1 100 mm Centrifugal Pump, 1 200 mm Axial Flow Pump
85SL028429	A	1 125 mm Centrifugal Pump
85SL028537	B	1 150 mm Centrifugal Pump
85SL029230	B	1 400 mm Axial Flow Pump
85SL029245	B	1 300 mm Axial Flow Pump
85SL029409	A	1 50 mm Centrifugal Pump
85SL029422	A	1 100 mm Centrifugal Pump
85SL029558	B	1 400 mm Axial Flow Pump
85SL029660H	C	1 200 mm Centrifugal Pump
85SL029878	B	1 100 mm Centrifugal Pump, 1 380 mm Centrifugal Pump
85SL029986	A	1 50 mm Centrifugal Pump
85SL030049	B	1 660 mm Axial Flow Pump
85SL031060	B	1 300 mm Centrifugal Pump
85SL031486	A	1 100 mm Centrifugal Pump
85SL031658	B	1 610 mm Axial Flow Pump
85SL033801	A	1 250 mm Centrifugal Pump
85SL035539	A	1 80 mm Centrifugal Pump
85SL035672	A	1 100 mm Centrifugal Pump
85SL035947	A	1 150 mm Centrifugal Pump
85SL036565	B	1 100 mm Centrifugal Pump
85SL036884H	C	1 300 mm Centrifugal Pump

***Water Act 1912* licence**	**Class**	**Authorised works**
85SL037049	B	1 150 mm Centrifugal Pump
85SL037213	B	1 100 mm Centrifugal Pump
85SL037505	A	1 80 mm Centrifugal Pump
85SL037919	A	1 80 mm Centrifugal Pump
85SL038627	B	1 610 mm Axial Flow Pump
85SL040043	B	1 610 mm Axial Flow Pump
85SL040057	C	3 610 mm Axial Flow Pump
85SL040097	A	1 65 mm Centrifugal Pump
85SL040262	A	1 100 mm Centrifugal Pump
85SL040876	A	1 100 mm Centrifugal Pump
85SL043183	A	1 100 mm Centrifugal Pump
85SL043528	A	1 150 mm Centrifugal Pump
85SL043546	A	1 150 mm Centrifugal Pump
85SL043949	A	1 350 mm Axial Flow Pump
85SL044188	A	1 80 mm Centrifugal Pump
85SL044420	B	1 760 mm Axial Flow Pump
85SL044510	A	1 80 mm Centrifugal Pump
85SL044614	A	1 125 mm Centrifugal Pump
85SL044705	A	1 350 mm Centrifugal Pump
85SL044738	A	1 460 mm Axial Flow Pump
85SL044879	A	1 150 mm Centrifugal Pump
85SL045085	A	1 400 mm Axial Flow Pump
85SL045095	A	1 150 mm Centrifugal Pump
85SL045110	A	1 150 mm Centrifugal Pump
85SL045316	A	1 150 mm Centrifugal Pump
85SL045527	A	1 150 mm Centrifugal Pump
85SL045530	A	1 150 mm Centrifugal Pump
85SL045541	A	1 100 mm Centrifugal Pump
85SL045561	A	1 300 mm Axial Flow Pump
85SL045946	C	3 915 mm Axial Flow Pump, 1 610 mm Centrifugal Pump
85SL046019	A	1 50 mm Centrifugal Pump, 1 100 mm Centrifugal Pump
85SL046259	A	1 100 mm Centrifugal Pump
85SL046386	A	1 150 mm Centrifugal Pump
85SL046739	A	1 150 mm Centrifugal Pump
85SL047088	A	1 150 mm Centrifugal Pump
85SL047309	A	1 125 mm Centrifugal Pump
85SL047803	A	1 150 mm Centrifugal Pump
85SL047825	A	1 150 mm Centrifugal Pump

***Water Act 1912* licence**	**Class**	**Authorised works**
85SL047845	A	1 150 mm Centrifugal Pump
85SL048281	A	1 150 mm Centrifugal Pump
85SL048297	A	1 150 mm Centrifugal Pump
85SL048391	A	1 125 mm Centrifugal Pump
85SL048658	A	1 150 mm Centrifugal Pump
85SL048666	A	1 150 mm Centrifugal Pump
85SL048671	A	1 150 mm Axial Flow Pump
85SL048672	C	2 915 mm Axial Flow Pump
85SL048685	A	1 150 mm Axial Flow Pump
85SL048863	A	1 150 mm Centrifugal Pump
85SL049148	A	1 150 mm Centrifugal Pump
85SL049225	A	1 150 mm Centrifugal Pump
85SL049323	A	1 80 mm Centrifugal Pump
85SL049394H	C	1 610 mm Centrifugal Pump
85SL049419	B	1 610 mm Centrifugal Pump
85SL050108	A	1 150 mm Centrifugal Pump
85SL050169	A	1 150 mm Centrifugal Pump
85SL050855	B	2 400 mm Axial Flow Pump
85SL050920	A	1 100 mm Centrifugal Pump
85SL050993	A	1 100 mm Centrifugal Pump
85SL051129	A	1 125 mm Centrifugal Pump, 1 50 mm Centrifugal Pump
85SL051130	A	1 150 mm Centrifugal Pump
85SL051295	A	1 50 mm Centrifugal Pump
85SL051368	B	1 660 mm Axial Flow Pump
85SL051372	B	1 660 mm Axial Flow Pump
85SL051430H	C	7 610 mm Axial Flow Pump, 4 660 mm Axial Flow Pump
85SL051633	B	1 400 mm Axial Flow Pump
85SL051650	B	1 610 mm Centrifugal Pump
85SL051696	A	1 150 mm Centrifugal Pump
85SL051895	B	1 610 mm Centrifugal Pump
85SL051976	B	1 660 mm Centrifugal Pump
85SL052000	B	1 660 mm Centrifugal Pump
85SL052034	A	1 125 mm Centrifugal Pump
85SL052153	B	1 660 mm Axial Flow Pump
85SL095034	B	2 610 mm Axial Flow Pump
85SL095068	B	1 400 mm Axial Flow Pump, 1 150 mm Centrifugal Pump
85SL095075	A	1 150 mm Centrifugal Pump
85SL095104	B	1 300 mm Centrifugal Pump

***Water Act 1912* licence**	**Class**	**Authorised works**
85SL095106	A	1 150 mm Centrifugal Pump
85SL095139	A	1 150 mm Centrifugal Pump
85SL095162	A	1 50 mm Centrifugal Pump
85SL095208	B	1 610 mm Axial Flow Pump
85SL095365	B	1 610 mm Axial Flow Pump
85SL095484	A	1 150 mm Centrifugal Pump
85SL095641	B	1 660 mm Centrifugal Pump
85SL095718	C	1 760 mm Axial Flow Pump
85SL095725	B	1 660 mm Centrifugal Pump
85SL095729	B	1 380 mm Axial Flow Pump
85SL095951	C	2 915 mm Axial Flow Pump, 6 610 mm Axial Flow Pump
85SL096028	A	1 100 mm Centrifugal Pump
85SL096050	A	1 150 mm Centrifugal Pump
85SL096134	B	3 660 mm Centrifugal Pump
85SL096168	A	1 100 mm Centrifugal Pump
85SL096196	B	2 400 mm Axial Flow Pump
85SL096219	A	1 150 mm Centrifugal Pump
85SL096220	A, B, C	3 660 mm Centrifugal Pump, 1 150 mm Centrifugal Pump
85SL096226	A	1 100 mm Submersible Pump
85SL096254	B	5 610 mm Axial Flow Pump, 2 610 mm Axial Flow Pump
85SL100097	A	1 50 mm Centrifugal Pump
85SL100291	B	1 660 mm Mixed Flow Pump
85SL100368	B	1 200 mm Centrifugal Pump, 1 660 mm Mixed Flow Pump
85SL100369	B	1 660 mm Mixed Flow Pump, 1 660 mm Mixed Flow Pump
85SL100376	B	1 660 mm Mixed Flow Pump
85SL100380	B	1 660 mm Mixed Flow Pump
85SL100467	B	2 660 mm Mixed Flow Pump
85SL100492	B	1 560 mm Centrifugal Pump, 1 100 mm Centrifugal Pump
85SL100766	A	1 150 mm Centrifugal Pump
85SL100792	B	1 510 mm Centrifugal Pump
85SL105001	B	1 350 mm Axial Flow Pump
85SL105002	B	1 660 mm Centrifugal Pump
85SL105003	B	1 80 mm Centrifugal Pump
85SL105004	A	1 150 mm Centrifugal Pump
85SL105044	B	1 510 mm Mixed Flow Pump
85SL105049	A	1 150 mm Submersible Pump
85SL105050	A	1 75 mm Centrifugal Pump
85SL105052	A	1 150 mm Centrifugal Pump

***Water Act 1912* licence**	**Class**	**Authorised works**
85SL105053	B	2 510 mm Centrifugal Pump
85SL105056H	C	1 660 mm Centrifugal Pump
85SL105057H	C	1 660 mm Centrifugal Pump
85SL105058	B	1 660 mm Centrifugal Pump, 3 610 mm Axial Flow Pump
85SL105059	B	4 660 mm Centrifugal Pump
85SL105061	A	2 150 mm Centrifugal Pump
85SL105064	B	2 660 mm Mixed Flow Pump
85SL105065	B	2 610 mm Axial Flow Pump, 2 400 mm Axial Flow Pump, 4 380 mm Centrifugal Pump, 1 150 mm Centrifugal Pump
85SL105065	C	1 610 mm Axial Flow Pump, 4 Other Pump, 2 400 mm Axial Flow Pump, 4 380 mm Centrifugal Pump, 1 150 mm Centrifugal Pump
85SL105066	B	2 610 mm Axial Flow Pump, 2 400 mm Axial Flow Pump, 4 380 mm Centrifugal Pump, 1 150 mm Centrifugal Pump
85SL105067	C	1 610 mm Axial Flow Pump, 4 Other Pump, 2 400 mm Axial Flow Pump, 4 380 mm Centrifugal Pump, 1 150 mm Centrifugal Pump
85SL105068	C (tied to Collymongle lagoon)	1 610 mm Axial Flow Pump, 1 610 mm Centrifugal Pump, 4 Other Pump, 2 400 mm Axial Flow Pump, 4 380 mm Centrifugal Pump, 1 150 mm Centrifugal Pump

Appendix 8: Upper Darling Alluvial risk assessment

Risk assessment for aquifer assets

Groundwater source:	Upper Darling Alluvial (GMA 46)					
	Risk			**Method and source of analysis**	**Other management tools**	**Relevant plan rules**
	High	**Moderate**	**Low**			
Financial asset						
What is the risk to security of access from extraction		**X**		Mainly use surface water		
What is the risk to groundwater usage			**X**		Ensure metering installed and monitored	
What is the risk to dependence on town water supply	**X**			Wilcannia town is main user		
What is the risk to dependence on groundwater related activities (irrigation, industry)			**X**			
What is the risk to investment in agriculture/industry			**X**	Mainly use surface water		
Sociological asset						
What is the risk to employment in agriculture or industry			**X**	Mainly use surface water		
Risk valuation	**X**					
Risk	**High**					

Risk assessment for socio-economic assets

Groundwater source:	Upper Darling Alluvial (GMA 46)					
	Risk			**Method and source**	**Mitigation action**	**Relevant plan rules**
	High	**Moderate**	**Low**			
Ecological asset						
What will be the risk of a change in groundwater levels on GDEs		**X**		Potential impact to floodplain as shallow extraction within lenses close to river. River reg has formed aquifer away from floodplain groundwater pumping has pronounced effect.		
What will be the risk to a change in the timing of groundwater level fluctuations on GDEs	**X**			Short term pumping can cause large drawdowns that would destroy GDEs.		
What will be the risk to changing base flow conditions on GDEs		**X**		Gaining stream (i.e. freshwater springs)		
Water Quality Asset						
What is the risk to changing the chemical conditions of the water source			**X**	Basement rocks are impermeable.		
What is the risk to the water source by a change in the freshwater/salt water interface			**X**	Low except between Bourke and Louth at Glen Villa regional saline inflow to river.		
What is the risk to a change in beneficial use of the water source			**X**	Beneficial use = agriculture, drought source only.		
Aquifer integrity asset						
What is the risk to substrate compaction			**X**	Sand sediments.		
Risk valuation	**X**					
Mitigation effect on risk	**N/A**			Drought supply only. Extraction will be self limiting due to water quality. Do not want to encourage development on a limited resource with little data known. Possible mitigation required later as irrigation may become significant with time		
Risk		**High**				

Appendix 9: Sustainability factor matrix

Sustainability factor – Percentage of recharge available for extraction

High environmental risk	5%	25%	50% Upper Darling Alluvial
Moderate environmental risk	25%	50%	60%
Low environmental risk	50%	60%	70%
	Low socio-economic risk	**Moderate socio-economic risk**	**High socio-economic risk**

The figure above shows the sustainability factor matrix that was used to determine the proportion of recharge reserved as environmental water and the percentage potentially available for extraction for the non-high conservation value areas of the groundwater source. The planned environmental water reserved for the areas outside the high conservation value areas has been set at a minimum of 30 percent and a maximum of 95 percent, reflecting the variation in risk to groundwater sources identified in the assessment process.