Namoi Water Resource Plan

Surface water resource description
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1. **Introduction**

The NSW Government is developing water resource plans as part of implementing the Basin Plan 2012 (the Basin Plan). Water resource plans will align Basin-wide and state-based water resource management in each water resource plan area. The plans will recognise and build on the existing water planning and management framework that has been established in NSW.

The Namoi Water Resource Plan covers all of the surface water sources of the Namoi and Peel catchments. The plan incorporates the Namoi and Peel Regulated River systems and all of the unregulated rivers in the catchment. This report is a detailed description of the Namoi Water Resource Plan Area (SW14) to provide an understanding of the region and the resources covered by the plan. It describes the location and physical attributes and provides background information on the hydrology, environmental assets and water quality characteristics relevant to these water sources.

This report is intended to provide supplementary information to other water resource reports for the Namoi Water Resource Plan including the Status and Issues Paper (DPI Water 2017a), the Risk Assessment and Water Quality Management Plan.

1.1 **Overview of the plan area**

The Namoi Water Resource Plan Area (WRPA) comprises the catchments of the Namoi and Peel rivers in the northern part of the Murray-Darling Basin in NSW. The plan area covers around 43,000 km² and represents around 4 per cent of the Murray-Darling Basin.

The Namoi River extends for more than 700 km from the rugged mountains of the Great Dividing Range near Tamworth to the alluvial plains of the Barwon River near Walgett (Figure 1). The catchment is bounded by the Great Dividing Range in the east, the Liverpool Ranges and Warrumbungle Ranges in the south, and the Nandewar Ranges and Mount Kaputar to the north. Elevations range from over 1,500 m in the mountains to the south and east to just 100 m on the alluvial floodplain west of Narrabri.

Major tributaries of the Namoi River include Coxs Creek and the Mooki, Peel, Manilla, and McDonald Rivers which join the Namoi upstream of Boggabri, and Baradine and Bohena Creeks downstream of Boggabri. Major distributary channels on the alluvial plains include Narrabri, Plan and Gundigera Creeks. Streamflows in the Namoi catchment are regulated by Keepit Dam on the Namoi River, Split Rock Dam on the Manilla River and Chaffey Dam on the Peel River.

The Peel River is a major regulated tributary to the Namoi with a catchment area of around 4,700 km². It flows through the town of Tamworth, the largest urban centre in the WRPA. The regulated section of the Peel River has historically been managed as a separate scheme to the Namoi Regulated River, and Chaffey Dam is managed independently to the other storages on the Namoi.

The Kamilaroi (Gamilaraay) people were the original custodians of the Namoi and Peel catchments. Their country extended from the Hunter Valley to the Warrumbungle Ranges and they occupied the valley until the mid-1880s when European settlement brought pastoralism and urban development to the region.

In 2011 there were over 93,000 people living within the Namoi WRPA (ABS 2011) mostly along the Namoi River and its tributaries between Tamworth and Narrabri. Tamworth, located on the Peel River, is the largest urban centre with a population of 36,100 people. Gunnedah, on the Namoi River, has a population of 9,300 people while Narrabri, also on the Namoi, supports around 6,000 people. Smaller towns throughout the catchment include Barraba, Manilla, Quirindi, Walgett, Wee Waa and Werris Creek which all have populations of between 1,000 and 3,000 people.
Figure 1: Namoi Water Resource Plan Area (SW14)
1.2 Water management units

The surface water of the Namoi WRPA is currently managed through three water sharing plans:

- **Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010**
- **Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016**
- **Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources 2012**

**The Peel Regulated River Water Source** is defined as the Peel River and relevant anabranches, from the upper limits of Chaffey Dam storage at full supply level to its confluence with the Namoi River. All water resources within the Peel Valley (regulated, unregulated, alluvium and fractured rock) are currently managed through the **Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources**. When the plan is replaced in 2020 the unregulated and groundwater components will be removed to other plans leaving the Peel Regulated River managed through its own plan.

**The Upper Namoi Regulated River Water Source** comprises all water between the banks of all rivers, from the dam wall of Split Rock Dam downstream to the dam wall of Keepit Dam.

**The Lower Namoi Regulated River Water Source** is located between the banks of all rivers, from the dam wall of Keepit Dam water storage downstream to the junction of the Namoi River with the Barwon River at Walgett.

**The Namoi Unregulated Water Sources** comprises all of the unregulated streams within the catchment of the Namoi River. There are currently 26 unregulated water sources managed through the Namoi Unregulated and Alluvial plan. When the Peel Valley water sharing plan is replaced in 2020 all of the unregulated streams within this valley will be merged with the Namoi unregulated water sources.

The location of the above regulated and unregulated water sources is shown in Figure 2.
Figure 2: Regulated and unregulated water sources in the Namoi WRPA
1.3 History of water management in the Namoi WRPA

1.3.1 Early water management

The Department of Water Resources began mapping the wetlands and floodplain vegetation of the Namoi River in 1991 as part of its three year Barwon-Darling Wetland Survey (Green and Dunkerley 1992). Further work by Foster (1999) provided a more detailed assessment of the commence-to-flow levels of wetlands and anabranches in the lower valley. Around this time the Department also commissioned an environmental study of the Namoi River which assessed the geomorphic and ecological condition of the river (Thoms 1998, Thoms et al. 1999). These studies provided the basis for the formulation of environmental flow objectives and watering strategies under the NSW Government’s water reform program in the late 1990s.

Early water management strategies relied solely on restricting access to unregulated flows at critical times to protect water for wetland function and environmental health. These rules were first implemented in 1998 and were later incorporated into the 2004 water sharing plan. The flow thresholds identified by Foster (1999) have also subsequently been adopted as environmental flow targets for the lower Namoi River by the Murray-Darling Basin Authority (MDBA 2012).

1.3.2 NSW Government water reforms

In February 1994 the Council of Australian Governments (COAG) endorsed a strategic framework for the efficient and sustainable reform of the Australian water industry. Following this meeting the NSW Government released a discussion paper in mid-1994 outlining changes to the management of the state’s rivers and waterways. Early reforms included the development of water quality and river flow objectives, embargoes on new licences on regulated and unregulated rivers in the Murray-Darling Basin to meet an agreed cap on water extractions from the basin, and a commitment to deliver water to key wetlands.

In 1997 the Government introduced its current program of rural water reforms that aimed to achieve a better balance in water use by more explicit and careful sharing of water between the environment and water uses. This program led to the development of the current legislative framework that defines how water is shared and managed under the Water Management Act 2000.

1.3.3 Namoi regulated water sharing plan

The Namoi River Management Committee was established in 1997 to provide recommendations to the Minister on environmental flow rules. The Committee included representatives of the irrigation industry, environmental interests, indigenous communities, the Namoi Catchment Management Board, the Regional Development Board, local councils and government agencies (the then Department of Land and Water Conservation, Environment Protection Authority, NSW Agriculture and NSW Fisheries). The committee considered the existing hydrologic and ecological information for the valley and recommended a set of environmental flow rules for the Namoi regulated system in March 1998. These rules were reviewed by the committee each year, providing the first phase of environmental protection for the river (DIPNR 2004).

In 2001 the Minister for Land and Water Conservation asked the committee to recommend water sharing rules to manage both environmental and extractive water through a statutory plan. A draft water sharing plan was prepared by the committee and placed on public exhibition in mid-2002. The plan included the environmental flow rules previously agreed to in 1998 and was approved by the Minister in February 2003. It was based on the recommendations of the committee, submissions received from the community following the public exhibition period, and agreed Government policy at the time. Some amendments were made to the plan in consultation with the committee before the plan commenced on 1 July 2004.

The Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River was amongst the first plans to be implemented in NSW. All of the 31 plans that commenced in 2004 were
subject to a formal review towards the end of their ten year period of operation. Through this review process and associated consultation some minor amendments were made to parts of the plan where there was considered to be no significant impact on water users.

In 2016 the water sharing plan was formally replaced. This Plan will continue operating to ensure continuity of rights to water while the water resource plan is being developed. All issues that were raised by stakeholders during the review process are considered in the development of the Namoi Water Resource Plan.

1.3.4 Unregulated water sharing plans

The Namoi Unregulated River Management Committee was appointed by the NSW Government to make recommendations on a water sharing plan by December 2001. At this time water sharing plans were being prepared for catchments or sub-catchments with the highest level of hydrologic stress. A draft *Water Sharing Plan for the Phillips Creek, Mooki Creek, Quirindi Creek and Warrah Creek Water Sources* was prepared by the committee and placed on public exhibition in 2002. The final plan was approved by the Minister for Land and Water Conservation in 2003 and commenced on 1 July 2004. The plan was based on the recommendations of the committee, public submissions received following the exhibition period and the government policy at the time.

After the first round of water sharing plans commenced in 2004 the government realised that a broader approach was required to implement water sharing in the unregulated water sources. The Namoi Interagency Regional Panel was established to guide the development of a ‘macro plan’ for the whole of the Namoi unregulated catchment (with the exception of the Peel Valley). The Panel comprised representatives of the former Office of Water, Department of Primary Industries, Department of Environment and Climate Change, and an observer from the Namoi Catchment Management Authority.

The plan was based on current government policy for defining water access with refinement of rules based on the local knowledge and expertise of the panel members. The draft water sharing rules were discussed with various interest groups in 2010 and were placed on public exhibition in September 2011. The *Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources* commenced on 4 October 2012.

In 2016 the water sharing plan was amended to incorporate the water source previously managed through the 2004 plan for the Phillips Creek, Mooki Creek, Quirindi Creek and Warrah Creek water sources which had reached the end of its term. The Namoi Interagency Regional Panel guided these amendments. The merging of the former Phillips Creek plan into the *Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources* allows all water in the Namoi catchment to be managed through one plan and brings consistency in management across the plan area.

1.3.5 Peel Valley water sharing plan

The Peel Regulated River has historically been managed as a separate volumetric allocation scheme under the former *Water Act 1912*. Operationally, Chaffey Dam is managed independent of storages on the Upper and Lower Namoi Regulated River Water Sources.

Development of an integrated water sharing plan for the Peel Valley was guided by the Peel Interagency Regional Panel. In addition to the Interagency Panel the Minister for Water established the Peel Advisory Group to advise his office on the many complex issues relevant to a water sharing plan for the Peel Valley. This group was formed in response to the high level of community concern in the valley over the possible impacts of a water sharing plan. There was also a pressing requirement to complete a plan covering the Peel Regulated River by the end of 2009 (later extended to March 2010) to satisfy Commonwealth funding conditions for the augmentation of Chaffey Dam (NOW 2010). The advisory group was chaired by the Member for
Tamworth, Peter Draper, and comprised a range of local stakeholders from the community and government agencies.

Due to the complexity of the issues and stakeholder demand, the draft water sharing rules were placed on public exhibition for an extended 74 day period during October-December 2009. The Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources commenced on 1 July 2010. The rules contained in the water sharing plan will be reviewed during the development of the Namoi Water Resource Plan.
2 Regional setting

2.1 Climate

Rainfall

The Namoi catchment has a dry semi-arid climate. Annual average rainfall varies across the Namoi WRPA, from a maximum of 1,300 mm over the ranges in the east to around 400 mm near Walgett (Figure 3). Although rain falls throughout the year, there is a marked wet season in summer through to early autumn. Rainfall in summer months averages twice to four times the rainfall in winter months (Figure 4). At Woolbrook (east of Tamworth) summer rainfall averages 100 mm per month while at Walgett in the far north of the catchment summer rainfall is 50-60 mm per month.

Figure 3: Average annual rainfall in the Namoi WRPA

![Map showing average annual rainfall in the Namoi WRPA]

Figure 4: Average monthly rainfall for selected stations

![Bar chart showing average monthly rainfall at Woolbrook, Gunnedah, and Walgett]

Source: Bureau of Meteorology Climate Data Online
Modelling, of potential climate change impacts, predicts that autumn rainfall across the New England North West Region will increase over the next 50 years by up to 30 per cent. Winter rainfall is likely to decrease in the near future (2030) by 5-10 per cent but increase slightly in the far future (2070). Summer rainfall is expected to change very little in the near future but increase in the far future by up to 20 per cent (OEH 2014).

Evaporation

Evaporation in the Namoi catchment has a strong east-west gradient. Average Class A pan evaporation varies from around 1,000 mm/year in the south-east, to over 2,200 mm/year in the north-west (Figure 6) and is strongly seasonal throughout the year. At Gunnedah mean monthly evaporation in the summer months is around 250 mm, which is more than three times the average rainfall for those months. In winter evaporation is around 60 mm in June and July (Figure 6).

Figure 5: Average annual evaporation across the Namoi WRPA

Figure 6: Average monthly evaporation at Gunnedah
Temperature

Temperatures are warm to hot in summer with relatively low humidity, mild in autumn and spring, and cool to mild in winter. Mean maximum temperatures in summer range from 25-28 °C at Woolbrook in the upper catchment to 34-35 °C at Narrabri and Walgett on the western plains.

Long-term records indicate that temperatures in the New England North West Region have been increasing since the 1970s. This warming is predicted to continue over the next 50 years with temperatures increasing by an average of 0.7 °C in the near future (2030) and 2.2 °C in the far future (2070). The greatest changes in maximum temperatures will occur in spring with temperatures increasing by 2.5 °C by 2070 (OEH 2014).

The number of hot days (>35 °C) is predicted to increase, while the number of cold nights is likely to decrease. The greatest increase in hot days is predicted for the north western part of the region with more than 30 hot days per year expected between Gunnedah and Narrabri and more than 40 hot days for the region north of Narrabri (OEH 2014).

2.2 Land use

The most extensive land use in the Namoi catchment is sheep and cattle grazing which accounts for 54 per cent of land use by area (Table 1, Figure 7). Wheat, cotton and other broad acre crops are grown along the alluvial floodplains. Together with horticultural crops, dryland agriculture accounts for 17 per cent of land use within the valley.

The Namoi valley is one of the most extensively irrigated catchments in the Murray-Darling Basin with irrigated crops accounting for nearly 4 per cent of land use. This includes irrigation from both surface water and groundwater sources. The Namoi valley is the second largest area for cotton production in Australia (Roth 2010) with around 70 per cent of the irrigated land used for this purpose. During years of high water availability about 65,000 ha of irrigated cotton is produced in the valley. In drier years this drops to around 20,000 ha and production becomes highly dependent on groundwater for irrigation.

In the Upper Namoi there are a large number of small irrigation farms producing irrigated lucerne and grain (sorghum, maize and wheat). There is also a small amount of irrigated horticulture and a substantial poultry and horse industry around Tamworth (EBC 2011). The Peel valley supports around 6,600 ha of irrigation where the predominant crops are lucerne and grain. Other activities in the Peel valley include the production of green feed for dairying, production of corn crops for either silage or grain, and the production of summer and winter fodder crops.

Extensive areas of land for conservation and forestry occur in the middle of the catchment to the east and south of Narrabri. Together with other native landscapes these land uses account for around 24 per cent of the catchment area. Much of this area comprises the Pilliga Scrub, a significant area of remnant dry sclerophyll forest.

Table 1: Land use in the Namoi WRPA

<table>
<thead>
<tr>
<th>Land use</th>
<th>Area (km²)</th>
<th>Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryland Cropping and Horticulture</td>
<td>7,723</td>
<td>17</td>
</tr>
<tr>
<td>Grazing</td>
<td>24,262</td>
<td>54</td>
</tr>
<tr>
<td>Irrigation</td>
<td>1,748</td>
<td>4</td>
</tr>
<tr>
<td>Mining</td>
<td>8</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Forestry, conservation reserve and native vegetation</td>
<td>10,560</td>
<td>24</td>
</tr>
<tr>
<td>Residential</td>
<td>208</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Urban intensive uses</td>
<td>119</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Water</td>
<td>159</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>
Figure 7: Land use of the Namoi WRPA

Source: Australian Bureau of Agricultural and Resource Economics and Sciences, National scale land use 2010-11
2.3 Topographic description

The Namoi WRPA can be divided into four main areas based upon the topography and flow characteristics of the water sources. These are the upland, the Peel catchment, the midland and the lowland regions (Figure 8).

Figure 8: Sub-regions of the Namoi WRPA

2.3.1 Upland (upstream of Keepit Dam)

The Namoi River rises in the Great Dividing Range to the south-east of Tamworth. There are three major tributaries – the Manilla River (with Split Rock Dam), the Macdonald River and Halls Creek – as well as numerous smaller creeks. The rivers rise at elevations over 1,000 m, falling to 400 m where the Upper Namoi and Manilla Rivers meet near Manilla. In these reaches the water flows within well-defined channels and the river has a limited floodplain.

The following unregulated water sources are located within this upland part of the catchment:

- Upper Macdonald River
- Mid Macdonald River
- Upper Namoi
- Upper Manilla
- Split Rock

2.3.2 Midland Peel River

The Peel River catchment covers about 11 per cent of the Namoi catchment. The river starts in the Great Dividing Range south of Tamworth and includes the major catchments of the Upper Peel River (including Chaffey Dam), Cookburn River, Goonoo Goonoo Creek and Dungowan Creek. The Peel River joins the Namoi River a short distance downstream of Keepit Dam.
The upper reaches of the Peel River (Photo 1) flow through narrow valleys to the Cockburn River junction with the river broadening into wide alluvial floodplains below Tamworth. Caroll Gap is considered the end of the regulated Peel system. Around 40 per cent of the annual discharge in the Peel River at Caroll Gap is contributed by the Cockburn River, while Goonoo Goonoo and Dungowan Creeks both contribute approximately 10 per cent (NOW 2010). Dungowan Creek Dam (6,300 ML) provides water for the town of Tamworth, whilst Chaffey Dam regulates flows in the Peel River and augments supply to Tamworth.

Unregulated water sources found within the Peel Valley are:

- Chaffey
- Goonoo Goonoo Creek
- Upper Peel Tributaries
- Lower Peel Tributaries
- Cockburn River

### 2.3.3 Midland Namoi River (Keepit Dam to Narrabri)

Downstream of Keepit Dam the Namoi River continues within a confined channel to the town of Gunnedah where the floodplain begins to broaden. A number of small lagoons are found upstream of Gunnedah, and between Gunnedah and Narrabri the floodplain includes a number of long, narrow lagoons that represent prior channels of the Namoi River. Upstream of Narrabri the river channel splits in two with the northern channel (Narrabri Creek) carrying most of the flow (Photo 2). Narrabri Creek rejoins the Namoi River at Mollee Weir.

Two major tributaries enter the Namoi River from the south within this reach. The Mooki River flows north-west from near Quirindi in the Liverpool Ranges and enters the Namoi River upstream of Gunnedah. The Mooki River catchment occupies about 9 per cent of the total area of the Namoi catchment. Adjacent to the Mooki catchment is Lake Goran, a large internal drainage basin, which forms the largest natural water body in the Namoi catchment when it is full.
The Coxs River flows north-west from Tambar Springs in the Warrumbungle Ranges and enters the Namoi River upstream of Boggabri. The Coxs River catchment also covers about 9 per cent of the total Namoi catchment. It contains good agricultural soils and is a highly productive area for agriculture (Welsh et al 2014). Another smaller tributary, Maules Creek, enters the Namoi River from the north just upstream of Narrabri.

Water sources in the midland part of the Namoi catchment are:

- Keepit
- Quirindi Creek
- Warrah Creek
- Werris Creek
- Rangira Creek
- Phillips Creek
- Mooki River
- Lake Goran
- Bluevale
- Maules Creek
- Coxs Creek
- Eulah Creek
- Bohena Creek
- Spring and Bobbiwaa Creeks

### 2.3.4 Lowland (Narrabri to the Barwon River)

Narrabri is considered to be the start of the true riverine zone of the Namoi catchment due to the increased frequency of lagoons, the low gradient of the channel and the development of several anabranches and effluent channels. There are a large numbers of lagoons in this reach, although most are small and require overbank flooding for inundation (Green and Dunkerley 1992). There has been extensive clearing of riparian vegetation along the river. The banks typically support a narrow fringe of river red gum and river cooba as shown in Photo 4 near Wee Waa.
Downstream of Wee Waa, the Namoi River is characterised by a complex pattern of anabranches, effluent channels, in-stream benches and small floodplain wetlands which are subject to extensive flooding (Foster 1999).

Pian Creek leaves the Namoi River just upstream of Wee Waa and is the largest effluent of the river. Under natural conditions, water entered the creek only when flows in the Namoi River were high. Pian Creek is now regulated to supply irrigation water to properties along its length and there are many private weirs and off-creek storages. Water is diverted into the system via Gunidgera Weir into Gunidgera Creek, and then into Pian Creek. When flows are sufficient, Pian Creek travels for over 200 km westward before it joins the Namoi River just 20 km upstream of its confluence with the Barwon River. Pian Creek receives local runoff from two small tributaries, these being The Sink Hole and Old Burren Creek.

Gunidgera Creek leaves the Namoi River at Gunidgera Weir and rejoins the river near Cuttabri, around 100 km downstream. The creek is regulated to supply water for irrigation, stock and domestic purposes. As with Pian Creek, there are many small instream storages which form artificial wetland habitat (Green and Dunkerley 1992).

To the south-west of Narrabri is a large area of low elevation. It includes Bohena, Coghill, Etoo and Baradine Creeks plus many other minor water courses. Many of these have their origins in the dry, semi-arid Pilliga area which supports extensive areas of native forest. This area generally contributes little inflow under normal conditions. However, during wet times, significant flood inflows to the Namoi River between Wee Waa and Walgett can be generated from this region.

Below Baradine Creek the lower reaches of the Namoi are characterised by multiple channels, and the occurrence of many small flood channels and lagoons alongside the river (Green and Dunkerley 1992). The capacity of the channel here is about half that of the channel at Narrabri. At the far end of the valley a number of flood runners, such as Two Mile Warrambool, break away from the river and carry water through to the Barwon River during high flows.
Water sources that are located in the lowland part of the catchment are:

- Bundock Creek
- Brigalow Creek
- Coghill Creek
- Etoo and Talluba Creeks
- Pian Creek
- Lower Namoi (Photo 4)
- Baradine Creek

2.4 Streamflow characteristics

2.4.1 Namoi River

The Namoi River is regulated by Keepit and Split Rock Dams which provide water for town water supplies, irrigation, stock and domestic use, industry, and environmental flows along the Namoi River. The volume and pattern of flows in the Namoi River has been significantly altered by the construction of these dams and the extraction of water for irrigation and other purposes. Modelled flow data for the period 1895–2009 shows that there has been a reduction in flows under current regulated rules, with the greatest degree of change occurring downstream of Pian Creek. However seasonal peaks in summer and winter months have been maintained (MDBA 2012).

The Namoi River contributes on average around 23 per cent of the flow of the Darling River upstream of Bourke under current development conditions (Webb McKeown & Associates 2007). Prior to development the catchment of the lower Namoi River was considered to be a gaining river system, however now it is largely a losing river as a result of surface water – groundwater connectivity (Welsh et al. 2014) and irrigation development. The mean daily flow of the Namoi River decreases from around 1,900 ML/day at Gunnedah to around 1,500 ML/d in the lower River at Bugilbone and Walgett.

The longest running gauging stations on the Namoi River are at Gunnedah and Narrabri where flows have been recorded since 1891. Gauging in the upper Namoi and Peel rivers commenced in the 1920s. The average annual flow in the Namoi River at Gunnedah is 653,000 ML. The lowest annual flow occurred in 1902 when just 33,270 ML was recorded, while the highest annual flow occurred in 1956 with 3,871,300 ML recorded (Figure 9). The Namoi catchment experienced a prolonged drought with nine consecutive years of below average flow from 2001 to 2009. This was followed by three years of average or above average flow in 2010 to 2012.

Figure 9: Annual flow in the Namoi River at Gunnedah 1892–2016
Daily streamflows provide an indication of the variability of flow patterns and the peak height of flood events. Moderate to major flooding at Gunnedah occurs at volumes above 48,500 ML/d and similar volumes result in flooding at Boggabri and Narrabri (S Samarawickrama, WaterNSW cited in Barma Water Resources et al. 2012). Further downstream at Bugilbone, anabranches along the Lower Namoi River are inundated at flows between 3,300 and 4,500 ML/d while broader floodplain inundation begins at flows between 18,000 and 24,000 ML/d (Foster 1999, MDBA 2012).

There have been several large floods in the Namoi River, the largest of these being in February 1955 when a peak flow of 707,000 ML was recorded at Gunnedah (Figure 10). Since completion of Keepit Dam in 1960 the largest recorded flows have been around 200,000 ML/d. Recent floods in the Namoi River have been small to medium sized events in December 2010, November 2011 and February 2012 each with a peak flow of 60,000 to 80,000 ML/d.

Figure 10: Daily flow in the Namoi River at Gunnedah

Daily and seasonal streamflow patterns in the unregulated streams vary across the Namoi valley. Figure 11 shows the seasonal variation in daily flows for three streams in the upland (Namoi River), midland (Mooki River) and lowland (Pian Creek) parts of the Namoi valley.

High flows (indicated by the 20th percentile flow) are strongly seasonal in both the upland and midland tributaries, occurring from July through to October in the upper Namoi River and July through to September in the Mooki River.

The median daily flow (50th percentile flow) in spring is up to 500 ML/d in the upper Namoi and up to 25 ML/d in the Mooki River. These figures illustrate the different nature of these catchments. Despite a larger catchment area than the Namoi River at North Cuerindi, the Mooki River misses out on the high rainfall that feeds the upper reaches of the Namoi River. Significant extraction along the Mooki River is also likely to have some effect on lowering the median flows during spring. The Mooki River may often cease flowing during the summer and autumn months as indicated by the 80th percentile flow. Similar patterns of flow are seen for the Coxs River another major tributary of the midland section of the Namoi River.

Pian Creek is regulated for the first half of its length but is unregulated in its lower reaches at Waminda (Figure 11). High flows occur from August to October, taking a month to flow through from the upper and middle tributaries. Summer storms can also result in high flows in March. The typical daily flow in Pian Creek is less than 10 ML/d and is lowest over winter when the creek often ceases to flow.
Figure 11: High, median and low daily flows in the Namoi WRPA

Namoi River at North Cuerindi (Upland Namoi) 1915-2016

Mooki River at Breeza (Midland Namoi) 1957-2016

Pian Creek at Waminda (Lowland Namoi) 1972-2016
2.4.2 Peel River

The Peel River is regulated by Chaffey Dam which provides irrigation, stock and domestic water for users along the Peel River. The section of river from Chaffey Dam to Dungowan Creek has been affected by this river regulation as there are no significant tributaries providing unregulated flows to this reach. Medium to high flows in the mid to lower reaches of the Peel River are relatively unaffected by current river regulation (NOW 2010).

The average annual flow in the Peel River at Carroll Gap (just upstream of its junction with the Namoi River) is 253,630 ML. The lowest annual flow occurred in 2006 when just 9,424 ML was recorded, while the highest annual flow occurred in 1955 with 1,462,000 ML recorded (Figure 12).

The most significant floods in the Peel River have occurred in 1955, 1971 and 1976. The highest daily flow since records began was in January 1976 when a total daily flow of 155,705 ML was recorded (Figure 13). Since Chaffey Dam was completed in 1979, moderate floods of 60,000 ML/d or more have occurred on average once a decade. The most recent flood in the valley occurred in February 2012 when more than 44,000 ML/d was recorded (Figure 13).

Figure 12: Annual flow in the Peel River 1930-2015

![Peel River at Carroll Gap 419006](image)

**Peel River Annual Flow (ML)**

**Mean annual flow (253,630 ML)**

Figure 13: Daily flow in the Peel River 1930-2016

![Peel River at Carroll Gap 419006](image)
As with the rest of the upper Namoi catchment daily flows vary seasonally throughout the year (Figure 14). High flows (indicated by the 20th percentile flow) are typically at their greatest between July and September. The median daily flow is around 10 ML/d or less from January to June and 25-50 ML/d for the remainder of the year. The Peel River rarely ceases to flow altogether however the daily flow may be less than 1 ML/d for extended periods during the summer and autumn months.
3 Environmental assets

3.1 Parks and reserves

There is around 3,270 km$^2$ of land conserved within national parks and nature reserves within the Namoi WRPA. Most of this area is associated with the slopes and ranges of the catchment. There is very little riverine or floodplain land under conservation.

In the upper catchment, Warrabah National Park protects around 40 km$^2$ along the banks of the Namoi River, about 80 km east of Tamworth. Scenic granite boulders, deep gorges and river rapids are a feature of the park (Photo 5). The hill slopes support woodlands of white cypress pine, hill red gum and Caley’s ironbark while tall stands of river oak, teatree and bottlebrush line the river banks.

To the east of Narrabri, Mount Kaputar National Park covers 502 km$^2$ of volcanic mountain ranges that drain to Maules Creek and other nearby tributaries. The park protects a range of vegetation communities including isolated patches of rainforest in sheltered locations, a variety of forest habitats ranging from semi-arid to subalpine, and heathland on the high plateaus and peaks.

Pilliga Nature Reserve is located around 80 km south-west of Narrabri in the upper catchment of Bohena Creek, and is the largest conservation area in the catchment. The reserve protects 805 km$^2$ of semi-arid woodland known as the Pilliga Scrub, with an additional 1,056 km$^2$ protected as state conservation area. Together with adjacent areas of forest managed by Forests NSW, the Pilliga Scrub is the largest remaining dry sclerophyll forest west of the Great Dividing Range in NSW (OEH 2015). The Nature Reserve is listed on the Register of the National Estate.

Photo 5: Namoi River flowing through Warrabah National Park
David Young, OEH
3.2 Wetlands

The Namoi catchment does not contain any extensive wetland complexes, however the floodplain downstream of Narrabri features many small lagoons, wetlands, and anabranches, as well as extensive areas of floodplain woodlands. More than 184,000 ha of wetlands and floodplain woodlands were mapped during the first wetland survey of the valley (Green and Dunkerley 1992). A further survey in 2008 mapped 2,766 ha of discrete wetlands in the valley, totalling 46,398 ha (EcoLogical Australia 2008). This study found that nearly half of the wetlands in the catchment would be inundated by a 1 in 2 year flood event and that at least 21 natural wetlands have water dependent threatened species within a 500 m radius.

Two of the largest semi-permanent riverine lagoons are Barbers Lagoon and Gulligal Lagoon. Barbers Lagoon is a 22 km anabranch of the Namoi River located near Boggabri which is lined by river red gums (Barma Water Resources et al. 2012). Gulligal Lagoon is located midway between Gunnedah and Boggabri and is another long lagoon approximately 4 km in length adjacent to the river. It connects with the Namoi River only under major flood conditions.

The draft Lower Namoi Valley Floodplain Management Plan (DPI Water 2017b) identifies 19 wetlands in the lower valley of state and national significance that are dependent on frequent flooding to maintain their ecological character (Table 2). These assets were included in a Special Protection Zone because they depend on regular flooding and:

- have a high degree of habitat complexity, or
- a history of supporting a diversity or abundance of waterbird, native fish or frog populations, or
- act as drought refuges, or
- are recognised in, or protected by local, state or commonwealth policy/legislation.

The Namoi catchment has a number of significant wetlands. The largest of these is Lake Goran, a large internal drainage basin south of Gunnedah that covers more than 60 km². The lakebed is cropped when the opportunity arises – the lake dried completely in 2014 allowing it to be cropped for the first time in six years (Namoi Valley Independent 2014). When flooded the lake provides drought refuge and habitat for large numbers of waterbirds, and for this reason is listed as a wetland of national significance (Department of Environment and Energy 2010). Yarrie Lake is a large ephemeral lake near Narrabri that is fed by local runoff. It is approximately 3 km in diameter, 2.5 m deep and fringed by river red gums. The lake is a popular site for water based recreation, camping and birdwatching when it is full.

There are approximately 2,770 small lagoons, wetlands and billabongs totalling 46,398 ha associated with the Namoi River, predominantly downstream of Narrabri. Of these 1,829 ha are identified as natural wetlands and 21 have wetland dependent threatened species within a 500 m radius.

Other areas of regional ecological significance include:

- Gulligal Lagoon near Gunnedah – a semi-permanent wetland that is filled from surface flows during flood events. The 4.2 km long channel provides important habitat for native fish species including olive perchlet. This lagoon acts as a drought refuge in the mid-Namoi region and was restocked with breeding pairs of purple spotted gudgeon in 2009 as part of the Namoi Demonstration Reach project.
- The reach of the Namoi River between Boggabri and Narrabri is characterised by a number of long, narrow lagoons that represent prior channels of the Namoi River. Barbers Lagoon is a major anabranch of this reach.
Table 2: Lower Namoi Floodplain Management Plan ecological assets

<table>
<thead>
<tr>
<th>Identified ecological assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Namoi Management Zone D - Special Protection Zone</td>
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</table>

3.3 High ecological value aquatic ecosystems

The High Ecological Value Aquatic Ecosystem (HEVAE) framework consists of five key criteria (diversity, distinctiveness, naturalness, vital habitat and representativeness) that can be used at a range of scales to map and prioritise aquatic assets for water management (Aquatic Ecosystems Task Group 2012). The HEVAE framework was applied by DPI Water to assign an ecological value to instream assets across NSW using four of the five criteria (the representativeness criteria was not used due to insufficient data).

The Namoi WRPA supports significant aquatic ecological values:

- There are five native aquatic species listed as threatened in NSW including the river snail, freshwater catfish, silver perch, olive perchlet, and purple spotted gudgeon. The Murray cod is nationally listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* as vulnerable;
- Habitat for threatened frog species such as Sloane’s froglet, Booroolong frog, and Davie’s tree frog;
- Habitat for 18 threatened bird species (NSW) including magpie goose, Australasian bittern, brolga, black-necked stork, Australian painted snipe, black-tailed godwit, blue-billed duck, freckled duck and grey falcon;
- The Namoi River forms part of the Lowland Darling River Endangered Ecological Community which is protected under the NSW *Fisheries Management Act 1994*. The community occurs in lowland riverine environments with meandering channels and provides a variety of aquatic habitats including deep channels and pools, wetlands, gravel beds and floodplains;

3.3.1 Ecological values in the regulated river

The HEVAE analysis for the Namoi WRPA shows that parts of the regulated Namoi River, in particular the lowland and midland sections have very high instream values (Figure 15). This is due to a number of factors including:

- Medium to high fish diversity
Figure 16) Large tracts of riparian vegetation with a widespread distribution of endangered ecological communities (Figure 17) and relatively undisturbed river reaches contributing to the provision of habitat and primary production.

Analysis of fish data by NSW Fisheries shows a significant spread of threatened fish species or endangered populations in the Namoi valley. Eel-tailed catfish and Murray cod were widespread in the regulated river sites, while silver perch was found at four sites within the regulated sections, including between Split Rock and Keepit Dams (Figure 16). Fish biodiversity was highest in the middle reaches of Namoi River extending upstream and downstream of Narrabri.

Figure 15: Instream values for the Namoi WRPA
Figure 16: Distribution of threatened fish species within the Namoi WRPA
Figure 17: Endangered ecological communities in the Namoi WRPA
3.3.2 Ecological values in the unregulated rivers

Unregulated rivers in the following water sources have very high or high ecological values (Figure 15):

- Bohena Creek Water Source supports eel-tailed catfish, Murray cod and the Lowland Darling River EEC. Both ‘diversity’ and ‘vital habitat’ criteria scored very high values.
- Lower Namoi Water Source supports Murray cod and the Lowland Darling River EEC. The HEVAE criteria ‘vital habitat’ was very high, while ‘naturalness’ and ‘distinctiveness’ criteria were both high.
- Lowland water sources Pian Creek and Etoo–Talluba Creeks both support Murray cod and the Lowland Darling River EEC. Pian Creek also contains the endangered ecological community Carbeen Open Forest. Pian Creek water source had very high ‘vital habitat’ and high ‘distinctiveness’.
- In the midland area Spring and Bobbiwa Creek water sources both contain the Lowland Darling River EEC. The ‘vital habitat’ criteria was very high and ‘naturalness’ was medium.
- Above Keepit Dam, the Upper Namoi water source supports both Eel-tailed catfish and Murray cod. There are also known records for two threatened tree frog species in this area: the endangered Booroolong frog and the vulnerable Davies’ tree frog.
4 Water quality

4.1 Background

Degradation of water quality can put stress on a range of aquatic organisms, affect Aboriginal cultural and spiritual values of water, increase the cost of drinking water treatment, contribute to public health risks, and decrease the suitability of water for irrigation (DPI Water 2017a).

Water quality condition in the Namoi WRPA varies from poor to good. The water quality status map (Figure 18) provides an overview of water quality condition within the plan area. Water quality condition index scores are an integrated indicator of total nitrogen, total phosphorus, pH, turbidity and dissolved oxygen at main monitoring locations in the plan area. The scores were calculated using the frequency and amplitude of exceedance of water quality targets listed in the Basin Plan between the years 2010-11 and 2014-15. Specific indices were also included for thermal pollution, harmful algal blooms, and salinity for irrigation water.

Changes to land use and alteration to natural river flows are some of the potential causes of poor water quality within the catchment. The following sections provide a summary of the water quality status and issues in the different areas of the plan (from DPI Water 2017a). The future water quality management plan will describe the water quality issues in the Namoi WRPA including possible management strategies.

Figure 18: Water quality condition of the Namoi WRPA

WaQI Scores: Blue = Excellent (100-95), Green = Good (94-80), Orange = Fair (79-60), Red = Poor (59-1).
4.2 Upland region  
**Condition: Poor to Good**

Dissolved oxygen concentrations were frequently below the target range for the period of analysis and generally unpredictable during low flows. pH was generally elevated due to high levels of plant and algal growth. Salinity in the upland was mostly low and negatively related to discharge, i.e. the highest salinities occur during lowest flow periods.

Nutrients (nitrogen and phosphorus) were high due to the soils being naturally high in nutrients. Bank erosion during high flows can result in high levels of turbidity but are generally low at other times. Harmful algal blooms in the upland water sources are rare.

4.3 Midland region (Namoi and Peel)  
**Condition: Poor to Fair**

Thermal pollution occurs in the Namoi River for up to 100 km below Keepit Dam as water can only be released from the bottom of the storage (DPI Water 2016). This results in water temperatures below natural during the summer months and above natural during the winter months. Temperature has a wide range of influences on biological processes. The release of cold water can interrupt important biological cues such as spawning in fish and other fauna. It can also reduce the growth rate of fish and increase mortality (Lugg and Copeland 2014).

Thermal impacts from Split Rock and Chaffey Dams are much more localised as they release water via a multi-level intake tower and the discharges are typically smaller (DPI Water 2016). Thermal pollution may occur for up to 35 km downstream of Split Rock Dam during bulk water transfers.

Dissolved oxygen and pH in the midland water sources are mostly within target ranges. Salinity is also generally low although there are some tributaries such as the Mooki River where salinity is naturally high during low flows due to the soil types. Coxs Creek and the Mooki River also have naturally high levels of nitrogen and phosphorus due to erosion of the fertile soils in these catchments. This results in elevated levels of nutrients in the Namoi River downstream of these tributaries. Similarly turbidity is highest in the lower section of this reach, reaching peak concentrations during high flow events when sediments are eroded from river banks.

Harmful algal blooms occur in Chaffey, Split Rock and Keepit Dams as a result of warm, clear water and high levels of nutrients. Occasional algal blooms also occur in Yarrie Lake, a large natural lake near Narrabri which is used for recreation.

4.4 Lowland region  
**Condition: Good**

Both sites in the lowland area of the WRPA (the Namoi River at Bugilbone and Goangra) are assessed as having good water quality. Dissolved oxygen, pH and nutrient levels are generally within the target ranges and salinity levels are low making the water excellent for irrigation use.

Turbidity and suspended sediment levels were high. These high levels of turbidity can be influenced by a number of factors including land use, riverbank and riparian condition, and the presence of European carp. Clay dominated soils also have an increased susceptibility to re-suspension within the water column.

Algal blooms sometimes occur in the Namoi River at Walgett during periods of low flow.
5 Riparian condition

Riparian vegetation is a key attribute connecting rivers and terrestrial ecosystems. It is important for controlling river bank stability, mitigating runoff, influencing instream processes and providing habitat for a range of biota (Lovett and Price 2007). Leaf litter derived from riparian vegetation is a key contributor of allochthonous energy sources into rivers, driving primary production and stimulating the development of food chains (Robertson et al. 1999; Westhorpe et al. 2010). Native riparian vegetation cover greater than 60 per cent and a riparian buffer zone width of up to 30 m are considered to be important for influencing good riparian condition (Jansen et al. 2003).

River Styles® recovery potential is related to geomorphic condition. It gives an indication of the capacity of a stream to return to good condition or to a realistic rehabilitated condition (Brierley and Fryirs 2005). Streams rated as having conservation or rapid recovery potential are likely to be the most stable and in a good condition, whereas streams with low recovery potential may never recover to a natural condition or may continue to decline quickly without intervention (Cook and Schneider 2006).

Figure 19 and Figure 20 provide a general overview of riparian and geomorphic condition for the Namoi WRPA. There has been extensive clearing of riparian vegetation throughout the Namoi WRPA, particularly in the upland and midland sections of the catchment upstream of Gunnedah. The highest areas of remaining riparian vegetation occur within the middle reach of the river between Narrabri and Pilliga, and on the tributaries flowing through the Pilliga Scrub conservation reserves.

For river recovery potential, river reaches identified as being ‘strategic’ can be in good, moderate or poor geomorphic condition. These reaches are often undergoing rapid change and should be a focus for action to control degradation. The recovery potential within the lower reaches of the catchment is generally good, however many streams in the upper catchment of the Namoi River are classed as having low recovery potential (Figure 20).
Figure 19: Native riparian vegetation cover in the Namoi WRPA

Figure 20: Geomorphic recovery potential in streams in the Namoi WRPA
6 River operations and management

6.1 Storages and regulating structures

6.1.1 Keepit Dam
Keepit Dam is located on the Namoi River 40 km upstream of Gunnedah. The dam has an operating capacity of 425,510 ML and was completed in 1960 as the major irrigation storage for the catchment. It also supplies town water for Walgett, provides for flood mitigation, and generates hydropower through a six megawatt hydropower station operated by Eraring Energy.

Extended periods of low inflows have resulted in low storage levels during 1980-1983, 1992-1995, 2002-2010 and most recently from 2013 to 2016 (Figure 21). Keepit Dam commenced the 2016-17 water year at just 8 per cent capacity but the significant rainfall that fell across the region in mid-late 2016 restored the dam to just below full storage level by November 2016.

6.1.2 Split Rock Dam
Split Rock Dam is located on the Manilla River around 30 km upstream of Tamworth. It was completed in 1987 to meet the increased demand for irrigation within the valley and provide a regulated water supply to users along the Manilla River. Keepit Dam and Split Rock Dam are operated as a joint water supply system for the Namoi catchment with bulk water transfers occurring from Split Rock to Keepit Dam during times of peak demand. A two megawatt hydroelectric power station generates power during irrigation, flood mitigation and environmental flows (WaterNSW 2017).

As with Keepit Dam the storage has experienced extended periods of low storage levels from 1992 to 1997, 2003 to 2012, and most recently from 2014 to 2016 (Figure 22). Some of these low levels are further extended due to the bulk transfer of water downstream to Keepit Dam.

Figure 21: Keepit Dam storage levels 1975-2016

![Figure 21: Keepit Dam storage levels 1975-2016](image)

Figure 22: Split Rock Dam storage levels 1990-2016

![Figure 22: Split Rock Dam storage levels 1990-2016](image)
6.1.3 Chaffey Dam

Chaffey Dam is located on the Peel River approximately 45 km south-east of Tamworth. Its main purpose is to provide regulated water supplies for irrigation, stock and domestic use along the Peel River, and to augment domestic water supply to Tamworth. Water is piped from Chaffey Dam to Dungowan Storage which is owned and operated by Tamworth City Council for town water supply. Chaffey Dam was completed in 1979 and has a total operating capacity of 100,500 ML.

6.1.4 Other storages and regulators

Two major weirs downstream of Narrabri distribute regulated water throughout the lower Namoi valley:

- Mollee Weir has a storage capacity of 3,300 ML and is designed to hold and re-regulate flows to improve the precision of water supply along the lower valley. Mollee Weir features a new fish lock for upstream-migrating fish and a dedicated overshot gate with dissipating pools for downstream-migrating fish which were both completed in 2014.
- Gunidgera Weir is just downstream of Wee Waa and has a storage capacity of 1,900 ML. It also assists with re-regulation, however its main function is to create height in the river to allow regulated flows to be transferred into Gunidgera and Pian creeks.

Weeta Weir, previously located downstream of Wee Waa, was removed in 2013 to improve fish passage as the weir was no longer operational.

There are a number of small weirs on Pian and Gunidgera Creeks which re-regulate flows within these watercourses for local water users. These are Knights Weir on Gunidgera Creek, and Hazeldean Weir, Greylands Weir and Dundee Weir which are all on Pian Creek.

Figure 23: Location of weirs in the Namoi WRPA
6.2 Licensed water use

6.2.1 Regulated entitlement

The Namoi catchment uses around 2.6 per cent of all surface water diverted for irrigation in the Murray-Darling Basin (CSIRO 2007). Water from Split Rock and Keepit Dams is released on an annual basis to meet the needs of general security and high security irrigators, stock and domestic users, and town water supplies.

A total of 567,461 ML of entitlement exists within the WRPA, associated with the regulated Peel and Namoi Rivers (Table 3). Licences are located along the full length of both river systems however the largest volumes of entitlement occur along the Namoi River and its distributary channels downstream of Wee Waa (Figure 23).

The majority of these are general security irrigators who account for 51 per cent of the regulated entitlement in the WRPA. The availability of general security water is less reliable and is affected by storage levels. Available water determination announcements at the beginning of each water year are used to determine the proportion of entitlement that is allocated to general security water users.

Around 4,788 ML of high security entitlement currently exists within the WRPA for irrigation, town water supply, and research purposes. The availability of high security water is guaranteed irrespective of circumstances and must be provided for prior to allocating water to other user users. In addition there is 19,186 ML allocated to local water utilities which also receive priority over general security water users.

There is 254,588 ML of entitlement for supplementary water within the Namoi WRPA accounting for 45 per cent of regulated share components. All of these shares are located in the Lower Namoi system. When flows in the river are greater than orders, access to this surplus water is declared. During these times, irrigators can divert water without debit to their account.

The regulated Namoi River and Peel River systems are currently managed under separate annual accounting systems. At the beginning of each water year, water is set aside to enable the delivery of essential requirements in a repeat of the lowest period of inflows. The remaining water held in storage is then distributed to licence holders as allocation, which may be adjusted throughout the year if water resources improve.

Table 3: Regulated river share components for the Namoi WRPA 2016

<table>
<thead>
<tr>
<th>Access licence category</th>
<th>Peel Regulated share component (ML)</th>
<th>Upper Namoi Regulated share component (ML)</th>
<th>Lower Namoi Regulated share component (ML)</th>
<th>TOTAL (ML)</th>
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<tbody>
<tr>
<td>Domestic and Stock</td>
<td>163</td>
<td>90</td>
<td>2,006</td>
<td>2,259</td>
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<tr>
<td>Local water utility</td>
<td>16,400</td>
<td>515</td>
<td>2,271</td>
<td>19,186</td>
</tr>
<tr>
<td>Regulated river (general security)</td>
<td>30,428</td>
<td>9,805</td>
<td>246,407</td>
<td>286,640</td>
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<tr>
<td>Regulated river (high security)</td>
<td>804</td>
<td>80</td>
<td>3,904</td>
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<td>Supplementary water</td>
<td>0</td>
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<td><strong>TOTAL</strong></td>
<td><strong>47,795</strong></td>
<td><strong>10,490</strong></td>
<td><strong>507,376</strong></td>
<td><strong>567,461</strong></td>
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</table>
Figure 24: Distribution of regulated licences in the Namoi WRPA
Namoi River

Water users on the Upper Namoi are allowed to carry over up to 0.5 ML per share but account usage cannot exceed 100 per cent of the share component. On the Lower Namoi general security licence holders are permitted to carryover up to 2 ML per share with an annual account usage no greater than 1.25 ML per share. All other categories have an account limit of 100 per cent of the share component and cannot carryover water between water years (Burrell et al. 2016).

The actual water used each year varies and depends on rainfall and the amount of water available in the accounts. Average annual water usage is currently 3,842 ML for the Upper Namoi, 118,108 ML for the Lower Namoi since water sharing commenced. These figures include supplementary water taken during declared periods of high flow.

Long term modelling indicates that general security water users in the Namoi River receive 100 per cent of their entitlement or more at the start of a water year in 44 per cent of years. However by the end of the water year 100 per cent entitlement or more is available in 73 per cent of years (Figure 25). These represent averages across the catchment however water availability can differ greatly between the upper and lower parts of the regulated system, as demonstrated by Figure 26 and Figure 27.

Figure 25: Long term simulated water availability for the Namoi River (excluding Peel)
Figure 26: Water availability in the Upper Namoi Regulated River (AWD plus carryover)

Figure 27: Water availability in the Lower Namoi Regulated River (AWD plus carryover)

Figure 28: Water usage in the Upper Namoi River

Figure 29: Water usage in the Lower Namoi River (including supplementary water)
Figure 26 shows the water available in the Upper Namoi River since the water sharing plan commenced in 2004. Here water users generally receive their full allocation in all but the driest years. In contrast general security water users in the Lower Namoi River often have access to less than 50 per cent of their entitlement (Figure 27). Between 2010-11 and 2013-14 excess water was available and general security water users were able to carry-over water into the next accounting year. The reduced water availability in drought years such as 2007-08 and 2008-09 is reflected in the lower levels of water usage during these years (Figure 28, Figure 29).

**Peel River**

Average annual usage in the Peel River since commencement of the water sharing plan in 2010 is 14,347 ML. In recent years general security irrigators in the Peel River have had reduced water availability due to drought conditions in the catchment (Figure 30). In 2014-15 there was no water available to general security users and reduced entitlement available to all other water users (no more than 70 per cent). With no water available for general security holders licensed account usage was low with just 4,344 ML debited to the accounts (Figure 31). Lower water availability corresponded to heavier reliance on uncontrolled flows with over 1,500 ML extracted by users (Burrell *et al*. 2016). In 2015-16 dry conditions continued and general security users received just 17 per cent of their full share entitlement.
6.2.2 Unregulated river entitlement

Water users located on the various unregulated tributaries of the Namoi WRPA are entitled to extract water with an unregulated water licence. These licences are subject to a range of access conditions, including cease to pump triggers that protect the health of the watercourses. Detailed water use is not available in the unregulated rivers because there is not yet broad scale metering in these water sources. Water is also extracted from these water sources through basic landholder rights which do not require a licence.

There is approximately 163,441 ML of entitlement allocated to water users on unregulated streams in the Namoi WRPA (Table 4). These water users are currently managed through two separate water sharing plans – the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources and the Upper and Lower Namoi Unregulated and Alluvial Water Sources.

### Table 4: Unregulated share components for the Namoi WRPA 2016

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<tr>
<th>Access licence category</th>
<th>Peel</th>
<th>Namoi</th>
<th>TOTAL</th>
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<tr>
<td>Domestic and Stock</td>
<td>209</td>
<td>784</td>
<td>993</td>
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<td>Local Water Utility</td>
<td>5,600</td>
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<td>Unregulated River Access</td>
<td>11,898</td>
<td>141,488</td>
<td>153,386</td>
</tr>
<tr>
<td>Unregulated River (high flow)</td>
<td>0</td>
<td>729</td>
<td>729</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>17,707</td>
<td>145,449</td>
<td>163,156</td>
</tr>
</tbody>
</table>

The majority of unregulated water use in the Namoi WRPA occurs in the central and western parts of the catchment where fertile grey clay soils are suitable for large scale irrigation development for crops such as cotton, cereals and oilseeds (DPI Water 2016). The largest volumes of entitlement are located in the Coxs River and Mooki River water sources and in the lower valley on the Namoi River downstream of Wee Waa and along Plan Creek.

Extraction is highly variable, depending on seasonal conditions, market influences and cropping opportunities. Many smaller licences are scattered throughout the eastern part of the WRPA in the upper Namoi and Peel valleys. Water usage is more consistent on these perennial rivers and creeks where there is better rainfall and lower crop requirements (DPI Water 2016).

Around 5 per cent of unregulated entitlement within the WRPA is allocated for town water supplies. Towns and villages that are dependent or partially dependent on unregulated surface water include Walcha, Bendemeer, Manilla, Barraba and Werris Creek (Table 5). Some of the suppliers listed in Table 5 also extract water from alluvial water sources.

### Table 5: Town water supply entitlements from unregulated water sources in the Namoi WRPA

<table>
<thead>
<tr>
<th>Local Water Utility</th>
<th>Water source</th>
<th>Town supplied</th>
<th>Entitlement (ML/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liverpool Plains Shire</td>
<td>Quirindi Creek</td>
<td>Werris Creek</td>
<td>1,000</td>
</tr>
<tr>
<td>Walcha Shire</td>
<td>Mid Macdonald River</td>
<td>Walcha</td>
<td>379</td>
</tr>
<tr>
<td>Tamworth Regional Council</td>
<td>Mid Macdonald River</td>
<td>Bendemeer</td>
<td>84</td>
</tr>
<tr>
<td>Tamworth Regional Council</td>
<td>Upper Manilla</td>
<td>Barraba</td>
<td>421</td>
</tr>
<tr>
<td>Tamworth Regional Council</td>
<td>Upper Namoi</td>
<td>Manilla</td>
<td>564</td>
</tr>
<tr>
<td>Tamworth Regional Council</td>
<td>Upper Peel River (Dungowan Dam)</td>
<td>Tamworth</td>
<td>5,600</td>
</tr>
</tbody>
</table>

DPI Water, June 2017
Figure 32: Distribution of unregulated entitlement in the Namoi WRPA
Tamworth Regional Council also extracts from the regulated Manilla River but uses unregulated flow impounded by Manilla Weir as its primary water source. At Barraba the unreliability of unregulated surface water has been a problem during recent drought years, prompting the recent construction of a pipeline to Split Rock Dam to access regulated supply (DPI Water 2016).

In some of the unregulated water sources competition for water during low flows can be an issue between agricultural users and the local water utility. In recognition of the role of local water utilities in meeting “critical human needs” the water sharing plans currently operating in the WRPA allow access to very low flows for town water supply purposes (below the cease-to-pump level), while other licensed holders are prohibited from extracting.

6.3 Water trading

In 1983-84 the temporary transfer of water licences (allocation trade) was introduced in regulated systems to facilitate business flexibility and optimise the benefits of water use to the NSW economy. Additionally, in 1989 permanent trades (entitlement trade) in regulated systems were provided for, and the NSW water market commenced to rapidly grow.

The implementation of water sharing planning has removed barriers to the efficient operation of these water markets, facilitating more efficient and better informed trades. This has been achieved through the inclusion of clear rules for trading in water sharing plans, the separation of the water licence from the land title in 2004, and the establishment of public registers in 2004, showing the volume and price paid for access licences.

Permanent trades include both share assignments and the sale of the licence entitlement. These trades may be for commercial use by other water users or acquired for environmental use. Environmental share components were first acquired in the Namoi valley under NSW and Commonwealth buy-back schemes in 2008-09 (Figure 33). The majority of permanent water trades are general security water however there is also smaller amounts of supplementary water which is traded permanently.

Temporary trades are temporary assignments of shares where water in a licence holder’s account is sold, but ownership of the licence is retained. Figure 34 and Figure 35 show temporary water licence trades within the Upper and Lower Namoi regulated water sources. Variations between years are generally related to climatic conditions and the volume of water made available to different licence categories.
Water that is traded into licences is shown in Figures 34 and 35 as ‘assignments in’ while water that is traded out of licences is shown as ‘assignments out’. The net assignments relate to the water that is temporarily traded from the Upper Namoi to the Lower Namoi.

Trading activity is highest in the years of plentiful flow (such as 2010-11). Trading activity has decreased in the past two years due to the low levels of general security water available to water users in the lower Namoi River during these seasons (see Figure 27).
6.4 Environmental water

Water sharing plans allow for two types of environmental water. Held environmental water is an entitlement that is held by a licence-holder for environmental watering purposes. Planned environmental water is water that is prescribed under the rules of a water sharing plan.

6.4.1 Held environmental water

Held environmental water (HEW) is an entitlement held by a licence-holder that is used for environmental watering purposes. Although a water sharing plan facilitates the HEW, the use and volumes of HEW are generally not defined by the plan. HEW was first acquired in the Namoi valley in 2008-09 and has gradually increased to a current volume of 9,549 ML of general security water in the Namoi River. The majority of this (9,442 ML) is attached to the Lower Namoi River (Figure 36). The volume of HEW in the Upper Namoi has remained unchanged since 2008 and currently totals 105 ML.

HEW share components are held by the Commonwealth Environmental Water Holder and the NSW Office of Environment and Heritage. It has been used once in the Lower Namoi in 2012-13 when Commonwealth environmental water was used to enhance flows along the Namoi River to contribute to the health of instream habitat and provide opportunities for native fish to feed, breed and shelter (Department of Environment and Energy 2017).

The Peel River has 1,257 ML of general security HEW available however there has been no use of this water to date (Figure 37).

Figure 36: Held environmental water shares and usage in the Lower Namoi River

![Graph showing held environmental water shares and usage in the Lower Namoi River.]

Figure 37: Held environmental water shares in the Peel River

![Graph showing held environmental water shares in the Peel River.]

6.4.2 Planned environmental water

Planned environmental water is defined in a water sharing plan according to rules. The Namoi unregulated water sharing plan provides for a minimum daily flow to be maintained in the Namoi River at Walgett. During the months of June, July and August a minimum daily flow equivalent to 75 per cent of the natural 95th percentile daily flow for each month must be maintained to the end of the river. This requirement does not apply during times of reduced water supply when the sum of water stored in Keepit Dam and Split Rock Dam is less than 120,000 ML.

The plan also specifies limits to total extractions by supplementary water holders in the Lower Namoi during periods when flows are above specified flow levels. These rules contribute to a number of flow objectives for the lower Namoi River including protecting important rises in water levels, maintaining wetland and floodplain inundation, and maintaining natural flow variability.

Planned environmental water in the Peel water sharing plan is provided by an environmental stimulus flow. When the volume of water held within Chaffey Dam exceeds 50,000 ML, the next 1,600 ML must be put aside and reserved for environmental purposes. The stimulus flow should be released between 1 July and 31 August or 1 March and 30 June and triggered when a flow in the Peel River at Piallamore has not exceeded 500 ML per day in the preceding 90 days. The stimulus flow should be provided over seven days, targeting a peak of 500 ML per day on the second day of the event to mimic a natural flow event. During the last two water years (2014-15 and 2015-16) Chaffey Dam remained below 50,000 ML for the whole year and therefore no stimulus release was provided in these years.

The Peel water sharing plan also includes a minimum daily release of 3 ML from Chaffey Dam which is required to be released at all times except when releases for extraction or stimulus flows exceed this amount.
### Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic ecosystems</td>
<td>Ecosystems that are dependent on flows, or periodic or sustained inundation/waterlogging for their ecological integrity. Examples include wetlands, rivers, karst and other groundwater-dependent ecosystems, saltmarshes, estuaries and areas of marine water not exceeding 6 m deep at low tide.</td>
</tr>
<tr>
<td>Allocation</td>
<td>The volume of water assigned to water allocation accounts in a given season, defined according to rules in the relevant water plan.</td>
</tr>
<tr>
<td>Allocation assignment</td>
<td>The transfer of water between licence holder allocation accounts as a result of a trade agreement. The assignment becomes part of the receiver’s allocation account water for the current water year.</td>
</tr>
<tr>
<td>Available water determination (AWD)</td>
<td>A determination referred to in section 59 of the <em>Water Management Act 2000</em> that defines the proportion of the share component that will be available for extraction under each category of water access licence.</td>
</tr>
<tr>
<td>Basic Landholder Rights</td>
<td>Domestic and stock rights, harvestable rights or native title rights that do not require a licence or approval to take or use water.</td>
</tr>
<tr>
<td>Cold water pollution</td>
<td>An artificial decrease in the temperature of water in a natural river.</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>Measured concentration of oxygen dissolved in water.</td>
</tr>
<tr>
<td>Domestic consumption</td>
<td>Consumption of water for normal household purposes in domestic premises on the land.</td>
</tr>
<tr>
<td>Ecological value</td>
<td>The perceived importance of an ecosystem which is underpinned by the biotic and/or abiotic components and processes that characterise that ecosystem.</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>A specific composition of animals and plants that interact with one another and their environment.</td>
</tr>
<tr>
<td>Ecosystem functions</td>
<td>The processes that occur between organisms and within and between populations and communities. They include interactions with the nonliving environment that result in existing ecosystems and bring about dynamism through changes in ecosystems over time.</td>
</tr>
<tr>
<td>Effluent</td>
<td>An effluent stream is one which leaves the main river and does not return.</td>
</tr>
<tr>
<td>Endangered ecological community</td>
<td>Ecological communities as listed in Schedule 1 of the <em>Threatened Species Conservation Act 1995</em> or Schedule 4 of the <em>Fisheries Management Act 1994</em>.</td>
</tr>
<tr>
<td>Eutrophication</td>
<td>The process where an accumulation of nutrients in water bodies leads to rapid growth of aquatic plants.</td>
</tr>
<tr>
<td>Farm dams</td>
<td>Private dams that are used to intercept catchment runoff that would otherwise contributed to streamflow or recharge of aquifers. Primarily located on hillsides (does not include floodplain harvesting dams).</td>
</tr>
<tr>
<td>General security licence</td>
<td>A category of water access licence implemented under the <em>Water Management Act 2000</em>. Forms the bulk of the water access licence entitlement volume in NSW and is a low priority entitlement i.e. only receives water once essential and high security entitlements are met in the available water determination process.</td>
</tr>
</tbody>
</table>

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*DPI Water, June 2017*
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>Water that occurs beneath the ground surface in the saturated zone.</td>
</tr>
<tr>
<td>Groundwater dependent ecosystems</td>
<td>Ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.</td>
</tr>
<tr>
<td>Harmful algal bloom</td>
<td>An algal bloom that causes negative impacts to other organisms through the production of natural toxins, mechanical damage, or other means.</td>
</tr>
<tr>
<td>High flows</td>
<td>Also called bankfull events, these reshape the channel, creating habitats such as pools, bars and benches.</td>
</tr>
<tr>
<td>High security licence</td>
<td>A category of licence water access licence implemented under the Water Management Act 2000. Receives a higher priority than general security licences but less priority than essential requirements in the available water determination process.</td>
</tr>
<tr>
<td>Instream value</td>
<td>Ecological condition value of river reaches based upon High Ecological Value Aquatic Ecosystems (HEVAE). In NSW HEVAE was calculated using four criteria: distinctiveness, diversity, naturalness and vital habitat.</td>
</tr>
<tr>
<td>Long term average annual extraction limit (LTAAEL)</td>
<td>The long term average volume of water (expressed in megalitres per year) in a water source available to be lawfully extracted or otherwise taken.</td>
</tr>
<tr>
<td>Low flows</td>
<td>Flows that are confined to the lower part of the channel; also often called base flows. These flows are between pools and riffle areas between pools. Generally defined as the 80th percentile flow.</td>
</tr>
<tr>
<td>Nitrogen and phosphorous</td>
<td>Chemical nutrients essential for growth and added to many fertilisers.</td>
</tr>
<tr>
<td>Overbank flows</td>
<td>High flows that connect the river to floodplain and wetlands allowing the exchange of nutrients and sediment to these areas.</td>
</tr>
<tr>
<td>Regulated river</td>
<td>Gazetted under the NSW Water Management Act 2000 and is a river where downstream flows are regulated by a major state-owned storage. Downstream licence holders can order water against a held entitlement.</td>
</tr>
<tr>
<td>Replenishment flows</td>
<td>Flows provided along effluent systems to supply water for household, town use and stock.</td>
</tr>
<tr>
<td>Riparian</td>
<td>Relating to or living or located on the bank of a natural watercourse, such as a river stream.</td>
</tr>
<tr>
<td>Salinity</td>
<td>The concentration of sodium chloride or other dissolved minerals in water, usually expressed in EC units or milligrams of total dissolved solids per litre. Conversion factor is 0.64 mg/l TDS = 1000 µS/cm = 1 dS/m.</td>
</tr>
<tr>
<td>Seasonality</td>
<td>The timing of flooding and low flow events.</td>
</tr>
</tbody>
</table>

Share component
An entitlement to water specified on the access licence, expressed as a unit share or in the case of specific purpose licences, a volume in megalitres (eg. local water utility, major water utility and domestic and stock).

Stock watering
The watering of stock animals being raised on the land but does not include the raising of stock animals on an intensive commercial basis that are housed or kept in feedlots or buildings for all (or a substantial period) during which the stock animals are being raised.

Stratification
The formation of separate water layers.

Supplementary water
Formerly known as off-allocation water, this is surplus flow resulting from storm events that cannot be captured in storages or weirs. When the water is not needed to meet current demands or commitments, then it is considered surplus to requirements and a period of Supplementary Access is announced. Supplementary Water Access Licence holders can only pump water against these licences during these announced periods. Other categories of licence holders may also pump water during these periods.

Water access entitlement
A water product (licence) issued under the Water Management Act 2000.

Water resource plan
A plan made under the Commonwealth Water Act 2007 that outlines how a particular area of the Murray–Darling Basin’s water resources will be managed to be consistent with the Murray–Darling Basin Plan. These plans set out the water sharing rules and arrangements relating to issues such as annual limits on water take, environmental water, managing water during extreme events and strategies to achieve water quality standards and manage risks.

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 source
The whole or any part of:
- one or more rivers, lakes or estuaries, or
- one or more places where water occurs naturally on or below the surface of the ground
and includes the coastal waters of the State.

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3 As defined in the Water Management Act 2000
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