

RURAL FLOODPLAIN MANAGEMENT PLANS

# Background document to the Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019

***Water Management Act 2000***

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**Background document to the Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019**

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# Abbreviations

Abbreviation	Description
ABS	Australian Bureau of Statistics
ADS40	Airborne Digital Sensor
AEP	annual exceedance probability
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
ASDST	Aboriginal Sites Decision Support Tool
ATWG	Aboriginal Technical Working Group
AWIS	Aboriginal Water Initiative System
DEM	digital elevation model
DPI	NSW Department of Primary Industries
Upper Namoi Valley FMP 2019	<i>Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019</i>
FMP	floodplain management plan
FPWEC	First Peoples' Water Engagement Council
FRMP	flood risk management plan
FRMS	flood risk management study
GVAP	gross value of agricultural production
Gwydir Valley FMP 2016	<i>Floodplain Management Plan for the Gwydir Valley Floodplain 2016</i>
HHIMS	Historic Heritage Information Management System
IPW	infrastructure protection work
IRP	Interagency Regional Panel
IRSAD	Index of Relative Socio-economic Advantage and Disadvantage
LGA	local government area
LiDAR	light detection and ranging
LLS	Local Land Services
MDB	Murray–Darling Basin

Abbreviation	Description
MDBA	Murray–Darling Basin Authority
ML	megalitres
MZ AD	management zone—major discharge areas, defined floodways
MZ AID	management zone—major discharge areas, ill-defined floodways
MZ BU	management zone—flood storage and secondary flood discharge, Upper Liverpool Plains
MZ BL	management zone—flood storage and secondary flood discharge, Lower Liverpool Plains
MZ C	management zone—flood fringe and flood-protected developed areas
MZ CU	management zone—urban areas
MZ D	management zone—special protection
NBAN	Northern Murray–Darling Basin Aboriginal Nations
NOW	NSW Office of Water
NSW	New South Wales
NVA 2003	<i>Native Vegetation Act 2003</i>
OEH	NSW Office of Environment and Heritage
PCT	plant community type
SEIFA	Socio-Economic Indexes for Areas
TAG	Technical Advisory Group
VIS	NSW Vegetation Information System
WM Act 2000	<i>Water Management Act 2000</i>
WSP	water sharing plan

# Purpose

The purpose of this document is to inform local landholders and the wider community about how the rural floodplain management planning approach presented in the Draft rural floodplain Management Plans: Technical manual for plans developed under the *Water Management Act 2000* (the technical manual) has been applied across the Upper Namoi Valley Floodplain. This document should be read in conjunction with the technical manual and the Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019 (Upper Namoi Valley FMP).

# The Upper Namoi Valley Floodplain

This document pertains to the area known as the Upper Namoi Valley Floodplain as shown in Figure 1 and Figure 3. The Upper Namoi Valley Floodplain is part of the Namoi Valley, which covers 4.2 million ha from the head of the MacDonald River westward to the township of Walgett. The Namoi Valley forms part of the Barwon–Darling River system and is bound 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 1500 metres above sea level in the south and east of the valley to just 100 metres above sea level on the alluvial floodplain west of Narrabri.

The Upper Namoi Valley Floodplain covers 588,600 ha from Narrabri to the upper reaches of the Liverpool Plains. The northern boundary is aligned to the Lower Namoi Valley Floodplain for which there is also a rural FMP in development. Between Narrabri and Boggabri, the boundary is mostly aligned to the existing Upper Namoi Valley Floodplain area designated in 1984 under section 166 of Part 8 of the

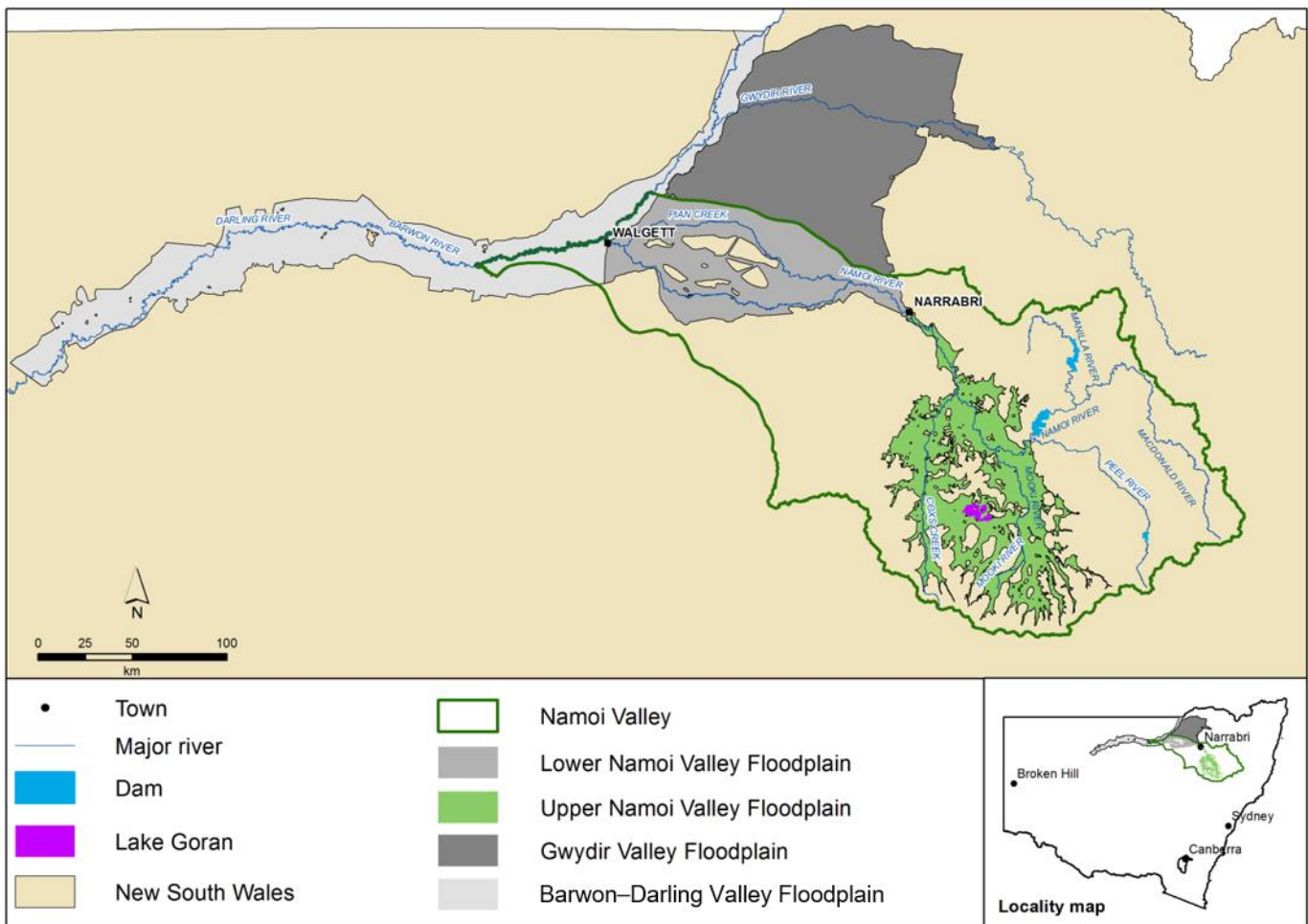


Figure 1. Key features of the Namoi Valley and the Upper Namoi Valley Floodplain

*Water Act 1912*<sup>1</sup>. Upstream of Boggabri, the floodplain includes areas with a slope of 2% or less, which was traditionally how the Liverpool Plains floodplain was designated in 1994 under the *Water Act 1912*. Major towns include Quirindi, Boggabri and Gunnedah.

Stream flows in the catchment are regulated by Keepit Dam on the Namoi River, Split Rock Dam on the Manilla River and Chaffey Dam on the Peel River. Regulated water released from these dams is mainly used for irrigation purposes.

The main headwater tributaries of the Namoi River include the MacDonald, Manilla, Peel and Mooki Rivers, which join the Namoi River upstream of Boggabri. Coxs Creek is a major tributary feeding into the Namoi River from the west of the floodplain.

Peel River is the major regulated tributary to the Namoi River with a catchment area of around 470,000 ha. Major tributaries of the Peel River are Goonoo Goonoo Creek, Cockburn River and Dungowan Creek. The management of Chaffey Dam is independent of the other storages on the Namoi, and Chaffey Dam's capacity has recently been upgraded from 62 to 100 gigalitres. The Peel River is subject to the Water Sharing Plan (WSP) for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010, while the Namoi River is subject to the WSP for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003.

Ecosystems on the floodplain are unique and diverse, with many depending on flooding to support their structure, function and long-term survival. The Gamilaroi<sup>2</sup> Nation is the traditional owner of the entire Namoi Valley and the floodplain contains many cultural sites and values that are important to the local Aboriginal community. Many of these cultural sites and values are flood dependent, such as Coolamon scars on flood-dependent living trees. Lake Goran, which is listed on the Australian Wetlands Database (NSW 2005, Environment Australia 2001), is the largest wetland in the floodplain and is just one of many ecologically and culturally significant sites in the floodplain.



**Figure 2. Lake Goran. G. Pezzimenti, OEH 2013.**

<sup>1</sup> Note that the *Water Act 1912* was repealed in 2015 and all existing designated floodplains under this Act have transitioned across to the *Water Management Act 2000*

<sup>2</sup> Also known as Kamilaroi, Gamilaraay and Gomeroi

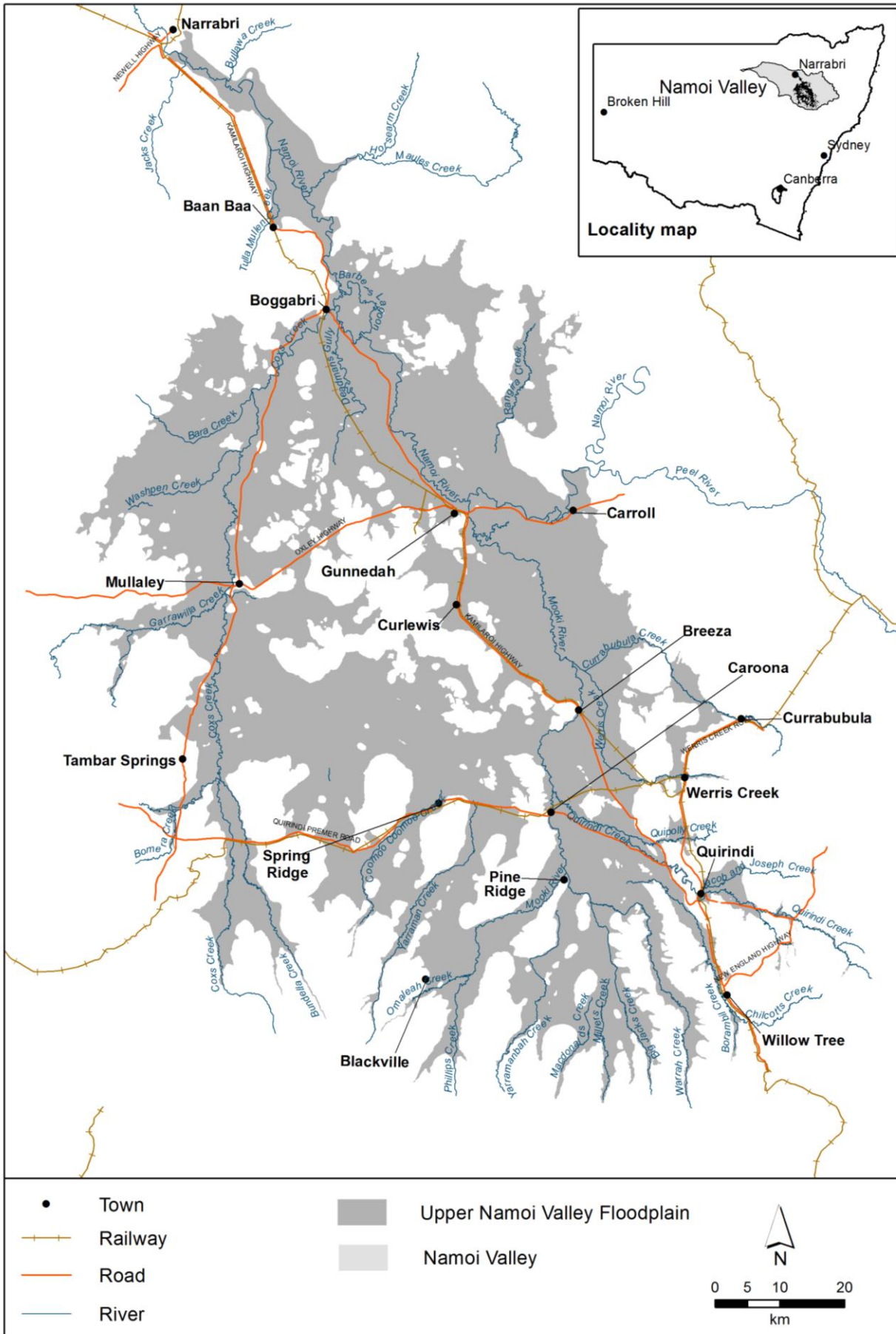


Figure 3. The Upper Namoi Valley Floodplain

The Namoi Valley contains some of the most fertile and productive agricultural lands in the state, representing about 1% of the NSW gross regional product per year, or 3.081 million dollars (OEH 2010). Primary industries provide about 40% of the region's gross regional product, which is chiefly comprised of agriculture (16%) and associated irrigation industries (48%) (OEH 2010). Broadacre cropping is widespread, with crops such as cotton and wheat generally being the dominant irrigated crops by area and value. Floodplain development has enhanced the agricultural productivity of land used for grazing, dryland cropping and irrigated cropping. Recreational fishing and the associated tourism is also considerable in the Namoi catchment.

The NSW Government has been responsible for rural floodplain management planning in the Namoi Valley since the 1970s. Before then, the region was almost entirely under native grasses and was used principally for wool production. This meant there was an absence of flood works that might affect flooding. However, when Keepit Dam was completed in 1960, the regulated water supply allowed for significant irrigation development that intensified from the 1990s onwards (Department of Industry, Planning and Natural Resource 2005). The flatter country was progressively developed for large-scale and intensive crop production, particularly under strip-cropping techniques in the Liverpool Plains region (Burton et al 1994). Major private irrigation development was introduced to parts of the region from groundwater resources, major creeks and the waters of Lake Goran (Burton et al 1994).

As of March 2018, approximately 57,700 ha (10%) of floodplain area are covered by floodplain works in the Upper Namoi Valley Floodplain. These floodplain works include levees, earthworks, banks and channels that have been built to protect crops, stock and properties from flooding; provide on-farm access; and to manage irrigation, stock and domestic water. Works such as these, which affect the distribution of flow of floodwaters, are referred to as flood works.

The progressive land-use changes over the past 50 years are purported to have substantially modified the surface and sub-surface hydrology of the region, causing more rapid and more frequent flood runoff and significantly modifying the historic flood-flow patterns across the flatter sections of the region (Burton et al 1994). Flooding problems have been aggravated by the many engineering and agricultural works that have been constructed across the region as land use has been modified (Burton et al 1994). Minor agricultural works, such as levees, irrigation channels, water storages, farm roads and even fence lines can produce major diversions or concentrations of shallow flood flows, often unexpectedly and to the substantial disadvantage of adjacent landowners (Burton et al 1994). It is important to note that non-agricultural works, such as roads and railways located to suit the hydrology of the region as it existed fifty years ago, now provide major interference to natural flood flows and provide focal points for flood discharge concentration (Burton et al 1994).

Although historic flood-flow patterns in the region have been modified as a result of floodplain development, the NSW Government has been working to manage this change and to reduce any disadvantage that may be experienced by adjacent landowners. Government planning has focused on areas with intensive irrigation development and where the potential impact of flood works needed to be investigated following major flood events. To date there are two floodplain areas designated under section 166 of Part 8 of the *Water Act 1912* in the study area and a total of eight existing rural FMPs (of which seven are in the Upper Namoi Valley Floodplain).

Existing floodplain management arrangements have been consolidated in the Upper Namoi Valley FMP, which applies floodplain management principles consistently across the extent of major flooding. Similar to current management measures, the new plan aims to coordinate flood work development to maintain flooding behaviour while minimising risk to life and property from the effects of flooding. The Upper Namoi Valley FMP provides management zones and transparent rules to be used when determining flood work development approvals for new flood works and amendments to existing flood works.

## Flooding behaviour

Major floods tend to occur in the summer months from January to March. During this time, heavy localised thunderstorms occur regularly in the valley and often the rainfall on the plains is as heavy as in the hills. Summer rains are caused by the southerly movement of high-pressure cells over the valley from Queensland, which allow the passage of cyclonic low-pressure systems. Although not an annual event, these long-duration cyclonic storms can produce very heavy rainfalls and are usually the cause of severe flooding. In winter, rainfall is generally low and unreliable.

In any one area in the floodplains of the Namoi Valley there is considerable variation in the extent, duration and source of flooding between different flood events. This is because the spatial distribution of rainfall and the arrival times of peak sub-catchment inflows along the main channel system all vary considerably between flood events. Unlike most other inland rivers, the Namoi receives significant flood-producing tributaries along the bulk of its course to the Barwon River, which drives variable flood behaviour.

The main headwater tributaries of the Namoi River are the Manilla, Peel and Mooki rivers. The Manilla and Peel rivers flow from the high mountainous country in the east and north of the catchment and have higher run-off than the Mooki River. This is because most of the valley above Keepit Dam can produce high runoff as it flows through undulating to often rugged country.

The Mooki River drains the south-eastern sections above Gunnedah, which runs through the flat Liverpool Plains. Extensive flooding is still common along the lower Mooki River and it can be a significant cause of flooding at Gunnedah and further downstream when coinciding with major flows in the Namoi River.

The grade of the Namoi River flattens downstream of Gunnedah and it becomes a slower-moving river with a well-developed and complex pattern of tributaries, anabranches and effluents. Coxs Creek and Maules Creek enter the Namoi between Gunnedah and Narrabri and can exacerbate flooding from the Liverpool Plains.

## Liverpool Plains

The Liverpool Plains form an extensive inland delta extending from the Liverpool Ranges to Boggabri. Widespread inundation in the area can be caused by shallow overland flow and out-of-channel flooding during periods of heavy rainfall. The country is extremely flat and fringed by hills and ranges.

In the southern fringes of the Liverpool Plains, the area is characterised by flat to gently rolling low hills with natural elevations of around 350 metres AHD. Lake Goran, a large shallow lake in the Liverpool Plains, fluctuates in size due to rainfall, runoff and evaporation and generally does not have an outlet except in extreme flood or wet seasons. There is a very intricate pattern of flow paths on the broad floodplain in the south of the Liverpool Plains. Generally, the main streams in the catchment come from the Liverpool Range at the southern catchment border and flow in a northerly direction. Beyond the foothills of the Liverpool Ranges, these streams do not follow a defined route.

The southern area of the Liverpool Ranges contains depressions that are consistent with a braided drainage system of small channels through a low-lying swampy area with very little lateral grade. In the confined floodplain zone, the braided channel system is probably of ancestral origin, when there were a number of channels that shared flood flows. The modern river channel behaves like a single channel river system, with a number of meanders.

The annual rainfall average ranges from about 550 millimetres at Caroon to approximately 900 millimetres at the top of the Liverpool Range. Records from Quirindi Post Office (Stn No 55049) indicate that the average rainfall since 1885 has been 682 millimetres. However, 10% of years have had less than 415 millimetres and 10% have had more than 770 millimetres (Hughes Trueman 2005). Wet periods in the Namoi were experienced from 1895–98, 1949–51, in the mid-1950s and 1973–74 (Hughes Trueman 2005). The data highlights a dominant summer rainfall peak and a minor winter rainfall peak, which correspond with flooding.

The wide eastern floodplain, with its low surface gradient, causes floodwater to be typically slow-moving and widespread. Exceptions are the natural constrictions at Breeza, the Melville Range and Nicholson Ridge, where flood velocities are increased slightly. Under natural conditions, scouring would not occur due to the low surface gradient of the area; however, scouring is known to occur in the area as a result of major earthworks. In terms of flood-flow distribution, most existing works have little impact, particularly once overtopped. There is

no consistent pattern to flooding because of the large catchment area and variability of storm-cell locations and the many sources of floodwaters. However, flooding is known to be significantly influenced by the magnitude and the timing of the contribution of the Namoi and Mooki Rivers, as well as the flow behaviour of the Peel River and local storage systems, such as Keepit Dam.

Six kilometres downstream of the confluence of the Namoi and Peel Rivers, floods inundate both sides of the river extensively, with a major breakout further downstream at Tommy Swamp. Some of the floodwaters move onto the Mooki River floodplain and can combine with Mooki River floodwaters to re-join the Namoi River upstream of Gunnedah. Immediately upstream of Carroll, floodwaters break out onto the narrow floodplain and significant volumes of water flows onto the Mooki River floodplain. The Namoi River breaks at the Oxley Highway near Carroll and flows south to spread broadly as it crosses the Carroll to Breeza road.

Downstream of Gunnedah, flooding extends across the floodplain as a number of flood runners come into effect. The principal flood runner is Dead Man's Gully, which affects the western floodplain and runs from Gunnedah to Boggabri. Immediately upstream of Boggabri, the flow pattern is quite complex, with a major system of prior streams passing flood waters either side of Flood Hill.

Apart from a few minor flood runners leaving and returning to the river immediately downstream of Breeza, the left bank of the Mooki River valley is not overtopped until well after the danger height for the river is exceeded (Breeza gauge at 6.0 m). At this point, the entire floor of the Mooki valley from Breeza to Gunnedah is inundated, with only a few isolated islands of high ground (Purcell 1995).

In the west of the Liverpool Plains, floodwaters enter the Upper Coxs Creek floodplain from the upstream boundary of the Coxs Creek system, predominantly affecting the southern floodplain at first, and gradually flowing to the lower reaches towards Premer, Tambar Springs and Mullaley, where flow from Garrawilla Creek enters the system. Flows in the Garrawilla Creek system can spread onto the north-western floodplain of Coxs Creek (with the obstruction of the Oxley Highway) can slow the drainage of the flood waters, when the timing of the peaks are similar.

Flows are generally shallow but can increase in depth, depending on the size of the flood in the river and the volume and timing of inflows into the main channels. Depending on the timing of the flows from local catchment creeks compared to the timing of the peak in Coxs Creek, the flows can hold each other up and increase the period of inundation and the depth of the flood.

## **Boggabri to Narrabri**

The floodplain between Narrabri and Boggabri is relatively narrow, especially in the area known as Gins Leap. There are a number of smaller anabranches or breakouts along the route; however, the main area of flooding is where Maules Creek joins the Namoi River. Maules Creek is one of the main tributaries of the Namoi River along this section, and floodwaters from Maules Creek combine with breakouts from the Namoi River. The combined flows then join back with the main Namoi channel before it reaches Narrabri.

Major floods occur in Narrabri about once every 10 years and very large floods occur every 40 to 50 years (URS Australia Pty Ltd 2011). About two and a half kilometres upstream of Narrabri town centre, the Namoi River splits into the main river on the west side and Narrabri Creek on the east side. High-level flood runners fragment the town during floods. The two branches join back together about 10 kilometres downstream of Narrabri's town centre. The town of Narrabri is located in the Lower Namoi Valley FMP.

## **Key changes to the natural flooding regime**

The construction of Keepit Dam in 1960 on the Namoi River, Chaffey Dam in 1976 on the Peel River and Split Rock Dam in 1984 on the Manilla River, combined with coinciding river regulation and land-use changes, have caused changes to the nature, frequency, extent and duration of flooding in the Upper Namoi Valley Floodplain.

Key changes to the nature of flooding include:

- alteration of the direction and depth of flood flows in some areas
- alteration of the carrying capacity of rivers, creeks and overland flow paths in some areas



- increase in the velocity of flood-flow rates, with flows getting to the lower reaches of the floodplain faster due to land-use changes
- erosion of drains and concentration of flows in scour paths.

Some parts of the floodplain have experienced a decrease in flooding due to the construction of Keepit Dam, while others have been subject to a potential increase in frequency due to channelisation and land use (for example, Bundella Creek).

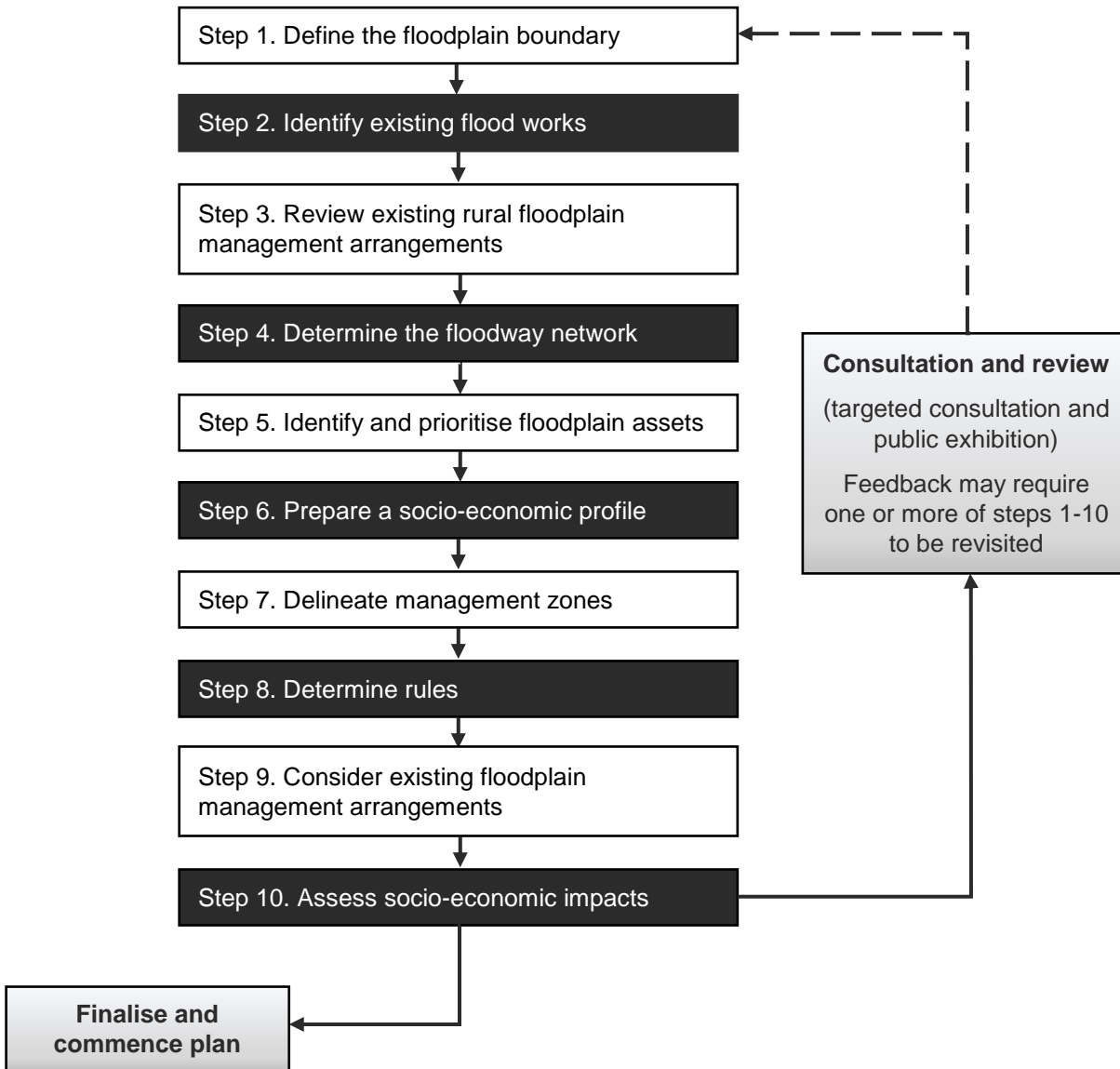
Changes to the duration of flooding include a reduction or increase in flooding duration in some flood events due to changes to the nature of flooding. Public infrastructure, including roads and railway lines, influences the direction and extent of floodwaters.

## Developing the plan

The Upper Namoi Valley FMP was primarily developed by the NSW Department of Industry—Lands & Water (the department) with technical support provided by the NSW Office of Environment and Heritage (OEH). The two agencies employed a 10-step process, as outlined in the technical manual and Figure 4 below, that involves collecting best-available data and analysis of current floodplain management arrangements to inform hydraulic, ecological, cultural and socio-economic assessments. During the steps involving the collection of data and undertaking of technical assessments, the Upper Namoi Technical Advisory Group (TAG) and Aboriginal Technical Working Group (ATWG) were engaged in consensus-based decision-making. The outputs from the assessments ensure that the steps used to determine the floodplain boundary, management zones, rules and assessment criteria are supported by good science.

Consultation on the Draft Upper Namoi Valley FMP occurred in two stages: targeted consultation and public exhibition. The consultation stages align with the department's internal policy originally developed for the making and review of water sharing plans under the WM Act 2000. During targeted consultation and public exhibition, community feedback is invited on the boundary, management zones, rules and assessment criteria in the FMP. Targeted consultation was undertaken with stakeholders, including members of the Aboriginal Community, at Narrabri and Gunnedah between February and May 2015. During the targeted consultation period, individual meetings with landholder representatives unable to attend the organised sessions also occurred. Outcomes from the targeted consultation are provided in this document in 'Consultation and review of the plan'. The Upper Namoi Valley FMP was released for public exhibition over 40 days from 19 September until 28 October 2016.

The department is also responsible for the formal review of the Upper Namoi Valley FMP prior to targeted consultation, public exhibition and finalisation and commencement of the plan. The reviews are primarily focused on engaging the Interagency Regional Panel (IRP) to seek recommendations and ultimately whole-of-government endorsements. The IRP reviews submissions made during public exhibition and is responsible for endorsement of the final boundary, management zones, rules and assessment criteria. Further details on the IRP review process are outlined in 'Consultation and review of the plan'.



**Figure 4. Ten steps to prepare rural floodplain management plans under the *Water Management Act 2000***

Appendix 1 contains a detailed table of the ten steps including the input/process and output/outcome related to each step.

## Step 1: Define the floodplain boundary

Floodplains are essentially areas of land subject to inundation by flooding. The Upper Namoi Valley Floodplain boundary covers 588,600 ha.

To define the Upper Namoi Valley Floodplain boundary, the existing Upper Namoi Floodplain designated on 18 October 1984 under the *Water Act 1912* (21,300 ha from Narrabri to Boggabri) and the Liverpool Plains Floodplain designated on 16 December 1994 under the *Water Act 1912* (538,900 ha that captures land with less than or equal to 2% slope upstream of Boggabri) were combined and then minor changes were made based on:

- boundaries of the Lower Namoi Valley Floodplain
- hydraulic effects from development and flooding history
- ADS40 DEM for more accurate slope calculations
- cadastral and administrative relevance (i.e. properties and roads)
- landscape features
- flood imagery
- urban boundaries
- floodplain harvesting register of interests
- the seven current gazetted rural FMPs within the Liverpool Plains.

Overall, 9,300 ha of the existing floodplains designated under Part 8 of the *Water Act 1912* were removed from the Upper Namoi Valley Floodplain boundary and in other areas 37,700 ha were added (Figure 5).

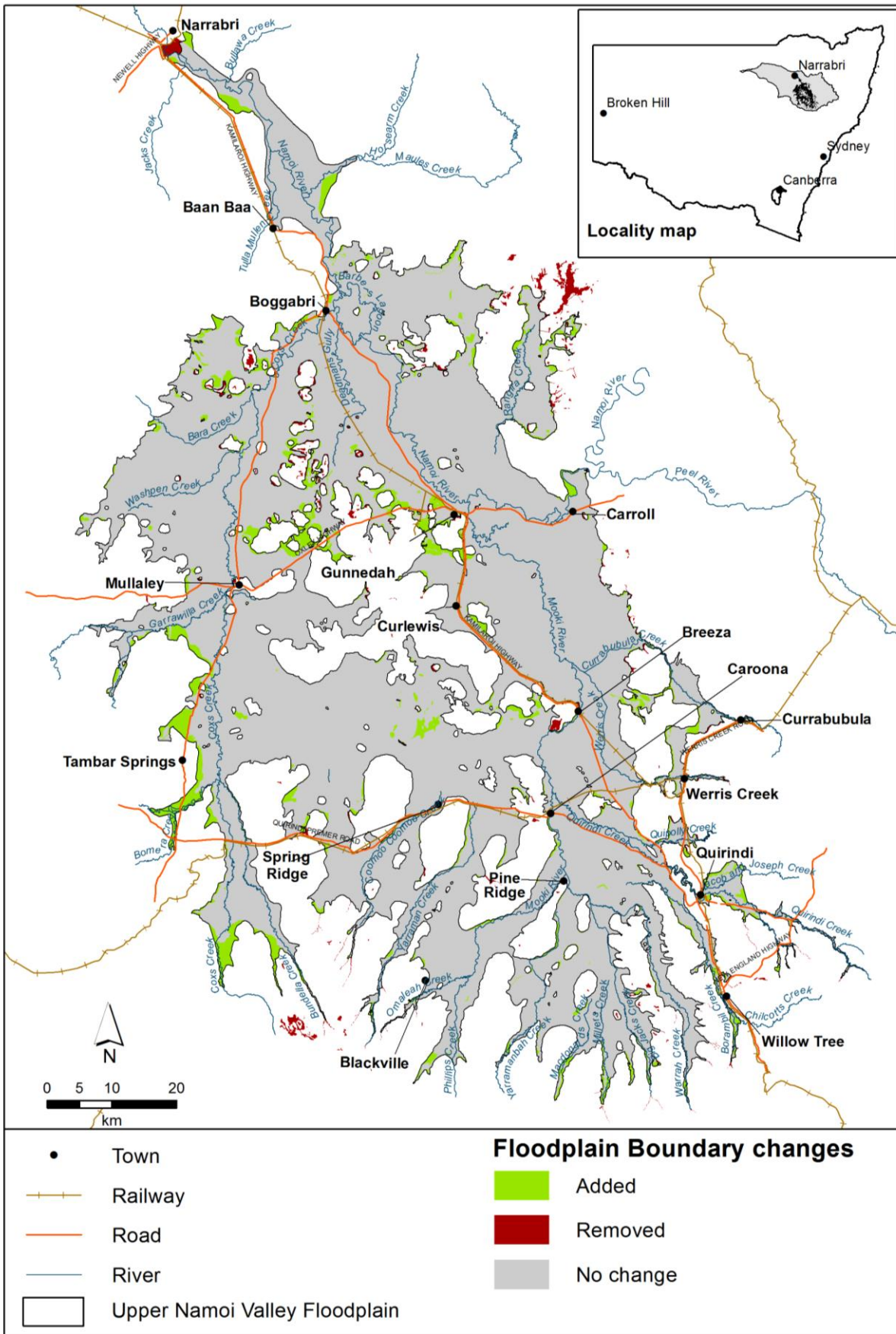


Figure 5. Changes made to the floodplain designated under Part 8 when delineating the Upper Namoi Valley Floodplain boundary

The majority of change to the Upper Namoi Valley Floodplain boundary in the Liverpool Plains area was from the better application of the 2% slope rule using more accurate digital elevation data. In some areas, the boundary was expanded to include river channels that were missed in the original designated floodplain as the height of the banks altered the slope and as such appeared greater than 2% slope (Figure 6). The river channels were added as they are a source of flood water and traditionally part of floodplains. In other areas, artefacts in the floodplain boundary that were higher areas but overlapped areas within 2% or less of the floodplain gradient were eliminated. These areas include Coolah Tops National Park, which comprises mountaintops.

In urban areas such as Gunnedah, the boundary was expanded in consultation with local governments to include the area where council manages flood risk. The boundary was also expanded in some areas after consideration of detailed wetland and stream data, as well as flood imagery.

Expressions of interest for the licensing of floodplain harvesting structures received as part of the NSW Healthy Floodplains Project (floodplain harvesting) were also considered when delineating the boundary. However, no changes were required.



## Step 2: Identify existing flood works

As of February 2018, approximately 57,700 ha (10%) of floodplain area are bordered by flood works in the Upper Namoi Valley Floodplain. Individual works are not shown in the footprint areas, but include (Figure 7):

- below-ground and above-ground supply channels
- infrastructure protection works
- levees
- private access roads
- storages
- stock refuge works
- other earthworks and embankments.

Limited-height works are also included in the existing work footprint areas. Instream works are not identified as flood works but are generally identified as controlled activities under the WM Act 2000. Supply channels and storages may be identified as water supply works and flood works.

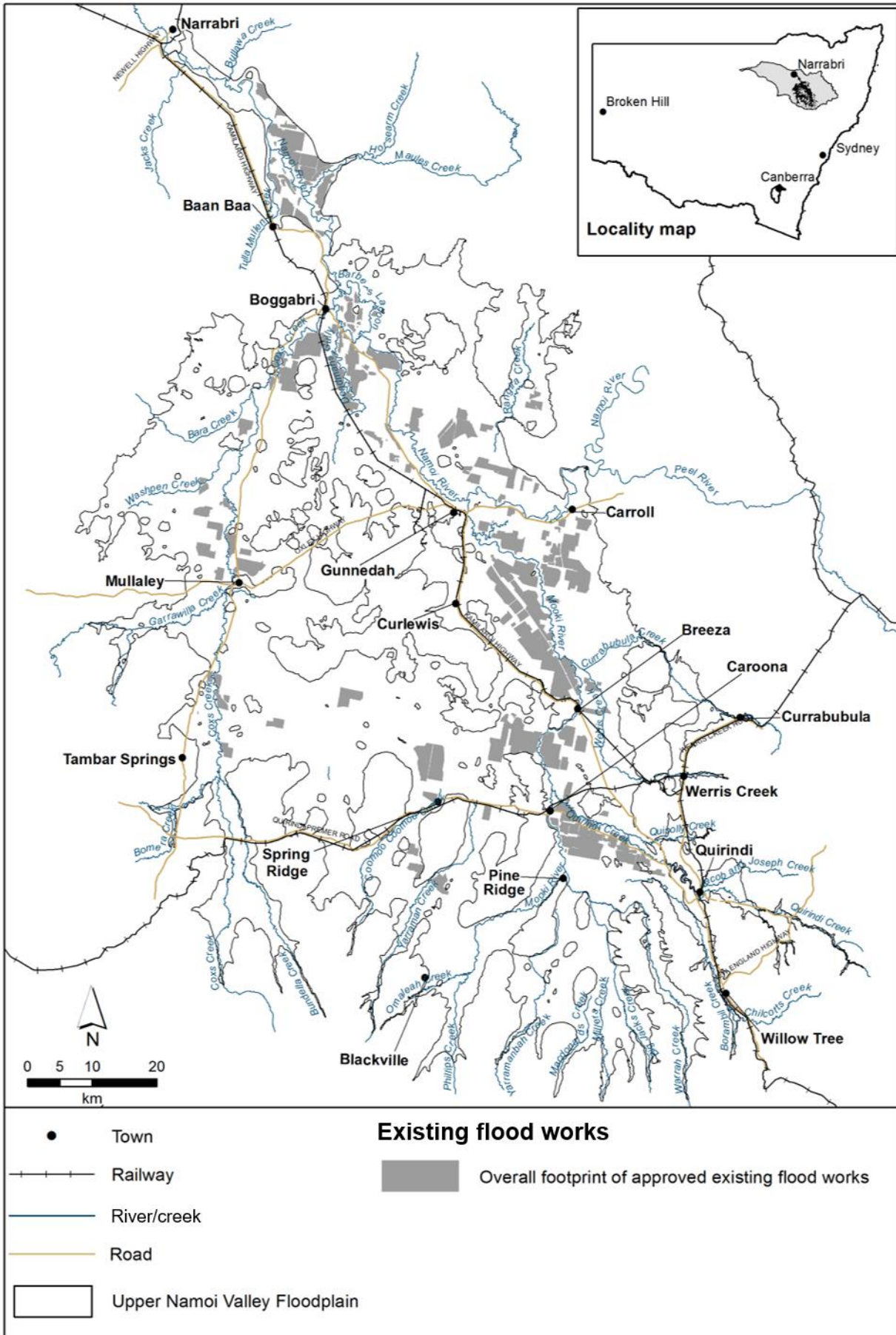


Figure 7. Overall footprint of approved existing flood works in the Upper Namoi Valley Floodplain



# Step 3: Review existing rural floodplain management arrangements

Existing rural floodplain management arrangements in the Upper Namoi Valley Floodplain include six first-generation rural floodplain development guidelines/studies that are non-statutory, and seven second-generation statutory rural FMPs made under Part 8 of the *Water Act 1912*.

Of the Upper Namoi Valley Floodplain, approximately (Figure 8):

- 47% (274,200 ha) is covered by existing second-generation rural FMPs—hereafter referred to as managed areas (FMPs)
- 24% (141,100 ha) has been the subject of a floodplain management study or guideline—hereafter referred to as managed areas (guidelines)
- 30% (173,400 ha) has not been the subject of any study—hereafter referred to as other areas

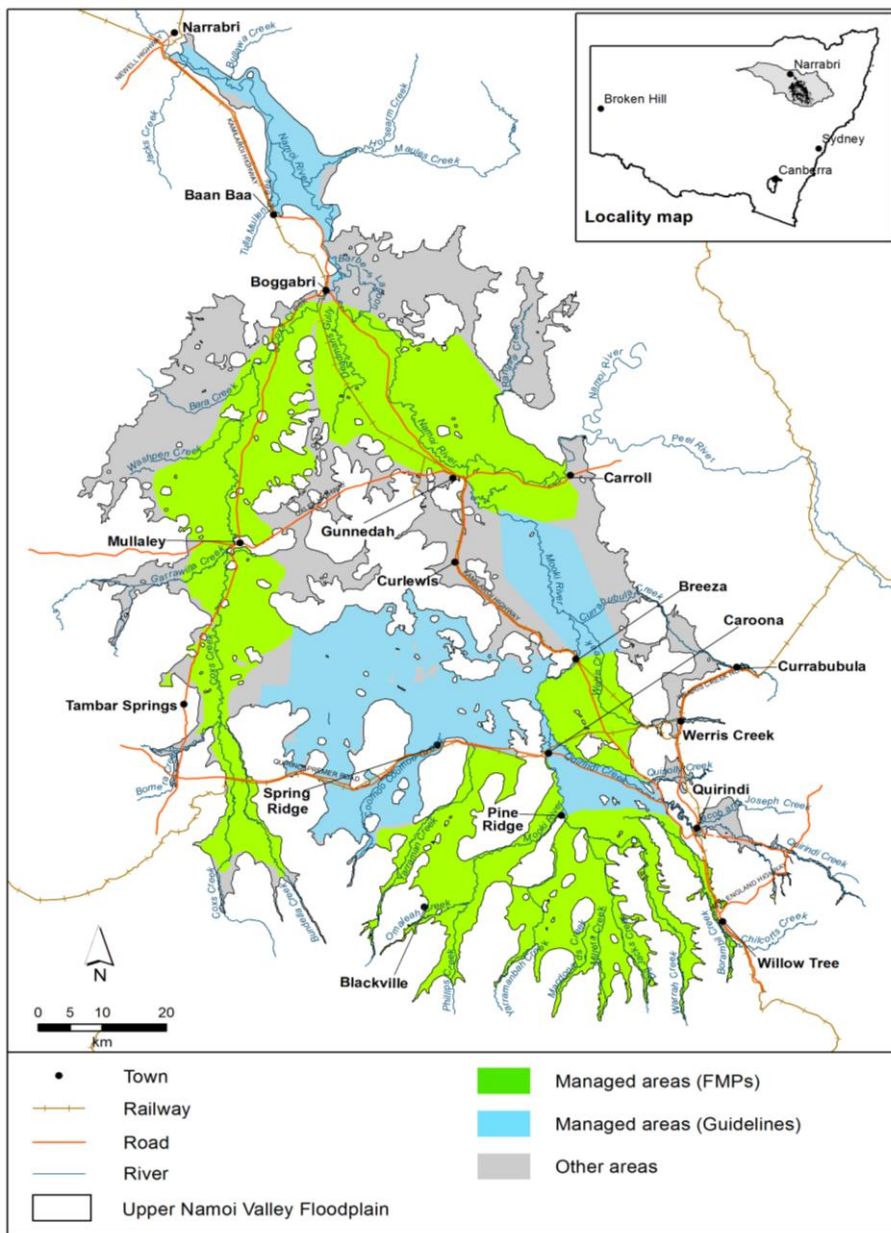


Figure 8. History of floodplain management in the Upper Namoi Valley Floodplain

The Upper Namoi Valley FMP supersedes all previous plans and guidelines in the Upper Namoi Valley Floodplain. A detailed history of floodplain management in the floodplain is outlined in Appendix 2. Existing rural floodplain management arrangements were reviewed to determine (see Appendix 3 for outcomes):

- flood management principles
- ecological and cultural heritage considerations
- floodway networks
- hydraulic models
- design flood events
- types of works considered for approval
- advertising requirements for applications
- assessment process for flood work applications, including any assessment criteria used.

## Rural floodplain development guidelines and floodplain management studies

Non-statutory floodplain management studies (also referred to as guidelines) that have been prepared in the Upper Namoi Valley Floodplain include:

- Borambil–Gunnadilly Floodplain Management Study (Department of Land and Water Conservation [DLWC] 1995a)
- Coomoo Coomoo and Yarraman Creeks Floodplain Management Study (Department of Water Resources (DWR) 1994)
- Breeza to Ruvigne study area comprised of the following flood studies:
  - Battery Hill (Barrett Purcell and Associates 1997)
  - Carroll Group (Barrett Purcell and Associates 1998)
  - Long Point properties (Barrett Purcell and Associates 1995)
  - Top River (Webb 2007)
  - Breeza Floodplain flooding review (Hugh Barrett and Associates 2001)
- Narrabri Floodplain Management Study (Bewsher Consulting 1996 and 1999)
- Red Bobs (DLWC 1995b; DLWC 1995c)—both studied the utility of proposed flood works
- Lake Goran hydrological study of the impact of land-use change on water levels (Bewsher Consulting 1995).

## Water Act 1912 rural FMPs

Previous second-generation rural FMPs were made under Part 8 of the *Water Act 1912*, which has since been repealed. These plans were transitioned over as minister's plans under the WM Act 2000. Previous second-generation rural FMPs include (Figure 9):

- *Blackville Floodplain Management Plan* (DIPNR 2003)
- *Caroona–Breeza Floodplain Management Plan* (DNR 2006a)
- *Carroll–Boggabri Floodplain Management Plan* (DNR 2006b)
- *Lower Coxs Creek Floodplain Management Plan* (OEH and NOW 2013)
- *Upper Coxs Creek Floodplain Management Plan* (DNR 2005)
- *Upper Yarraman Creek Floodplain Management Plan* (DNR 2006c)
- *Warrah Creek Floodplain Management Plan* (OEH and NOW 2012).

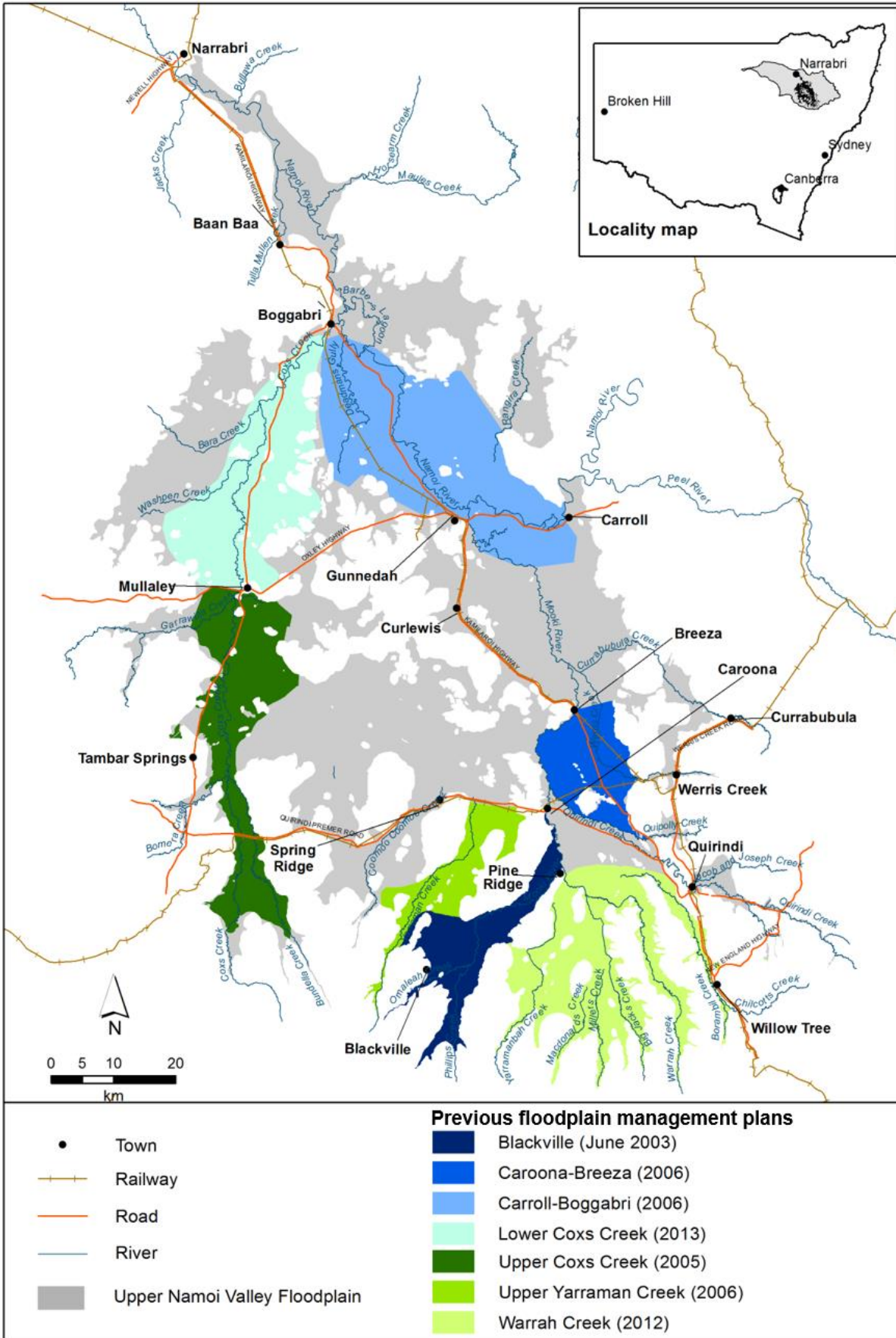


Figure 9. Previous rural floodplain management plans made under Part 8 of the *Water Act 1912*.

## Step 4: Determine the floodway network

In step 4, hydraulic criteria were determined to map the floodway network and design floods of different magnitudes were selected to be used during the technical assessment of flood work applications against assessment criteria outlined in the FMP.

As part of this step, two-dimensional modelling was undertaken across 92,600 ha (16%) of the floodplain where high resolution digital elevation modelling (DEM) was available. More extensive two-dimensional modelling was not undertaken because the majority of the floodplain is covered by existing FMPs or studies where there is good general acceptance of identified flow paths. In these areas, existing flow paths were finessed using better available data and by consistently applying the hydraulic criteria determined in this step. Hydraulic criteria based on slope were also developed to determine the extent of the core floodplain, which is a good indication of inundation extent.

The outcome of step 4 is the Upper Namoi floodway network (Figure 10 and Figure 11). This is comprised of three hydraulic categories:

- Defined floodways (37,000 ha or 6% of the floodplain), which are major discharge areas with defined channels or riverbanks. A significant discharge of floodwater occurs during design floods and these areas are important for the continuity of flood flows over the floodplain.
- Ill-defined floodways (39,700 ha or 7% of the floodplain), which are major discharge areas that are overland flow paths with no defined channels or riverbanks. A significant discharge of floodwater occurs during design floods and these areas are important for the continuity of flood flows over the floodplain.
- Inundation extent (255,400 ha or 43% of the floodplain), which includes areas of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood and for secondary flood discharge. Flood works that are limited height are included in the inundation extent, whereas those that are not overtopped by flooding are excluded.

The floodway network was the hydraulic basis for determining the management zones, rules and assessment criteria of the Upper Namoi Valley FMP. Further information on design floods and hydraulic criteria is provided below.

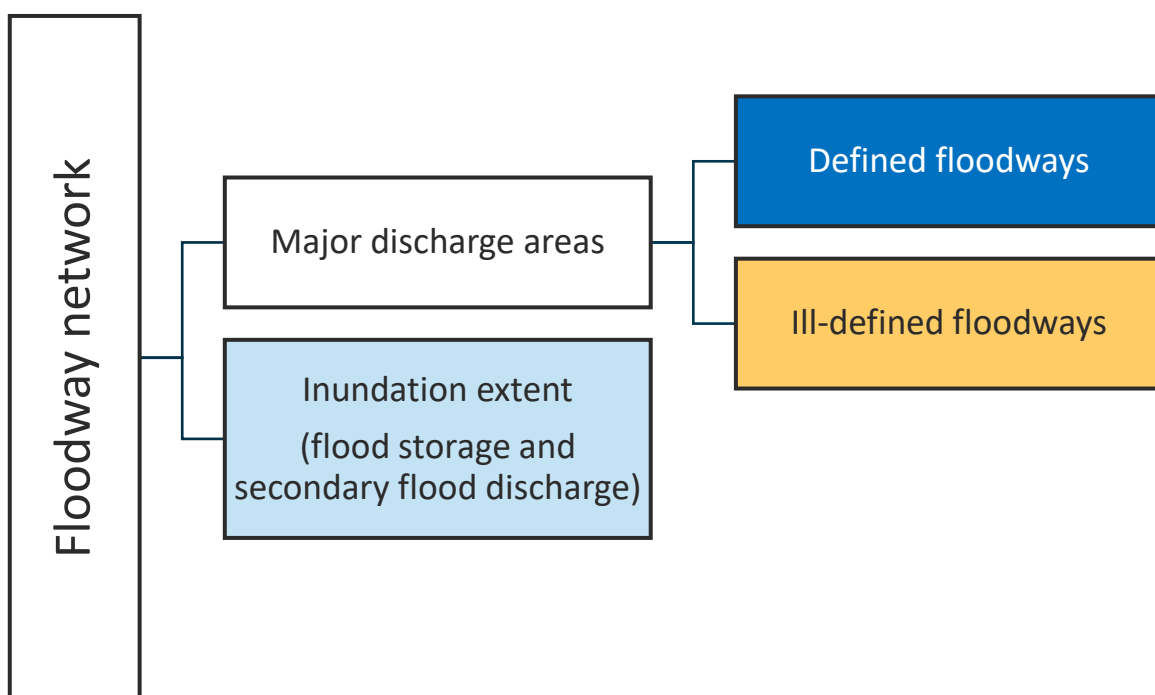


Figure 10. Finger diagram of hydraulic categories comprising the Upper Namoi floodway network

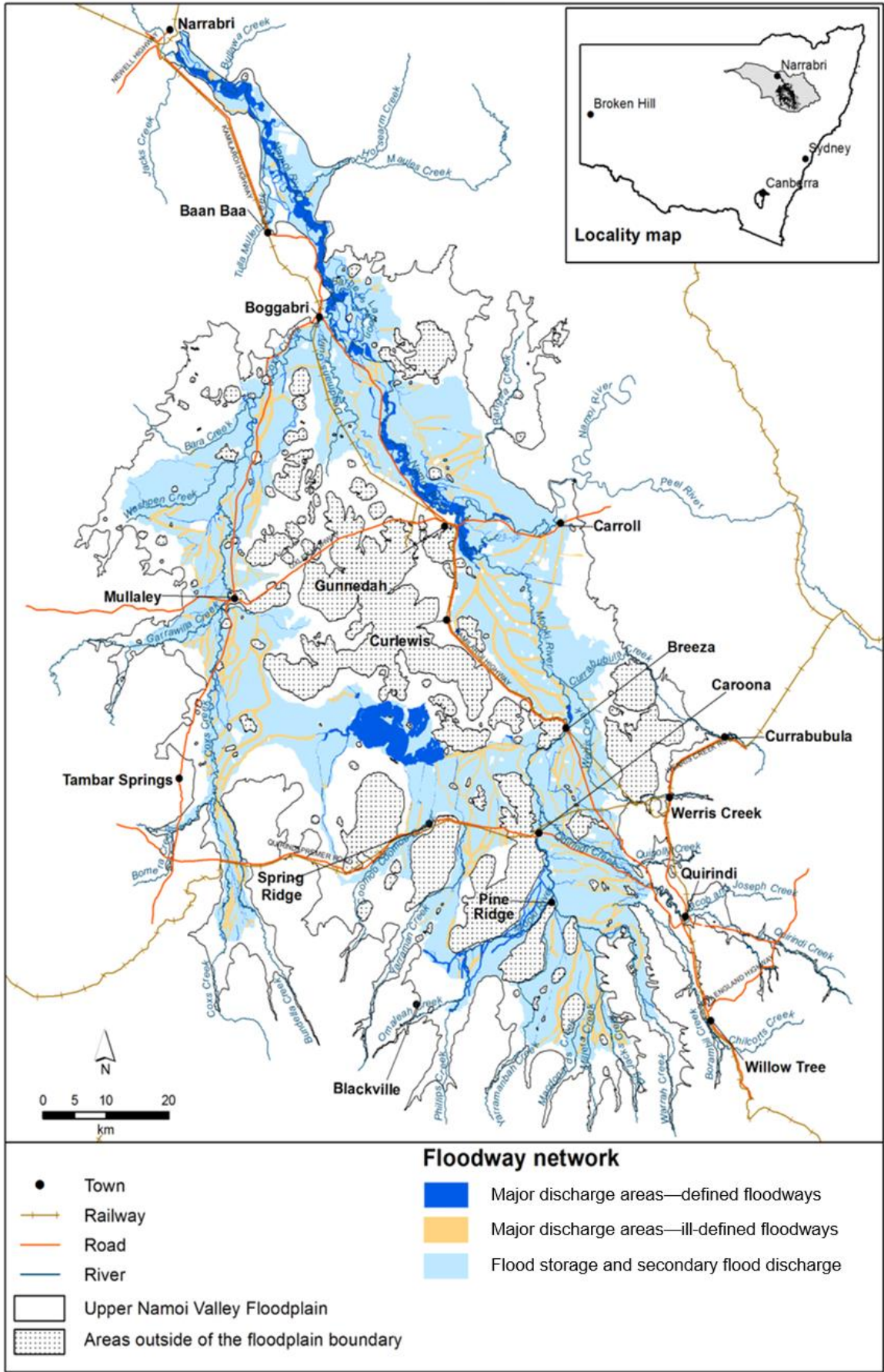


Figure 11. Map of the Upper Namoi Floodway network

## Design floods

Four large design floods, which approximate a 1 in 20 or a 5% AEP flood event, were selected across the floodplain (Figure 12):

- 1998 (at the Caroona and Tambar Springs gauging stations)
- 1971 (at the Boggabri gauging station)
- 1984 (at the Boggabri and Breeza gauging stations, a 1 in 50 or 2% AEP at the Quirindi gauging station)
- a probabilistic 1 in 20 or 5% AEP.

Two small design floods that approximated a 1 in 5 or a 20% AEP flood event were also selected (Figure 12):

- 1992
- probabilistic 1 in 5 or 20% AEP.

The design floods are used when applying the assessment criteria of the Upper Namoi Valley FMP during the technical assessment of flood work applications (see step 8). The technical manual outlines that design floods can be used to determine the extent of the floodway network. This was not done in the Upper Namoi Valley Floodplain because:

- there is already good general acceptance of identified flow paths in areas covered by an existing FMP or study (70% of the floodplain)
- two-dimensional modelling was only undertaken in 16% of the floodplain
- slope was considered a good proxy for flood inundation.

Where possible, the large design floods were also used to refine existing major discharge areas and inundation extents by using flood imagery taken during the design event or during an event of similar magnitude. The small design floods were selected to ensure that critical flow paths to floodplain assets are considered during the technical assessment of flood work applications. See Appendix 4 for more details on how the design floods were selected, including the results for the flood frequency analysis used to determine the frequency of flood events in the floodplain.

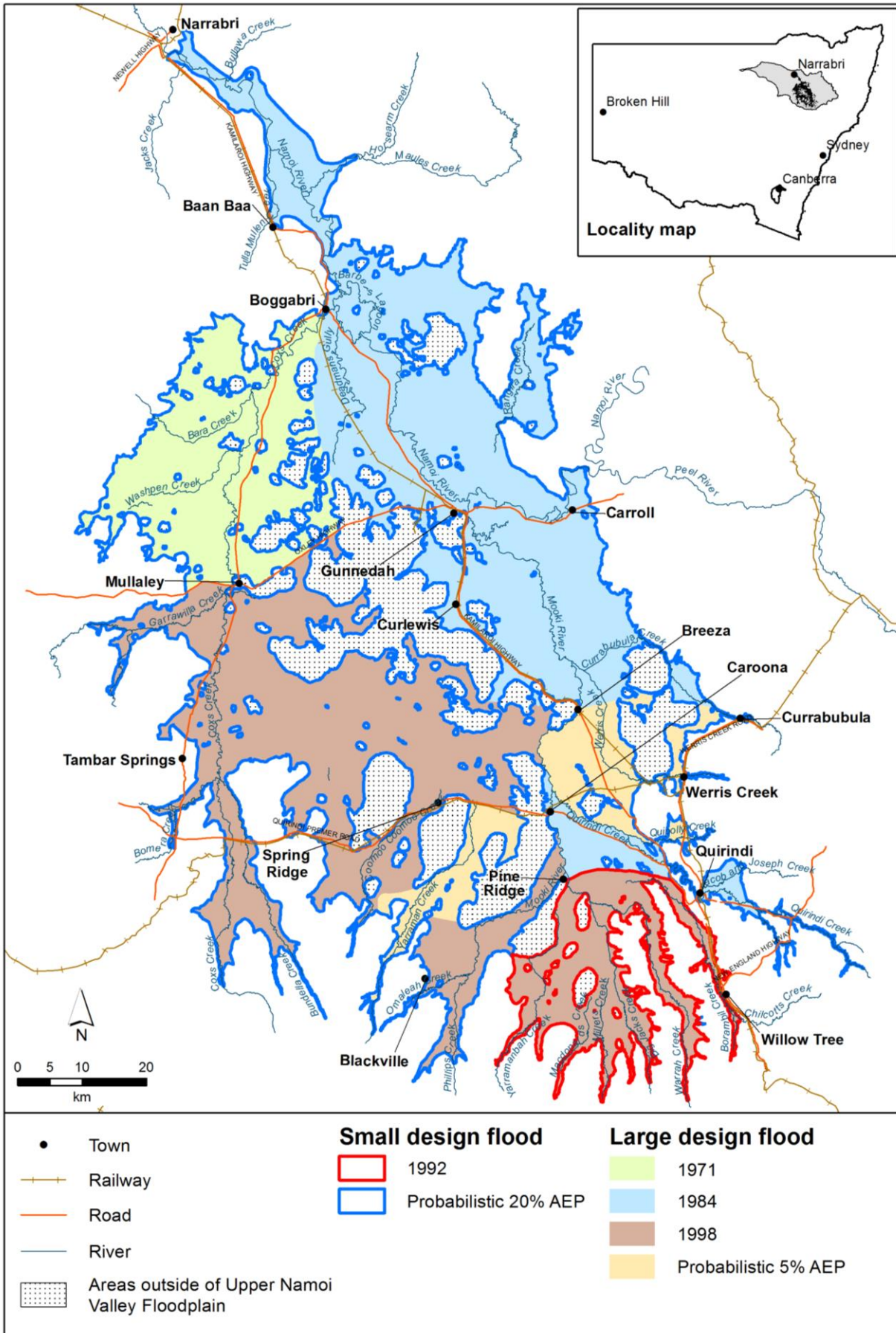


Figure 12. Map of small and large design floods

# Modelling

## Hydrologic models

Hydrologic models simulate rainfall run-off on a catchment by converting storm rainfall to flow hydrographs. This is done using a procedure known as run-off routing, which subtracts losses, such as from soil infiltration, from the total rainfall. The rainfall excess is then routed through the catchment storage to produce discharge hydrographs at specified locations (Laurenson et al. 2010). Additional hydrological modelling was not undertaken because it had been undertaken as part of previous studies.

## Hydraulic models

Due to the complexity of the Upper Namoi Valley Floodplain and the availability of existing models, a single hydraulic model to cover the entire floodplain was not built. Instead, the results from a total of 11 models were referenced when determining the floodway network.

For the purposes of this plan, six existing rectified MIKE11 models were updated for Blackville, Breeza to Ruvigne, Carroll to Boggabri, Lower Coxs Creek, Upper Coxs Creek and Warrah Creek areas. A rectified RMA-2 model for Caroon to Breeza was converted to a MIKE 21 flood model and a semi-rectified RUBICON model for Upper Yarraman was converted to a MIKE 11 model. A new MIKE11 model and RORB hydrology model was also developed to match the existing flow distribution of the Borambil to Gunnadilly Flood Study. In addition, two new two-dimensional models were created, which are described in more detail below.

### Two-dimensional models built for the plan

The hydraulic model built for the area between Pine Ridge, Spring Ridge, Lake Goran and Breeza is known as the Yarraman model, while the hydraulic model built for the area between Boggabri, Baan Baa and Narrabri is known as the Boggabri to Narrabri model. The Yarraman model covers 84,400 ha, of which 68,600 ha are within the floodplain boundary. The Boggabri to Narrabri model covers 34,900 ha, of which 24,000 ha are within the floodplain boundary (Figure 13 and Figure 14).

These models are made of two-dimensional grids which simulate water flowing over floodplains and were run to produce a depth velocity product map from the large design flood. The depth velocity map was used to help determine the location and width of floodways. The location of flow paths in the models were determined using digital elevation models, flood aerial photography, satellite imagery, watercourse layers, flood marks and local knowledge.

The overall footprint of constructed works was identified in step 2. For the purposes of hydraulic modelling, these floodplain areas enclosed by existing flood works that are not limited-height works were assumed to not be overtopped by floodwater and were excluded from the models' computational grid. Areas protected by limited-height works (as indicated by licence files) were assumed to be overtopped by floodwater and were represented in the models as indicated by their licence files.



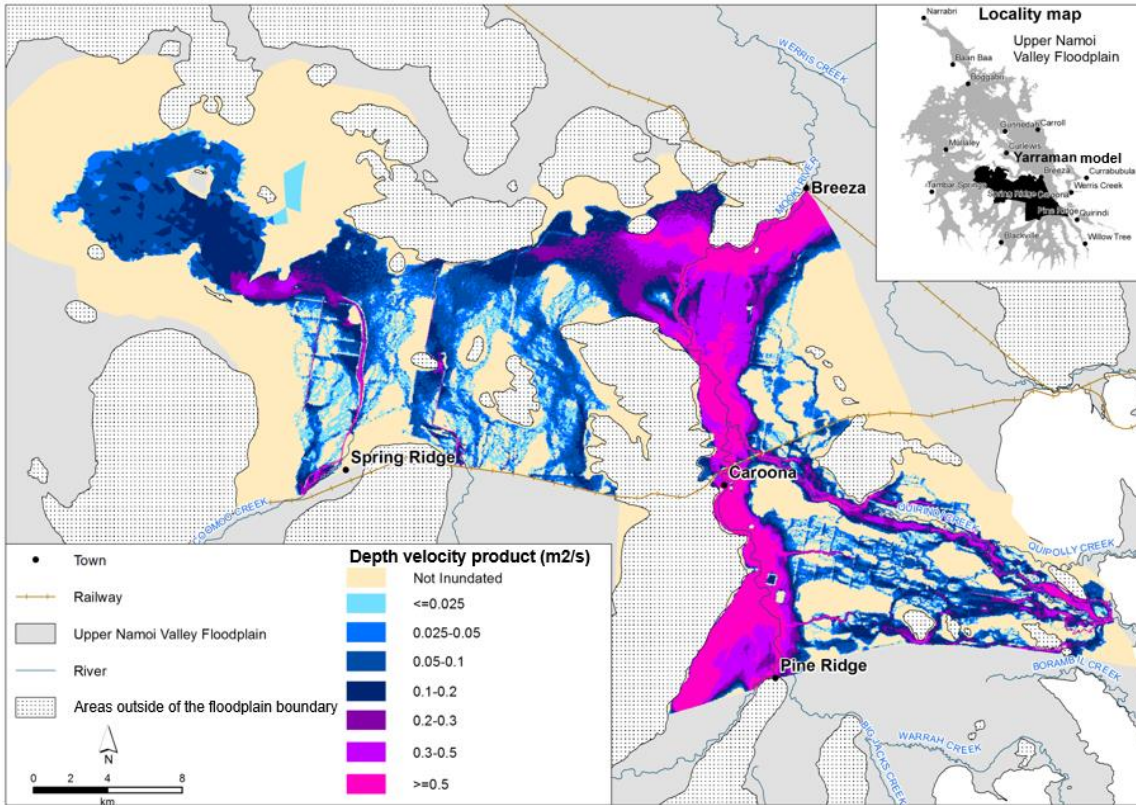


Figure 13. Depth velocity product map for the Yarraman model

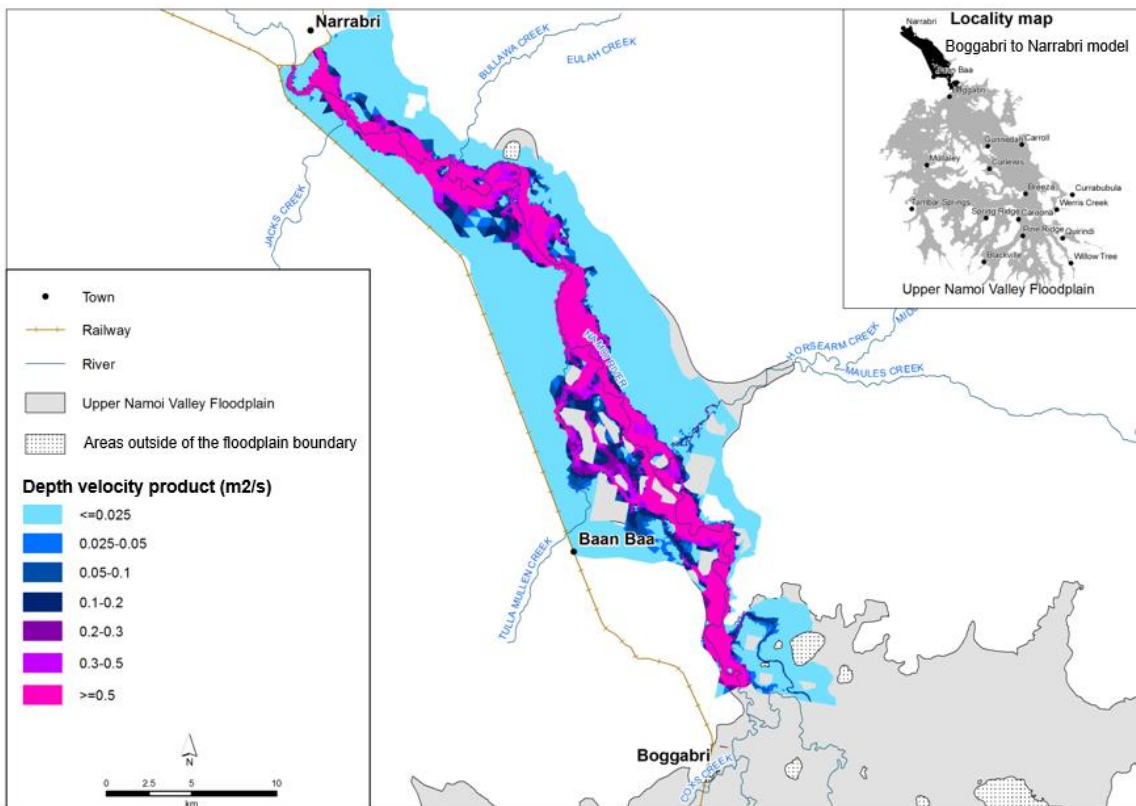


Figure 14. Depth velocity product map for the Boggabri to Narrabri model

# Hydraulic criteria for the floodway network

## Floodways

Hydraulic criteria were determined for defined floodways and ill-defined floodways through consideration of existing floodplain management arrangements and in discussion with the TAG.

The TAG recommended that the basis for delineating floodways should be existing plans and studies because they are generally well accepted within the community. Other data sources that provide better information, such as more recent flood aerial photography, satellite imagery, LiDAR, digital elevation models (DEMs) and updated hydraulic modelling results, were recommended to be used to refine existing floodways and to fill in data gaps.

The location and size of floodways in the floodway network is strongly reflected in the design of the management zones. Therefore, the socio-economic impacts of hydraulic criteria selected were also a consideration. This is discussed further in step 10: phase 1.

## Ill-defined floodways

Flooding in the Upper Namoi Valley Floodplain does not always follow a defined route. Many existing FMPs have floodways represented by dotted lines on maps, which indicates that major discharge occurs in the area but the precise location of the floodway is unknown and/or relatively flexible. The department and OEH agreed that floodways where there was not an easily identifiable bank or channel would be classed as ill-defined floodways in the new plan. When considered in the context of the rules (which require that a proportion of the ill-defined floodway be subject to the same rules as a defined floodway), the use of ill-defined floodways in the plan reflects the flexibility of floodways in existing FMPs.

Advice was requested on the best method for determining the width of ill-defined floodways. The advice received culminated in ill-defined floodways being given a minimum width of 100 m and a maximum width of 500 m. The final width is determined by referencing flood imagery and topographical data and represents confidence as well as likely conveyance of flood water. This approach was determined after consideration of the rules which would require a 20 m flood-flow corridor be identified within an ill-defined floodway. The minimum and maximum widths of the ill-defined floodways were considered a reasonable extent for a 20 m flood-flow corridor to be identified within and in most cases would allow for the conveyance of major discharge of flood water during a flood.

## Defined floodways

Floodways with banks or channels became defined floodways and included the main drainage lines and named rivers. The drainage lines and rivers were initially identified using the spatial layer *Stream Order* (Revised in 2011; ANZNS0359100076). Stream ordering is a process whereby streams are described according to a hierarchy of orders of magnitude within a catchment so that a drainage network can be subdivided into individual lengths. Stream ordering begins with first-order streams at the top of the catchment. Where two first-order streams join they produce a second-order stream and where two second-order streams join they produce a third-order stream and so on down the catchment.

The TAG recommended that stream orders greater than or equal to three be defined floodways because they promote flood connectivity, whereas stream orders that are less than three (headwaters) were not suitable to be defined floodways because they are:

- usually ephemeral and not essential for flood continuity, or
- on the steeper sections of the floodplain (greater than 0.5% slope) and are a complicated network of channels where flooding is typically confined, or
- on the flatter sections of the floodplain (less than 0.5% slope) and do not provide connectivity across the floodplain.

Stream orders greater than or equal to three were then checked against defined flow paths identified from other sources such as flood imagery, hydraulic modelling, existing FMPs and guidelines and ADS40 aerial

imagery. Any discrepancies between floodways in existing FMPs and guidelines and stream orders were examined carefully using all available information before changes were made to existing floodways. This was due to the generally good acceptance of existing floodways in the community and the philosophy that these floodways should not be significantly changed. In some instances, stream orders less than three were made to be defined floodways if additional information showed them to be essential for flood connectivity.

Defined floodways are a minimum width of 20 m. That is, they are the width of the channel plus a riparian buffer distance of 10 m. This minimum width approach was selected because it:

- can be applied consistently across the floodplain without spatial biasing of data rich areas
- is simple to apply and understand by relevant stakeholders, including the community
- was generally consistent with second-generation FMPs
- allows for adequate drainage and spatial continuity of flows to occur.

In addition, the extent of the 1998 flood was considered when determining the width and location of defined floodways along the Namoi River and parts of the Mooki River. This resulted in a wider floodway than simply the channel and a 10 m buffer. These floodway amendments were reviewed against the 1998 flood and adopted because the extent of the floodway in these areas was originally too narrow to convey floodwater effectively downstream.

### **Floodways on the higher slopes**

The TAG recommended that floodways in the floodway network not be mapped in areas of the floodplain with a slope that is greater than or equal to 0.5% because these areas are not generally considered part of the core floodplain (see 'Inundation extent' below for more information on slope). Floodways were also not mapped in these steeper areas because works proposed to be built in these instream areas would be adequately assessed by controlled-activity provisions (Division 6, WM Act 2000). Furthermore, rules for floodways would likely affect the ability to construct soil conservation works, which are essential for controlling erosion in the steeper sections of the Liverpool Plains.

### **Inundation extent**

Areas within the inundation extent of the (large) design floods are considered important for providing temporary pondage during large floods. Areas beyond the inundation extent may also be flood-prone but would only become inundated during larger floods, including extreme events, and would generally have low conveyance or pondage capacity.

The TAG recommended that the steepness of the floodplain (or % slope) could be used to determine the core floodplain area, which would provide a good indication of the inundation extent of the floodplain. There is already a precedent in the Liverpool Plains region to use slope to define the floodplain area. This was part of the approach adopted to refine the Upper Namoi Valley Floodplain boundary (see step 1).

The inundation extent of the floodway network was mapped as those areas where slope was found to be less than or equal to 0.5% (Figure 15). This area was also refined using topographical aerial data and satellite flood imagery. The threshold of 0.5% was selected because it is generally accepted that areas with a slope that is less than or equal to 0.5% have a landform and geomorphological structure susceptible to widespread inundation by shallow overland flow and out-of-channel flooding during periods of heavy rainfall (Burton et al. 1994). Furthermore, the 0.5% slope threshold approximates the extent of the floodplain as defined by diverging flows, which are those that break out of the riverine system, as well as the extent of the land classified as plains, outwash and water in the Liverpool Plains and Goran Basin Plains Physical Regions (Figure 16; OEH 2012).

Areas of the floodplain that are protected by existing flood works that are limited height and overtopped during moderate to large floods were included in the inundation extent. Those areas of the floodplain that are protected by existing flood works and are not overtopped during moderate to large floods were excluded from the inundation extent (step 2).

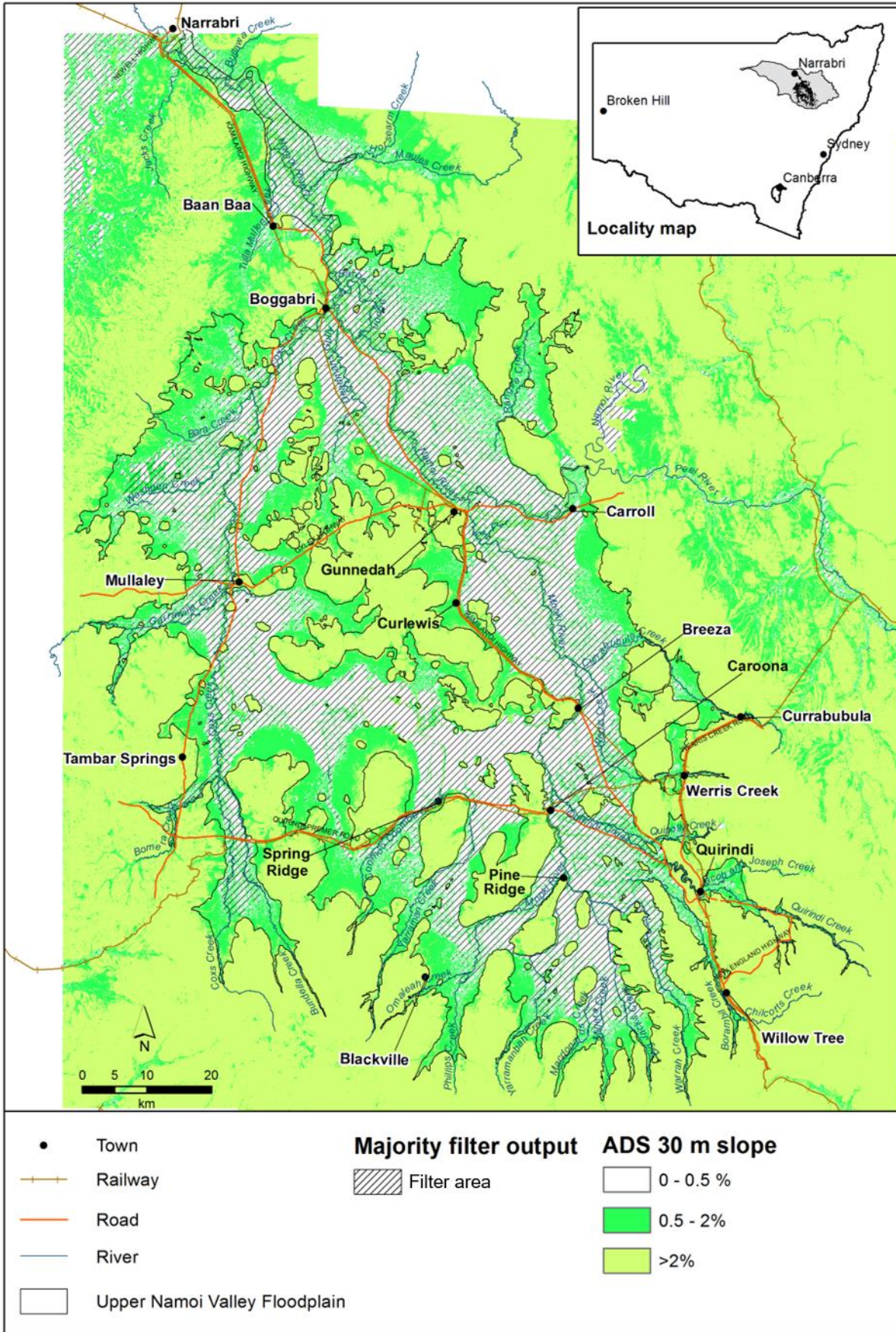


Figure 15. Floodplain slope generated using ADS40 DEM

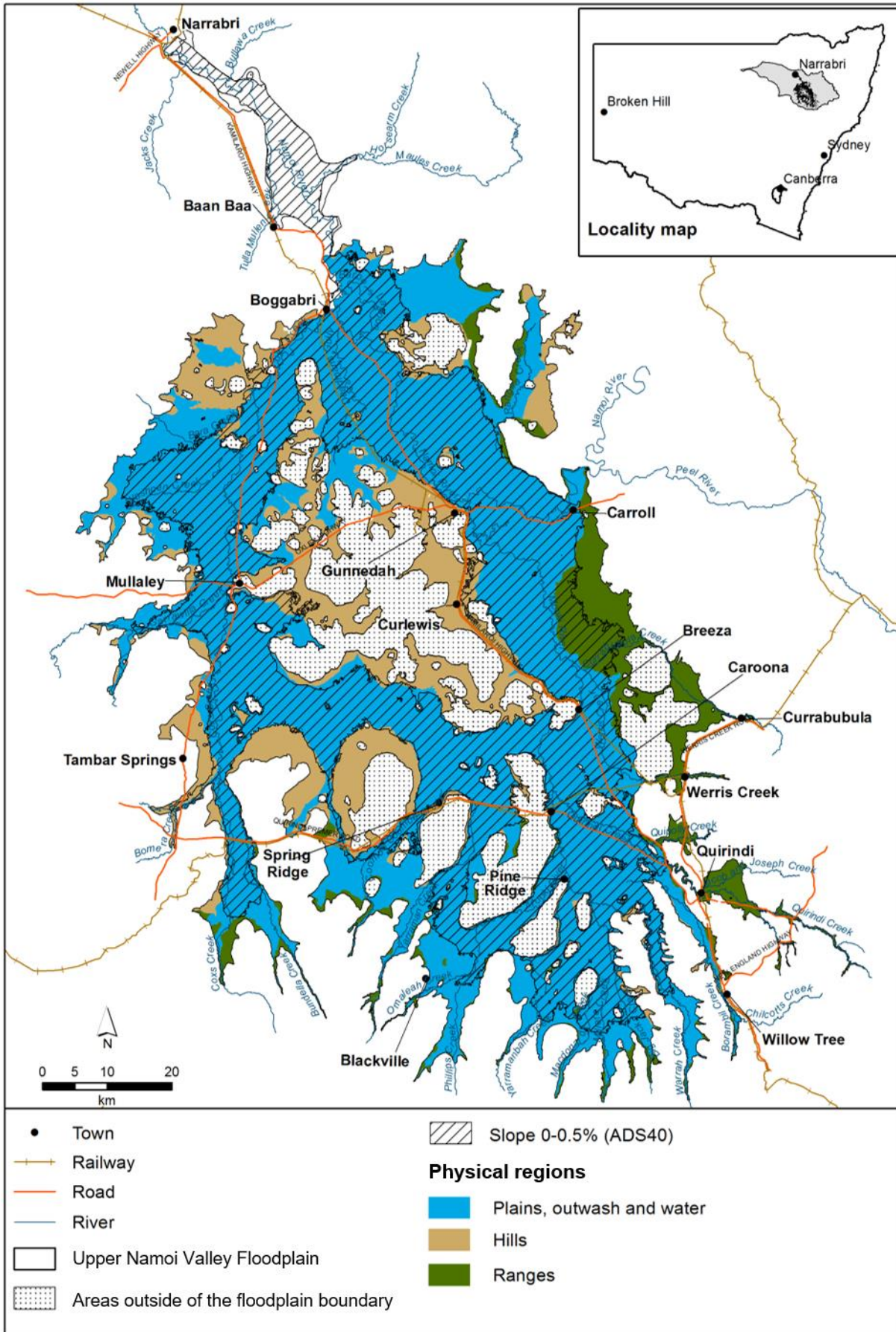


Figure 16. Comparison of physical regions (OEH 2012) and 0.5% slope

## Percent slope generation

Slope was generated using ADS40 DEM, which is a product from Land and Property Information's aerial photography program (Land and Property Information 2013). The ADS40 sensor used to capture the aerial photography captured elevation points at approximately one point per 20 cm pixel. These points were created in the form of a raw point cloud, similar to a LiDAR data capture. The point cloud was filtered for ground returns and processed into a 30-metre-resolution DEM.

Higher-resolution grids were available (one or five metre); however, these higher-resolution grids show a lot of local variation (noise) in elevation, which masks the overall floodplain slope. Figure 17 shows % of slope and elevation for ADS sampled at one, five and 30 m. The figure shows how the ADS 30 m slope line best represents the elevation data while eliminating a large proportion of the noise.

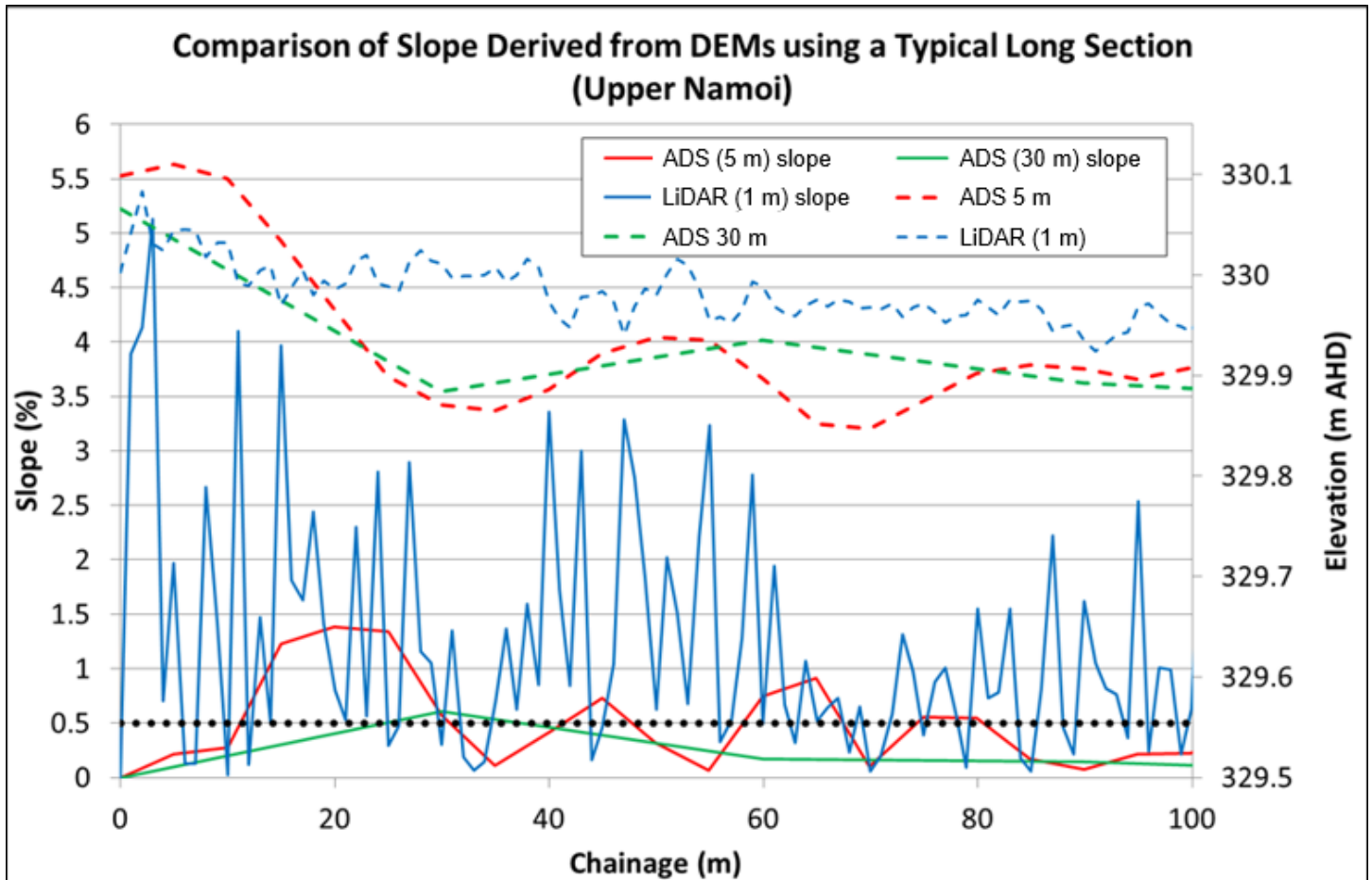


Figure 17. Resulting slope data across the floodplain as a slope percentage

To determine the 0.5% slope boundary, the 30 m slope layer was classified into integer categories for simplicity of analysis (that is, 1 = 0–0.5%, 2 = 0.5–2% and 3 = >2% slope). Across the floodplain there was significant blur between the core areas of the 1 and 2 categories (i.e. the demarcation of the flood extent and the outer part of the floodplain). To improve the clarity of the boundary, the majority filter geoprocessing tool was used where each pixel is assigned the value of the majority of its surrounding pixels. This process was used to consolidate areas into distinct slope categories with a clearly defined boundary (Figure 15). The boundary was then manually smoothed to produce a neat delineation of the inundation extent.

## Summary of hydraulic criteria for the floodway network

Hydraulic criteria were determined for mapping the floodway network and are summarised in Table 1. The methods for determining the criteria are outlined in detail below. An overview of the flood imagery available is in Appendix 5.

**Table 1. Summary of criteria used to delineate the hydraulic categories in the floodway network**

Hydraulic category	Criteria
Major discharge areas, defined floodways	<p>Major discharge areas that have channels and/or banks and can be identified from:</p> <ul style="list-style-type: none"> <li>• flood aerial photography</li> <li>• satellite imagery</li> <li>• spatial watercourse layers</li> <li>• topographical mapping</li> <li>• LiDAR</li> <li>• ADS40 DEM</li> <li>• hydraulic modelling</li> <li>• second-generation FMPs</li> <li>• first-generation development guidelines</li> <li>• local knowledge obtained from floodplain communities and/or floodplain/environmental managers.</li> </ul> <p>Defined floodways are identified in areas with less than 0.5% slope. The width of defined floodways is the width of the channel plus a riparian buffer distance of 10 metres. Along the Namoi River and parts of the Mooki River, the extent of the 1998 flood was also considered when determining the width and location of defined floodways.</p>
Major discharge areas, ill-defined floodways	<p>Major discharge areas that do not have channels and/or banks and can be identified from:</p> <ul style="list-style-type: none"> <li>• flood aerial photography</li> <li>• satellite imagery</li> <li>• spatial watercourse layers</li> <li>• topographical mapping</li> <li>• LiDAR</li> <li>• ADS40 DEM</li> <li>• hydraulic modelling</li> <li>• second-generation FMPs</li> <li>• first-generation development guidelines</li> <li>• local knowledge obtained from floodplain communities and/or floodplain/environmental managers.</li> </ul> <p>Ill-defined floodways are identified in areas with less than 0.5% slope. The minimum width of the ill-defined floodways is 100 m, except in areas where the transition to smaller defined floodways requires a narrower width to ensure consistency along the floodways. The maximum width of ill-defined floodways is 500 m. The width is determined by referencing flood imagery and topographical data.</p>
Flood storage and secondary flood discharge areas	<p>Flood storage and secondary flood discharge areas were identified as areas of the floodplain that:</p> <ul style="list-style-type: none"> <li>• have a slope that is less than or equal to 0.5% (based on ADS40 DEM), where slope is a proxy for the inundation extent of large floods</li> <li>• are protected by existing flood works that are limited height and overtopped during moderate to large floods</li> <li>• not already identified as defined floodways or ill-defined floodways.</li> </ul>
Areas outside floodway network (known as flood fringe and flood-protected areas)	<p>Areas outside of the floodway network include the flood fringe areas of the floodplain where:</p> <ul style="list-style-type: none"> <li>• slope is greater than 0.5% (based on ADS40 DEM) up to the Upper Namoi Valley Floodplain boundary</li> <li>• protected by existing flood works that do not have limited-height conditions and are therefore not likely to be overtopped by floodwaters during moderate to large flood events.</li> </ul>

## Step 5: Identify and prioritise floodplain assets

Step 5 was undertaken to identify and prioritise the many unique and diverse floodplain assets found on the Upper Namoi Valley Floodplain to inform the design of the management zones, rules and assessment criteria in later steps.

### Ecological assets

During step 5, ecological assets were:

- identified using best-available spatial data
- grouped using information on their optimum watering requirements
- prioritised to select the assets that best represent biodiversity on the floodplain.

### Identifying ecological assets

The Upper Namoi Valley FMP considered three types of ecological asset including wetlands, other floodplain ecosystems (Figure 18) and areas of groundwater recharge. However, areas of groundwater recharge were not mapped due to data limitations.

Native vegetation mapping was predominantly used to identify wetlands and other floodplain ecosystems. Approximately 22,000 ha (or 4% of the floodplain) was identified as native vegetation that is flood dependent. Several regional vegetation maps sourced from the NSW Vegetation Information System (VIS) and previous wetland studies were utilised to identify semi-permanent (non-woody) wetlands, floodplain (flood-dependent shrubland) wetlands and other floodplain ecosystems, including flood-dependent forest/woodland (wetlands) of the Upper Namoi Valley Floodplain:

- Eco Logical Australia (2008) Vegetation Mapping for the Namoi and Border Rivers–Gwydir Catchment Management Authorities (CMAs). Compilation of API Datasets and Preparation of a Hierarchical Vegetation Classification. Project numbers 125-002 and 129-002. Report prepared for Namoi and Border Rivers–Gwydir CMAs (VIS ID: 3842)
- Eco Logical Australia (2008a) Namoi Wetland Assessment and Prioritisation Project. Project number 125-005. Report prepared for Namoi CMA, PO Box 1927, Armidale NSW.
- Eco Logical Australia (2009) A vegetation map for the Namoi CMA. Project number 125-004. Report prepared for Namoi CMA June 2009 (VIS ID: 3851)
- Eco Logical Australia (2013) Refinement of vegetation mapping in the Namoi Catchment: Extant and pre-European. Prepared for Namoi CMA. May 2013 (VIS ID: 4028)
- Green, D and Dunkerley, G (1992) Wetlands of the Namoi Valley: Progress Report. Department of Water Resources Technical Services Division. A progress report to the Murray–Darling Basin Commission for the Barwon–Darling Wetland Survey, funded under the Natural Resources Management Strategy.
- OEH (2015) and OEH (2017) BRG–Namoi Regional Native Vegetation Mapping. Technical notes, NSW Office of Environment and Heritage (OEH), Sydney, Australia (VIS ID: 4204).

The BRG–Namoi Regional Native Vegetation Mapping (OEH 2015) was used to identify regional scale plant community types (PCTs) across the Upper Namoi Valley Floodplain. This map was developed by OEH in 2015 using vegetation surveys, remote-sensing derivations, visual interpretations of high-resolution imagery and spatial distribution models. OEH developed the NSW PCT classification to establish an unambiguous community-level classification for use in vegetation mapping programs, BioMetric-based regulatory decisions and as a standard typology for other planning and data-gathering programs. A composite map was created to identify semi-permanent wetland vegetation communities using wetland vegetation components from the BRG–Namoi Regional Native Vegetation Mapping (OEH 2015) and several additional sources including the regional vegetation maps of Eco Logical Australia 2008, Eco Logical Australia 2009 and Eco Logical Australia



2013. The composite semi-permanent wetlands map also included some natural waterbody features identified from the hydroarea polygon feature class in the NSW Digital Topographic Database.

Second-generation rural FMPs were also considered when identifying ecological assets as these second-generation rural FMPs aimed to maintain flood-flow connectivity to regionally significant wetlands. Nicholson's Lagoon was identified in the Caroonā–Breeza FMP 2006 and semi-permanent wetland areas were identified in the Warrah Creek FMP 2012.

Lake Goran was identified as a wetland of national importance in the Upper Namoi FMP and is listed on the Australian Wetlands Database (Environment Australia 2001). Wetlands such as Nicholson's Lagoon and Lake Goran were identified as significant wetlands that were given special protection in the Upper Namoi Valley FMP. Step 7 details the ecological criteria applied in the design of the management zones.

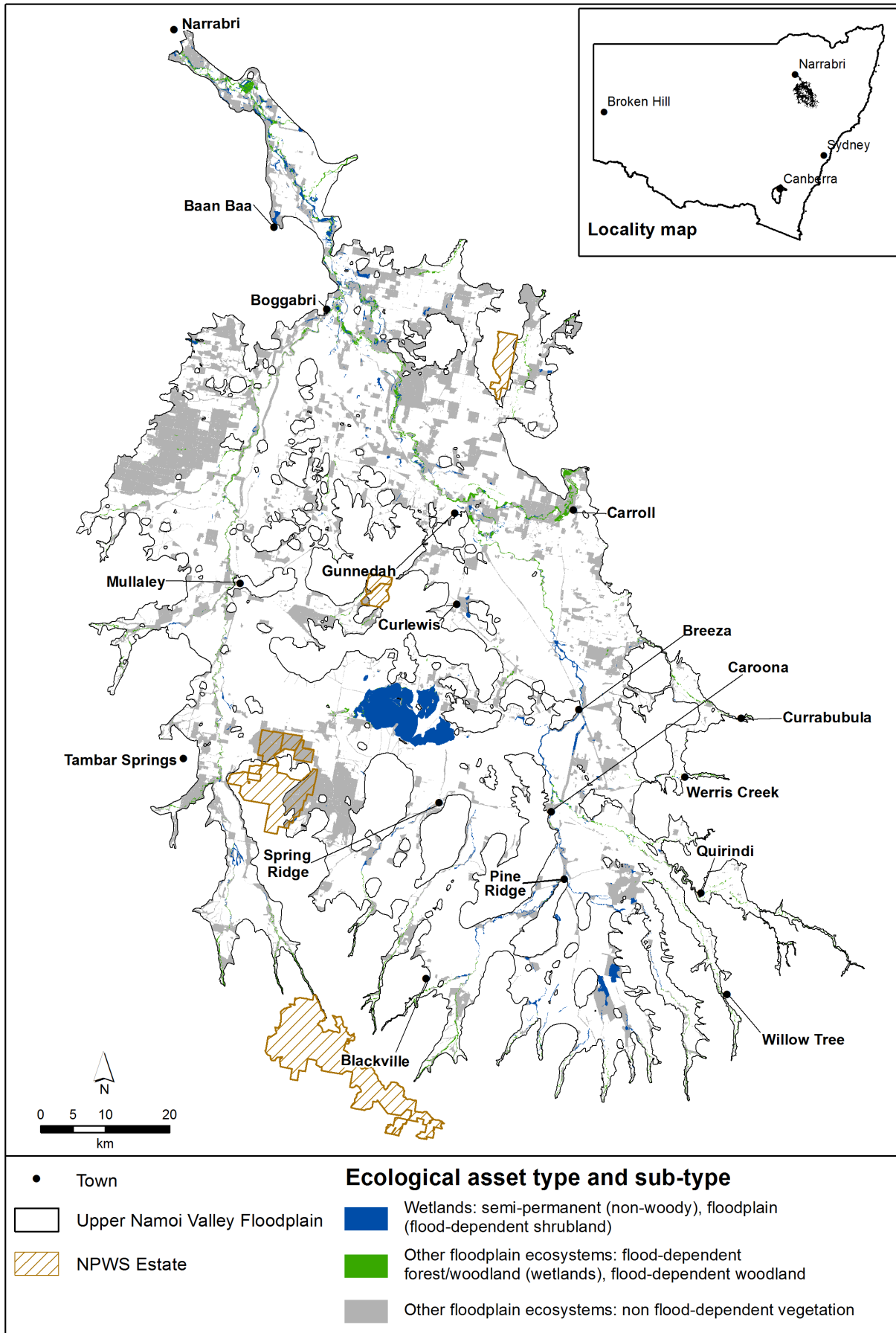


Figure 18. Ecological assets identified on the Upper Namoi Valley Floodplain

## Ecological asset type—wetlands

The ecological asset 'wetlands' is comprised of semi-permanent wetlands and floodplain (flood-dependent shrubland) wetlands.

Semi-permanent (non-woody) wetlands require annual or a higher frequency of inundation to maintain structure and community composition. Semi-permanent wetlands contain the following vegetation communities (PCT, plant community types; RVC, regional vegetation communities):

- shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains (PCT 53)
- water couch marsh grassland wetland of frequently flooded inland watercourses (PCT 204)
- sedgeland fen wetland of spring-fed or runoff-fed creeks in the southern Pilliga–Warrumbungle Range region, Brigalow Belt South Bioregion (PCT 361)
- riparian sedgeland rushland wetland of the Pilliga to Goonoo sandstone forests, Brigalow Belt South Bioregion (PCT 400)
- tall rushland, reedland or sedgeland of inland rivers, Darling Riverine Plains and Brigalow Belt South (RVC 69)
- wetlands and marshes (RVC 70).

Floodplain (flood-dependent shrubland) wetland requires flooding at intervals of one to five years (Roberts and Marston 2011; Rogers and Ralph 2011). Floodplain wetland contains the following vegetation communities:

- river coobah swamp wetland on the floodplains of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion (PCT 241)
- lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion (PCT 247)

Wetlands can provide habitat for a variety of flood-dependent fauna such as nesting waterbirds, fish, amphibians and turtles.

## Ecological asset type—other floodplain ecosystems

The ecological asset 'other floodplain ecosystems' is comprised of flood-dependent forest/woodland (wetlands) and flood-dependent woodlands.

Flood-dependent forest/woodland (wetlands) requires flooding at intervals of between one and three years (Roberts & Marston 2011) or up to every five years (Roberts & Marston 2011). Flood-dependent woodland requires flooding at least once every 10 years (Roberts & Marston 2011). Flood-dependent forest/woodland contains the following vegetation communities:

- river red gum, riparian tall woodland/open forest wetland in the Nandewar Bioregion and Brigalow Belt South Bioregion (PCT 78)
- river oak, rough-barked apple, red gum, box, riparian tall woodland (wetland) of the Brigalow Belt South Bioregion and Nandewar Bioregion (PCT 84)
- black tea-tree, river oak, wilga, riparian low forest/shrubland wetland of rich soil depressions in the Brigalow Belt South Bioregion (PCT 112)
- red gum, rough-barked apple, +/-<sup>3</sup> tea tree, sandy creek woodland (wetland) in the Pilliga–Goonoo sandstone forests, Brigalow Belt South Bioregion (PCT 399).

Flood-dependent woodland contains the following vegetation communities:

- coolabah, river coobah, lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion (PCT 39)

<sup>3</sup> +/- means with or without

## Ecological asset type—groundwater recharge

Groundwater recharge areas are sites where water from a flood event leaks through the soil profile into underlying aquifers. The scale of groundwater recharge mapping in the Upper Namoi Valley Floodplain is not appropriate for making management decisions in the Upper Namoi Valley FMP, such as where management zones should be located on the floodplain. Nevertheless, flooding is an important source of groundwater recharge on floodplains, and changes to flood connectivity may impact on groundwater storage. Therefore, to minimise harm to groundwater reserves and groundwater-dependent ecosystems that are either partially reliant on surface floodwaters or rely wholly on groundwater sourced by floods, the Upper Namoi Valley FMP will aim to achieve a natural flood-flow distribution where practicable and to maintain core floodplain inundation. This will improve the likelihood and duration of groundwater recharge areas being subjected to flood inundation. If further information on flood-sourced groundwater recharge areas becomes available, the Upper Namoi Valley FMP may need to be reviewed to ensure that they are adequately considered in the design of the management zones and rules.

Appendix 7 provides further detail on groundwater recharge in the Upper Namoi Valley Floodplain.

## Flood dependency of wetlands and other floodplain ecosystems

The flood dependency of ecological assets in the Upper Namoi Valley Floodplain was a key consideration informing FMP management zone delineation. This aims to protect the passage of flood water to ecological assets dependent on flooding to maintain their long-term persistence, structural integrity and community condition.

The distribution of vegetation across a floodplain may reflect the water regime (Casanova and Brock 2000). Vegetation communities in the immediate vicinity of the Namoi River are in contrast to those found in drier environments beyond the extensive alluvial floodplain where non-flood-dependent species are likely to occur. The timescales of flooding and the spatial extent of wet/dry ecotone may influence the types of plants that can germinate, grow and reproduce (Brock and Casanova 1997, Capon and Brock 2006).

Semi-permanent wetland vegetation communities in the Upper Namoi Valley Floodplain are connected with major watercourse channels by over-bank flooding and vegetation composition and condition reflect differences in flood frequency, timing and duration. In the Upper Namoi Valley Floodplain, the shallow channels and depressions associated with Barbers Lagoon may support semi-permanent wetland plant species such as water couch (*Paspalum distichum*) (Barma Water Resources et al. 2012), which may form a littoral fringe at sites on moist soils surrounding areas of stable permanent water. Water couch requires regular flooding to maintain vigorous growth. Other seasonally inundated wetlands in the Upper Namoi Valley FMP such as Landry Lagoon and Curlewis Swamp may support aquatic ferns such as *Marsilea* spp. (nardoo) (Green and Dunkerley 1992; Namoi CMA 2008), which prefer moist water-logged soils and have growth traits such as flexible stems to cope with fluctuating water levels (Capon 2016). Wetland sites in the Upper Namoi Valley FMP may also support submerged macrophytes such as curly pondweed (*Potamogeton crispus*), which may be found in Goran Lake and in the Boggabri area in slowly flowing freshwater (Namoi CMA 2008). This aquatic species is dependent on water being present to grow, reproduce and, when conditions are favourable, provides habitat for a range of aquatic fauna including native fish.

When Goran Lake is full of water from major flooding, it transforms from a dry plain and may support areas of wet meadow containing water couch, *Juncus* spp. and nardoo and supports a high diversity of waterbirds and aquatic biota (North West Local Land Service 2016). In contrast to ephemeral wetland habitats, infrequently flooded parts of the floodplain occur further away from main watercourse channels on higher elevation parts of the Upper Namoi Valley Floodplain where non-flood-dependent species such as narrow-leaved ironbark (*Eucalyptus crebra*), black and white cypress pine (*Callitris endlicheri* and *Callitris glaucophylla*) and poplar box (*Eucalyptus populnea* subsp. *bimbil*) may occur. These species do not solely depend on surface water flooding to grow and reproduce. There are 50 non-flood-dependent PCTs identified in the study area (Appendix 6).

In step 5, wetlands and other floodplain ecosystems of the Upper Namoi Valley Floodplain were categorised into hydro-ecological functional groups according to the surface water requirements of the dominant or canopy species in a floodplain vegetation community to maintain their ecological character using information sourced

from the reviews of Roberts and Marston (2011) and Rogers and Ralph (2011), which provide a synthesis of the best available knowledge (Table 2 and Table 3).

**Table 2. Hydro-ecological functional groups that comprise wetlands<sup>1</sup> in the Upper Namoi Valley Floodplain**

HEF <sup>2</sup> group	Vegetation/watercourse class	Ideal watering frequency
<b>Semi-permanent wetlands</b>	Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains (PCT 53)	Annual or near annual
<b>Semi-permanent wetlands</b>	Water couch marsh grassland wetland of frequently flooded inland watercourses (PCT 204)	Annual or near annual
<b>Semi-permanent wetlands</b>	Sedgeland fen wetland of spring-fed or runoff-fed creeks in the southern Pilliga–Warrumbungle Range region, Brigalow Belt South Bioregion (PCT 361)	Annual or near annual
<b>Semi-permanent wetlands</b>	Riparian sedgeland rushland wetland of the Pilliga to Goonoo sandstone forests, Brigalow Belt South Bioregion (PCT 400)	Annual or near annual
<b>Semi-permanent wetlands</b>	Tall rushland, reedland or sedgeland of inland rivers, Darling Riverine Plains and Brigalow Belt South (RVC 69)	Annual or near annual
<b>Semi-permanent wetlands</b>	Wetlands and marshes, inland NSW (RVC 70)	Annual or near annual
<b>Floodplain wetlands (flood-dependent shrubland wetlands)</b>	River coobah swamp wetland on the floodplains of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion (PCT 241)	Every year to 1 in 5 years
<b>Floodplain wetlands (flood-dependent shrubland wetlands)</b>	Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion (PCT 247)	Every year to 1 in 5 years

(Source: Optimum watering requirements adapted from Roberts and Marston 2011 and Rogers and Ralph 2011)

<sup>1</sup>Examples of wetlands include lakes, lagoons, rivers (including watercourses), floodplains, swamps, billabongs and marshes. PCT—plant community type; RVC—regional vegetation communities.

<sup>2</sup>HEF—Hydro-ecological functional.

Any mapped vegetation classes that were described as non-native were discarded from the analysis.

**Table 3. Hydro-ecological functional groups that comprise other flood-dependent ecosystems in the Upper Namoi Valley Floodplain**

HEF <sup>1</sup> group	Vegetation/watercourse class	Ideal watering frequency
<b>Flood-dependent forest/woodland (wetlands)</b>	River oak, rough-barked apple, red gum, box, riparian tall woodland (wetland) of the Brigalow Belt South Bioregion and Nandewar Bioregion (PCT 84)	In-channel freshes and overbank flows <sup>2</sup>
<b>Flood-dependent forest/woodland (wetlands)</b>	Black tea tree, river oak, wilga, riparian low forest/shrubland wetland of rich soil depressions in the Brigalow Belt South Bioregion (PCT 112)	In-channel freshes and overbank flows <sup>2</sup>
<b>Flood-dependent forest/woodland (wetlands)</b>	River red gum, riparian tall woodland/open forest wetland in the Nandewar Bioregion and Brigalow Belt South Bioregion (PCT 78)	1 in 3 to 1 in 5 years
<b>Flood-dependent forest/woodland (wetlands)</b>	Red gum, rough-barked apple, +/- <sup>3</sup> tea tree, sandy creek woodland (wetland) in the Pilliga–Goonoo sandstone forests, Brigalow Belt South Bioregion (PCT 399)	1 in 3 to 1 in 5 years
<b>Flood-dependent woodland</b>	Coolabah, river coobah, lignum, woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion (PCT 39)	1 in <10 years

(Source: Optimum watering requirements adapted from Roberts and Marston 2011 and Rogers and Ralph 2011)

<sup>1</sup> HEF—Hydro-ecological functional.

<sup>2</sup> Roberts and Marston (2011) state for river oak *Casuarina cunninghamiana* that groundwater levels in the riparian zone are key, rather than overbank flooding. In-channel freshes and overbank flows provide the flow variability that is probably important in maintaining groundwater levels in immediate riparian zone.

Any mapped vegetation classes that were described as non-native were discarded from the analysis.

<sup>3</sup> +/- means 'with or without'.

## Prioritisation of ecological assets

Ecological assets were prioritised to select those assets that best represent biodiversity in the Upper Namoi Valley Floodplain. The TAG recommended a target of 100% of flood-dependent vegetation on the floodplain as the conservation objective that would be needed to be met in order to ensure the persistence of existing flood-dependent vegetation on the Namoi Valley Floodplain (to be split into the Upper and Lower Namoi Valley Floodplains). The TAG's decision was based on the extensive clearing of vegetation, leaving only a small percentage of assets remaining relative to pre-1750 vegetation reconstruction extents (Eco Logical Australia 2013).

As outlined in the technical manual, the targets determined by the TAG were used to drive the selection of priority assets for protection and are used in the conservation planning decision-software Marxan, which is used as a decision support tool to assist the determination of areas of high conservation significance where floodplain connectivity should be secured (Ball & Possingham 2000; Possingham et al. 2000; Ball et al. 2009). Conservation targets are prescribed in Marxan to determine the amount of each feature the program is instructed to select. In conservation planning, variable targets are often prescribed for ecological surrogates based on ecological objectives to determine relative conservation priority (higher and lesser priority areas). In the Upper Namoi Valley Floodplain, the Marxan analysis determined that all ecological assets were a priority. Nevertheless, the prioritisation method was undertaken in full for completeness and to provide information on the relative conservation significance of fauna species and discrete wetlands identified in studies as determined by targets set by the TAG.

The prioritisation method for the Namoi Valley Floodplains together, was to:

- partition the Upper and Lower Namoi Valley Floodplains into planning units (Appendix 8)
- use local and expert knowledge to set targets for ecological surrogates, which are spatially definable components of biodiversity patterns. Ecological surrogates are referred to as ecological values in the Upper Namoi Valley FMP. Ecological surrogates/values include (Appendix 9):

- fauna habitat—species distribution models for fish, frogs, turtles and a snake and modelled fish biodiversity hotspots
- vegetation communities—wetlands and other floodplain ecosystems
- fauna observations for fish, frogs, amphibious reptiles and mammals
- areas of state and international conservation significance including Lake Goran (NSW005; Australian Government 2015)
- wetlands identified in current FMPs and studies—Caroona Breeza FMP and Wetlands of the Namoi Valley (Green and Dunkerley 1992)
- develop a constraint surface to constrain the selection of priority planning units (Appendix 10)
- run Marxan to identify priority ecological assets (section below).

Marxan analyses key ecological surrogates to represent biodiversity patterns and identifies floodplain areas which complement each other, producing an efficient, well-connected system that aims to ensure the future persistence of flood-dependent ecological assets.

To prioritise the assets, Marxan is run to select the planning units that achieve targets and minimise constraints. Planning units are either in or out of a solution. Marxan was run with one million iterations across 100 runs using a simulated annealing optimisation method<sup>4</sup> (Ball & Possingham 2000). The best solution from the 100 runs was chosen to identify the high-priority planning units. The best solution is the minimum set solution or the optimum planning unit portfolio. It is selected because it has the minimum amount of planning units that will achieve the conservation targets at the least cost (Figure 19). Of the 24,712 planning units in the Upper and Lower Namoi Valley Floodplains, 2692 planning units or 20% of the Upper Namoi Valley Floodplain and 4414 planning units or about 40% of the Lower Namoi Valley Floodplain was identified as a high priority for conservation (Figure 19).

The high-priority ecological assets form part of the larger decision framework for the final determination of the management zones in step 7.

### **Selection frequency score**

It was not possible to generate Marxan selection frequency score. This is because when targets are high (that is, near or ~100% as they were in the Upper Namoi), there is little room for trade-off because all the areas are important and all planning units are selected as a priority. When targets are softer, relative priority can be determined and a map showing a gradient of importance (frequency score) can be generated.

<sup>4</sup> a way of finding an optimal solution to a problem by comparing many possible solutions

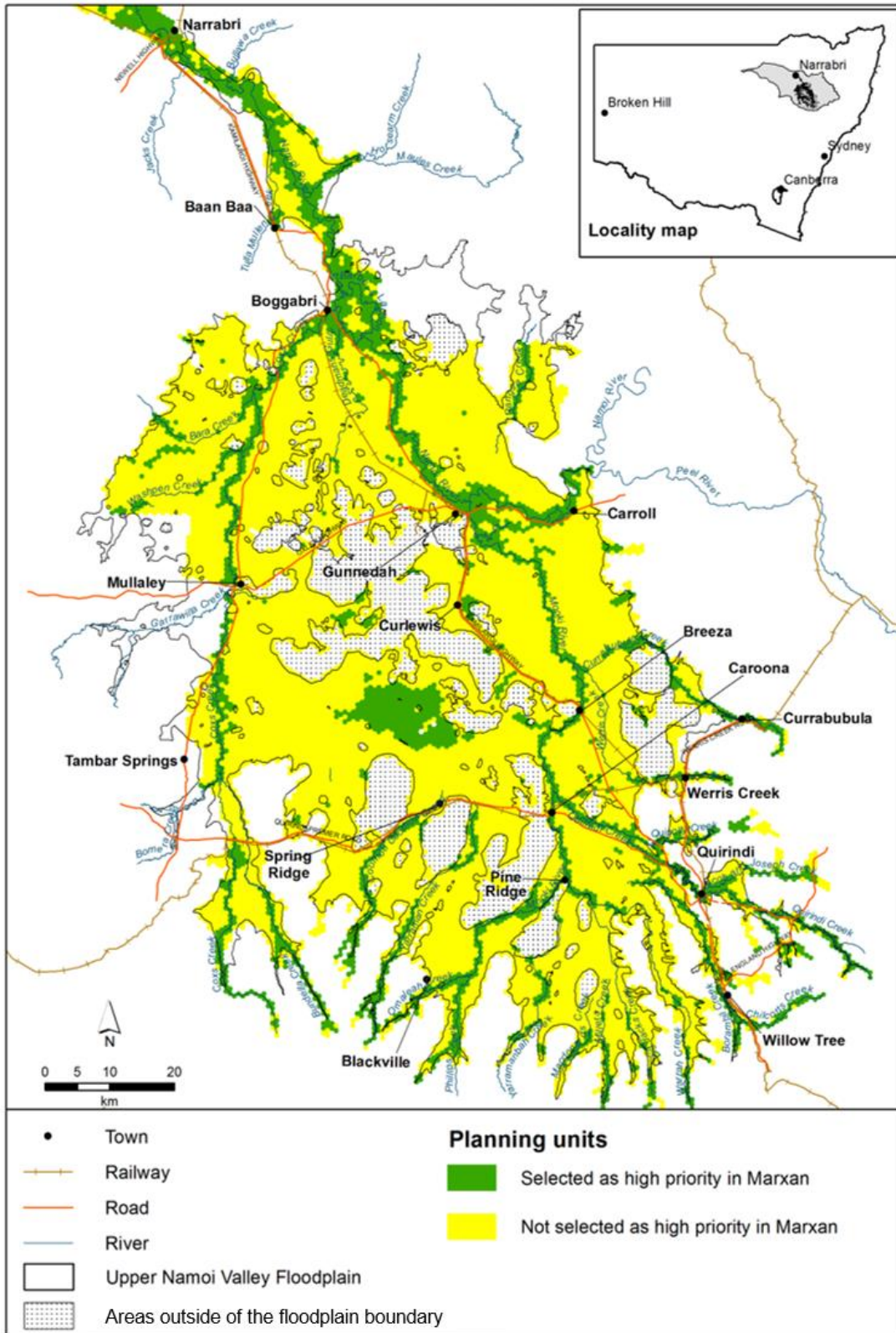


Figure 19. High-priority planning units selected in Marxan



## Cultural assets

The Upper Namoi Valley Floodplain contains assets that have Aboriginal and cultural heritage value (cultural assets).

The Upper Namoi Valley FMP identified and prioritised two types of cultural assets:

- Aboriginal values—sites, objects, landscapes, resources and beliefs that are important to Aboriginal people as part of their continuing culture. Aboriginal values also include functions, services and features that benefit Aboriginal people that are listed in Commonwealth, state and local government register
- Heritage sites—cultural heritage objects and places as listed on Commonwealth, state and local government heritage registers.

In some cases, information about sensitive cultural assets are held by elders and may not be listed in a Commonwealth, state or local database or register. To accommodate this information, flexibility has been integrated into the Upper Namoi Valley FMP to accept Aboriginal values and heritage sites that are derived from any other source and/or database deemed relevant by the minister.

### Cultural asset type—Aboriginal values

Aboriginal values are sites, objects, landscapes, resources and beliefs that are important to Aboriginal people as part of their continuing culture.

The Gamilaroi Nation is the traditional owner of the entire Namoi valley prior to colonisation. The Dughutti and Anaiwain Nations share country<sup>5</sup> at the head waters with the Gamilaroi Nation. Today, there is a Gomeroi Native Title Claim that covers 111,000 square kilometres of the North West region of NSW and encompasses the Namoi Valley. The Gomeroi Claim represents some 50,000 Gomeroi people. There are 12 Local Aboriginal Land Councils representing some 6,500 people (Namoi Catchment Management Authority 2011).

The Namoi Valley Floodplain contains many cultural sites and values that are important to the local Aboriginal community. Due to the sensitive nature of the data, specific Aboriginal values cannot be listed or mapped in published documents. The process of identifying Aboriginal values at a regional scale has commenced and will continue into the public exhibition phase of FMP development. Identifying Aboriginal values is an ongoing process that will be continued by the department.

Aboriginal values include those places and knowledge located within or connected to the floodplain nominated by Aboriginal people with cultural connection to the region. They can also include places and landscapes identified through previous recording to have significant cultural importance and are dependent on or connected with the passage of floodwater during flood events. These values can include tangible (e.g. archaeological site) or intangible (e.g. recognition of spiritual value) features, and can be place-specific (e.g. a waterhole or camp site) or nondescript spatially (such as a traditional story about the activities of ancestral beings).

A variety of connections between Aboriginal values and floodwater were considered. For example, some values are dependent on the passage of floodwater (e.g. a fish trap), some are maintained by floodwater (e.g. the health of a living culturally modified flood-dependent tree), some may be enhanced by floodwater (e.g. the harvesting of resources during cultural events) and some may be connected with the natural processes operating within the floodplain (e.g. traditional stories about ancestral figures). Each individual Aboriginal value could have any combination of these features.

Confirmed and potential Aboriginal values identified in the Upper Namoi Valley Floodplain include:

- wetlands and river channels that were an important focus of settlement and are also places of spiritual and specifically dreaming significance

<sup>5</sup> Country is a term that Aboriginal people often use to describe many of the facets of how they are connected with the land and sea. It concerns the physical, spiritual and cultural concept of belonging to places, along with the sense of responsibility and self-identity that these create. Country can also refer to the notion of the life-giving force that resides in the landscape and all of its elements that are recognised by Aboriginal people, which provide nourishment, and bring with them a duty of care.

- locations of Bora (initiation) ceremonies
- core semi-permanent wetlands with iconic plants (e.g. cumbungi and nardoo)
- riverine forests, woodland and grassland areas with iconic plants (e.g. river coobah, river red gum, coolabah, Mitchell grass and native millet)
- sites with scarred trees
- long-lasting waterholes or swamps in wetland areas that may have been a focus of settlement
- semi-permanent waterholes and channels on the floodplain that may have been a focus of settlement.

For the Upper Namoi Valley FMP, Aboriginal values were identified at a regional scale by:

- reviewing previous studies that had investigated cultural values in the floodplain
- consulting with various NSW government agencies involved with landscape management within the valley (e.g. Local Land Services, National Parks and Wildlife Service, Department of Industry—Lands & Water and OEH)
- targeted consultation with members of the Aboriginal community with knowledge of values connected with the floodplain
- consultation with the ATWG, which is comprised of Aboriginal people with cultural connection to each of the valleys being investigated during the Healthy Floodplains Project
- context-setting using existing spatial information about the potential distribution of unidentified values using the Aboriginal Sites Decision Support Tool (ASDST) (Ridges 2010) (Appendix 11).

Aboriginal values were also identified by reviewing the values recorded within the floodplain in the following databases:

- NSW Aboriginal Heritage Information Management System (AHIMS) (see <http://www.environment.nsw.gov.au/licences/AboriginalHeritageInformationManagementSystem.htm>), which includes:
  - information on Aboriginal objects
  - information about Aboriginal Places
  - archaeological reports
- NSW Aboriginal Water Initiative System (AWIS)
- Murray–Darling Basin Authority Aboriginal Submissions Database
- NSW State Heritage Inventory (see <http://www.environment.nsw.gov.au/heritageapp/heritagesearch.aspx>), which includes:
  - Aboriginal Places
  - NSW State Heritage Register
  - Interim Heritage Orders
  - NSW State Agency Heritage Registers
  - heritage items in Local Environmental Plans
- Australian Heritage Database, also referred to as the Commonwealth Heritage List in the Upper Namoi Valley FMP (see <http://www.environment.gov.au/heritage/publications/australian-heritage-database>), which includes places in the:
  - World Heritage List
  - National Heritage List
  - Commonwealth Heritage List
  - Register of the National Estate.

## Cultural flows

Aboriginal people view themselves as an inherent part of the river system. A holistic understanding of how water is connected to the land and rivers and the connection that Indigenous people feel to river systems feeds a strong feeling of responsibility for the health of rivers and floodplains. The Murray Lower Darling Rivers Indigenous Nations and Northern Murray–Darling Basin Aboriginal Nations define cultural flows as ‘water entitlements that are legally and beneficially owned by the Indigenous Nations and are of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Indigenous Nations. This is our inherent right.’ Cultural flows are being integrated into water planning and management.

Work is currently being undertaken by the National Cultural Flows Planning and Research Committee to improve our knowledge of cultural flows, including Indigenous water values and uses, and volumes of water that provide for those values and uses. Cultural flows may improve the health and wellbeing of Aboriginal people and empower Aboriginal communities to care for their country and undertake cultural activities.

This body of work was instigated by the Northern Murray–Darling Basin Aboriginal Nations (NBAN). NBAN is a confederation of 24 member Nations that has advised and advocated on behalf of Ancestral Owners for the past two years. Its sister organisation, the Murray Lower Darling Indigenous Nations, has produced a document called the *Echuca Declaration* which the adoption of the term Cultural Flows came from. Both organisations ratified the meaning in 2011, providing the aforementioned consistent definition right across the whole Murray–Darling Basin.

The Upper Namoi Valley FMP does not address cultural water. However, cultural water will likely be a component of the water sharing plans being developed by the department, which will incorporate the Aboriginal cultural values identified in this study.

## Aboriginal Water Initiative

The First Peoples’ Water Engagement Council (FPWEC) was established to provide advice to the National Water Commission on national Indigenous water issues. The May 2012 advice set the over-arching policy framework, including that there must be an Aboriginal water allocation in all water plans; that Aboriginal people are engaged in decision-making, planning and management; and that Aboriginal access to water for cultural and economic purposes is mandatory. The FPWEC also sought to establish and implement a National Aboriginal Water Strategy through the Council of Australian Governments. The FPWEC ended its tenure in 2012 and an Indigenous Water Advisory Council was formed to carry on with the initial work of the FPWEC at a national level.

An Aboriginal Water Initiative was established in June 2012 to better the involvement and representation of Aboriginal people in water planning and management in New South Wales. The initiative allows the department to start monitoring the success of water sharing plans in meeting their statutory requirements for performance indicators specific to Aboriginal people, including providing water for Native Title rights.

The Aboriginal Water Initiative has established the Aboriginal Water Initiative System (AWIS) database, which includes cultural features that are water dependent. All cultural values and features identified in the making of the Upper Namoi Valley FMP will be included in the AWIS database, which will follow up with consultation on the water and flooding requirements of those values and features. The FMP includes provisions that the AWIS database be consulted as part of the approval process of all future work provisioned under the FMP.

## Cultural asset type—heritage sites

Heritage sites are cultural heritage objects and places as listed on Commonwealth, state and local government heritage registers. Some Aboriginal values may also be heritage sites and for the purposes of the Upper Namoi Valley FMP, heritage sites were divided into historic heritage sites and Aboriginal heritage sites.

Commonwealth, state and local government heritage registers include the:

- Australian Heritage Database
- Historic Heritage Information Management System (HHIMS)

- Murray–Darling Basin Authority Aboriginal Submissions Database
- NSW State Heritage Inventory
- NSW AHIMS
- NSW AWIS.

## **Flood dependency of Aboriginal values and heritage sites**

During the development of the Upper Namoi Valley FMP, flood dependency of cultural assets was established so that consideration could be given to how changes to the flooding regime may impact Aboriginal values across the floodplain.

### **Flood dependency—Aboriginal values**

Flood dependency of the Aboriginal values nominated by the Aboriginal community was determined through direct discussion with knowledge holders about the nature of the value and how it is connected with floodwater. The places nominated as having significant Aboriginal value were all found to have a strong connection or dependency on flooding of the floodplain.

Flood-dependent Aboriginal values can be complicated because of the nature of association between cultural value or feature and flooded area. For example, some Aboriginal values are not straightforwardly flood-dependent, but exist because of the close proximity or association with flooding; for instance, ceremonial locations connected with intact flood-dependent vegetation and camp sites near wetlands that may persist regardless of flooding, but may not be utilised until the landscape is flooded, and resources only abundant during flood events. Wherever possible, the nature of these cultural relationships was considered in the design of the management zones.

### **Flood dependency—historic heritage sites**

Flood dependency was assessed by reviewing the heritage listing records to establish the nature of the heritage theme and value of the site to determine if this was dependent on, or connected with floodwater. In the Upper Namoi Valley Floodplain, none of the listed floodplain historic assets that were reviewed were found to have flood-dependent values.

### **Flood dependency—Aboriginal heritage sites**

The following Aboriginal site types occurring within the region were identified as having flood-dependent values associated with them:

- cultural modifications (e.g. Coolamon scars) to living trees that are flood-dependent species
- fish traps
- ceremony sites located within or surrounded by floodplain vegetation<sup>6</sup>.

Some Aboriginal sites were identified as being sensitive to the effect of erosion associated with the redistribution of flood flow or to ground disturbance caused by the construction of new flood works or the modification of existing flood works. For instance, thin elevated ridges known as ‘red country’, which were inhabited in floods when ‘black country’ (floodplains and wetlands) was too wet to live in, contain stone artefact sites and plants with cultural values. Such plants include belah, quandong and boobialla that may be vulnerable to changes in flood flows.

The specific flood dependency of cultural assets in the Upper Namoi Valley Floodplain is outlined in Table 4.

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<sup>6</sup> While it is recognised the ceremony site itself may not be flood-dependent, based on advice received from the ATWG, it was noted that many ceremonies were connected with the surrounding flood-dependent landscape, and were undertaken when many floodplain resources were abundant.

**Table 4. Flood dependency of cultural assets**

Asset	Type	No.	Flood dependency
Aboriginal values and heritage sites	Scarred trees	113	Based on the flood dependency of the living vegetation
Aboriginal values and heritage sites	Places identified by the community	7	Predominantly lagoons that are dependent on frequent flooding.
Aboriginal values and heritage sites	Fish traps	0	No fish traps recorded; if found, dependent on frequent flooding
Historic heritage sites	N/A	0	N/A

## Prioritisation of cultural assets

High-priority cultural assets that are dependent on flooding were considered in the design of the management zones to protect their flood connectivity. The process for identifying these high-priority cultural assets is outlined below.

Cultural assets vulnerable to the effect of erosion associated with the redistribution of flood flow or vulnerable to the direct impacts of the installation of new flood works or the modification of current works are not dealt with in the design of the management zones. Therefore, these cultural assets were not prioritised. Where identified, these cultural assets will be an additional consideration for licensing staff when assessing flood work applications.

## Prioritisation of Aboriginal heritage sites

### Scarred trees

Scarred trees were investigated using AHIMS records and by inspecting the original site cards. Those scarred trees where it was clear that the tree was dead at the time of the recording, were excluded from the prioritisation. The location of each tree was also compared to current 2009 SPOT imagery to ensure that there was a reasonable likelihood the tree still existed (some recordings were over 30 years old). As a result of the comparison with SPOT, some recordings were found to have locations recorded that were inconsistent with information in the original site card and were corrected when found.

### Fish traps

There are no records of fish traps within the study region; however, the possibility of them being used was noted by the ATWG.

### Ceremonial sites

A search of the AHIMS database identified several ceremony sites recorded in the region. Based on the records and comparison with SPOT 2009 imagery, there was little remaining physically of these sites. The exception was AHIMS site 10-2-0014. The ceremonial site and associated carved trees were originally recorded by Etheridge in the late 19<sup>th</sup> century (Etheridge 1918), and when the AHIMS site was recorded in the 1980s, there was still evidence of the carved trees in situ. Given the rarity of sites remaining intact, this is a highly significant place and was included as an Aboriginal value.

## Prioritisation of Aboriginal values

Targeted consultation was undertaken with members of the Aboriginal community throughout the region who have knowledge about flood-dependent Aboriginal values. Given available timeframes, this was not an exhaustive consultation process, and the incorporation of Aboriginal values into the plan should be considered an ongoing process.

Discussions were had in person with community members with printed maps that they could annotate. The maps were left with the community members to give them a chance to consider the requirements of the plans, and follow-up discussions were held a week or so later.

The consultation process identified areas where the significance of Aboriginal values warranted an exclusion of further flood works. In some cases, this was because of the sensitivity of important and largely intact ceremony grounds. In other cases, this was due to the occurrence of relatively intact land that was rich with sites associated with living in the floodplain.

These areas were digitised and used to inform the design of the management zones. The areas identified and their associated values will be stored in a database of flood-dependent Aboriginal values being established by the department. The database will be used by staff when implementing the plan.

## Step 6: Prepare a socio-economic profile

To develop options for future floodplain management, the floodplain area must be understood and the ability of the community to absorb change appreciated. A socio-economic profile of the Upper Namoi Valley Floodplain area is required so that the social and economic impact of development controls in the floodplain and flood risk to life and property from the effects of flooding can be effectively considered. The socio-economic profile is detailed in Appendix 14 and a summary is provided below.

The profile is an assembly of existing key socio-economic data, which provide a general picture of the catchment in terms of its socio-demographic and economic structures. Key socio-economic data that inform the baseline profile include:

- geographies that are relevant to the socio-economic discussion water use on the floodplain
- demographic profiles
- income statistics
- employment by industry
- economic wellbeing indicators
- production statistics.

Information from this assessment was used in the socio-economic impact analysis of the FMP, which is outlined in step 10. The socio-economic impact analysis is undertaken in coordination with the development of management zones and rules for a valley and informs steps 7, 8 and 9 of this process.

### Study area geography

There are three geographies that are relevant to the socio-economic discussion of water management within the Upper Namoi Valley Floodplain (see Table 5 for a description and Appendix 14 for figures of the areas).

**Table 5. Description of study area geographies used in socio-economic profile**

Geography	Size (hectares)	Description
Upper Namoi Valley Floodplain Economy	1,565,100	The Upper Namoi Valley Floodplain Economy area includes the Upper Namoi Rural and Urban Floodplains as well as the adjacent areas in the Gwydir and Castlereagh catchments that engage with the economy of the region. This area extends from the Liverpool Range in the south east to Narrabri in the north west. Most goods and services consumed in the Upper Namoi Valley Floodplain Economy area are sourced from the regional centres of Gunnedah, Narrabri, Quirindi or the small townships in this area
Upper Namoi rural floodplain	702,500	The Upper Namoi Rural Floodplain is the rural area downstream of the Liverpool Range to the Namoi River at Narrabri. The Upper Namoi Valley Floodplain narrows from Boggabri to Narrabri following the Namoi River. This area of the Upper Namoi Rural Floodplain and will be directly impacted by the Upper Namoi Valley FMP. The community residents who live and work in this area are predominantly agriculture-based, but the community does include people who live in small rural towns. There are limited community services and infrastructure in this area; most of the required farm inputs and human services are provided from the local towns and the three regional centres.
Upper Namoi Urban Floodplain	N/A	The regional centre of Gunnedah, part of the Narrabri and Quirindi regional centres, and the townships of Boggabri, Carroll, Curlewis, Carroona and Werris Creek constitute the third area, the Upper Namoi Urban Floodplain. While this area is situated on or adjacent to the floodplain and is affected by flood water, flood water management is provided under the Local Government Act. The communities that live in these towns are reliant upon the surrounding rural floodplain areas both as a source of employment and as a consumer of services.

## Data sources

Demographic data for the Upper Namoi Valley Floodplain Economy, the Upper Namoi Rural Floodplain and the Upper Namoi Urban Floodplain is drawn from the ABS Census of Population and Housing 2011 Statistical Area level (SA1) level data (ABS 2011b). This includes data on population including Indigenous community, sex and age ratios; household weekly incomes; and employment, labour participation rates and employment by industry sector. The SA1 areas are the smallest unit for release of census data. The boundaries closely align with the boundary of the Upper Namoi Valley Floodplain Economy area and of the Rural and Urban Floodplain areas. Regional population trends for the Narrabri, Gunnedah and Liverpool Plains Local Government Areas have been drawn from the ABS Regional Population Growth 2013 data (ABS 2013).

Information on the relative socio-economic advantage and disadvantage for the SA1 areas of the floodplain area is drawn from the ABS Census of Population and Housing 2011 Socio-economic Indexes for Areas (ABS 2011c).

Agricultural production is a significant component of the floodplain economy. The ABS Agricultural Census 2011 (ABS 2011a) provides comprehensive data on both dry land and irrigated agricultural production at the Statistician Area Level 2 (SA2) for six regions that partially cover the Upper Namoi Valley Floodplain agricultural region: Gunnedah, Gunnedah Region, Narrabri, Narrabri Region, Quirindi and Coonabarabran regions. SA2 areas are a general-purpose medium-sized area built from whole SA1s. SA2 areas represent a community that interacts socially and economically.

## Demographic profiles

Demographic information is provided in Table 6 and includes information on the population, percentage of the population living in towns, percentage of the community who are Aboriginal, gender ratio and the dependency ratio for each geography and the state average.

**Table 6. Demographic information per socio-economic geography**

Geography	Population	Percentage living in towns	Aboriginal community (%)	Gender ratio (men to women)	Dependency ratio (proportion of the population not working vs working)
Upper Namoi Valley Floodplain Economy <sup>1</sup>	23,630	71	10.2	101.2	64 <sup>2</sup>
Upper Namoi rural floodplain	3,630 <sup>3</sup>	N/A	4.3	112.3	53 <sup>2</sup>
Upper Namoi urban floodplain	16,670	80	12.7	97.2	69
State average	N/A	N/A	2.5	97	52

- <sup>1</sup> The information about population is based on ABS collection district (CD) boundaries that do not match the boundary of the Upper Namoi Valley Floodplain economic areas (rural and urban floodplains). Therefore, the total of the Upper Namoi rural and urban populations does not equal the overall Upper Namoi Valley Floodplain Economy.
- <sup>2</sup> may be overstated as there are a considerable number of farmers over the age of 64 years working in the agriculture sector.
- <sup>3</sup> based on 33 people per 100 km<sup>2</sup> based on the ABS Census 2011

Regional populations have stabilised over recent years, with the estimated population for the Gunnedah and Narrabri Local Government Areas recovering slightly. The age by sex distribution of this community reveals an under-representation in the 20 to 49 age groups, as compared to the under 20 and over 49 age groups and as compared to NSW. This under-representation is also demonstrated in the rural floodplain. This is likely to be related to the inaccessibility of secondary and tertiary education opportunities, and associated employment, in this area. The urban community does not reflect the same degree of under-representation in the 20 to 49 age groups as observed in the rural community.



# Employment by industry

## Upper Namoi Valley Floodplain Economy

The labour force of the Upper Namoi Valley Floodplain Economy is 10,230 persons. Employment in the Upper Namoi Valley Floodplain Economy is predominantly within the agricultural, forestry and fishing sector, with 19% of employment (1,980 people, with this number including a large agricultural area not on the rural floodplain). In contrast, the NSW state agriculture sector engages 2% of the workforce. There is a relatively even distribution of the remaining 81% of employment among the remaining sectors. The next most significant employment sectors are retail trade, and healthcare and social assistance, each with 9% of employment. Employment in the Upper Namoi Rural Floodplain is dominated by the agriculture, forestry and fishing sector, with 51% of the workforce (970 people) working in the agricultural industry. In contrast with the surrounding rural community, employment in the Upper Namoi Urban Floodplain is reasonably evenly distributed across sectors. A significant proportion of the workforce is employed in the service sectors. The retail trade sector is the most significant employer, with 12% of the workforce closely followed by healthcare and social assistance (11%) and then by education and training, and manufacturing with 8%. Agriculture, forestry and fishing has 6% of the workforce.

## Estimated employment of the Upper Namoi Valley FMP area

Given the location of the townships, it is likely that about half of the 410 Upper Namoi Urban Floodplain residents employed in the agriculture sector work in the adjacent rural floodplain while the other half would be working in the areas of agriculture outside the floodplain area.

The estimated total employment in the agriculture sector potentially impacted by the Upper Namoi FMP is 1,170 persons, counting the 970 agriculture workers from the rural floodplain and half of the 410 agriculture workers from the urban floodplain.

## Income

The weekly household income in the Upper Namoi Valley Floodplain Economy closely correlates with that of the Upper Namoi Urban Floodplain, with 71% of the population living in the townships. The proportion of low-income households in the Upper Namoi Valley Floodplain Economy, Upper Namoi rural floodplain and Upper Namoi Urban Floodplain is, 32%, 25% and 34% respectively, compared with the NSW state proportion of 23%. The medium-income proportion of 57% in the Upper Namoi Valley Floodplain Economy, 50% in the rural floodplain and 56% in the urban floodplain are similar to the NSW proportion of 56%. The proportion of high-income households within these three areas (11%, 16% and 10%) are each lower than the NSW state proportion of 21%.

## Economic wellbeing indicators

The Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) ranks areas in terms of relative socio-economic advantage and disadvantage, using 25 variables. An area with a high score on this index has a relatively high incidence of advantage and a relatively low incidence of disadvantage.

The IRSAD scores for key regions are (see Appendix 14):

- Local Government Areas of Narrabri, Gunnedah and Liverpool Plains are in the 4<sup>th</sup>, 3<sup>rd</sup> and 2<sup>nd</sup> decile of NSW, marginally to reasonably disadvantaged.
- The lowest SA1 area score is 638 (decile 1 in the state), which is the SA1 of Walhollow near Caroon.
- The highest-scoring area has a score of 1,072 (decile 8 in the state), which is the rural area north of Mullaley, west of Gunnedah.
- The IRSAD scores for the smaller SA1 areas, representing the townships of Gunnedah, Narrabri and Quirindi, are relatively disadvantaged.

## Production

The economy of the Upper Namoi Valley Floodplain is interwoven with the economy of the adjacent north west community, drawing inputs from, passing outputs through and using services from the same business centres as the floodplain. It is appropriate therefore to consider the socio-economic profile of the wider Upper Namoi Valley Floodplain Economy.

Agricultural production is the significant production activity of the region's economy, occupying 93% of the farm holding area in the Upper Namoi Valley Floodplain. Agricultural production is predominantly cropping, which is dominated by cotton and to a lesser extent wheat. Irrigation on the Upper Namoi Valley Floodplain is dominated by irrigated cotton production. The regional economy is structured to process the inputs and outputs of these industries and provide the services they require. The performance of the regional economy responds in large part to the fortunes of the cotton and wheat industries.

The ABS Agricultural Census 2011 provides agricultural production statistics for the Gunnedah, Gunnedah Region, Narrabri, Narrabri Region, Quirindi and Coonabarabran regions that cover the majority of the Upper Namoi Valley Floodplain and the Upper Namoi Valley Floodplain Economy area (ABS 2011a). The combined area of these six regions is distinct from the FMP area, as the combined area includes a substantial area of non-floodplain to the north, south and west of Narrabri, part of the Gwydir River Floodplain.

The Gross Value of Agricultural Production (GVAP) in 2010-2011 in the Upper Namoi Valley Floodplain, using a farm holding area of 659,300 ha, is estimated to be \$185.0 million or 1.6% of total NSW GVAP. Broadacre cropping constitutes 80% of the GVAP (\$147.7 million) of the FMP area production, using 189,930 ha or 29% of the area. The highest value producing individual broadacre crops are cotton, yielding \$50 million or 27%, and wheat, yielding \$34 million or 18%, of the total Upper Namoi Valley Floodplain GVAP. Livestock and livestock products yield \$37 million, accounting for 20% of GVAP while using 71% of the area.

There was an estimated total of 27,200 ha of irrigated land in the Upper Namoi Valley Floodplain in 2010–2011. This area of irrigated land constitutes approximately 4% of the area of the FMP farm holding area. It is estimated that 80,500 megalitres of water was extracted for agricultural irrigation across the Gunnedah, Gunnedah Region, part of Narrabri, Narrabri Region and Quirindi regions in 2010–2011. The majority of the irrigation water used in 2010–2011 was applied to cotton using 58,800 megalitres or 73%, at an estimated average rate of 3.8 megalitres per hectare. Irrigation for cotton used an estimated 15,600 ha or 57% of the estimated Upper Namoi Valley Floodplain irrigated area.

## Step 7: Delineate management zones

In step 7, the nature and location of the management zones for the Upper Namoi Valley Floodplain were determined using hydraulic, ecological and cultural criteria as well as criteria to ensure the plan reflects current floodplain management arrangements. This approach considered the impact of existing and future development on flooding in rivers and floodplains; the flood risk to life and property; the flood connectivity of floodplain assets and the social and economic impacts of restricting flood work development.

The above approach resulted in seven different management zones for the Upper Namoi Valley FMP.

### Description of management zones

The Upper Namoi Valley FMP contains seven management zones (MZ) (Figure 20):

- MZ AD—major discharge Areas, defined floodways (36,100 ha or 6% of the floodplain)
- MZ AID—major discharge areas, ill-defined floodways (41,100 ha or 7% of the floodplain)
- MZ BL—flood storage and secondary flood discharge, Lower Liverpool Plains (199,700 ha or 34% of the floodplain)
- MZ BU—flood storage and secondary flood discharge, Upper Liverpool Plains (52,900 ha or 9% of the floodplain)
- MZ C—flood fringe and flood-protected developed areas (247,700 ha or 42% of the floodplain)
- MZ CU—urban areas managed by local council (2,000 ha or less than 1% of the floodplain)
- MZ D—special environmental and cultural protection zone (8,900 ha or 2% of the floodplain)

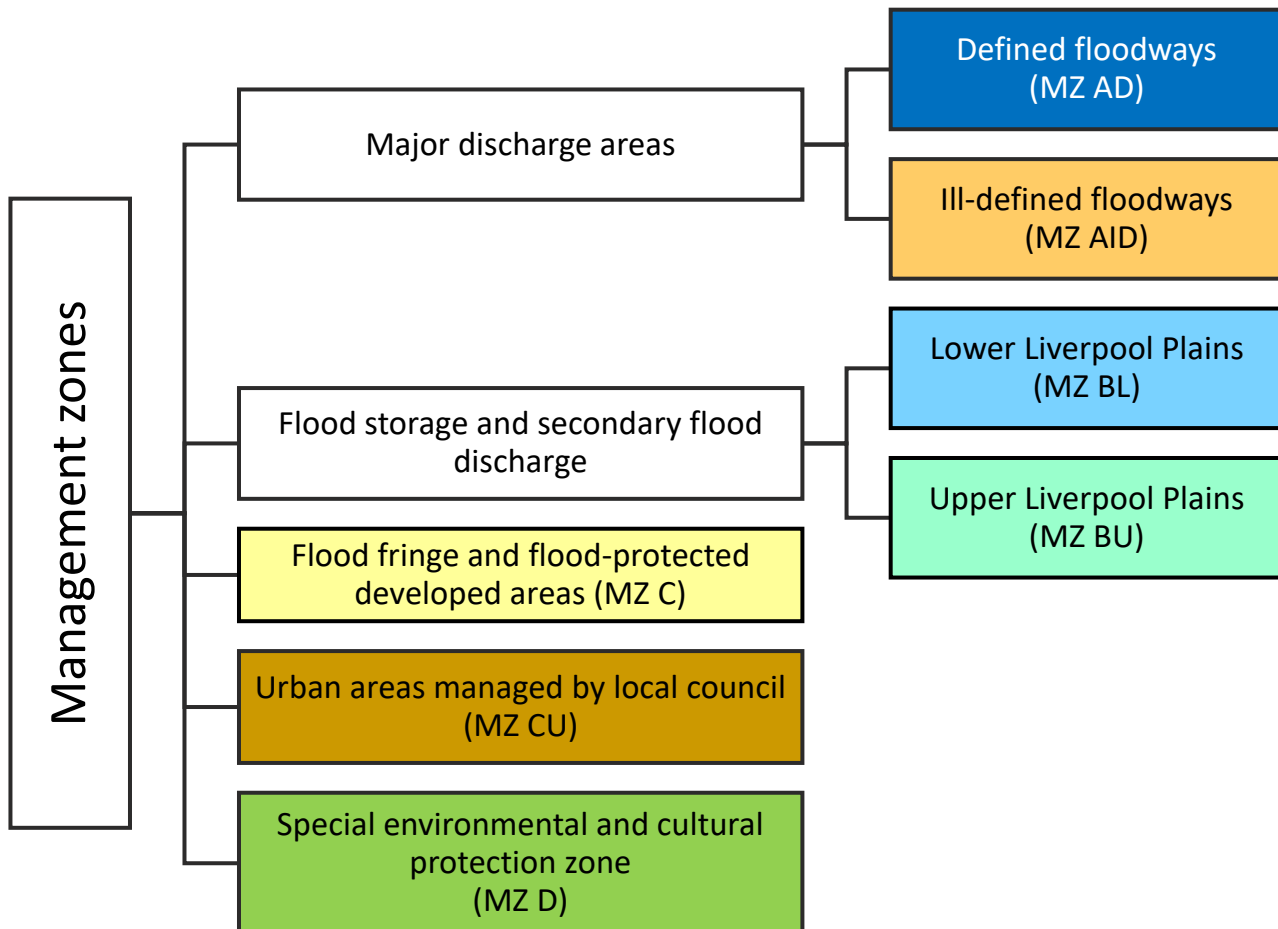


Figure 20. Finger diagram of management zones

Part 10 'Amendment of this Plan' in the Upper Namoi Valley FMP provides opportunity for landholders to seek to modify a management zone.

A map of the management zones is shown in Figure 21 and a summary description is provided below. More information is provided at the end of this step. Six more detailed maps of the management zones are provided in Appendix 12.

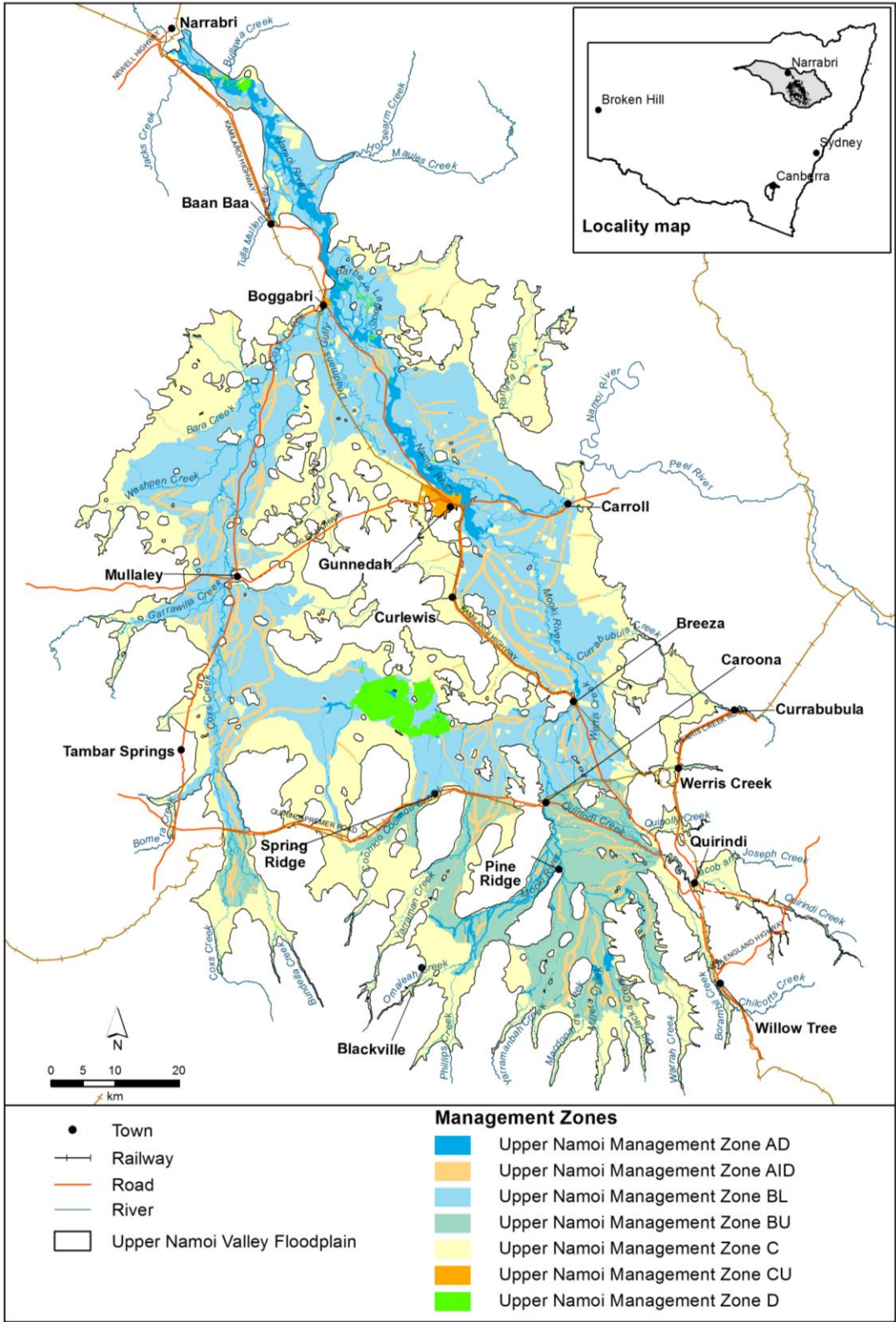


Figure 21. Map of the management zones in the Upper Namoi Valley Floodplain

## Management Zone AD—major discharge areas, defined floodways (MZ AD)

MZ AD covers 36,100 ha, or 6% of the floodplain. It includes defined floodways with channels or banks that include major drainage lines and other areas where a significant discharge of floodwater occurs during all flood events. These areas are generally characterised by relatively high flood-flow velocity and depth. MZ AD is also important for the conveyance of floodwater to highly flood-dependent ecological and cultural assets.

MZ AD includes areas where uncoordinated flood work development may have a high adverse impact on flood behaviour. It was designed to ensure a reduction in the risk to life and property by limiting flood work developments to prevent flood-flow redistribution, increased flood velocities and flood levels. MZ AD was designed to ensure there is continuity of flow and flow paths and assist in maintaining the overall flow distribution on the floodplain.

Generally, MZ AD is in areas of the floodplain with a slope of less than 0.5%; however, MZ AD is used to connect floodplain assets located in higher areas (slope is greater than or equal to 0.5%) to flooding when the asset is highly dependent on flooding.

MZ AD was designed with consideration of the extent of the 1998 flood along the Namoi River and parts of the Mooki River. In the Blackville FMP area, MZ AD was extended at least 100 metre from the bank tops of the waterways. This was done for consistency with rules in the Blackville FMP.

MZ AD includes the extent of semi-permanent wetland and key fish passage areas to ensure connectivity to these significant assets that are highly dependent on flooding. MZ AD was also designed to provide flood connectivity to floodplain wetland and flood-dependent forest/wetland. MZ AD includes ecological flow corridors that were created by adding a 40 m buffer to capture waterfront land.

MZ AD includes the extent of Aboriginal values that are highly flood-dependent. Certain trees that have been modified by Aboriginal people have also been included in MZ AD. Such trees must be scarred or carved trees, found to be living, in close proximity to floodways and require flooding at least every five years to maintain their ecological character.

## Management Zone AID—major discharge areas, ill-defined floodways (MZ AID)

MZ AID covers 41,100 ha, or 7% of the floodplain. It includes ill-defined floodways that are major discharge areas without clear channels or banks. In all other respects, MZ AID is designed using the same principles as MZ AD.

Ultimately, MZ AID functions much like MZ AD but it provides landholders with the opportunity to negotiate the location of the flood-flow corridor. Within the flood-flow corridor, the construction or amendment of flood works will be subject to the rules and assessment criteria for MZ AD for the purposes of conveying flood flow. Once flood-flow corridors are agreed on, landholders may construct flood works outside the corridors in accordance with the rules of the management zone the original MZ AID lies within (MZ BU or MZ BL).

An additional rule in MZ AID (wide flood-flow corridors) provides a pathway for the approval of certain other flood works that are not minor or existing, provided that the flood work has or will have a height of no greater than 30 cm above natural surface level and meets the assessment criteria for MZ BU or MZ BL (whichever is relevant). Applications for flood works that meet the requirements of this clause must be advertised.

## Management Zone BL—flood storage and secondary flood discharge, Lower Liverpool Plains (MZ BL)

MZ BL covers 199,700 ha, or 34% of the floodplain. It includes areas of the Lower Liverpool Plains Floodplain north of the Binnaway to Werris Creek railway that are important for the conveyance of floodwater during large flood events and for the temporary pondage of floodwaters during the passage of a flood. The split at the railway was made to allow rules to be tailored to the different types of flooding behaviour experienced either side of the railway. For instance, north of the railway line flooding is more extensive where the floodplain is less confined.

The outer boundary of the management zone is defined by the extent of the large design flood which is considered to be the area of floodplain with a slope of less than 0.5%. MZ BL also includes areas that are

protected by existing flood works that are limited height and therefore overtopped during moderate to large floods.

MZ BL was designed to include ecological assets that have a moderate level of flood dependency. MZ BL includes areas of floodplain wetland—flood-dependent shrubland wetlands and flood-dependent forest/woodland (wetlands). MZ BL also includes cultural assets such as modified trees that are likely to only be flood connected during moderate and large floods.

MZ BL is important for the conveyance of floodwater to floodplain assets during larger flood events. The zone includes areas where coordinating flood work development is important to manage the cumulative and local impact of works on flood behaviour.

### **Management Zone BU (MZ BU)—flood storage and secondary flood discharge, Upper Liverpool Plains**

MZ BU covers 52,900 ha, or 9% of the floodplain. It includes areas of the Upper Liverpool Plains Floodplain south of the Binnaway to Werris Creek railway that are important for the conveyance of floodwater during large flood events and for the temporary pondage of floodwaters during the passage of a flood. The outer boundary of the MZ is defined by the extent of the large design flood which is considered to be the area of floodplain with a slope of less than 0.5%.

MZ BU was designed to include ecological assets that have a moderate level of flood dependency. MZ BU includes small areas of flood-dependent forest/woodland (wetland) which requires flooding at least every five years.

Like MZ BL, MZ BU is important for the conveyance of floodwater to floodplain assets during larger flood events. The zone includes areas where coordinating flood work development is important to manage the cumulative and local impact of works on flood behaviour.

### **Management Zone C—flood fringe and flood-protected developed areas (MZ C)**

MZ C covers 247,700 ha, or 42% of the floodplain. It contains flood fringe and flood-protected developed areas. The flood fringe is the areas of the floodplain with a slope greater than or equal to 0.5%. MZ C also includes areas protected by flood works that are unlimited height and are not overtopped by water during moderate to large floods.

MZ C is not specifically designed to include ecological assets that are flood-dependent; however, ecological assets that occur in MZ C include flood-dependent forest/woodland (wetlands). Some flood-dependent forest lies in developed areas and is potentially disconnected from flooding.



**Figure 22. Storages, such as the one pictured, are zoned as MZ C. G. Pezzimenti, OEH 2013**

MZ C also includes some cultural assets such as scarred trees. Generally, these trees are species that require infrequent flooding or ones for which the record of the tree could not be verified. All cultural asset records in MZ C are to be considered during the assessment of flood work applications.

The rules and assessment criteria of MZ C are less restrictive than other zones as MZ C includes areas where flood work development is unlikely to have a significant effect on flood behaviour. Nevertheless, flood works still require an assessment and approval to protect the health of the floodplain environment.

### **Management Zone CU—urban areas (MZ CU)**

MZ CU covers 2,000 ha, which is less than 1% of the floodplain. It includes parts of Gunnedah, Carroll and Boggabri that are urban areas where flood risk is managed by local councils through flood risk management plans and studies developed in accordance with the *Floodplain Development Manual* (NSW Government 2005).

### **Management Zone D—special protection (MZ D)**

MZ D covers 8,900 ha, or 1% of the floodplain. It is a special protection zone for areas of ecological and/or cultural significance. These areas are subject to very frequent inundation and have high ecological and/or cultural value. The largest MZ D is Lake Goran, which is also the largest wetland complex in the Namoi Valley. To maintain flood connectivity to these significant assets, only ecological, Aboriginal value and heritage-site enhancement works can be applied for. The eleven MZ D areas include Barbers Lagoon, Broadwater Lagoon, Bundella Lagoon, Curlewis Swamp, Goran Swamp, Gulligal Lagoon, Gunnible Lagoon, Lake Goran, Landry Lagoon, Nicholsons Lagoon and an un-named lagoon near Tarriaro. All of these are described in Appendix 13.

## Hydraulic criteria

Preliminary management zones were established based on hydraulic criteria that were developed from information on flood behaviour within the floodway network and the flood fringe (i.e. areas outside the floodway network) (Table 1 and Figure 11 in step 4). The three hydraulic categories identified during step 4 were the basis for four different management zones, so that the:

- defined floodways are the hydraulic basis for MZ AD
- ill-defined floodways are the hydraulic basis for MZ AID
- inundation extent is the hydraulic basis for MZ BU and MZ BL
- flood fringe is the hydraulic basis for MZ C.

MZ CU and MZ D do not have a hydraulic basis.

## Ecological criteria

In the Upper Namoi Valley Floodplain, there are a wide range of aquatic habitats of ecological importance, including oxbow lagoons, wetlands such as Lake Goran and many endangered ecological communities, as well as species protected under state legislation, including silver perch and broilga. Floodplain water flows are crucial to maintain the structure, function and long-term survival of the flood-dependent communities that occur in the Upper Namoi Valley Floodplain.

The purpose of the ecological criteria is to ensure that ecological assets are not impacted by changes to the passage of floodwater caused by new flood works or amendments to existing flood works. To this end, refinements were made to MZ AD and MZ AID, and MZ D was created as a new zone. Ecological refinements to MZ AD were made to include the riparian land adjacent to complex meandering river reaches. Ecological refinements were also made to MZ AD and MZ AID after consideration of the ecological assessment outputs from step 5 (Figure 23).

MZ D was based on floodplain assets of special value that thrive in frequently flooded areas of the floodplain identified during the assessment of ecological and cultural assets in step 5. In terms of ecological criteria only, MZ D was based on:

- ecological assessment outputs from step 5
- criteria determined through consultation with the TAG.

There were no modifications made to MZ BU, MZ BL or MZ C based on ecological criteria.

## Ecological refinements to MZ AD and MZ AID

Refinements were made to MZ AD to include tracts of floodplain land that are likely to be important for conveying floodwater discharge during smaller flood events through the floodplain to flood-dependent communities. This was done by adding a riparian buffer distance of 40 m (consistent with waterfront land defined under the WM Act 2000) to the hydraulically defined floodways that are complex, meandering river reaches, including anabranches. This approach is important for supporting lateral connectivity between the river and floodplain as well as longitudinal connectivity.

In step 5, wetlands and other floodplain ecosystems were categorised according to the optimum watering requirements of vegetation communities using information sourced from the reviews of Rogers and Ralph (2011) and Roberts and Marston (2011), which provide a synthesis of the best available knowledge (Table 2).

This information was a key consideration in step 7, where the optimum watering requirements of ecological assets were used as a guide to align the assets to an appropriate management zone. For the purposes of this plan, it was assumed that vegetation communities that need water more frequently will be in an area of the floodplain where there is a higher probability of flooding (AEP) and are more likely to be in or near floodways (i.e. MZ AD or MZ AID). Based on this assumption, assets that required water very frequently (that were not allocated to MZ D) were recommended to be in MZ AD or MZ AID. The breakdown of these management zone



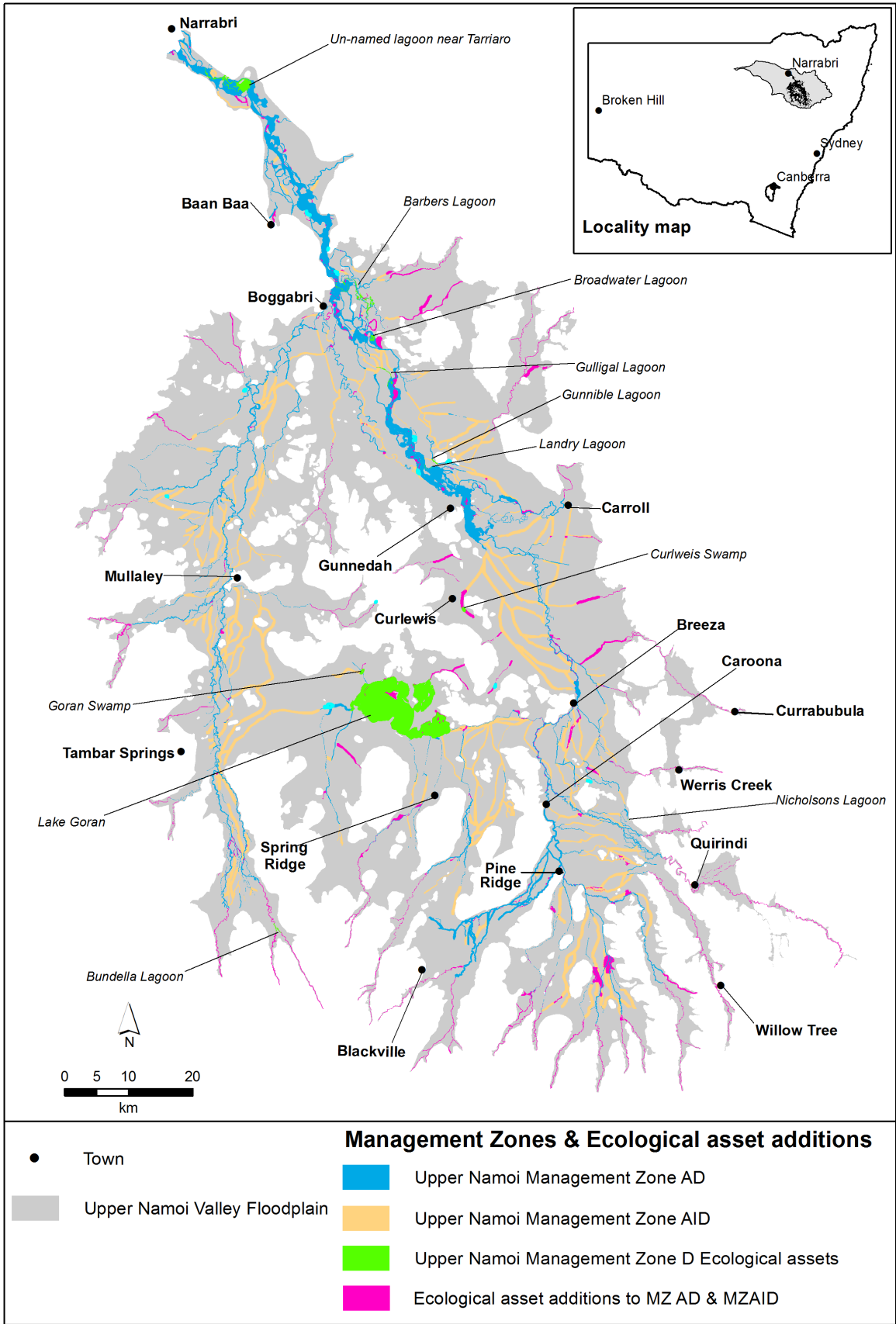
recommendations is presented in Table 7. Note that management zone recommendations were not made for groundwater recharge areas due to limited available data.

**Table 7. Management zone recommendation for ecological assets**

Ecological asset	Hydro-ecological functional group	Ideal frequency of watering	Management zone recommendation
Wetland	Semi-permanent wetland	Annual or near annual	MZ AD (entire record or polygon)
Wetland	Floodplain wetland (flood-dependent shrubland wetlands)	Every year to 1 in 5 years	MZ AD or MZ AID (polygon at least connected)
Other floodplain ecosystem	Flood-dependent forest/woodland (wetlands)	Ranges from in-channel freshes and overbank flows to 1 in 3 to 1 in 5 years	MZ AD or MZ AID (polygon at least connected)

A spatial analysis was undertaken to determine if the assets were captured in the recommended management zone. The high-priority ecological assets such as inner floodplain semi-permanent wetlands were found to occur within channels or depressions within or in close proximity to floodways (MZ AD and AID) as these vegetation communities depend on frequent flooding to survive and maintain their condition. Similarly, ecological assets such as flood-dependant forest/woodland (wetlands), including river oak (*Casuarina cunninghamiana subsp. Cunninghamiana*) and river red gum (*Eucalyptus camaldulensis*) are predominantly inner floodplain vegetation communities found on stream-banks of major rivers and creeks. These vegetation communities were well aligned with existing floodways (MZ AD and ID). Where assets were not captured in the recommended management zone, flood data was re-examined to determine if a hydraulic connection could be identified to extend MZ AD or MZ AID to encompass the asset. In some instances, there was not enough hydraulic justification to connect an asset to the recommended management zone. In these instances, management rules to protect flood connectivity to the assets developed in step 8 would have to be sufficient. Approximately 7,700 ha of MZ AD and 2,200 ha of MZ AID were added as a result of ecological refinements (Figure 23).

Key fish passage areas required for access to spawning and feeding locations were also allocated to MZ AD which were identified using the predicted current distributions of Silver Perch (*Bidyanus Bidyanus*), Purple Spotted Gudgeon (*Mogurnda adspersa*), Olive Perchlet (*Ambassis agassizii*) and Eel Tailed Catfish (*Tandanus tandanus*) NSW Fish Community Status and Threatened Fish Species Data (NSW Department of Primary Industries 2015). There were some minor changes made to the extent of MZ AD and MZ AID based on key fish passage areas. This resulted in 350 ha and 90 ha being added to zone MZAD and MZ AID respectively. Where key fish habitat was adjacent to MZ AD, the width of MZ AD was expanded to cover the flow paths identified by the *NSW Strahler Stream Order Hydroline* (2013), which were the predicted current distributions provided by NSW Department of Primary Industries 2015. ADS imagery was also referenced to include the extent of any visible anabranches/meanders near the identified fish habitat. All key fish passage areas are in-stream.



**Figure 23. Refinements to management zones based on ecological criteria and the locations of management zone D ecological assets.**

Note: Locations of 40 m buffers and key fish passage are not shown due to map scale.

## Management Zone D ecological criteria

MZ D includes ecological and cultural assets that have high flood dependency, high ecological or cultural value, and/or are a feature that are identified as important in environmental planning policies or are a feature that may be susceptible to conversion or loss of flood connectivity due to flood work development.

Eleven floodplain assets were recommended to become MZ D (Table 8, Figure 23). All eleven assets have high ecological value and a description of the ecological significance of each MZ D is provided in Table 8. A detailed description of MZ Ds is provided in Appendix 13.

**Table 8. List of floodplain assets classified as management zone D**

Ecologically significant asset	Size (ha)	Ecological significance	Easting	Northing	Zone
Barbers Lagoon	204	Functional capacity to act as an aquatic drought refuge. History of supporting a diversity of waterbird and native fish species	221929	6600250	56
Broadwater Lagoon	47	Functional capacity to act as an aquatic drought refuge. History of supporting a diversity of frog and waterbird species.	224593	6594310	56
Bundella Lagoon	29	Functional capacity to act as an aquatic drought refuge	784235	6501410	55
Curlewis Swamp	42	Functional capacity to act as an aquatic drought refuge	241206	6552750	56
Goran Swamp	46	Functional capacity to act as an aquatic drought refuge	225871	6542170	56
Gulligal Lagoon	50	Functional capacity to act as an aquatic drought refuge. History of supporting a diversity of waterbird and native fish species	227001	6588460	56
Gunnible Lagoon	19	Functional capacity to act as an aquatic drought refuge. History of supporting a diversity of waterbird and native fish species	235374	6575560	56
Lake Goran	8,028	Nationally significant large wetland complex listed on the Australian Wetlands Database. Functional capacity to act as an aquatic drought refuge. History of supporting a diversity of waterbird species.	229694	6537210	56
Landry Lagoon	6	Functional capacity to act as an aquatic drought refuge. History of supporting a diversity of waterbird and native fish species	234376	6574630	56
Nicholsons Lagoon	2	Functional capacity to act as an aquatic drought refuge	268697	6521440	56
Un-named lagoon near Tarriaro	473	Functional capacity to act as an aquatic drought refuge. History of supporting a diversity of frog and waterbird species.	777065	6633540	55

Note: Coordinates were calculated using GDA 1994 MGA 55 or 56, depending on the location of the asset.

Criteria to classify an ecological asset as MZ D included that the asset:

- had been identified in previous studies as having a high degree of floodwater dependency, habitat complexity and/or a history of supporting a diversity or abundance of waterbird, native fish or frog populations and/or
- has the functional capacity to act as an aquatic drought refuge and/or
- has been mapped, recognised in or protected by a local, state or Commonwealth environmental policy and/or
- has been reviewed by technical expert panel.

The extent of MZ D was determined in different ways, depending on the nature of the ecological asset. For Lake Goran, the extent was determined from vegetation mapping (OEH 2015, Eco Logical 2009), Land and Property Information (2012) and *NSW Hydro Area* (revised 2013) which is a polygon feature class of the NSW

Digital Topographic Database (DTDB). For other assets that were not lagoons, the extent was determined only from vegetation mapping (OEH 2015, Eco Logical Australia 2013, Eco Logical 2009). If the asset was a lagoon, the extent was determined using Land and Property Information (2012) Hydro area feature class of the NSW Digital Topographic Database (DTDB), where available. Additionally, where the asset was on waterfront land, a 40 m buffer was applied to the high water mark.

## Cultural criteria

The Upper Namoi Valley Floodplain contains many flood-dependent Aboriginal heritage sites and values that are important to the local Aboriginal community. The purpose of developing cultural criteria was to ensure that such flood-dependent cultural assets are not impacted by changes to the passage of floodwater caused by new flood works or amendments to existing flood works. Other historic heritage sites in the floodplain were found to not depend on flood waters and were not included as part of the cultural criteria for management zone delineation.

In step 5, the flood dependency of Aboriginal values and heritage sites was determined and this information was used to determine cultural criteria for refining management zones (Table 9). A number of high-value Aboriginal values identified by the community and assessed as flood-dependent were recommended for MZ AD or MZ D. To this effect, additions were made to MZ AD and MZ AID, and MZ D was created based on cultural assessment outputs from step 5. MZ BU, MZ BL and MZ C were not modified to specifically address cultural assets. A map of the cultural refinements made to management zones is not provided due to the cultural sensitivity of data. More detail is provided after the table.

**Table 9. Cultural criteria to include cultural assets in recommended management zones (MZs)**

Asset	Type	Description	MZ recommendation	Criteria for MZ inclusion
Flood-dependent Aboriginal values and heritage sites	Scarred trees	Living/flood-dependent vegetation	Variable—refer to vegetation	Include area in recommended MZ if within 200 m of MZ AD or AID
Flood-dependent Aboriginal values and heritage sites	Places identified by the community	Seven areas that are dependent on frequent flooding	MZ AD or D	Include whole of mapped area in MZ AD or D—ensure a hydraulic connection with either AD or AID
Flood-dependent Aboriginal values and heritage sites	Fish traps	None recorded	If found—MZ AD	Include whole of mapped area in MZ AD or D—ensure a hydraulic connection with either AD or AID
Flood-dependent historic heritage sites	N/A—No flood-dependent historic heritage sites were identified	N/A	N/A	N/A

### Scarred trees

Scarred trees, which are high-priority Aboriginal values and associated with living flood-dependent vegetation, were referred to a management zone based on the optimum watering requirements (ideal watering frequency) of the associated vegetation community (Table 7). MZ AD (or MZ AID) was amended to include the scarred (or carved) trees where living flood-dependent vegetation had an ideal watering frequency of at least every five years to maintain their ecological character. Due to the uncertain accuracy of scarred tree records, MZ AD (or MZ AID) was only amended when the record was within 200 m of a hydraulic floodway.

### Other Aboriginal values and Aboriginal heritage sites

Refinements were made to the management zones based on Aboriginal values (other than scarred trees) and heritage site as indicated in Table 9 when the:

- Aboriginal values are highly flood-dependent and:
  - identified on AWIS database and/or
  - were identified during direct community consultation with the local indigenous community, or

- are listed on AHIMS.
- location for a heritage site is flood dependent and the cultural heritage object(s) or place(s) is listed on Commonwealth, state and local government heritage registers.

To ensure management zone refinements represent on-ground conditions the above criteria were field validated against expert recommendations and to account for data accuracy and confidence. Where hydraulic justification could not be made to amend the management zones, there were opportunities for developing rules to protect flood connectivity to the assets in step 8.

## Non-flood-dependent cultural assets

Cultural assets vulnerable to the effect of erosion associated with the redistribution of flood flow or vulnerable to the direct impacts of the installation of new flood works or the modification of current works are not dealt with in the design of the management zones. Where identified, these cultural assets will be an additional consideration for licensing staff when assessing flood work applications.

## Management Zone D cultural criteria

Of the 11 MZ Ds, an undisclosed number (due to cultural sensitivities) also had high cultural value. Information on the cultural significance of sites cannot be provided due to cultural sensitivities; however, the cultural criteria used to delineate MZ D are provided below.

Criteria to classify a cultural asset as MZ D included that the asset was a location or landscape feature with a high degree of:

- floodwater dependency, such as swamps, marshes, lagoons, billabongs, rocky bars or warrumbools that are strongly dependent on the passage of floodwater, and
- cultural significance to the Aboriginal community, including spiritual, archaeological or resource use-values and are listed on a heritage register or are a place that is recognised for its cultural significance by several senior knowledge holders in the Aboriginal community.

MZ Ds based on cultural criteria are to be included in the AWIS database for follow-up investigations of their water requirements and the production of condition report cards by the Aboriginal Water Initiative team.

## Criteria to better reflect current floodplain management arrangements

Approximately 47% (274,200 ha) of the Upper Namoi Valley Floodplain is covered by existing second-generation FMPs and 24% (141,000 ha) has been the subject of a floodplain management study or guideline. There is good general acceptance of current floodplain management arrangements. It was therefore recommended that existing plans should be the basis for delineating management zones.

The aim of the new planning process was to provide as consistent an approach as possible across the floodplain while limiting change between the existing floodplain management arrangements and the Upper Namoi Valley FMP. To balance these two, at times, opposing aims, new criteria were developed at the scale of current FMPs and studies. This included criteria to:

- delineate floodways in the Blackville FMP study area to reflect rules specific to the Blackville FMP
- split MZ B at the Binnaway to Werris Creek Railway to account for differences in the flooding behaviour and rules of the FMPs north and south of the railway
- create a management zone for urban areas where local council is responsible for granting approvals for the majority of flood works under the *Environmental Planning and Assessment Act 1979*.

The purpose of criteria to better reflect current floodplain management arrangements were to amend management zones to better reflect current floodplain management arrangements in specific parts of the floodplain where required. Ultimately, change was seen across the management zones between current and

former floodplain management arrangements; however, as outlined in step 9, the changes reflect improvements in our understanding of the floodplain, improvements in the management of flood work development and a more consistent approach to floodplain management across the floodplain.

## Floodways in the Blackville FMP study area

The Blackville FMP (DIPNR 2003) included rules for proposed levees (either identified in the plan or not) that required that the levee:

- be located at least 100 m away from the bank of the outermost flow channel
- must allow for unimpeded flow of water via major flow lines as deemed to be a width of 100 m either side of the banks of the major flow line.

The floodways for the Upper Namoi Valley FMP were initially identified using hydraulic criteria identified in this step. Once identified, the extent of the floodways was then modified to include 100 m from the outer bank to be consistent with the Blackville FMP. This was only done in areas that are less than 0.5% slope to maintain consistency with the hydraulic criteria.

## Split of MZ B at the Binnaway to Werris Creek Railway

It was recommended that the MZ B be split at the Binnaway to Werris Creek railway to create:

- MZ B Upper (BU) to the south of the railway
- MZ B Lower (BL) to the north of the railway.

The railway is a reasonable landmark indicating a change to the floodplain topography with the floodplain being more constricted upstream (south) of the railway than downstream (north). The difference in topography is reflected in the current floodplain management arrangements. For instance, the Warrah Creek FMP (OEH and NOW 2012), which is south of the railway, has rules that specifically deal with drains. These drain rules are relevant to all the floodplain areas south of the railway where erosion of drains into large channels is a historical problem. The split into two management zones in the Upper Namoi Valley FMP allows rules to be tailored to the different types of flooding behaviour experienced either side of the railway.

## Urban areas in the floodplain (MZ CU)

MZ CU includes urban areas where flood risk is managed by local government through flood risk management plans and studies developed in accordance with the *Floodplain Development Manual* (NSW Government 2005) and also includes areas protected by flood mitigation works, such as town levees.

In the Upper Namoi Valley FMP, parts of the following towns were placed in MZ CU:

- Gunnedah (1,741 ha)
- Carroll (99 ha)
- Boggabri (204 ha).

Gunnedah and Carroll were identified by comparing the study areas shown in the *Gunnedah and Carroll Floodplain Management Study: December 1999 Executive summary* (SMC Australia Pty Ltd 2000) to zones in the local environmental plans (LEPs) and the town boundaries historically omitted from the floodplain designated under the *Water Act 1912*. Both the Gunnedah and Carroll MZ CUs were delineated in consultation with the Shire of Gunnedah.

Near the town of Gunnedah, MZ CU was delineated as:

- the area of floodplain where historically Gunnedah Council was the determining authority (purple line in Figure 24)

- all areas other than those zoned for Primary production (RU1) that are within the Gunnedah study area (blue line in Figure 24; SMEC Australia Pty Ltd 2000) with the exception of small primary production areas south of the Namoi River
- urban areas<sup>7</sup> in the LEP that are contiguous to the areas identified above, including any:
  - large lot residential (R5)
  - public recreation (RE1)
  - environmental management (E3).

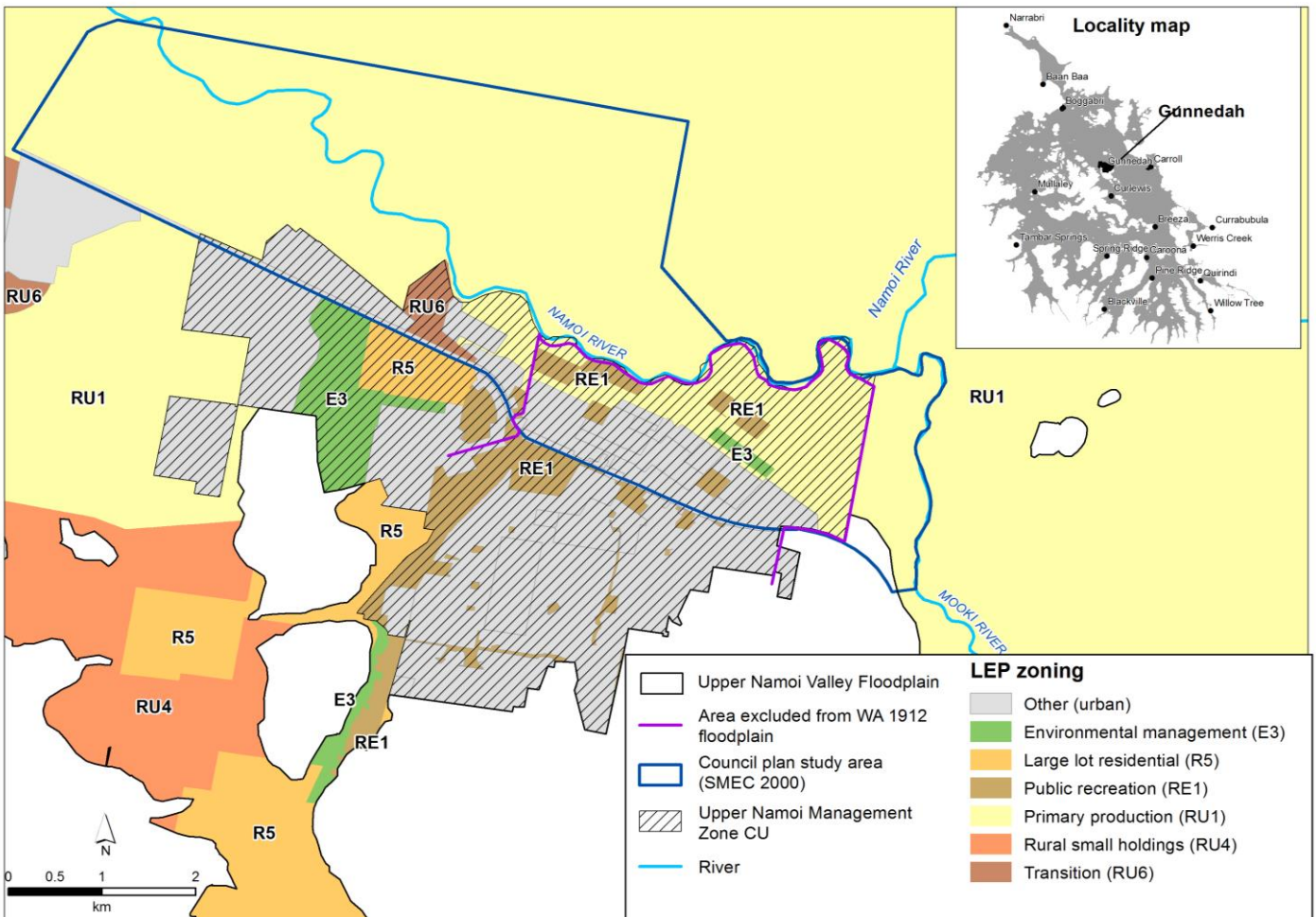


Figure 24. Management zone CU near the town of Gunnedah

<sup>7</sup> Urban includes the LEP zones local centre (B2), mixed use (B4), business development (B5), general industrial (IN1), heavy industrial (IN3), low-density residential (R2), medium-density residential (R3), private recreation (RE2), infrastructure (SP2)

The final MZ CU was essentially the area within the Carroll study area identified in the *Gunnedah and Carroll Floodplain Management Study* (SMEC Australia Pty Ltd 2000) that was zoned as a village (RU5) in the LEP (Figure 25).

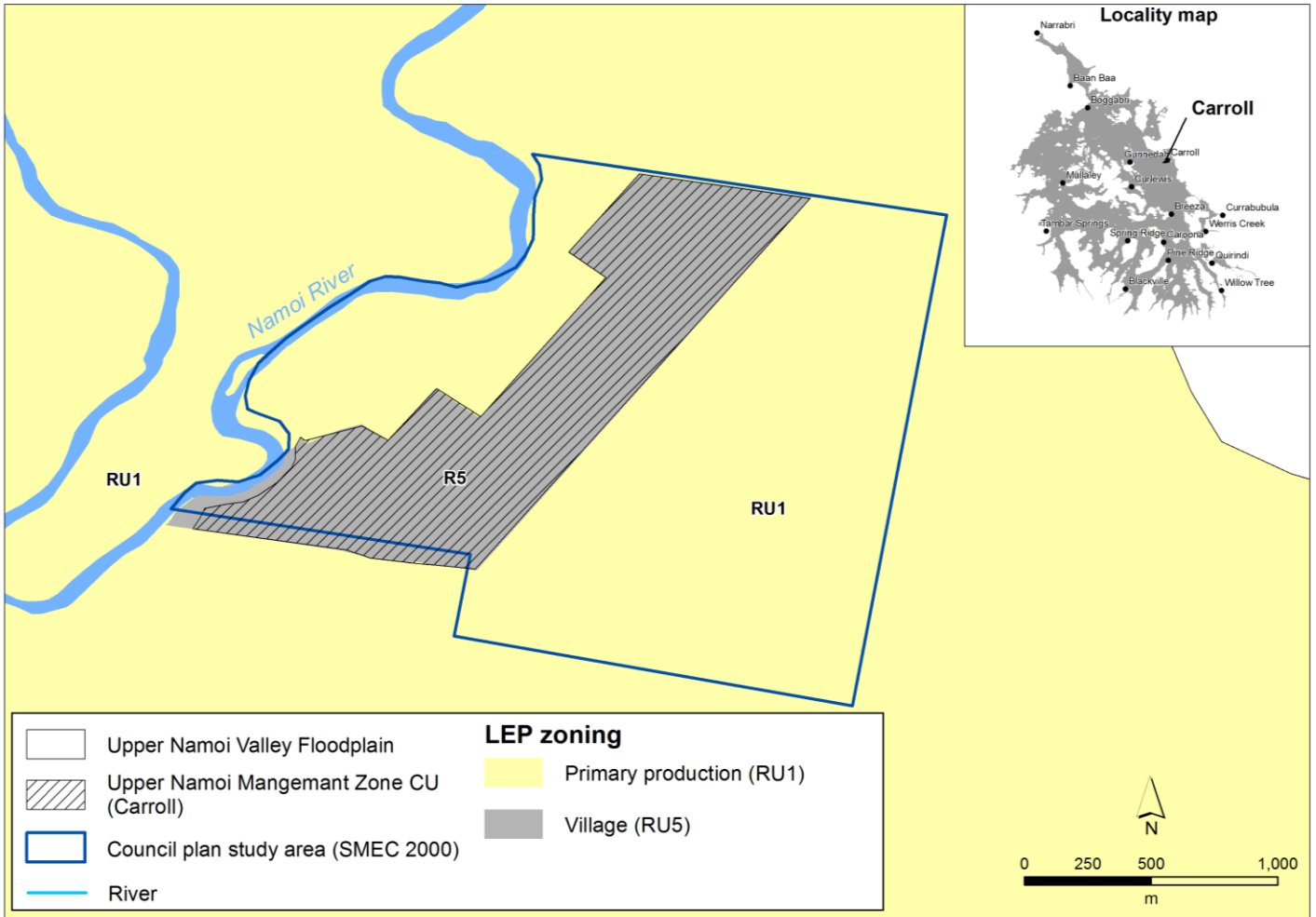


Figure 25. Management zone CU near the town of Carroll



Near the town of Boggabri, MZ CU was delineated as the areas within the flood planning area identified in the LEP 2012 (blue line on Figure 26) that are not zoned as primary production (RU1) and that are contiguous with urban areas. Urban areas were identified as the following LEP zones:

- local centre (B2)
- mixed use (B4)
- light industrial (IN2)
- general residential (R1)
- private recreation (RE2)
- infrastructure (SP2).

Outside of the flood planning area, the contiguous urban areas within the floodplain boundary were also identified as MZ CU.

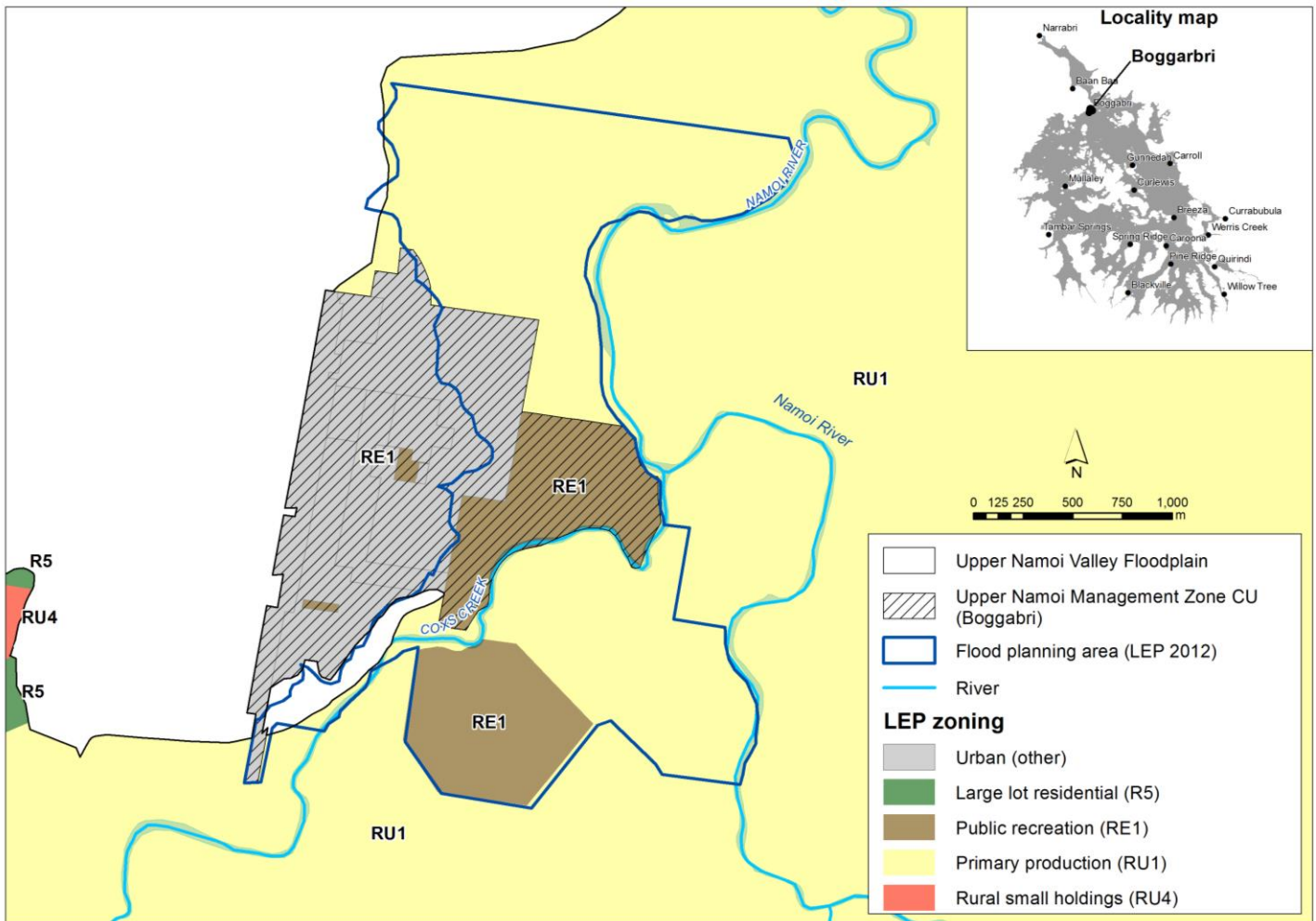


Figure 26. Management zone CU near the town of Boggabri

## Modifying a management zone

Part 10 Amendment of this plan in the Upper Namoi Valley FMP provides opportunity for landholders to seek to modify a management zone.

Amendments may be made to modify the area to which the plan applies or any management zone using any of the following information, or supporting information as determined by the minister:

- an aerial photograph or equivalent satellite image showing flood inundation at the property scale of either the small design flood or the large design flood
- oblique photos showing flood inundation of either the small design flood or the large design flood that contain verifiable land marks
- oblique photos of flood survey marks that can be verified for either the small design flood or the large design flood.

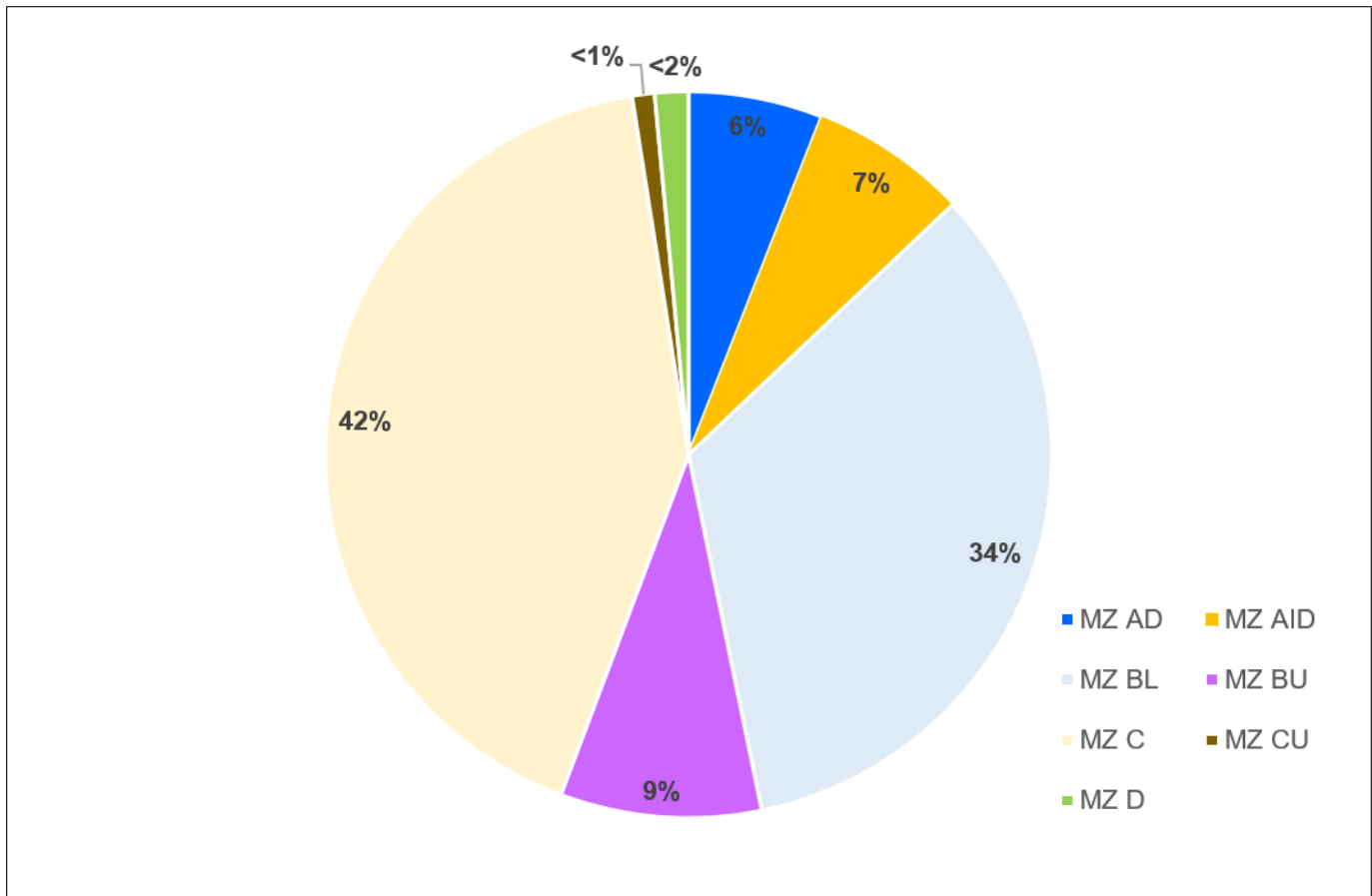
Note that a hydraulic study which provides velocity and depth information for the large design flood may be used to support this information.

## Summary of management zone criteria

The overall proportion of each management zone in the Upper Namoi Valley Floodplain is shown in Table 10 and Figure 27.

**Table 10. Proportion of each management zone in the Upper Namoi Valley Floodplain (rounded to nearest 100 ha)**

Management zone	Hectares	Percent of floodplain
AD	36,200	6
AID	41,100	7
BL	199,700	34
BU	52,900	9
C	247,700	42
CU	2,000	<1
D	8,900	2
<b>Total</b>	<b>588,600</b>	<b>100</b>



**Figure 27. Pie graph showing the proportion of the floodplain mapped as each of the seven types of management zones**

The overall configuration of management zones in the Upper Namoi Valley Floodplain was based on four categories of management zone criteria:

- hydraulic
- ecological
- cultural
- current floodplain management arrangements (existing planning)

The area contribution of each criteria to each management zone is shown in hectares in Table 11 and as a percentage of each zone in Table 12.

**Table 11. Contribution of each criteria to each management zone in hectares (rounded to the nearest 100 ha).**

Management zone	Hydraulic	Ecological*	Cultural	Existing planning	Total
AD	26,100	8,100	100	1,900	36,200
AID	38,800	2,300	0	0	41,100
BL	199,700	0	0	0	199,700
BU	52,900	0	0	0	52,900
C	239,300	0	0	8,400	247,700
CU	0	0	0	2,000	2,000
D	0	8,900	0	0	8,900
<b>Total</b>	<b>556,900</b>	<b>19,300</b>	<b>100</b>	<b>12,300</b>	<b>588,600</b>

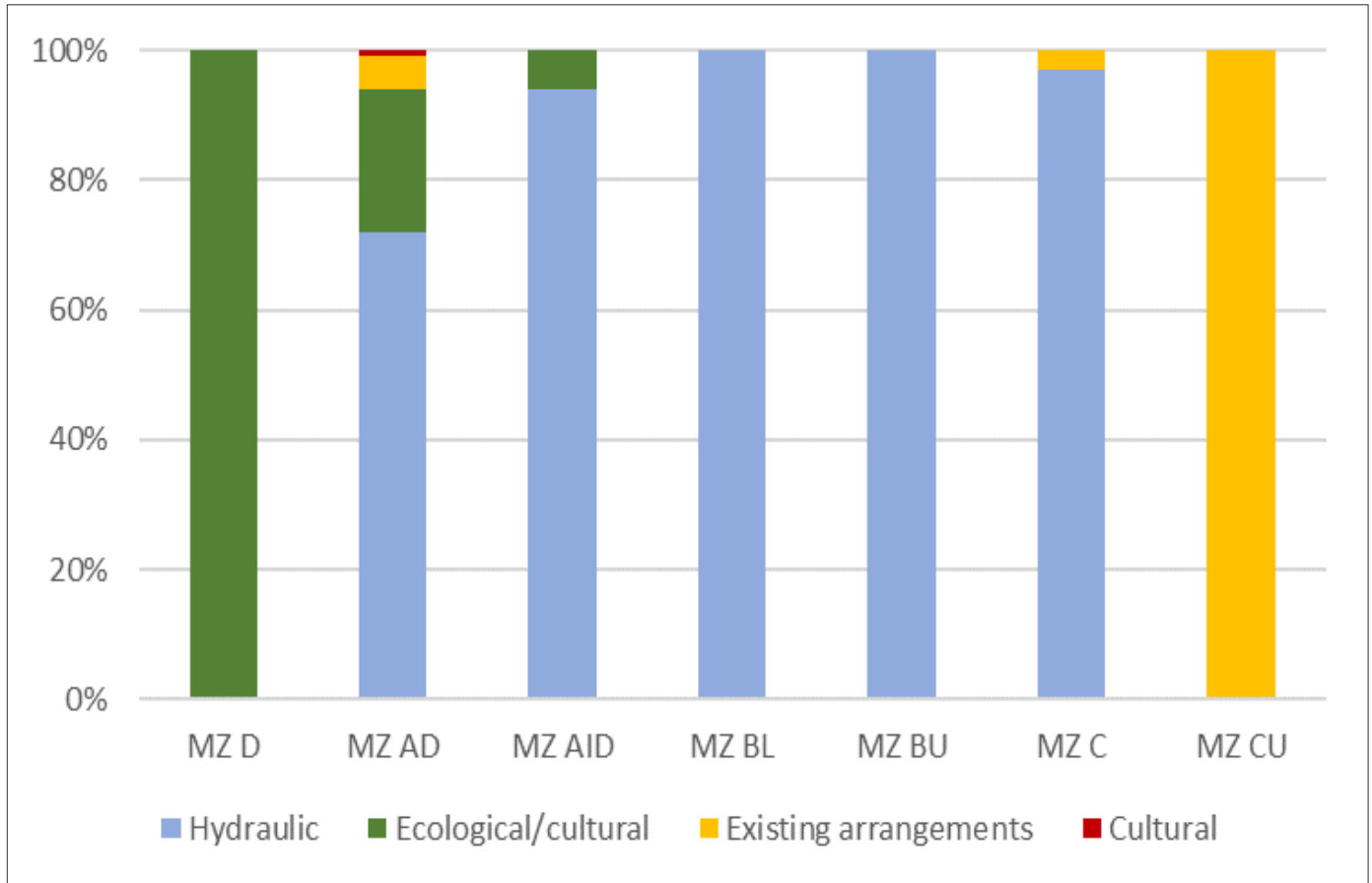
\* Where cultural and ecological criteria both contributed to the zoning decision, the area was added to the 'ecological' total.

**Table 12. Percentage contribution of each criteria to each management zone**

Management zone	Hydraulic	*Ecological	Cultural	Existing planning
AD	72	22	<1	5
AID	94	6	0	0
BL	100	0	0	0
BU	100	0	0	0
C	97	0	0	3
CU	0	0	0	100
D	0	100	0	0

\* Where cultural and ecological criteria both contributed to the zoning decision, the proportion was added to the 'ecological' total.

The relative contribution of each of the four categories of management zone criteria in the Upper Namoi Valley Floodplain is shown in Figure 28. A summary of the criteria for delineating the management zones is provided in Table 13 to Table 19.



**Figure 28. Contribution of each of the four types of criteria (hydraulic, ecological, cultural, existing arrangements) to each management zone.**

Note: The split of MZ B at the Binnaway to Werris Creek railway and the adjustment to floodways in the Blackville FMP study area are not reflected in this graph.

**Table 13. Criteria for Management Zone AD**

<b>Management Zone AD (36,200 ha/6%)</b>
<p><b>Hydraulic criteria</b></p> <p>MZ AD was mapped if the area was identified:</p> <ul style="list-style-type: none"> <li>• as major discharge areas with channels or banks</li> <li>• in a part of the floodplain with less than or equal to 0.5% slope</li> <li>• along the Namoi River or Mooki River and inundated by the 1998 flood.</li> </ul> <p>The width of MZ AD is the width of the channel plus a riparian buffer distance of 10 m (minimum width of 20 m in total).</p> <p><b>Ecological criteria</b></p> <p>Waterfront land was added to MZ AD identified in Stage 1 using a riparian buffer distance of 40 m for complex, meandering river reaches. In addition, MZ AD was mapped if the area is:</p> <ul style="list-style-type: none"> <li>• semi-permanent wetland</li> <li>• provides essential flood connectivity to high-priority ecological assets and channels or banks can be identified</li> <li>• key fish passage.</li> </ul> <p><b>Cultural criteria</b></p> <p>MZ AD was mapped if the area was identified as:</p> <ul style="list-style-type: none"> <li>• having an Aboriginal value(s) that is highly flood-dependent</li> <li>• having living scarred/carved trees that are flood-dependent species and the record was within 100 m of MZ AD/AID identified in Stage 1</li> <li>• a location for heritage site(s) that are flood dependent and are cultural heritage objects and places as listed on Commonwealth, state and local government heritage registers</li> <li>• providing essential flood connectivity to any of the above assets and channels or banks could be identified.</li> </ul> <p><b>Current floodplain management arrangements criteria</b></p> <p>In the parts of the current designated Blackville floodplain area that are less than 0.5% slope, MZ AD was mapped in areas that extend 100 m from the western flood runner identified in the Blackville FMP and from all other outermost flood channels.</p> <p>MZ AD was also reviewed for consistency with existing FMPs.</p>

**Table 14. Criteria for Management Zone AID**

<b>Management Zone AID (41,100 ha/7%)</b>
<p><b>Hydraulic criteria</b></p> <p>MZ AID was mapped if the area was identified as:</p> <ul style="list-style-type: none"> <li>• a major discharge area without channels or banks</li> <li>• in a part of the floodplain with less than or equal to 0.5% slope.</li> </ul> <p>The minimum width of MZ AID is 100 m, except in areas where the transition to smaller MZ ADs required a narrower width to ensure consistency along the floodways. The maximum width of MZ AID is 500 m. The width of MZ AID was determined by referencing flood imagery and topographical data.</p> <p><b>Ecological criteria</b></p> <p>MZ AID was mapped if the area provides essential flood connectivity to high-priority ecological assets and channels or banks could not be identified. The same width requirements as described in the hydraulic criteria for MZ AID applied.</p> <p><b>Cultural criteria</b></p> <p>MZ AID was mapped if the area was identified as providing essential flood connectivity to cultural assets mapped as MZ AD and banks or channels could not be identified. The same width requirements as described in the hydraulic criteria for MZ AID applied.</p> <p><b>Current floodplain management arrangements criteria</b></p> <p>MZ AID was reviewed for consistency with existing FMPs.</p>

**Table 15. Criteria for Management Zone BL**

<b>Management Zone BL (199,700 ha/34%)</b>
<p><b>Hydraulic criteria</b></p> <p>MZ BL was mapped if the area was identified:</p> <ul style="list-style-type: none"> <li>as important for flood storage and/or secondary flood discharge (i.e. parts of the floodplain with less than or equal to 0.5% slope)</li> <li>as not being MZ AD or MZ AID.</li> </ul>
<p><b>Ecological criteria</b></p> <p>The basis of MZ BL was not ecological.</p>
<p><b>Cultural criteria</b></p> <p>The basis of MZ BL was not cultural.</p>
<p><b>Current floodplain management arrangements criteria</b></p> <p>MZ BL was mapped as the flood storage and secondary flood discharge areas north of the Binnaway to Werris Creek Railway.</p>

**Table 16. Criteria for Management Zone BU**

<b>Management Zone BU (52,900 ha/9%)</b>
<p><b>Hydraulic criteria</b></p> <p>MZ BU was mapped if the area was identified:</p> <ul style="list-style-type: none"> <li>as important for flood storage and/or secondary flood discharge (i.e. parts of the floodplain with less than or equal to 0.5% slope)</li> <li>as not being MZ AD or MZ AID.</li> </ul>
<p><b>Ecological criteria</b></p> <p>The basis of MZ BU was not ecological.</p>
<p><b>Cultural criteria</b></p> <p>The basis of MZ BU was not cultural.</p>
<p><b>Current floodplain management arrangements criteria</b></p> <p>MZ BU was mapped as the flood storage and secondary flood discharge areas south of the Binnaway to Werris Creek Railway.</p>

**Table 17. Criteria for Management Zone C**

<b>Management Zone C (247,700 ha/42%)</b>
<p><b>Hydraulic criteria</b></p> <p>MZ C was mapped if the area was identified as:</p> <ul style="list-style-type: none"> <li>flood fringe (i.e. parts of the floodplain with a slope that is greater than 0.5%)</li> <li>protected from moderate to large floods by existing flood works.</li> </ul>
<p><b>Ecological criteria</b></p> <p>The basis of MZ C was not ecological.</p>
<p><b>Cultural criteria</b></p> <p>The basis of MZ C was not cultural.</p>
<p><b>Current floodplain management arrangements criteria</b></p> <p>MZ C was reviewed for consistency with existing plans.</p>

**Table 18. Criteria for Management Zone CU**

Management Zone CU (2,000 ha/<1%)
<p><b>Hydraulic criteria</b></p> <p>The basis for MZ CU was not hydraulic.</p>
<p><b>Ecological criteria</b></p> <p>The basis of MZ CU was not ecological. If any assets fall within MZ CU, ecological asset mapping will be provided to the relevant local government authority for consideration in land-use planning and assessment of development applications.</p>
<p><b>Cultural criteria</b></p> <p>The basis of MZ CU was not cultural. If any assets fall within MZ CU, the relevant local government authority will be notified and provided with relevant contact details.</p>
<p><b>Current floodplain management arrangements criteria</b></p> <p>MZ CU was mapped as urban areas covered by a flood study, flood risk management study, or flood risk management plan or that are protected by flood mitigation works such as town levees.</p>

**Table 19. Criteria for Management Zone D**

Management Zone D (8,900 ha/2%)
<p><b>Hydraulic criteria</b></p> <p>The basis for MZ D was not hydraulic.</p>
<p><b>Ecological criteria</b></p> <p>MZ D was mapped if the area was identified as having:</p> <ul style="list-style-type: none"> <li>• high ecological value</li> <li>• a high degree of flood water dependency</li> <li>• high irreplaceability as identified by Marxan</li> <li>• the functional capacity to act as an aquatic drought refuge.</li> </ul>
<p><b>Cultural criteria</b></p> <p>MZ D was mapped if the areas were identified as having a high degree of:</p> <ul style="list-style-type: none"> <li>• floodwater dependency such as swamps, marshes, lagoons, billabongs, rocky bars or warrumbools that are strongly dependent on the passage of floodwater</li> <li>• cultural significance to the Aboriginal community including spiritual, archaeological or resource use-values and are listed on a heritage register or are a place that is recognised for its cultural significance by several senior knowledge holders in the Aboriginal community.</li> </ul>
<p><b>Current floodplain management arrangements criteria</b></p> <p>MZ D was reviewed for consistency with existing plans.</p>



## Step 8: Determine rules

The management zones and rules (including assessment criteria) together provide the legal framework to assess flood work applications. Step 8 was undertaken to develop specific rules to define the type, nature and construction of flood works that can occur in each management zone. The rules vary between management zones to reflect differences in flooding behaviour and the floodplain environment. Step 8 was also undertaken to develop rules to license or modify existing licences for eligible existing flood works in MZ AD and MZ D.

The rules can be split into five general types, including those that:

- maintain flood-flow corridors through MZ AID
- specify the physical nature of permissible flood works
- specify advertising requirements
- are assessment criteria to determine the acceptable impacts of flood works
- relate to existing flood structures and works in MZ AD and MZ D.

The Upper Namoi Valley FMP is supported by assessment guidelines to assist with applying the rules to assess flood work applications.

The rules outlined in step 8 should be considered in conjunction with the statewide exemptions as set out in the Water Management (General) Regulation 2018 (see 'Exemptions to flood work approvals' below for further information).

### Flood-flow corridors

A flood-flow corridor is a hydraulic corridor that conveys flood flow through a management zone.

Flood-flow corridors were not mapped in the Upper Namoi Valley FMP because the floodways in MZ AID are ill-defined. This means that, although the evidence shows that a floodway goes through this area, the exact location and width of this floodway are unknown at the scale that the management zones were mapped (step 4).

Rather than mapping all floodways with the same management zone and applying the same restrictive rules as MZ AD, ill-defined floodways were appointed their own management zone (MZ AID) so that the uncertainty regarding the location of the major discharge area could be negotiated by the landholder applying for a flood work.

As such, the location of the flood-flow corridor within MZ AID is flexible and a landholder can negotiate a corridor that best suits their flood work application while also maintaining flood connectivity. The final location and width of the flood-flow corridor will depend on the location of flood-flow corridors (if identified) and MZ AD on adjacent properties, technical flood studies as well as consideration of the proposed location included in the flood work application.

### Rules for flood-flow corridors

In MZ AID applications for proposed or amended flood works must maintain a flood-flow corridor which meets the following requirements:

- (a) the flood-flow corridor must have a minimum width of:
  - (i) 20 m (a narrow flood-flow corridor), or
  - (ii) 100 m (a wide flood-flow corridor).
- (b) the flood-flow corridor must link:
  - (i) to other flood-flow corridors on the property under application or on adjacent landholdings, or

- (ii) to MZ AD on the property under application or on adjacent landholdings, if linking to other flood-flow corridors is not possible

Applications for proposed or amended flood works in MZ AID that are located wholly or partly within a flood-flow corridor must comply with the rules and meet the assessment criteria for flood works in MZ AD.

Applications for proposed or amended flood works in MZ AID that are located outside a flood-flow corridor and south of the Binnaway to Werris Creek railway must comply with the rules and assessment criteria for MZ BU.

Applications for proposed or amended flood works in MZ AID that are located outside a flood-flow corridor and north of the Binnaway to Werris Creek railway must comply with the rules and assessment criteria for MZ BL.

## Rules for certain other flood works in MZ AID (wide flood-flow corridors)

An application for a new or amended flood work approval in MZ AID that meets the following requirements must be advertised.

A flood work approval in MZ AID may be granted for a flood work that does not comply with the rules for MZ AD if the flood work:

- (a) is or is proposed to be located wholly or partially within a wide flood-flow corridor
- (b) is not one of the following:
  - (i) an infrastructure protection work
  - (ii) a stock refuge
  - (iii) an access road
  - (iv) a drain
  - (v) a supply channel
  - (vi) an ecological, Aboriginal value or heritage-site enhancement work
- (c) has or will have a height of no greater than 30cm above the natural surface level.

Applications for flood works that meet these rules must be assessed against the assessment criteria for MZ BU or BL (whichever is applicable).

## Permissible flood works

Permissible flood works are works for which an application for an approval will be accepted. Applications for permissible flood works must still go through the assessment process to receive an approval. Applications for non-permissible flood works will not be approved

The types of flood works that can be applied for in each management zone (permissible flood works) are determined by considering the optimal balance between hydraulic, ecological, cultural and socio-economic considerations on the floodplain. Rules relating to the physical nature of flood works are used to specify the types of permissible flood works and are easy to interpret and do not require technical assessment.

## Types of flood works

Nine types of flood works were identified in the Upper Namoi Valley Floodplain:

- (a) private access roads—to ensure landholders have basic provisions to access property
- (b) drains—to allow landholders to draw off surface water from their land
- (c) ecological, Aboriginal value and heritage-site enhancement works—to provide a positive outcome for an ecological or cultural asset that is mapped, recognised in or protected by the FMP, or a local, state or Commonwealth environmental policy or legislation
- (d) infrastructure protection works—to minimise risk to life and property

- (e) supply channels—to ensure supply channels reach water sources so landholders can access water rights
- (f) stock refuges—to account for animal welfare and to minimise a landholder's potential to lose stock to floodwaters
- (g) levees
- (h) storages
- (i) other earthworks and embankments.

### **Permissible flood works by management zone**

In MZ AD (including identified flood-flow corridors in MZ AID) and MZ D there is a high risk that flood works may impact on flooding behaviour. To minimise this risk, restrictions were placed on the types of flood works that could be applied for in these two zones. The restrictions on permissible flood works were made to be sympathetic to landholder needs and decisions were checked against:

- works likely to be approved under existing floodplain management planning arrangements (step 9 and step 10: phase 1)
- targeted consultation with the community and interagency officers.

The rules specify that the types of permissible flood works in MZ AD (and identified flood-flow corridors) are:

- access roads
- supply channels
- drains
- ecological, Aboriginal value and heritage-site enhancement works—to provide a positive outcome for an ecological or cultural asset that is mapped, recognised in or protected by the FMP, or a local, state or Commonwealth environmental policy or legislation
- infrastructure protection works
- stock refuges.

The rules specify that Aboriginal value, ecological and heritage-site enhancement works are the only type of permissible flood works in MZ D.

In MZ BL, MZ BU, MZ C and MZ CU all types of flood works are permissible.

The rules that specify the physical nature of permissible flood works in MZ AD (and identified flood-flow corridors) and MZ D are described in detail below.

## Access roads

In MZ AD (and identified flood-flow corridors), access roads\* must:

- (a) be no more than 15 cm in height above the natural surface level, and
- (b) be constructed with causeways at no higher than the natural surface level and occurring at least once every 200 m of road length, and
- (c) have causeways that comprise at least 10% of the total length of the access road that is in MZ AD, and

Note: This applies to access roads within a single property that span multiple properties.

- (d) be constructed so that the borrow associated with the construction and maintenance of access roads is located on the downstream side of the road and must not exceed 15 cm below the natural surface level.

\*Primary access road: a road providing access from a public road to a permanently occupied fixed dwelling via a direct route.

## Justification for specifications

The height limit of 15 cm for access roads was selected as the threshold for the Gwydir Valley FMP 2016 (NOW 2014) and was also the height allowable for access roads in the Carroona to Breeza FMP (DNR 2006a).

Prior to targeted consultation (February to May 2015), it was recommended that access roads be at ground level through MZ AD due to the narrow and concentrated flow in the Upper Namoi; however, during targeted consultation landholders raised concerns that the access road would not function during or after floods if it was at ground level. As a result, access roads are now permissible via application at 15 cm in height in MZ AD.

In the Upper Yarraman and Warrah Creek FMPs (DNR 2006c, OEH and NOW 2012), access roads were required to be less than or equal to 10 cm. This was increased to 15 cm for consistency across the floodplain and with the Gwydir Valley FMP (NOW 2014). Furthermore, hydraulic modelling indicates that roads less than 15 cm high will be overtopped by most floods and will have minimal impact on flood flows.

The causeway requirements are to allow unimpeded flood flow during small flood events. The causeways also allow for connectivity that is important for fish passage. The requirements for causeways are modelled on the Gwydir Valley FMP 2016 (NOW 2014), which were originally adopted from the Lower Gingham Watercourse FMP (DNR 2006d). Causeways are included to ensure that access roads will not block or divert flood flows, which are important for flood-dependent ecological and cultural assets.

Rules relating to borrow pits were developed for the Gwydir Valley FMP 2016 (NOW 2014) and represent current best-practice principles. The positioning of the borrow pit on the downstream side and limiting the depth to 15 cm was selected to facilitate the passage of floodwater, prevent diversion of floodwater, minimise soil erosion and reduce disruption to access by maintaining the stability of the roadway.

## Infrastructure protection works (IPWs)

In MZ AD (and identified flood-flow corridors), IPWs:

- on landholdings less than 20 ha in area must enclose less than or equal to 10% of the total area of the landholding, or
- on landholdings greater than 20 ha in area can enclose up to 2 ha or up to 1% of the total area of the landholding, whichever is the greater
- must not block more than 5% of the width of MZ AD at the location of the work.

### Justification for specifications

To avoid flood-flow redistribution impacts, IPWs are to be regulated and subjected to an assessment process. Size thresholds are based on those in the Gwydir Valley FMP 2016 (NOW 2014) and the Carroll to Boggabri FMP (DIPNR 2005). The rules recognise the different asset protection requirements of small and large properties.

In the Warrah Creek FMP (OEH and NOW 2012), IPWs are exempt from needing a Part 8 approval. It is now proposed that IPWs require licensing in this area so the impacts on flood behaviour can be minimised. Conversely, in the Upper Yarraman Creek FMP (DNR 2006c) works within the riparian zone (roughly equivalent to MZ AD) could not be built unless listed in the Yarraman Creek River Care Plan (1996). It is now proposed that IPWs be allowed in MZ AD areas of the Upper Yarraman Creek so that landholders can protect life and property.

In other areas, it was general policy to approve IPWs according to the Carroll to Boggabri FMP (DIPNR 2005). The Upper Namoi Valley FMP now formalises this policy in the rules.

The rules requiring IPWs to not block more than 5% of the width of MZ AD at the location of the works was referenced from the Gwydir Valley FMP 2016 (NOW 2014) and was used in interim working policies adopted by the department prior to this. This rule provides greater certainty to landholders wishing to construct an IPW by specifying a threshold for how much of MZ AD can be blocked.

## Supply channels

In MZ AD (and identified flood-flow corridors), supply channels must be:

- below the natural surface level, and
- constructed in such a way as to allow for the adequate passage of floodwater and to adequately prevent the diversion of floodwater from natural flow paths, and

Note: A structure may be required to be put in place at a low point of the supply channel to achieve this.

- constructed and maintained so that the spoil is windrowed parallel to the direction of flow such that it does not block more than 5% of the width of MZ AD at the location where the work is being constructed, or
- is levelled to a maximum 10 cm above the natural surface level.

### Justification for specifications

Supply channels were assessed as flood works in the Carroona to Breeza FMP (DNR 2006a) and were required to be at or below ground level. In other areas of the Upper Namoi Valley Floodplain, below-ground supply channels did not require approval if they had an existing approval under Part 2 of the *Water Act 1912*. As for the Gwydir Valley FMP 2016 (NOW 2014), it was proposed to assess below-ground supply channels as a flood work because of their potential to impact on flooding behaviour. This assessment would be consistent with Part 2 practice, which would place a condition that water supply works could not impact flooding. The regulation of this type of work as a flood work better ensures flood connectivity during small flood events.

There are additional rules when assessing supply channels that are modelled on those from the Gwydir Valley FMP 2016 (NOW 2014). These rules are important for ensuring that low flows are not captured and/or diverted by below-ground channels and that spoil is managed to minimise impacts by limiting obstruction of active

discharge areas. Construction of siphons or equivalent structures will enable floods to pass through or under these works.

## Stock refuges

In MZ AD (and identified flood-flow corridors), stock refuge:

- on landholdings less than 20 ha in area must enclose less than or equal to 10% of the total area of the landholding, or
- on landholdings greater than 20 ha in area can enclose up to 2 ha in area or up to 1% of the total area of the landholding, whichever is the greater
- must not block more than 5% of the width of MZ AD at the location of the work.

## Justification for specifications

To avoid flood-flow redistribution impacts, stock refuges are regulated and subjected to an assessment process. The same thresholds as used for IPWs were used for stock refuge.

## Drains

In MZ AD (and identified flood-flow corridors), drains must be constructed:

- no more than 30 cm below the natural surface level, except where the drain is in transition into another drain, natural depression or watercourse, and
- to convey flow of no more than a 1-year EY<sup>8</sup> event, and
- at an orientation of approximately 90° to the direction of flow, and
- with a longitudinal slope of less than 1 in 500 and a non-scouring velocity, and
- so that the distance over which the drain is in transition is kept to a minimum, and
- in a way that does not increase the capacity of the drain or impact flood behaviour

Note:

1. Spoil must not be placed in a way that increases the capacity of the drain.
2. Where possible, the drain should be constructed or modified so that it transitions into an existing drain or natural depression rather than into a watercourse. Transition length must be kept to a minimum to prevent erosion. A drop structure may be required to pass water to a lower elevation in a controlled manner and prevent erosion. Drop structures can take many forms, depending on the transition depth, length or topography. A common example of a drop structure is a grade control, sill or weir.

## Justification for specifications

The proposed specifications for drains were adopted from the Warrah Creek FMP (OEH and NOW 2012). In other areas of the Upper Namoi Valley FMP, there were no specific criteria in FMPs when licensing drains, although they would still have been licensed with conditions.

It was proposed to apply the drains criteria because drains have been constructed that have subsequently eroded into large gullies which have changed flooding patterns and led to siltation problems downstream. Accordingly, any future drains will need to be carefully designed and constructed to abate the risk of adverse environmental impacts.

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<sup>8</sup> EY refers to Exceedance per Year which is the expected number of times in a year that the event will occur or be exceeded.

## Ecological enhancement work

In MZ A and MZ D the ecological enhancement work must provide a positive outcome for an ecological asset that is mapped, recognised in or protected by this plan, or a local, state or Commonwealth environmental policy and/or legislation.

### Justification for specifications

An ecological enhancement work is a type of flood work that provides a positive outcome for the environment. These types of works are permissible in MZ A and MZ D as they will provide a positive outcome for the environment, consistent with the WM Act 2000 additional provision 30(c) which allows for an FMP to deal with the restoration or rehabilitation of land, water sources or their dependent ecosystems, in particular in relation to the following:

- the passage, flow and distribution of flood water
- existing dominant floodways and exits from floodways
- rates of flow, floodwater levels and duration of inundation
- downstream water flows
- natural flood regimes, including spatial and temporal variability.

## Aboriginal value enhancement work

In MZ A and MZ D, an Aboriginal value enhancement work must provide positive outcomes for an Aboriginal value asset that is listed on at least one of the following databases:

- NSW AHIMS
- NSW AWIS
- MDBA Aboriginal Submissions Database
- NSW State Heritage Inventory
- Australian Heritage Database (also referred as Commonwealth Heritage List)
- any other source or database deemed relevant by the minister.

### Justification for specifications

An Aboriginal value enhancement work is a type of flood work that enables the protection of locations or landscape features that have Aboriginal value. These types of works are permissible in MZ A and MZ D areas as they will provide a positive outcome for locations or landscapes that contain Aboriginal values. This rule is consistent with the objects of the WM Act 2000, clauses 3(c)(iii) and (iv), which ensure that culture and benefits to Aboriginal people in relation to their spiritual and customary use of land and water are recognised and incorporated into sustainable water resource management. As Aboriginal values are linked with ecological assets, this rule is also consistent with the WM Act 2000 additional provision 30(c), which allows for a FMP to deal with the restoration or rehabilitation of land, water sources or their dependent ecosystems.

## Heritage-site enhancement work

In MZ A and MZ D, a heritage-site enhancement work must provide a positive outcome for a heritage-site asset that is listed in at least one of the following databases:

- NSW AHIMS
- NSW AWIS
- MDBA Aboriginal Submissions Database
- NSW State Heritage Register
- NSW State Heritage Inventory
- Historic Heritage Information Management System
- Australian Heritage Database (also referred as Commonwealth Heritage List)
- any other source or database deemed relevant by the minister.

## Justification for specifications

A heritage-site enhancement work is a type of flood work that enables the protection of Aboriginal or heritage locations in the floodplain that have recognised significance. These types of works are permissible in MZ A and MZ D areas as they will provide a positive outcome to flood-dependent heritage sites. This rule is consistent with the objects of the WM Act 2000, clauses 3(c)(iii) and (iv), which ensure that culture and heritage, and benefits to Aboriginal people in relation to their spiritual and customary use of land and water are recognised and incorporated into sustainable water resource management. As some heritage sites are linked with ecological assets, this rule is also consistent with the WM Act 2000 additional provision 30(c), which allows for a FMP to deal with the restoration or rehabilitation of land, water sources or their dependent ecosystems.

## Advertising requirements

The Upper Namoi Valley FMP does not require advertising for works deemed to be minor in nature in most management zones. Advertising requirements were determined by considering the level of impact flood works would likely have on flood behaviour, floodplain connectivity and on neighbouring properties.

The types of flood works that can be applied for in MZ AD and MZ D are minor in nature and therefore flood work applications in these zones do not need to be advertised.

The incremental increase in the risk of unsuitable development in MZ AID (wide flood-flow corridors) is mitigated by the requirement for 'Certain other flood works in MZ AID' to be advertised and to meet the assessment criteria for MZ BU or BL, which are more restrictive than the assessment criteria for MZ AD.

There are no restrictions on the types of flood works that can be applied for in MZ BU and MZ BL. However, because these zones are major flood storage and secondary flood discharge areas, there is a reasonable risk that some flood works will impact on flood behaviour and floodplain connectivity. To address this issue, the rules for these zones divide flood work applications into:

- flood work applications that do not require advertising, including:
  - drains in MZ BU
  - infrastructure protection works in MZ BL
  - stock refuges in MZ BL
  - minor flood protection works that are less than 50 cm in height above the natural surface level in MZ BL
- flood work applications that do require advertising, which are all other flood work applications (non-specified flood works) not listed as requiring advertising.



In MZ BL, a flood work application does not require advertising if it is:

- no more than 50 cm in height above the natural surface level, or
- used to protect infrastructure or as a stock refuge and the area used or protected:
  - accounts for no more than 1% of the total area of the landholding, and
  - is no more than 2 ha in size in any single location in MZ BL.

There are no restrictions on the types of flood works that can be applied for in MZ C. However, because MZ C includes flood fringe and existing developed areas, there is a low risk that flood works will impact third parties except for during very large floods, such as the 1% AEP flood. Therefore, flood work applications do not need to be advertised unless requested by the minister.

There is also no restriction on the types of flood works that can be applied for in MZ CU. A number of flood works likely to be applied for in MZ CU will be exempt from requiring a flood work approval under the WM Act 2000 (see 'Exemptions to flood work approvals'). For those works that are not exempt, flood work applications will be assessed under MZ C assessment criteria. This means that such flood work applications do not need to be advertised unless requested by the minister.

## Assessment criteria

Assessment criteria relating to the acceptable impacts of flood works have been designed to consider the potential for a flood work to have:

- Aboriginal, ecological and heritage-site impacts
- social (drainage) impacts
- local hydraulic impacts
- cumulative hydraulic impacts.

The above categories of impacts are considered in the assessment criteria in different ways, depending on the management zone that a flood work application is made for (

Table 20).

**Table 20. Categories of impacts that flood work applications must be assessed against to be approved by management zone**

Assessment criteria		MZ AD	MZ AID	MZ BU	MZ BL	MZ C/CU	MZ D
Ecological and cultural impacts	Flood connectivity to ecological assets (including fish passage), Aboriginal values, heritage sites	✓	*	✓	✓	✓	✓
Ecological and cultural impacts	Heritage site impacts	✓	*	✓	✓	✓	✓
Social (drainage) impacts	Drainage impacts	✓	*	✓	✓	✓	✓
Local hydraulic impacts	Redistribution	^	*	✓#	✓#	^	^
Local hydraulic impacts	Flood levels	^	*	✓#	✓#	^	^
Local hydraulic impacts	Velocity	^	*	✓#	✓#	^	^
Cumulative hydraulic impacts	Redistribution	✓	*	✓#	✓#	^	✓

\*Flood works located wholly or partially within a narrow flood-flow corridor will be assessed as MZ AD. Flood works outside the flood-flow corridor will be assessed against the criteria for MZ BU/BL (whichever is applicable). See 'Flood-flow Corridors' for applicable assessment criteria for 'certain other flood works' that do not comply with the rules for MZ AD.

^ Assessment criteria are discretionary.

# Assessment criteria are discretionary for minor works that do not require advertising. For flood works that require advertising, all assessment criteria are mandatory.

Assessment criteria relating to the acceptable impacts of flood works follow a merit-based assessment approach and require technical assessment to interpret and apply. Flood work applications may require supporting information to assist with interpretation during the determination. Flood events (known as 'flood scenarios' in the Upper Namoi Valley FMP) are considered when applying the assessment criteria. The types of flood scenarios depend on the management zone and the type of assessment criteria as outlined in the Upper Namoi Valley FMP. More information on each of the four assessment criteria categories is found below. The blue boxes provide a plain English version of the assessment criteria found in the Upper Namoi Valley FMP.

## Ecological and cultural impacts

### Description of the criteria

The ecological and cultural impacts assessment criteria are designed to ensure that flood connectivity to ecological and cultural assets is considered when determining a flood work approval. Criteria were also developed to ensure that areas of cultural heritage significance are not disturbed during construction of flood works.

## Flood connectivity to assets

In all management zones, a flood work must be constructed to maintain adequate flood connectivity to:

- ecological and/or cultural assets
- facilitate fish passage
- Aboriginal values
- heritage sites.

Such flood connectivity must be maintained under a range of flood scenarios, including, at a minimum, scenarios for the relevant small and large design floods.

## Heritage site impacts

In all management zones, the construction of a flood work must not disturb the ground surface of a heritage site or cause more than minimal erosion to a heritage site.

## Why are ecological and cultural impacts considered?

Ecological and cultural impacts assessment criteria were developed to ensure that floodplain assets were specifically considered during the assessment of flood work applications. The management zones were designed on a strategic scale and may not always account for the complex network of flow paths and pathways that are important for maintaining the ecological character of flood-dependent ecological assets, Aboriginal values and heritage sites. This assessment criteria ensures that flood works will not block these critical flow paths. TAG and agency experts determined that fish habitat on the floodplain is a significant asset that requires additional protection measures. Regulatory structures and flow alteration have contributed to a significant decline in the abundance and distribution of native fish in the Murray–Darling Basin (Cadwallader 1978; Horwitz 1999; Thorncraft & Harris 2000; Humphries et al. 2002). Therefore, flood connectivity that facilitates fish passage will be specifically dealt with in the assessment criteria. Consultation with the ATWG and agency experts identified that some heritage sites are at risk from being impacted during the construction of a flood work or as a result of erosion from changes to flood behaviour caused by a flood work. Sites that may be potentially impacted by flood work development were identified in the FMP and will be considered as part of the flood work application assessment process. If a flood work is proposed in the vicinity of such a site, the *National Parks and Wildlife Act 1974* will be triggered and a due diligence assessment will be required to be undertaken to ensure the sites are not impacted by the proposal.

## How were the criteria determined?

The criteria were determined by considering current floodplain management arrangements and after discussions with the Fisheries NSW representative of the TAG and the ATWG. These assessment criteria are also in the Gwydir Valley FMP 2016 (NOW 2014).

## How will the criteria be applied?

Ecological and cultural impacts assessment criteria will be assessed using spatial floodplain asset datasets and site observation data. NSW State and Commonwealth heritage registers will also be checked to identify any heritage sites within the local area of a flood work application. Flow paths across a range of flood scenarios may be considered to ensure flood connectivity is maintained to ecological and cultural assets.

There may be instances where the flood work proposal triggers the need for the applicant or the assessing officer to seek advice, permits or to notify external agencies of a flood work application. Referrals will be an integral part of meeting these assessment criteria due to the overlap of the assessment requirements of the WM Act 2000 and other legislation relevant to flood work approvals, including the *Environmental Planning and Assessment Act 1979*, the *Fisheries Management Act 1994*, the *National Parks and Wildlife Act 1974* and the *Biodiversity Conservation Act 2016*.

Referrals will improve the assessment of flood work applications against the assessment criteria by strengthening links with other agencies or groups that have a responsibility or function to contribute to the assessment of the impacts under related legislation.

In some cases, additional detailed ecological and cultural assessments may be required to support a flood work application.

If an application is required to be supported by a flood study, there will be specific requirements that the applicant (or consultant on behalf of the applicant) will be required to address to demonstrate that flood connectivity is adequately maintained to flood-dependent ecological and cultural assets.

## **Social (drainage) impacts**

### **Description of the criterion**

The drainage impacts assessment criterion was designed to ensure that local drainage on neighbouring properties is maintained.

In all management zones, a flood work must maintain drainage on adjacent landholdings and other landholding within 12 hours of existing drainage times when compared to drainage times under pre-development and existing development conditions for a range of flood scenarios including, at a minimum, the relevant small and large design flood.

### **Why are drainage impacts considered?**

Drainage impacts are considered because the management zones were designed on a strategic scale that may not account for a flood work impacting on local drainage in such a way as to cause a significant disruption to the daily life of surrounding landholders. For instance, changes to local drainage may cause considerable local issues, nuisance or conflict, or property access may be disrupted.

### **How was the criterion determined?**

The criterion was determined by considering current floodplain management arrangements. This assessment criterion was also in the Gwydir Valley FMP 2016 (NOW 2014).

### **How will the criterion be applied?**

The flood work applicant will need to demonstrate that flood water will not remain in the local area for an excessively long time compared to existing floodplain conditions. Consideration will also need to be given to avoiding peak travel time being unduly accelerated to downstream users.

Assessment of this criterion will involve giving key consideration to pondage times, peak travel time downstream and soil types that may influence permeability (i.e. potential waterlogging of land). A range of spatial datasets will be used to assist with this assessment, including contours, slope, soils information as well as site observation data.

If a flood study is available, information from the study will be used during the assessment. Assessment will also consider additional data such as floodplain asset datasets to ensure that changes to drainage do not have a significant effect on flood connectivity to sensitive wetland areas. Local topography will be considered to minimise the likelihood of new flood works changing local drainage lines in a disruptive manner. Local flooding patterns across a range of floods may also be considered, including the small and large design floods.

## **Local hydraulic impacts**

### **Description of the criteria**

The local hydraulic impacts assessment criteria were designed to ensure that within the local area, a flood work application has a minimal impact (thresholds apply) on:

- redistribution of peak flood flow

- flood levels
- flow velocity.

The 'local' area is generally defined as the adjacent landholding and other landholdings that may be affected by the proposed flood work.

The use of the assessment criteria to assess applications for minor works (i.e. those that do not require advertising) in MZ BU and MZ BL is discretionary. The use of the assessment criteria to assess applications for all types of flood works in MZ C and CU is also discretionary. For flood work applications that require advertising in MZ BU and MZ BL, the assessment criteria are mandatory.

In MZ BU and MZ BL, applications for flood works that require advertising (i.e. are not minor) must demonstrate that the work is unlikely to:

- redistribute the peak flood flow by more than 5% in the adjacent landholdings and other landholdings that may be affected by the proposed flood work when compared to the peak flood flow under pre-development and existing development conditions for a range of flood scenarios including, at a minimum, the relevant small and large design floods, or
- increase flood levels by more than 20 cm on adjacent landholdings and other landholdings that may be affected by the proposed flood work when compared to flood levels under pre-development and existing development conditions for a range of flood scenarios including, at a minimum, the relevant small and large design floods, or
- increase flow velocity by more than 50% on the landholding under application or in the adjacent landholdings and other landholdings that may be affected by the proposed flood work when compared to flow velocity under pre-development conditions for a range of flood scenarios including, at minimum, the relevant small and large design floods, unless:
  - increases by more than 50% are allowed in isolated areas where the landholder mitigates the impact of the flood wave so that the average impact across the landholding under application is no greater than 50%, and
  - flow velocity is not increased by more than 50% at the boundary of the landholding under application, or
- increase flood levels such that they impact high-value infrastructure when compared to flood levels under pre-development and existing development conditions for a range of flood scenarios including the relevant small and large design floods, or
- increase flow velocity by an amount that is likely to have more than minimal impact on soil erodibility on the landholding under application, adjacent landholdings and other landholdings that may be affected by the proposed flood work, taking into account the ground cover on those landholdings,
- redistribute the peak flood flow of more the 5% at any of the peak discharge calculation locations when compared to redistribution under existing development conditions for a range of flood scenarios including, at a minimum, scenarios for the relevant small and large design floods, and
- redistribute the peak flood flow under existing development conditions by more than 5% at any location and under any flood scenario considered relevant by the minister.

In MZ C (and MZ CU), applications for flood works may be required by the minister to demonstrate that they adhere to the assessment criteria specified above for MZ BU and MZ BL. The flood scenarios used to assess the application are not prescriptive and may be determined by the minister.

## Why are local hydraulic impacts considered?

Local hydraulic impacts assessment criteria were developed to ensure that flood work applications do not significantly change key hydraulic parameters in the local area and, in some instances, on the landholding under application. To best assess impacts on local flood behaviour, each relevant flood work application must be assessed on a case-by-case basis. This assessment will reduce the likelihood that flood works will impact on flood behaviour, including the potential to redistribute peak flood flows, increase the flood risk and inundation extents by raising flood levels, and increase the potential for erosion and siltation by increasing flood flow velocities.

## How were the criteria determined?

The criteria were determined by considering current floodplain management arrangements and the Gwydir Valley FMP 2016 (NOW 2014) and to limit the impact of future development on flooding behaviour. Specifically, the selected thresholds were referenced from current floodplain management plans in the following areas:

- Gwydir Valley FMP (NOW 2014)
- Carroona–Breeza FMP (DNR 2006a)
- Carroll–Boggabri FMP (DIPNR 2005)
- Lower Coxs Creek FMP (OEH and NOW 2013)
- Upper Coxs Creek FMP (DNR 2005)
- Upper Yarraman Creek FMP (DNR 2006c)
- Warrah Creek FMP (OEH and NOW 2012).

For further detailed information, see step 9, Table 26.

Prior to targeted consultation (February to May 2015), the criteria relating to increased flow velocity did not have flexibility to allow for isolated areas to increase velocities by more than 50%. During targeted consultation, stakeholders raised concerns that they wanted landholders to be able to have localised higher velocity on their land if they used management techniques (such as retention basins) to ensure that the flow time boundary to boundary was unchanged. The IRP reviewed this request and agreed that it was reasonable considering that separate criteria would ensure that the flood work did not impact more than minimally on soil erodibility. As a result, the velocity criteria were amended to allow for localised increases in velocity greater than 50% with the conditions specified above.

## How will the criteria be assessed?

Assessment against hydraulic local impacts criteria will occur when an application is required to be supported by a flood study. In most cases, a flood study will be required to report on and be supported by hydraulic modelling. A flood study will only be accepted if the assessing officer considers that it meets appropriate reporting requirements, document standards and technical standards for hydraulic modelling. The results of the flood study must clearly demonstrate that the thresholds for the hydraulic local impacts assessment criteria are not exceeded.

Typically, the criteria will be assessed by comparing key modelled hydraulic parameters (flood-flow redistribution, flood levels and flow velocity) for proposed development conditions against flood study results for pre-development and/or existing conditions, under relevant flood scenarios (such as the large design flood or the 1% AEP flood). Incremental changes brought on by the various stages of floodplain development over time (as represented by the various modelled floodplain conditions) will need to be reported in the flood study for subsequent consideration in any final assessment of whether nominated criteria thresholds are exceeded.

For the purposes of assessing a flood work application, the following definitions apply:

- pre-development conditions—derived from running a model with the floodplain without flood work development on the landholding under application

- existing development conditions—derived from running a model with the accepted level of flood work development at the time the application is made
- proposed development conditions—derived from running a model with the floodplain, the accepted level of flood work development at the time that the application is made and the flood work proposal.

In regard to assessing flow velocity impacts, soil erodibility will be assessed by ensuring that maximum permissible velocities relevant to the Upper Namoi Valley Floodplain are not exceeded. This assessment criterion provides flexibility to consider ground cover when assessing the potential impact of a flood work on soil erodibility. It is likely that soil types will be a consideration—for instance, maximum permissible velocities may be relaxed for applicants who can prove the soil type is not highly erodible.

## Cumulative hydraulic impacts

### Description of the criteria

Cumulative hydraulic impact assessment criteria differ between the management zones. MZ AD and MZ D share the same criteria and MZ BU, MZ BL, MZ C and MZ CU have similar assessment criteria relating to cumulative hydraulic impacts.

In MZ AD and MZ D, the minister must consider the cumulative effect that the proposed flood work and other existing works on the landholding may have on adjacent landholdings, other landholdings and the floodplain environment. All flood works in MZ AD and MZ D must be assessed against this criterion. When considering the cumulative impacts of a proposal on the floodplain environment, consideration will be given to those impacts that are likely to combine with each other or with impacts of other activities to produce a beneficial or adverse effect. Impacts should be considered in terms of:

- the relationship of the activity to other proposals or developments in the area
- synergistic effects of individual developments when considered in combination
- any known environmental stresses in the affected area and the likely contribution of the proposed activity to increasing or decreasing those stresses.

In MZ BU, MZ BL, MZ C and MZ CU, the intent of the cumulative hydraulic impact assessment criteria is to limit the redistribution of flood flows across the floodplain to acceptable thresholds. Flood-flow distributions are quantified at given peak discharge calculation locations. The use of this assessment criteria to assess applications for minor works (i.e. those that do not require advertising) in MZ BU and MZ BL is discretionary. The use of this assessment criteria to assess applications for all types of flood works in MZ C and CU is also discretionary. For flood work applications that require advertising in MZ BU and MZ BL, these assessment criteria are mandatory.

Peak flood-flow distribution was selected to measure cumulative impacts because distribution of flood waters is an important flood parameter and any significant changes to distribution may signify changes to other flood parameters such as velocity and depth.

### Why are cumulative hydraulic impacts considered?

Current estimates are that the area protected by flood works (hereafter referred to as developed areas) makes up approximately 9% of the Upper Namoi Valley Floodplain (step 2). Typically, the developed areas are protected by levees, which will only overtop in extreme floods and so are likely to impact on flooding behaviour in small and large floods.

The hydraulic models developed as part of step 4 were used to estimate the redistribution of floodwater that may have occurred due to the current level of development. Existing flood work development has been found to have altered the flow distribution between major branches of the Upper Namoi Valley Floodplain.

Further redistribution may have consequences from socio-economic, hydraulic, ecological and cultural perspectives. Therefore, the cumulative impact of current and future works must be assessed to ensure that the current flood-flow distribution is maintained.

## How were the thresholds for the criteria determined?

Some redistribution has likely occurred due to existing flood works, and this redistribution is likely to be variable across the floodplain. However, limitations with representing the pre-development floodplain preclude a quantitative analysis of the redistribution within the sub-floodplain areas. Therefore, a uniform threshold has been set across the entire floodplain.

## How will the criteria be assessed?

For MZ BU, MZ BL, MZ C and MZ CU, the hydraulic cumulative impacts will be assessed by comparing the peak flow distribution (for the relevant large design event) of the April 2015 level of development to the current level of development in addition to the proposed works. For MZ C and MZ CU, the hydraulic cumulative impacts may need to be assessed against the 1% AEP flood as well. Information from the 1% AEP flood will need to be obtained. Records of the current level of development as well as the April 2015 level of development will be maintained and provided in order to assist with the assessment.

For MZ AD and MZ D, where minor works only are permitted, cumulative assessments of proposed flood works will be considered in relation to other existing works on a landholding, other landholdings and the floodplain environment. Typically, the applicant must demonstrate that the flood work proposal has considered cumulative impacts of the proposal and other existing works by considering development in the surrounding area. Consideration may need to be given to whether the existing development is concentrated on one side of the floodplain or if there is any existing blockage to floodways or smaller flow paths important for flood connectivity to flood-dependent assets. It should be noted that the rules for MZ AD and MZ D alleviate the potential for cumulative impacts in these zones, existing flood works and structures.

## Existing flood works and structures

Rules to license existing unlicensed flood works or to modify existing licensed flood works were required in MZ AD or MZ D where the Upper Namoi Valley FMP restricts the types of permissible flood works.

The inclusion of these rules allows acceptance of applications for existing works that do not comply with the rules for MZ AD or MZ D.

The rules for granting approval to an existing flood structure are outlined below.

Approval may be granted for an **existing unlicensed work** that does not comply with the rules for MZ AD or MZ D if all of the following criteria are met:

- the flood work was constructed as at the date of commencement of the plan
- the flood work is for an infrastructure protection work, a stock refuge, an access road, a drain or a supply channel
- as at the date of application, the flood work is not the subject of:
  - an undetermined controlled work application under Part 8 of the *Water Act 1912*
  - a previously refused Part 8 application under the *Water Act 1912*
  - an undetermined work application under the *Water Management Act 2000*

a previously refused flood work application under the *Water Management Act 2000*.

The rules for amending the flood work approval of an existing flood work are outlined below.

An amendment to an **existing licensed work** in MZ AD or MZ D may be granted for a flood work that does not comply with the rules for MZ AD or MZ D if all of the following criteria are met:

- the flood work was constructed as at the date of commencement of the plan
- the proposed modification to the flood work will reduce the impact of the work on the flow patterns (distribution of flows, drainage, depth or velocity) in MZ AD or MZ D.

In either scenario, to be granted a flood work approval, the work must be assessed against the assessment criteria outlined in MZ AD or MZ D, whichever is applicable.



## Exemptions to flood work approvals

An approval is required to construct or use a flood work under section 91D(1) of the WM Act. However, flood works that satisfy the exemption criteria outlined in the Water Management (General) Regulation 2018, do not require an approval. Statewide exemptions are for works or types of works which are considered low risk or are necessary for public safety, or which are more appropriately overseen by another government body such as a local council (Table 21).

For further information on statewide exemptions, refer to the Water Management (General) Regulation 2018.

**Table 21. Description of works that have a statewide exemption under the WM Act 2000 and in which of the FMP management zones they apply.**

Statewide exemptions under Water Management (General) Regulation 2018	Where does this exemption apply?
Works constructed by or under the direction of the State Emergency Service	All management zones
Works constructed by a local council within a managed designated high flood risk area under a development authorisation granted by the council	Management zones B, C and CU
Works constructed by a person (other than a local council) within a managed designated high flood risk area, on a total landholding area of no more than 0.2 ha, under a development authorisation granted by the council	Management zones B, C
Ring embankments around homes and farm infrastructure, protecting not more than 2 ha in area and not more 10% of the total property area	Management zone B, C and CU
Public roads and railways	All management zones
Earthworks less than 150 mm above natural surface level including farm tracks and check banks	Management zone B, C and CU

## Step 9: Consider existing floodplain management arrangements

Consideration of existing floodplain management arrangements was integrated throughout the planning process outlined in this document. Step 9 reports on how these arrangements were considered, including the occurrence of change between existing rural floodplain management arrangements and the Upper Namoi Valley FMP.

Change was seen across the floodplain boundary, management zones, rules and assessment criteria. The changes reflect improvements in our understanding of the floodplain, improvements in the management of flood work development and a more consistent approach to floodplain management across the floodplain.

### Floodplain boundary

#### Change has occurred.

The Upper Namoi Valley Floodplain boundary is essentially the existing:

- Upper Namoi Floodplain designated on 18 October 1984 under the *Water Act 1912* (21,336 ha from Narrabri to Boggabri), and the
- Liverpool Plains Floodplain designated on 16 December 1994 under the *Water Act 1912* (538,935 ha that captures land with less than or equal to 2% slope upstream of Boggabri).

Minor changes were made to the combined floodplains that amounted to a net addition of 28,300 ha (or 5% of the total floodplain area). See step 1 for more detail on why these changes were made.

### Management zones

#### Change has occurred.

The Upper Namoi Valley FMP introduces the use of management zones in floodplain management in the Upper Namoi Valley Floodplain. Current floodplain management arrangements include existing FMPs with mapped floodway networks which are used as a basis for assessing if a flood work application requires advertising. Existing floodway networks were compared against the management zones to determine the occurrence of change.

In summary, changes to the management zones occurred due to:

- extension of the floodplain boundary to capture areas of major flooding
- improved ecological and cultural data across a greater floodplain area
- strategic consideration of flood connectivity throughout the entire floodplain
- significantly more accurate hydraulic data (supported by new LiDAR) available.

### Management zones AD and AID

#### Change has occurred.

The floodway networks of existing FMPs are equivalent in principle to the hydraulic criteria used to develop MZ AD and MZ AID. However, the data used to develop MZ AD and MZ AID is more sophisticated and better represents flooding behaviour. Another key difference is that ecological and cultural assets were considered in the design of MZ AD and MZ AID. Ecological and cultural assets were incorporated into the management zones to reflect the greater emphasis that the WM Act 2000 places on protecting the floodplain environment.

The precedent for MZ AID is mostly found in the Lower Coxs Creek FMP (OEH and NOW 2013), where floodways were flexible and it was the practice for the licensing officer to ensure that floodways were congruent across property boundaries.

## Management zones BU and BL

### Change has occurred.

The areas outside the floodway networks of existing FMPs are equivalent in principle to the hydraulic criteria used to develop MZ BU and MZ BL.

MZ BU was split from MZ BL at the Binnaway to Werris Creek Railway. The railway is a reasonable landmark indicating a change to the floodplain topography, with the floodplain being more constricted upstream of the railway than downstream. The difference in topography is reflected in the current floodplain management arrangements. For instance, the Warrah Creek FMP (OEH and NOW 2012) which is south of the railway has rules that specifically deal with drains. These drain rules are relevant to all the floodplain areas south of the railway where erosion of drains into large channels is a historical problem. The split was made so that the rules of existing FMPs could be better reflected in the rules of the Upper Namoi Valley FMP.

## Management zone C

### Change has occurred.

Flood fringe and developed areas that form part of MZ C were not specifically identified in current floodplain management arrangements, but were areas where flood work applications would have been assessed using the same approach for the areas now identified as MZ BU and MZ BL (i.e. outside the floodways). MZ C was delineated so that the rules and assessment criteria could be relaxed for areas only inundated by very large floods.

## Management zone CU

### Change has occurred.

MZ CU was created to include urban areas that are covered by a flood study, flood risk management study or flood risk management plan or that are protected by flood mitigation works such as town levees. Flood works are typically assessed by local council under the *Environmental Planning and Assessment Act 1979*.

## Management zone D

### Change has occurred.

MZ D is a new type of management zone in the Upper Namoi Valley Floodplain. It was created to provide additional protection to special ecological and cultural assets, with regards to the potential for flood works to affect flood connectivity.

## Rules (including assessment criteria)

### Change has occurred.

Change between the rules of existing floodplain management arrangements and the rules of the Upper Namoi Valley FMP has occurred for:

- flood-flow corridors
- permissible flood works
- advertising requirements
- assessment criteria, including:
  - ecological and cultural impacts
  - social (drainage) impacts

- local hydraulic impacts
- cumulative hydraulic impacts
- existing flood structures and works.

The nature of the change is described in greater detail below.

## Changes in flood-flow corridors

Applications for flood works in MZ AID, which are located wholly or partially within a flood-flow corridor (minimum width of 20 m), must comply with the rules for flood works in MZ AD. Applications for flood works in MZ AID, which are located outside of a flood-flow corridor must comply with the rules for MZ BU or MZ BL (whichever is applicable).

The precedent for MZ AID is mostly found in the Lower Coxs Creek FMP (OEH and NOW 2013), where floodways were flexible and it was the practice for the licensing officer to ensure that floodways were congruent across property boundaries. The remaining areas of the Upper Namoi Valley FMP covered by FMPs had floodways mapped with definite locations and extents. Historically, floodways in FMPs have been a minimum of 20 m, although this has not been specified as a rule or criteria.

## Change to permissible flood works

**Change has not occurred in MZ BU, MZ BL, MZ C or MZ CU.** Under current management practices and the Upper Namoi Valley FMP, a landholder can apply for any type of flood work to be built in areas that are equivalent to MZ BU, MZ BL, MZ C or MZ CU.

**Change has occurred in MZ AD and MZ D and is outlined below.**

### Management zone AD

Under current management practices, a landholder can apply for any type of flood work to be built in areas that correspond to MZ AD areas. The Upper Namoi Valley FMP only allows flood work applications in MZ AD for six different types of permissible works. Under current assessment practices, works other than those permissible in the FMP would be unlikely to be approved. This is because areas corresponding to MZ AD in current plans (floodway network areas) are non-complying areas where works need to satisfy stringent assessment criteria before being approved. By limiting applications to certain permissible works in the Upper Namoi Valley FMP, landholders save time and money by applying only for those works likely to be approved. This also reduces the chances of inconsistency in discretionary approvals.

Although current management practices do not stipulate where such works can be applied for, the specifications for these permissible works were adopted from current management practises, where applicable (Table 22).

**Table 22. Primary origin of rules for specifications of permissible works**

Work type	Current management practices where rule was primarily sourced from
Access roads	Caroona to Breeza FMP (DNR 2006a) Gwydir Valley FMP 2016 (NOW 2014)
Below-ground supply channels	Caroona to Breeza FMP (DNR 2006a) Gwydir Valley FMP 2016 (NOW 2014)
Drains	Warrah Creek FMP (OEH and NOW 2012)
Ecological and cultural enhancement works	N/A—new work
Infrastructure protection works	Carroll to Boggabri FMP (DIPNR 2005) Gwydir Valley FMP 2016 (NOW 2014)
Stock refuges	Carroll to Boggabri FMP (DIPNR 2005) Gwydir Valley FMP 2016 (NOW 2014)

Access roads in the Blackville FMP and IPWs in the Warrah Creek FMP were exempt from needing a flood work approval based on rules contained in the plans. In these areas, the new rules are more restrictive; however, MZ AD is considered to be an area where uncoordinated flood work development may have a high adverse impact on flood behaviour. The statewide exemptions developed independently of this plan do not allow privately owned works to be exempt in MZ AD.

## Management zone D

Under current management practices, a landholder can apply for any type of flood work to be built in areas that correspond to MZ D areas. The Upper Namoi Valley FMP will only allow flood work applications in MZ D for Aboriginal value, ecological and heritage-site enhancement works. Although this is a new type of flood work, under current assessment practices only minor works would have been likely to be approved.

## Changes to advertising requirements

Advertising requirements have been updated in the Upper Namoi Valley FMP to reflect changes made to the types of flood works that will be considered for approval. Some of the proposed rules will have advertising requirements, depending on the management zone in which the flood work is proposed to be developed as well as the purpose, nature and construction of the work. These factors relate directly to the potential of the work to cause or exacerbate flooding problems. Therefore, advertising requirements reflect the level of impact that flood works are likely to have on flood behaviour, floodplain connectivity and neighbouring properties.

## Management zone AD

In managed areas (FMPs), flood work applications in areas that correspond to MZ AD (in the floodway network) require advertising (assessed as 'non-complying'). In other areas and managed areas (guidelines), all flood works require advertising. The Upper Namoi Valley FMP does not require flood work applications in MZ AD to be advertised. This is because the types of flood works that can be applied for are minor in nature and unlikely to impact flooding patterns.

## Management zone AID

Applications for flood works in MZ AID that are located wholly or partly within a flood-flow corridor must comply with the rules for flood works in MZ AD. As such, these applications do not require advertising.

Applications for flood works in MZ AID that are located outside of a flood-flow corridor must comply with the advertising requirements for MZ BU or MZ BL, whichever is applicable.

An additional rule in MZ AID (wide flood-flow corridors) provides a pathway for the approval of certain other flood works that are not minor or existing, provided that the flood work has or will have a height of no greater than 30 cm above natural surface level and meets the assessment criteria for MZ BU or MZ BL (whichever is relevant). An application for a new or amended flood work approval in MZ AID that meets the requirements for 'Certain other flood works in MZ AID (wide flood-flow corridors)' must be advertised.

## Management zone BU

Under previous FMPs south of the Binnaway to Werris Creek railway, flood work applications in areas that correspond to MZ BU (areas outside the floodway network) did not require advertising (assessed as 'complying'). In other areas and managed areas (guidelines), all flood works required advertising. In addition to these general advertising rules, some of the previous floodplain management arrangements that sit within the floodplain south of the Binnaway to Werris Creek railway had specific advertising requirements (Table 23).

**Table 23. Additional advertising requirements for FMPs relevant to MZ BU**

FMP	Advertising requirements
Blackville	There are provisions for levees identified in the FMP and those that are not identified in the FMP to determine if they are 'acceptable or not acceptable'. There are also requirements for the works to comply with the general provisions of the plan.

FMP	Advertising requirements
Upper Coxs Creek	All flood works require advertising.
Upper Yarraman Creek	Flood work applications need to be advertised if they are inside the riparian zone. If they are outside the riparian zone, the work needs to be advertised if: <ul style="list-style-type: none"> <li>• they are <math>\geq 10</math> cm in height</li> <li>• the area protected is <math>\geq 20\%</math> of the floodplain extending on their side of Yarraman Creek and if the width of any section taken perpendicular to Yarraman Creek and Kickerbell Creek is <math>\geq 100</math> m</li> <li>• they are IPWs and are <math>\geq 25</math> m perpendicular to Yarraman Creek and are <math>\geq 2.5</math>ha.</li> </ul>

The Upper Namoi Valley FMP specifies that drains that meet certain requirements specified in the rules do not require advertising in MZ BU and all other flood work applications do require advertising. The Upper Namoi Valley FMP requires the advertising of flood works (except drains) in MZ BU where current floodplain management arrangements would generally have not. This is because works other than drains are likely to affect flood behaviour and should be advertised to alert neighbouring properties.

## Management zone BL

Under previous floodplain management plans north of the Binnaway to Werris Creek railway, flood work applications in areas that correspond to MZ BL (areas outside the floodway network) did not require advertising (assessed as 'complying'). In other areas and managed areas (guidelines), all flood works required advertising. In addition to these general advertising rules, some of the previous floodplain management arrangements that sit within the floodplain north of the Binnaway to Werris Creek railway had specific advertising requirements (Table 24).

**Table 24. Additional advertising requirement for FMPs relevant to MZ BL**

FMP	Advertising requirements
Carroll-Boggabri	Flood work applications need to be advertised if the work: <ul style="list-style-type: none"> <li>• is an IPW on a small property (less than 20 ha) and is <math>\geq 10\%</math> of the total property area</li> <li>• is an IPW on a large property (<math>\geq 20</math> ha) and is <math>\geq 2</math> ha or <math>\geq 1\%</math> of the total property area, whichever is the greater</li> <li>• is less than 100 m from an adjoining property's high-value infrastructure</li> <li>• is greater than 50 cm in height (10% of the structure can exceed this and works are preferentially constructed parallel to flow).</li> </ul>
Lower Coxs Creek	N/A
Upper Coxs Creek	All flood works required advertising.

The additional advertising requirements in the Carroll to Boggabri FMP (DNR 2006b) have been mostly adopted (with modifications) for MZ BL. The Upper Namoi Valley FMP specifies that infrastructure protection works, stock refuges and flood works less than 50 cm in height do not require advertising in MZ BL. All other flood work applications do require advertising. In this way, only flood works with a greater likelihood of affecting flood behaviour will be advertised to alert neighbouring properties.

## Management zone C

Under existing FMPs, flood work applications in areas that correspond to MZ C (areas outside the floodway network) do not require advertising (assessed as 'complying'). In other areas and managed areas (guidelines), all flood works require advertising.

The Upper Namoi Valley FMP does not require flood work applications to be advertised as it is unlikely that a flood work in this area would impact on flood behaviour, floodplain connectivity or neighbouring properties. In this way, the Upper Namoi Valley FMP is generally consistent with existing FMPs but is slightly less restrictive in some of the manages areas (FMPs) and less restrictive in other areas and managed areas (guidelines), where advertising is required.

## Management zone CU

Under previous floodplain management arrangements, MZ CU is essentially those areas where flood works are assessed by local council under the *Environmental Planning and Assessment Act 1979*. These works would have been assessed under different legislation to the *Water Act 1912* and would not have required advertising.

The Upper Namoi Valley FMP requires flood work applications in MZ CU to comply with the assessment criteria for MZ C. Flood work applications in MZ CU are not required to be advertised.

Under the *Water Management (General) Amendment (Flood Work Approvals) Regulation 2015* a number of flood works undertaken by councils and private landholders within MZ CU are exempt from requiring a flood work approval under the WM Act 2000 (see 'exemptions and MZ CU').

## Management zone D

MZ D areas are a component of major floodways. Under existing FMPs, MZ D areas would have been part of the floodway network, where flood work applications required advertising. In other areas and managed areas (guidelines), all flood works require advertising.

The Upper Namoi Valley FMP does not require flood work applications in MZ D to be advertised, as the only allowed flood works (ecological/cultural enhancement works) will undergo rigorous assessment.

## Changes in assessment criteria

The Upper Namoi Valley FMP is based on the assessment criteria of previous FMPs; however, as there are seven FMPs in the floodplain all with different assessment criteria, some change was inevitable if the new FMP was to increase consistency in how flood works were licensed across the floodplain. The assessment criteria from existing floodplain management arrangements as well as from the Gwydir Valley FMP (NOW 2014) have been incorporated into the Upper Namoi Valley FMP, where appropriate.

A summary of the types of assessment criteria in current floodplain management plans considered in the Upper Namoi Valley FMP is provided in Table 25 (further detail is provided in Appendix 3).

**Table 25. Summary of types of assessment criteria in current FMPs considered in the Upper Namoi Valley FMP**

Historical	Socio-economic	Ecological	Flooding
Existing Floodplain guidelines	Disruption to daily life (relates to local drainage)	Wetland connectivity	Natural flooding characteristics
Concerns and objections	Health impact	Floodplain flora and fauna	Hydraulic capacity
Time/flood experience (complying works)	Cost of the works	Soil condition and structure	Pondage and flow duration
	Infrastructure damage	Fish passage	Redistribution/flood-flow effects/hydraulic criteria
	Equity	Cultural sites	Flow velocities
	Land use and restrictions	Groundwater recharge	Works in floodways
	Maintenance costs	Riverine environment	

Note: Criteria highlighted in green have been explicitly incorporated into the Upper Namoi Valley FMP as assessment criteria. All the assessment criteria were considered during the development of the management zones.

## Ecological and cultural impacts

Six of the seven previous FMPs required that the effects of a proposed flood work on the floodplain environment be assessed. The Lower Coxs Creek FMP, Upper Yarraman Creek FMP, Caroona to Breeza FMP and Carroll to Boggabri FMP had very similar assessment criteria to the Upper Namoi Valley FMP, including consideration of flood connectivity to assets, fish passage and consideration of the delivery of flood flows to cultural sites.

The Upper Coxs Creek FMP also gave specific consideration to the riverine environment and did not allow the removal or excavation of material within 40 m of the creek bank nor the development of flood works within 20 m of the creek bank. The Warrah Creek FMP did not give consideration to groundwater recharge, which is now a requirement of the WM Act 2000 floodplain management provisions.

The Blackville FMP did not contain assessment criteria and the new Upper Namoi Valley FMP is required to be more specific and transparent during the assessment of flood works.

The assessment criteria dealing with ecological and cultural impacts for the Upper Namoi Valley FMP is consistent with the Gwydir Valley FMP 2016 (NOW 2014).

In general, the intent of the ecological assessment criteria from the majority of the previous FMPs has been captured by the Upper Namoi Valley FMP.

## Cultural heritage

Six of the seven previous FMPs required consideration of cultural sites (the Blackville FMP did not contain any assessment criteria). The assessment criteria generally required that unless an agreement had been reached with the National Parks and Wildlife Service and the Local Aboriginal Lands Council, works should not destroy or damage any Aboriginal site or relic.

## Social (drainage impacts)

Five of the seven previous FMPs required consideration of any changes to pondage and flow duration potentially caused by flood works. The Blackville FMP and Lower Coxs Creek FMP did not specifically address drainage impacts of flood works.

The Carroona to Breeza FMP and Carroll to Boggabri FMP also specified that the drainage duration is to be within 12 and 24 hours of the natural/existing drainage time, respectively. The Carroll to Boggabri FMP threshold of 24 hours was initially selected for the Upper Namoi Valley FMP as 24 hours is more measurable than 12 hours. However, in response to feedback received at public exhibition of the Draft Upper Namoi Valley FMP (concerns about inundation and the impact of waterlogging) the threshold was reduced to 12 hours.

## Local hydraulic impacts

The Blackville FMP did not contain any assessment criteria, including any relating to local hydraulic impacts. All of the remaining six previous FMPs dealt with local hydraulic impacts, including redistribution of flood flow, changes to flood levels and flow velocities in their assessment criteria (Table 26). The Upper Namoi Valley FMP has adopted thresholds for each of the local hydraulic assessment criteria based on one or more of these six existing FMPs. These assessment criteria do not apply to works in MZ AD or MZ D.

**Table 26. Comparison of hydraulic assessment criteria with previous FMPs**

Local hydraulic assessment criteria	Upper Namoi Valley FMP	Blackville	Carroona-Breeza	Carroll-Boggabri	Lower Coxs Creek	Upper Coxs Creek	Upper Yarraman Creek	Warrah Creek
Redistribution	5%	N/A	2%	5%	2-2.5%	2-2.5%	5%	N/A
Flood levels—Allowable (general)	≤20 cm	N/A	<30 cm	≤10 cm	≤20 cm	≤20 cm	<10 cm	≤10 cm
Flood levels—Allowable (high-value infrastructure)	No impact	N/A	N/A	N/A	N/A	N/A	No impact	N/A
Flood levels—Advertising required	>10 cm	N/A	N/A	>10 cm	>10 cm	>10 cm	N/A	N/A
Velocity—allowable	≤50%	N/A	≤50%	≤50%	≤50%	≤50%	≤20%	N/A
Velocity—soil erodibility	Y	N/A	Y	Y	Y	Y	Y	Y

Y= considered



## Cumulative hydraulic impacts

The Blackville FMP did not contain any assessment criteria, including any relating to cumulative hydraulic impacts. The Upper Yarraman Creek FMP and Warrah Creek FMP also did not contain assessment criteria relating to cumulative redistribution of peak flood discharges.

The Carroona to Breeza FMP and the Carroll to Boggabri FMP put a 2% and 10% limit to the cumulative redistribution of peak flood discharges, respectively. The Lower Coxs Creek FMP and Upper Coxs Creek FMP put a 5% limit to the cumulative redistribution of peak flood discharges, which was the threshold adopted for the Upper Namoi Valley FMP.

The 5% limit was selected as it is found in two of the existing FMPs and is between the 2% and 10% thresholds used in other FMPs. A threshold of 5% is also used for the Gwydir Valley FMP 2016 (NOW 2014).

MZ AD and MZ D also required that the potential cumulative effect of the proposed flood work and other flood works be considered. However, the approach was a qualitative assessment.

## Existing flood works and structures

Under existing floodplain management arrangements, some types of works that do not meet the specifications to be a permissible work in MZ AD and MZ D may not currently require an approval. The rules in the Upper Namoi Valley FMP allow works that do not meet the specifications to be a permissible work to be licensed, so long as they meet certain criteria. This ensures that existing works within MZ AD and MZ D that may not have previously required approval will not become illegal works.

For licensed works that do not comply with the rules of MZ AD and MZ D, the plan allows amendment of these works that will reduce their impact on flow patterns. Under existing management arrangements, modification of such works that would result in an increased impact would unlikely have been approved, so this is not likely to represent any change from the current arrangements.

## Step 10: Assess socio-economic impacts

Step 10 is split into two phases and examines the extent of change between the base case (floodplain without reform) and the Upper Namoi Valley FMP to determine the negative socio-economic impacts of the plan. Phase 1 has been completed and was undertaken prior to community consultation; the results are outlined below. Phase 2 will occur post consultation with the community to ensure that community stakeholders have the opportunity to provide feedback on potential socio-economic impacts of the Upper Namoi Valley FMP. The second phase is a detailed assessment that will only occur if phase 1 indicates that there may be a significant socio-economic impact or there are major concerns raised during the public exhibition of the plan. Each problem or issue to be analysed will:

- clearly state the key assumptions underlying the proposed analysis
- consider the key quality assurance principles in defining the analysis
- identify an appropriate method of analysis and the tools and techniques to be utilised
- identify appropriate sources of data to collect.

The assessment approach is based on the Socio-economic Assessment Guidelines for River, Groundwater and Water Management Committees prepared by the Independent Advisory Committee for Socio Economic Assessment (IACSEA 1998). This approach is being applied to the development and revision of WSPs in NSW.

This assessment only considers the negative impacts of the FMP and is therefore an impact assessment. Estimates prepared as part of the socio-economic profile of the Upper and Lower Namoi floodplain area were based on Australian Bureau of Statistics data for 2011. Therefore, the negative effects of the implementation of the FMP are quantified in 2011 dollars.

Benefits of the proposed FMP have not been included in these calculations and therefore it is not a cost-benefit analysis. There are significant benefits from the implementation of the FMP that are expected to outweigh the negative impacts. Some of the benefit categories include minimising impacts of flooding due to constructed flood works, reduced erosion and reduced sediment deposition, and ecological and cultural benefits. Benefit value types include use, existence and bequest values.

The detail of the methodology used in this analysis is included in the Floodplain Management Plan technical manual.

### Phase 1 assessment

The first phase is the preliminary assessment that occurs prior to community consultation. During this phase, the effect of change between the base case and the Upper Namoi Valley FMP construct on different sectors of the community was assessed across the whole floodplain. Once the effects were identified, a socio-economic impact table (preliminary assessment) was developed to assess the extent, likelihood, intensity and timing of the effect. A breakdown of the land capability of the floodplain was then undertaken and, where the impact of the Upper Namoi Valley FMP construct was quantifiable, this was determined in 2011 dollars. Where a preliminary assessment indicates significant impacts, a detailed analysis is developed. However, there were no significant impacts identified.

### Changes between the base case and the Upper Namoi Valley FMP construct

The base case is the socio-economic condition of the floodplain had the Upper Namoi Valley FMP not been prepared. The base case is the condition where the following assumptions are made over the next 10 years (the period of the Upper Namoi Valley FMP):

- flood work approvals will continue under the provisions of the WM Act 2000
- a greater area of floodplain will be covered by new FMPs in due course

- floodplain guidelines may be revised or upgraded to an FMP as better data and modelling become available
- more emphasis will be put on environmental issues associated with flood work approvals as the community increases its general awareness of environmental issues
- flood works will continue to be approved in areas outside the floodway networks identified in FMPs and guidelines/studies
- the approval rate of flood works within the floodway networks identified in FMPs and guidelines will decline as cumulative impacts approach acceptable limits.

Note that applications for flood work approvals or amendments in the base case will be assessed under the WM Act 2000 and should be consistent with the seven second-generation FMPs and four Floodplain Guidelines for Floodplain Development that have been prepared for the Upper Namoi Valley FMP area (see step 3 for more information). Consistency with guidelines is assumed because although they have no legal status, they are public documents that assist landowners to identify areas included as part of floodway networks and where applications for flood works are more likely to be approved. Guidelines were prepared using hydraulic parameters that are consistent with the hydraulic requirements for approval under the WM Act 2000. The base case is spatially represented as the floodway network presented in step 4.

The Upper Namoi Valley FMP construct is the parts of the Upper Namoi Valley FMP including the floodplain boundary (step 1), the management zones (step 7) and the rules, including the assessment criteria (step 8).

For the purposes of the preliminary socio-economic impact assessment, the following assumptions were made regarding this construct:

- flood work applications in floodway areas identified in the FMP would have been unlikely to be approved had the applications continued to be assessed under the WM Act 2000 (because these areas are part of existing floodway networks)
- statewide exemptions that apply in MZ BL, MZ BU and MZ C may go some way to mitigating the potential negative impacts of rules
- management zone restrictions may lead to reduced land-use options available to the landholder, change the risk of inundation or change secured access to floodwater afforded to flood-dependent vegetation
- the Upper Namoi Valley Floodplain is roughly equivalent to the combined Upper Namoi and Liverpool Plains floodplains designated under the WM Act 2000.

Table 27 summarises rule changes between the base case and the Upper Namoi Valley FMP construct.

Table 27. Summary of rule changes between the Base Case and the Upper Namoi Valley FMP construct

Base case	Upper Namoi Valley FMP construct
<p>Flood work across the whole floodplain requires application for a Part 8 of the <i>Water Act 1912</i> approval or <i>Water Management Act 2000</i> flood work approval under similar criteria.</p>	<p>Flood works in the designated flood plain management area are subject to the FMP and require application for a flood work approval under the WM Act 2000.</p>
<p><b>Floodway network</b></p> <p>In an identified floodway in a FMP area, while flood works are not prohibited, it is unlikely that they will be approved due to the need to maintain natural flooding patterns to these areas for hydraulic and/or environmental requirements. All applications will be considered under WM Act 2000 hydraulic parameters<sup>1</sup>. All applications are deemed to be non-complying and require advertising and objections are to be considered before possible approval.</p> <p>In an identified floodway in a guideline/study area or a suspected unidentified floodway in a non-guideline area, the applicant is required to provide a floodplain engineer's report identifying that the WM Act 2000 are not exceeded. All applications are deemed to be non-complying and require advertising and objections are to be considered before possible approval. WM Act 2000 applications are unlikely to be approved in floodway networks.</p>	<p><b>MZ D</b> provides for a prohibition of flood work approvals except for:</p> <ul style="list-style-type: none"> <li>• ecological, Aboriginal Value and heritage-site enhancement works.</li> <li>• existing works—licensed and unlicensed</li> </ul> <p><b>MZ AD</b> provides for flood work approvals by application that is one of the following:</p> <ul style="list-style-type: none"> <li>• access road up to 15 cm above the natural surface level</li> <li>• supply channel</li> <li>• drain</li> <li>• infrastructure protection work</li> <li>• stock refuge</li> <li>• ecological, Aboriginal value or heritage-site enhancement works</li> <li>• existing works—licensed and unlicensed.</li> </ul> <p>Applications do not require advertising.</p> <p><b>MZ AID</b> provides for the construction of flood works in flood-flow corridors. Applications for flood works located wholly or partially with a flood-flow corridor must be assessed against the rules and assessment criteria for MZ AD. Flood work applications in areas outside of flood-flow corridors must be assessed against the assessment criteria for that zone that MZ AID lies within, MZ BU for flood works south of Binnaway to Werris Creek railway, or MZ BL for flood works north of Binnaway to Werris Creek railway. A flood work approval in MZ AID may be grated or amended to authorise the construction or modification of a flood work that does not comply with the rules for MZ AD if the flood work:</p> <ol style="list-style-type: none"> <li>(a) is or is proposed to be located wholly or partially within a wide flood-flow corridor (100 m minimum width)</li> <li>(b) is not one of the following: <ul style="list-style-type: none"> <li>• infrastructure protection work</li> <li>• stock refuge</li> <li>• access road</li> <li>• drain</li> <li>• supply channel</li> <li>• ecological, Aboriginal value or heritage-site enhancement work</li> </ul> </li> <li>(c) is advertised.</li> </ol> <p>Applications for flood works that meet the rules for certain other flood works in MZ AID (as described above) must be assessed against the assessment criteria for MZ BU for flood works south of Binnaway to Werris Creek railway, or MZ BL for flood works north of Binnaway to Werris Creek railway.</p>

Base case	Upper Namoi Valley FMP construct
<p><b>Non-floodway network area</b></p> <p>If the application is outside the identified floodway in a FMP area, the applicant is required to provide a floodplain engineer's report identifying that the WM Act 2000 hydraulic parameters<sup>1</sup> are not exceeded. Complying applications do not require advertising. Non-complying applications do require advertising and objections are to be considered before possible approval.</p> <p>If the application is outside a FMP area, the applicant is required to provide a floodplain engineer's report identifying that the WM Act 2000 hydraulic parameters<sup>1</sup> are not exceeded. All applications are deemed to be non-complying and <b>require</b> advertising, and objections are to be considered before possible approval.</p>	<p><b>MZ BU</b> provides that flood work approvals or modifications by application do not require advertising if they are for a below-ground drain.</p> <p>All other flood works require advertising.</p> <p><b>MZ BL</b> provides that flood work approvals or modifications by application do not require advertising if they are:</p> <ul style="list-style-type: none"> <li>• for infrastructure protection works or stock refuges, or</li> <li>• less than 50 cm in height above the natural surface level</li> <li>• account for no more than 1% of the total area of land holding and are no more than 2 ha in size in any single location in MZ BL.</li> </ul> <p>All other flood works require advertising.</p> <p>The application <b>must not</b> be approved if it exceeds the assessment criteria defined in the plan.</p> <p>Statewide exemptions apply in MZ BU and MZ BL.  <a href="https://www.industry.nsw.gov.au/water/licensing-trade/approvals/flood-work-approvals">https://www.industry.nsw.gov.au/water/licensing-trade/approvals/flood-work-approvals</a></p> <p><b>Zone C</b> provides for Flood Work approvals by application if they meet the assessment criteria.</p> <p>The application does not require advertising.</p> <p>Statewide exemptions apply in MZ C.  <a href="https://www.industry.nsw.gov.au/water/licensing-trade/approvals/flood-work-approvals">https://www.industry.nsw.gov.au/water/licensing-trade/approvals/flood-work-approvals</a></p>

<sup>1</sup>Hydraulic parameters are based on hydraulic criteria defined under Part 8 of the *Water Act 1912* that have been transferred to flood work assessments under the WM Act 2000 and are consistent with the rules and assessment criteria in the Upper Namoi Valley FMP.

Approximately 53% (~310,000 ha) of the Upper Namoi and Liverpool Plains Floodplains designated under Part 8 of the *Water Act 1912* are not covered by an FMP. In these areas, it is a requirement of the WM Act 2000 that flood work applications be advertised.

Under the Upper Namoi Valley FMP, flood work applications in MZ AD, MZ CU, MZ C or MZ D do not require advertising. Flood work applications in MZ BU and MZ BL may require advertising, depending on the type of flood work applied for.

Collectively, MZ BU and MZ BL make up about 43% (~250,600 ha) of the floodplain. This is a potential decrease in area of about 10% (~60,000 ha) where a flood work application may require advertising when compared to existing conditions. Furthermore, certain minor works do not require advertising in MZ BU or MZ BL if they meet the rules specified in the Upper Namoi Valley FMP (step 8). This is expected to provide additional benefits to landholders and streamline the assessment process for the approving department.

## Effect of change (general)

### Management zone D

MZ D is a special protection zone for special ecological and cultural assets, such as wetland or cultural areas that are highly significant. The inclusion of this zone in the Upper Namoi Valley FMP is to ensure that flood connectivity to these assets is maintained and protected. All the assets included in this special protection zone are associated with water bodies and are flooded regularly compared to other areas of the floodplain. Flood works are not permitted in this zone unless they are ecological, Aboriginal values or heritage-site enhancement works, which are works that are constructed for the improvement, conservation and protection of ecological and/or cultural assets and are not for an agricultural purpose. If any other type of work is applied for, it would require a controlled-activity approval under the WM Act 2000. It is unlikely that such a controlled-

activity approval would be given in the base case. It is expected that flood work approvals in this zone are not likely to be substantially negatively affected by the Upper Namoi Valley FMP.

### **Management zone AID**

The rules of MZ AID provide for the identification of flood-flow corridors as part of the approval process for flood work applications in MZ AID. Flood-flow corridors through MZ AID are a minimum width of 20 metres (narrow flood-flow corridor). Once flood-flow corridors are identified, any flood work applications for within a flood-flow corridor must be constructed consistently with the rules described for MZ AD. In areas outside of the flood-flow corridors, flood works must be constructed consistently with the rules of the management zone they sit within (either MZ BU or MZ BL).

The inclusion of a rule for certain other works in MZ AID (wide flood-flow corridors, minimum width of 100 m) provides a pathway for the approval of flood works that are not minor or existing (as described at Clauses 38 and 39 of the plan), provided that the flood work:

- (a) has or will have a height of no greater than 30 cm above natural surface level
- (b) is advertised
- (c) meets the assessment criteria for MZ BU/BL (whichever is relevant).

Practically, this rule provides consistency between existing floodplain management planning arrangements and proposed floodplain management planning arrangements described as part of the plan.

Consideration of the other changes introduced by the Upper Namoi Valley FMP in MZ AID will be addressed in the following sections: MZ AD, MZ BU, MZ BL and MZ C.

### **Management zone C**

Flood work applications in MZ C will be required to meet assessment criteria but will not require advertising. It is expected that flood work approvals in this area will not be substantially negatively affected in the existing seven FMP areas (detailed below) and will be positively affected in the guideline and other areas by the Upper Namoi Valley FMP.

## Management zones BU, BL and AD

The three remaining zones, MZ AD, MZ BU and MZ BL, have slightly different impacts in areas where the seven second-generation FMPs have been implemented compared to guideline and other areas that were subject to Part 8 in the base case.

## Effect of change (existing FMP areas)

There are currently seven second-generation FMPs enacted within the Upper Namoi Valley Floodplain (see step 3).

## Management zone AD and AID

Generally, land covered by a second-generation FMP that is within the floodway network will become MZ AD or MZ AID in the Upper Namoi Valley FMP. The width of MZ AD is the width of the channel plus a riparian buffer of 10 m. MZ AID has a minimum width of 100 m. The extra width of MZ AID provides the landholder some flexibility to identify the most convenient location of the flood-flow corridor within that zone. The area within the flood-flow corridor will assume the rules of MZ AD while the area of MZ AID outside the flood-flow corridor will assume the rules of MZ BU or MZ BL (whichever is applicable).

Most of the provisions of the second-generation FMPs are quite similar to the provisions of the Upper Namoi Valley FMP with the following exceptions:

- Infrastructure protection works: Warrah Creek FMP landholders previously did not require approval. There was no restriction specified in any of the seven second-generation FMPs for the percentage of the flow path that could be blocked with an infrastructure protection work.
- Access roads: Upper Yarraman Creek FMP landholders could construct access roads less than 10 cm above ground level. There was no restriction specified in five other second-generation FMPs.
- Supply channels: there was no restriction specified in any of the seven second-generation FMPs.

There are a number of factors that minimise the impact of these changes, including:

- relatively high land slope, concentration and speed of floodwater
- small areas involved in infrastructure protection works and proximity of alternative sites
- conditions required by controlled-activity approval (required within 40 metres of a water body).

In the seven second-generation FMP floodway network areas it is unlikely that substantial works other than those permissible in MZ AD would have been approved in the base case.

It is expected that flood work approvals in this area are not likely to be substantially negatively affected by the Upper Namoi Valley FMP.

MZ AD and MZ AID in the Upper Namoi Valley FMP include areas of ecological or cultural amendment, that is, areas added to the hydraulic criteria zone as a result of the application of ecological or cultural criteria. These are known as ecological or cultural amendments to MZ A (defined or ill-defined). Land included as the ecological or cultural amendment to MZ A (defined or ill-defined) will be subject to significant change. If the Upper Namoi Valley FMP had not been developed, it is likely that flood work proposals in these areas would have been assessed in general accordance with the rules in the adjacent zone, usually MZ BU or BL. However, with the addition of the ecological or cultural amendment to MZ A (defined or ill-defined), the flood-flow corridors within these areas can now only have: infrastructure protection works, approved access roads up to 15 cm above surface level, drains, ecological, Aboriginal value and heritage-site enhancement works, stock refuge and/or supply channels below the natural surface level. This will incur costs to landholders in the form of lost option value on this land compared with the base case.

It is expected that flood work approvals in these areas may be significantly negatively affected by the Upper Namoi Valley FMP.



## Management zone BU

Floodplain land that is outside MZ D, MZ AID, MZ AD and upstream (south) of the Binnaway to Werris Creek railway line but is within the large design flood area will become the Flood Storage and Secondary Flood Discharge—Upper Liverpool Plains, MZ BU.

Flood works in MZ BU, other than drains with specification limits, will require advertising and thus will be restricted compared to the base case (

Table 27). This rule will maintain the conditions that applied to drains in the Warrah Creek FMP and will provide reduced advertising provisions in other FMP areas for drains within specification limits.

It is expected that flood work approvals for drains may be marginally positively affected by the Upper Namoi Valley FMP.

The MZ BU rule that requires advertising for all works other than drains within specified limits will result in:

- no change in the Upper Coxs Creek FMP
- requiring advertising of the former limited-height complying applications in Upper Yarraman Creek FMP and Blackville FMP
- requiring advertising of the former complying applications that met the historic, hydraulic, ecological and socio-economic assessment criteria that are specified in the Upper Yarraman Creek FMP, Blackville FMP, Warrah Creek FMP and the upper part of Caroon to Breeza FMP. These specified assessment criteria and best-management practices are not substantially different to the Upper Namoi Valley FMP criteria.

This rule will incur some minor costs to landholders and the approving department in the form of additional advertising of applications and considering objections compared with the base case for formerly complying applications. The area and number of applications within MZ BU that will be impacted by this rule are unknown as they depend upon the intentions of the current and future landholders. It is not possible to forecast number and complexity of applications or the time needed to advertise, assess objections, negotiate modifications and consider approval or rejection. Considering the maturity of the irrigation water resources in the area, and that future expansion of the irrigation industry will depend on water-use efficiency gains, the number of applications is expected to decrease but the complexity of applications increase. This cost will not be estimated in this assessment. Former non-complying flood work applications in MZ BU also required advertising in the base case.

It is expected that flood work approvals in this category may be negatively affected by the Upper Namoi Valley FMP.

### **Management zone BL**

Floodplain land that is outside MZ D, MZ AID, MZ AD and downstream (north) of the Binnaway to Werris Creek railway line but is within the large design flood area will become the Flood Storage and Secondary Flood Discharge—Lower Liverpool Plains, MZ BL.

Flood works in MZ BL, other than infrastructure protection works and stock refuges within specified limits and flood works below 50 cm in height, will require advertising and thus will be restricted compared to the base case (

Table 27).

MZ BL rules requiring advertising for all works, other than infrastructure protection works and stock refuges within specified limits and limited-height works, will result in:

- a minor change in the Carroll to Boggabri FMP
- advertising being required for the former complying applications that met the historic, hydraulic, ecological and socio-economic assessment criteria that is specified in the Upper Coxs Creek FMP, Lower Coxs Creek FMP and Carroll to Breeza FMP. These specified assessment criteria and best-management practices are not substantially different to the Upper Namoi Valley FMP criteria.

This rule will incur some minor costs to landholders and the approving department in the form of advertising and considering objections compared with the base case for formerly complying applications. The area and number of applications within MZ BL that will be impacted by this rule are unknown as they depend upon the intentions of the current and future landholders. It is not possible to forecast number and complexity of applications or the time needed to advertise, assess objections, negotiate modifications and consider approval or rejection. Considering the maturity of the irrigation water resources in the area, and that future expansion of the irrigation industry will depend of water use efficiency gains, the number of applications is expected to decrease but the complexity of applications increase. This cost will not be estimated in this assessment. Former non-complying flood work applications in MZ BL also required advertising in the base case.

It is expected that flood work approvals in this category may be negatively affected by the Upper Namoi Valley FMP.

### Effect of change (guidelines and other areas)

There are four areas within the Upper Namoi Valley FMP area that have had flood studies completed but have not had second-generation FMPs implemented. They are Borrambil to Gunnadilly, Breeza to Ruvigne, Lake Goran and Boggabri to Narrabri. Flood work approvals in these areas and the remainder of the Upper Namoi Valley FMP area were determined under the *Water Act 1912*.

### Management zone AD and AID

Land that would probably have been recognised as floodway network in the base case. That is, land that would have been in a guideline floodway area or in a creek or flood runner, will become MZ AD or MZ AID under the Upper Namoi Valley FMP. In these areas, it is highly unlikely that any works other than those permissible in MZ AD would have been approved in the base case.

It is expected that flood work approvals in this area will not be substantially negatively affected by the Upper Namoi Valley FMP.

MZ A (defined or ill-defined) in the Upper Namoi Valley FMP includes areas of ecological or cultural amendment, that is, area added to the hydraulic criteria zone as a result of the application of ecological or cultural criteria. These are known as ecological or cultural amendment to MZ A (defined or ill-defined). Land included as the ecological or cultural amendment to MZ A (defined or ill-defined) will be subject to significant change. If the Upper Namoi Valley FMP is not developed, it is likely that flood work proposals in these areas would be assessed in general accordance with the rules in the adjacent zone, usually MZ B (U or L). However, with the addition of the ecological or cultural amendment to MZ A (defined or ill-defined), these areas can now only have IPWs, approved access roads up to 15 cm above surface level, and drains and/or supply channels below the natural surface level (see

Table 27 for rule changes). This will incur costs to landholders in the form of lost option value on this land compared with the base case.

It is expected that flood work approvals in these areas may be significantly negatively affected by the Upper Namoi Valley FMP.

### **Management zones BU and BL**

Land that is not in MZ D, MZ AID or MZ AD but is within the design flood area will become MZ BU or MZ BL. Flood works below the size limits will not require advertising (see

Table 27 for rule changes). This will provide additional benefits to landholders and the approving department as all applications required advertising in the base case. Flood works in excess of the size limits in MZ BU and MZ BL will require advertising which is the same requirements as the base case. Former non-complying flood Work applications in MZ BU and MZ BL, which were unlikely to be approved in the base case, are unlikely to be approved under the Upper Namoi Valley FMP.

It is expected that flood work approvals in this category may be marginally positively affected by the Upper Namoi Valley FMP.

## Socio-economic impact preliminary assessment table

Considering the changes from the base case to the Upper Namoi Valley FMP construct, the following negative impacts have been identified and presented in (Table 28):

1. lost access by landholders to all but limited applications in the area of ecological or cultural amendment to MZ A (defined or ill-defined)
2. the requirement to advertise applications for flood works that are greater than limited drainage works in MZ BU of land in the existing seven second-generation FMP areas
3. the requirement to advertise applications for limited infrastructure protection works and stock refuges and limited-height flood works in MZ BL of land in the existing seven second-generation FMP areas.

Table 28. Impact table of Upper Namoi Valley FMP

		1. Ecological/cultural amendment to MZ A (ID & D)	2. Land in MZ BU of the five second-generation FMPs	3. Land in MZ BL of the four second-generation FMPs
<b>Total area (ha)</b>		8,982	Unknown	Unknown
<b>Possible land use</b>		Cropping	Cropping and grazing	Cropping and grazing
<b>Representative land use</b>		Wheat	N/A	N/A
<b>Impact</b>		Lost access to complying works other than infrastructure protection works, access roads, drains and below-ground supply channels	Lost access to non-advertising of former complying applications other than limited design drains	Lost access to non-advertising of former complying applications other than limited infrastructure protection works, stock refuges and limited-height works (less than 50 cm)
<b>Who is impacted</b>		Landholder	Landholder	Landholder
<b>Quantifiable (\$)</b>		Yes	No	No
<b>Data sources</b>		GIS—area; ABS—Wheat \$ GVAP	Unknown area and number of applications: not estimated	Unknown area and number of applications: not estimated
<b>Scale: extent and intensity*</b>	<b>Plan</b>	Negative, low	Positive, low	Positive, low
<b>Scale: extent and intensity*</b>	<b>Regional</b>	Negative, low	Positive, low	Positive, low
<b>Scale: extent and intensity*</b>	<b>Local</b>	Negative, low	Positive, low	Positive, low
<b>Scale: extent and intensity*</b>	<b>Owner</b>	Negative, medium	Negative, medium	Negative, medium
<b>Likelihood and duration*</b>	<b>Plan</b>	Low, permanent	Low, permanent	Low, permanent
<b>Likelihood and duration*</b>	<b>Regional</b>	Low, permanent	Low, permanent	Low, permanent
<b>Likelihood and duration*</b>	<b>Local</b>	Low, permanent	Low, permanent	Low, permanent
<b>Likelihood and duration*</b>	<b>Owner</b>	Medium, permanent	Low, permanent	Low, permanent

\*Assess each factor with the other three factors held constant. Magnitude: low, medium, high.

## Land capability of impacted area

The area of ecological or cultural amendment to MZ AID is approximately 2,290 ha and to MZ AD is 8,200 ha (Figure 23 shows the ecological amendments). The area of MZ AID that will be determined to be a flood-flow corridor and subject to the rules for MZ AD, is estimated to be all of the MZ AID area as it was considered to be of significant ecological or cultural importance. The net impact is an estimated total area of 10,972 ha that is an ecological or cultural amendment to MZ A (defined and ill-defined), of which there are 1990 ha of crown land and 8,982 ha that are held privately. As the crown land is mainly used for roads, riparian zones and reserves, it will not be impacted by the FMP. All of the 8,982 ha of private land area are identified as being 'suitable for regular cultivation' according to the land capability data. It should be noted that land capability mapping was developed for broad-scale application and may not be applicable to small-scale portions of the landscape. The area most likely to be economically worth protecting with flood works is land that is private land holdings that are suitable for regular cultivation. The total area of the Upper Namoi Valley FMP by land capability including the area of private land sub-category within the sub-category of area of ecological or cultural amendments to MZ A (defined and ill-defined) is presented in Table 29.

Table 29. Land capability of the Upper Namoi Valley Floodplain

Land capability	Area (ha)
Other—unsuitable for agriculture and pastoral production	1,650
State forest	12,120
Suitable for grazing with no cultivation	2,2110
Suitable for grazing with occasional cultivation	13,050
Suitable for regular cultivation	558,300
Ecological or cultural amendment to MZ A (D&ID)	10,970
Private land likely to be negatively impacted	8,980
Urban area	1,380
<b>Total floodplain area</b>	<b>588,610*</b>

\*Numbers do not sum due to rounding.

This area is adjacent, in close proximity to or connects with the hydraulic floodway network. This amounts to less than 1.8% of the floodplain area. It is acknowledged that, depending on the property size, these areas may have a large impact on option value for individual landowners.

The Upper Namoi Valley FMP rules regulate only the construction of flood works and do not regulate land use such as cultivation or grazing of the land. Actual development of these areas may be limited by other legislation including the *Native Vegetation Act 2003* (NVA 2003).

## Land use

All the 8,982 ha that has been included in the ecological or cultural amendment to MZ A (defined and ill-defined) is suitable for regular cultivation. The restrictions on flood work approvals to be implemented under the FMP only regulate the construction of flood works and do not prevent cultivation or grazing of the land. The actual development of these areas for cultivation may be limited by other legislation including the NVA 2003 and controlled activities under the WM Act 2000.

Notwithstanding the NVA 2003, it is expected that it would not be practical for a large proportion of this land to be developed for reliable cultivation. In the absence of information on the proportion of the area that could practically be developed for reliable cultivation, we have assumed that all of this area (8,982 ha) could be developed for cultivation in order to estimate the annual gross value associated with the option value, knowing that it will result in an estimate of the maximum impact.

## Estimated values of economic impacts

The financial impact of the restrictions imposed on the area of ecological or cultural amendment to MZ A (defined and ill-defined) can be estimated using data on the area of land suitable for regular cropping and the gross value of agricultural production (GVAP). This land in the Upper Namoi may be used for any of as many as 10 summer or 10 winter crops in various rotation sequences. The most widely recognised crop type and cropping sequence is continuous wheat production. The potential use of the area suitable for regular cultivation (8,982 ha) is assumed to be continuous wheat production. The estimated gross value and area of 'wheat for grain' produced in the Upper Namoi Valley FMP area was \$730 GVAP per hectare. These estimates were prepared as part of the socio-economic profile of the Upper and Lower Namoi floodplain area and are based on Australian Bureau of Statistics data for 2011. The GVAP loss due to the prevention of the capacity to construct flood protection banks in this area under the plan will be compared to the total GVAP for the Upper Namoi Valley FMP to identify the level of significance.

The area of ecological or cultural amendment to MZ A (defined and ill-defined) is largely adjacent to or flowing to a watercourse and is therefore likely to be exposed to frequent flooding. Some of these flood events are beneficial to the crop or pasture and some are devastating, depending on the timing (relative to crop and pasture growth cycle), depth, duration and speed of the floodwater. As flood works to protect crops cannot be constructed in MZ A (defined and ill-defined), it is assumed that the outcome of these events is an additional one crop failure in four years.

On average, the gross value of wheat production from the 8,982 ha of cropping land could potentially produce \$6.56 million per year in the base case with bank protection. Without flood works protection under the FMP this area would potentially produce \$4.92 million per year from cropping—a reduction of \$1.64 million (a result of an additional 1:4 crop failure). The upper limit of the net impact of the implementation of the FMP on the area of private cropping due to ecological or cultural amendments to MZ A (defined and ill-defined) land is estimated to be a reduction of \$1.64 million. This is very small, 0.89% of the total GVAP for the Upper Namoi Valley FMP area of \$185 million.

Feedback received during public exhibition indicated that FMP-affected land may be more likely to grow irrigated cotton with a higher economic return. On this basis, economic loss was assessed as 8,982 ha with a GVAP per hectare of \$3,070 for irrigated cotton with a one in four year crop loss, a total impact of \$6.89 million. This equates to 3.72% of the total GVAP for the Upper Namoi FMP area of \$185 million. An irrigated cotton based analysis ignores higher capital costs incurred by growers for irrigated cotton and the need for surplus irrigation water to service any additional production area.

## Sensitivity analysis

This analysis is sensitive to the assumed frequency of crop failure, the cropping area within the area of ecological or cultural amendments to MZ A (defined and ill-defined) and the impact on individual property owners.

The loss due to the inability to construct flood works to protect these areas from flooding is an estimated additional one crop failure in four years. If the rate of additional crop failure due to flooding was to increase to one crop failure in two years, the estimated impact would rise to \$3.28 million or 1.78% of regional GVAP (based on \$730/ha for wheat). Conversely, if the rate of additional crop failure due to flooding was to decrease to one crop failure in six years, the estimated impact would be reduced to \$1.09 million or 0.59% of regional GVAP.

The estimated impact is expected to be an over-estimate because much of the 9,982 ha, identified in the analysis as holding potential for continuous wheat production, is currently used for grazing as it floods too often to be cropped reliably. In such cases the farmer's assessment has been that the higher cost of cropping and the risk of loss are greater than the more reliable pasture grazing option of lower cost and smaller gain. If the area was reduced by one half to 4,491 ha, due to incorrect classification as suitable for regular cropping or inability to crop because of other restrictions such as the NVA 2003, the estimated impact would be reduced to \$0.82 million or 0.45% of regional GVAP.

Many landholders will not be impacted by the FMP. However, there may be some individual farm-level impacts that could be more significant, depending on the proportion of their land that is affected. A counter-balancing

item is that the area of ecological or cultural amendment to MZ A (defined and ill-defined) would probably have a discounted land value due to flooding frequency.

## Summary

In considering change from the base case to the Upper Namoi Valley FMP construct, the following key negative impacts were identified, including lost opportunities for approval in the:

- area of ecological or cultural amendment to MZ A (defined and ill-defined) for works other than IPWs, stock refuges, access roads, drains and supply channels below the natural surface level
- five second-generation FMP areas in the area of MZ BU without advertising for works other than drains
- four second-generation FMP areas in the area of MZ BL without advertising for works other than: IPWs, stock refuges and works less than 0.5 metres in height.

Depending on the crop grown, the impact of the Upper Namoi Valley FMP is estimated to be a reduction of between 0.89% (wheat) and 3.72% (irrigated cotton) of the GVAP for the Upper Namoi Valley Floodplain area and therefore no further investigation is currently proposed. This is the estimated upper limit, considering that it is unlikely that all the area of ecological or cultural refinement to MZ A (ID & D) that is suitable for regular cultivation could be cropped. The cost of advertising applications in MZ BU and MZ BL compared to that for previous FMPs has not been estimated due to the unknown size, number and complexity of possible applications that may have occurred in the base case compared to the Upper Namoi Valley FMP construct.

Community consultation of the Upper Namoi Valley FMP occurred as part of targeted consultation and for public exhibition. Any potential socio-economic impacts and/or options identified by the community as part of public exhibition were included in the socio-economic impact analysis where appropriate.

Many landholders will not be impacted by these estimated costs. However, there may be some individual farm-level impacts that are more significant, depending on where the land is situated in the landscape.

## Phase 2 assessment

A detailed analysis (phase 2) is to be undertaken if the preliminary analysis in phase 1 indicates that there may be significant socio-economic impact. Considering that the estimated impact of the Upper Namoi Valley FMP rules (estimated to be a reduction of 0.66% of the total GVAP for the Upper Namoi Valley Floodplain area) is of low significance for the regional economy, no further investigation is currently proposed. In addition, there was no other major issue raised during the public exhibition period that warrants further detailed assessment.

## Role of socio-economics in plan development

This impact assessment concludes that there is a limited significant negative socio-economic impact from the Upper Namoi Valley FMP and therefore no further investigation is currently proposed.

Socio-economic advice has influenced the development of the Upper Namoi Valley FMP management zones, rules and assessment criteria. Key consideration was given to achieve a balance at each stage between flood behaviour and the environment, social and economic outcomes. Some examples include:

- categorising the types of flood works enabled consideration of important information on the socio-economic benefits of flood works along with the level of risk that a flood work type would significantly impact on flood behaviour (step 3)
- ensuring socio-economic impacts were included in the criteria for reasonable consistency with previous floodplain management arrangements (step 9)
- incorporating, wherever possible, areas with approved existing flood work developments into MZ C (step 4 and 7)
- weighing up the socio-economic impacts of development controls against the potential for different types of flood works to impact on flooding behaviour. The restrictions on the types of flood works that could be



applied for were made to minimise the risk that flood works would impact flooding behaviour while being sympathetic to landholder needs. These decisions were checked against the works likely to be approved under existing floodplain management planning arrangements and discussions held during targeted consultation with the community and interagency officers (step 8)

- the requirement to advertise proposed works provides local landholders with an opportunity to comment on any impact that a proposed flood work could have in causing or exacerbating flooding depth, duration or flow rate problems on their land
- the non-advertising of proposed minor flood works enables landholders to construct approved flood works of a more minor nature without advertising their proposed works, which will save both money and time (step 8).

# Consultation and review of the plan

The department is responsible for the review and consultation processes throughout the development of the Upper Namoi Valley FMP. OEH contributes technical expertise and local experience to the review and consultation processes. All stakeholders and interested parties have an opportunity to review and provide comment on the Upper Namoi Valley FMP at key stages throughout the FMP's development.

## Consultation process

Consultation activities involve:

- technical assessment: consultation of regional and scientific experts to collect relevant data/knowledge, provide technical input and review the FMP planning approach and criteria for delineating management zones, rules and assessment criteria
- targeted consultation: engagement of targeted community groups for feedback on the proposed boundary, management zones, rules and assessment criteria
- public exhibition: formal public exhibition of the Draft Upper Namoi Valley FMP and collection, review and incorporation of feedback from formal submissions to finalise the FMP for ministerial approval and commencement.

Consultation with Aboriginal stakeholders was undertaken using the approach outlined in Appendix 12 to be in line with:

- *Aboriginal people, the environment and conservation* (APEC) (DEC 2006)
- *An Aboriginal Community Engagement Framework for DECC* (DECC 2007)
- *Working to protect Aboriginal cultural heritage* (OEH 2011).

## Technical assessment

### Technical Advisory Group (TAG)

The TAG was responsible for providing expert knowledge and technical advice to the project team to help facilitate the development of the FMP. The TAG was composed of NSW Government agencies and other key agencies involved in water management in NSW, including the department, OEH, DPI Agriculture, Local Land Services and DPI Fisheries.

The TAG was engaged throughout the FMP development process through a combination of teleconferences and face-to-face meetings. The TAG officially met four times from February 2013 to August 2014 to:

- split the Upper Namoi Valley Floodplain from the Lower Namoi Valley Floodplain at Narrabri
- identify design floods and hydraulic modelling parameters
- identify assets that are dependent on flooding
- establish conservation targets for assets for inclusion in Marxan
- identify existing floodplain management planning arrangements for consideration when delineating management zones
- identify a minimum width of 20 m for floodways
- identify that a slope of 0.5% could be used to determine MZ C
- refinement and removal of 'islands' within the FMP boundary based on high ground
- identify socio-economic considerations.

Information provided by the TAG was incorporated into the development of the Upper Namoi Valley FMP.

## Aboriginal Technical Working Group (ATWG)

The ATWG was created as a consultative group to provide strategic advice on the:

- type, scope and integration of flood-dependent Aboriginal values into the FMPs
- identification and prioritisation of cultural assets that require protection under the FMPs
- key contacts and knowledge holders in the Aboriginal community to consult with
- cultural knowledge on the history of flooding.

The ATWG was comprised of state and regional cultural heritage experts. Workshops were held with the ATWG to:

- define and identify Aboriginal values that are dependent on flooding
- identify watering requirements of Aboriginal values and other floodplain assets that have Aboriginal value
- identify and document significance of Aboriginal values and other floodplain assets that have Aboriginal value
- develop a community consultation process for identification of Aboriginal values in data gap areas.

Information provided by the ATWG was incorporated into the development of the FMP and is outlined in steps 4, 6 and 7.

## Aboriginal community

The local Aboriginal communities were engaged by an OEH Aboriginal Natural Resource Officer through informal meetings. The aim of these informal discussions with Aboriginal stakeholders was to identify issues of concern in the valley and to introduce the objectives of the FMP in the context of the issues raised. During these activities, the OEH Aboriginal Natural Resource Officer collected spatial information on cultural assets that are dependent on flooding. This was later analysed as part of step 5 to be factored into the management construct. These cultural assets were discussed with the Aboriginal community during targeted consultation to obtain further feedback.

## Targeted consultation

Targeted consultation was an opportunity to road-test the proposed Upper Namoi Valley FMP boundary, management zones, rules and assessment criteria (management construct). Targeted consultation was undertaken with stakeholders at Narrabri and at Gunnedah from February 2015 to May 2015 (8 events, 27 participants, 161 items of inquiry collated). During this period individual meetings with landholder representatives who were unavailable to attend organised sessions also occurred.

The objectives of targeted consultation were to:

- provide background for key stakeholders as to why the floodplain management plans were being developed, how they were developed, what management zones, rules and assessment criteria were proposed in the Draft Upper Namoi Valley Floodplain and how stakeholders could provide feedback
- road-test the proposed Draft Upper Namoi Valley FMP boundary, management zones, rules and assessment criteria.

Targeted consultation involved the following key stakeholder groups within the Upper Namoi Valley Floodplain:

- landholder representatives including graziers, dryland and irrigation landholders and organisations
- environmental representatives
- local and state government representatives
- mining representatives
- industry representatives

- consultant and agronomist representatives
- Aboriginal community representatives.

Of the items of inquiry received, 43% related specifically to the Draft Upper Namoi Valley FMP management construct. About 30% related to the process for developing and implementing the Upper Namoi Valley FMP.

An issue with the proposed rules for access roads in MZ AD was identified during targeted consultation. Access roads were originally proposed to be constructed at a height equivalent to the natural surface level. During consultation it was highlighted that access roads at ground level would be ineffective and that access roads to a height of 15 cm above the natural surface level with appropriate causeway requirements should be included within MZ AD. This suggestion was incorporated as a recommendation for consideration by the Interagency Regional Panel (IRP) and adopted into the Upper Namoi Valley FMP.

An issue with the proposed hydraulic local impact (velocity) assessment criteria in MZ BU, MZ BL and MZ C was identified during targeted consultation. It was originally proposed that flow velocity could not increase by more than 50% or in accordance with any threshold established by the minister when compared to flow velocity under the relevant large design flood under pre-development conditions. During consultation it was highlighted that stakeholders wished to be able to use management techniques (such as retention basins) to have localised higher velocity but continue to ensure that flow time boundary to boundary was unchanged. This suggestion was incorporated as a recommendation for consideration by the IRP and adopted into the Upper Namoi Valley FMP.

Adjustments were also made to the management zones after targeted consultation; however, these changes were not a result of stakeholder feedback but rather were done as part of internal desktop and field validation processes.

## Public exhibition

The Draft Upper Namoi Valley FMP was on public exhibition over 40 days from 19 September to 28 October in 2016. Over this period, 11 stakeholder consultation events were held, with 59 participants, and 44 submissions were received, from which 415 items of inquiry were collated.

The objectives of this consultation were to provide background to stakeholders on:

- why the FMP is being developed
- how the FMP has been developed to date
- what rules and assessment criteria are proposed in the various areas
- how to make a formal submission.

The following took place in response to community feedback that the exhibition period overlapped the peak harvest period:

- Late submissions to public exhibition of the plan were accepted by the department for an additional 60 days after the conclusion of the exhibition period (to Friday 6 Jan 2017).
- An additional information appointments session was hosted at Tambar Springs, largely for landholders in the Upper Cocks Creek area on 18 January 17 (16 participants).

The public exhibition of the plan was advertised in local papers and on the NSW Government HaveYourSay website. The department posted 1,704 letters to flood work approval holders, landholders who submitted floodplain harvesting registrations of interest (ROIs) and landholders whose properties intersected MZ AD, MZ AID and MZ D of the Draft Upper Namoi Valley FMP, notifying them of the exhibition period.

Display packages containing information about the draft plan were available for inspection throughout the exhibition period from locations in Gunnedah (2), Quirindi, Narrabri (2), Boggabri and Spring Ridge, including Local Aboriginal Land Councils within the FMP area.

The department hosted information appointments for stakeholders at Quirindi (2 events), Gunnedah (2 events), Boggabri, Spring Ridge (2), Tambar Springs and Breeza during the exhibition period to view the draft management zones at individual property scale at locations within the Upper Namoi Valley FMP area.

A suite of products was developed to support stakeholders in understanding the Draft Upper Namoi Valley FMP, and this information was available to stakeholders in hard copy from each display location (6), by post or email upon request, and for download from the department's website (Table 30).

**Table 30. Upper Namoi Valley FMP: public exhibition display products**

Document name	Description
Report cards for each management zone of the Draft Upper Namoi Valley FMP	A summary of the draft rules and key factors developed for each management zone of the Draft Upper Namoi Valley FMP
Map of the Draft Upper Namoi Valley FMP	A colour map illustrating the floodplain boundary and management zones contained within the Draft Upper Namoi Valley FMP
Draft rural floodplain management plans: technical manual	A general description of the method employed for development of floodplain management plans across rural New South Wales
Rural floodplain management plans: Background document to the Draft Floodplain Management Plan for the Upper Namoi Valley Floodplain 2017	A description of how the method presented in the technical manual has been applied across the Draft Upper Namoi Valley Floodplain and should be read in conjunction with the technical manual
Draft Floodplain Management Plan for the Upper Namoi Valley Floodplain 2017	The legal document that includes all of the rules and requirements in a statutory format
Floodplain management under the <i>Water Management Act 2000</i> : A guide to the changes	A guide to the transition of floodplain management planning from the <i>Water Act 1912</i> to the <i>Water Management Act 2000</i> in NSW
An overview of floodplain management plans under the <i>Water Management Act 2000</i>	A general, plain English explanation of the key provisions of floodplain management plans. The overview is a summary that should be read in conjunction with the Draft Upper Namoi Valley FMP
Submission form for public exhibition	A template that stakeholders can use to provide comments on the Draft Upper Namoi Valley FMP during public exhibition
FMP comparison posters	A series of A3 posters to highlight differences and commonalities between the Draft Upper Namoi Valley FMP and the 7 existing FMPs developed under the WA1912 within the Upper Namoi valley

Submissions were accepted in writing, electronically and by post.

In addition to the targeted consultation and public exhibition processes, the preparation of the Upper Namoi Valley FMP was supported by the implementation of two additional consultation processes:

- ground-truthing (field validation)
- post-public exhibition consultation.

The ground-truthing process involved the department and OEH undertaking a series of 15 property visits with landholders, including 7 property visits with landholders in the Yarraman area to discuss issues and gain a practical understanding of flood behaviour on the ground over the period February–June 2017. In addition, the department and OEH met with a stakeholder from the Yarraman area on 18 July 2017 to discuss landholder concerns and to review the draft management zones in the Yarraman area.

On 4 October 2017, the department wrote to 96 landholders whose properties were affected by the proposed property-scale changes and sought their feedback

The department has written to all stakeholders who provided a submission to public exhibition (44) and also those who responded to post-public exhibition consultation (7), describing the updates that have been made to the plan in response to the feedback received and providing a copy of the final draft of the management zones map for information.

## Review

### Interagency Regional Panel

The Interagency Regional Panel (IRP) was established to review the boundary, management zones, rules and assessment criteria contained in the Upper Namoi Valley FMP. The IRP consists of one representative from the department to cover water management interests, one representative from OEH to cover environmental interests and one representative from the NSW Department of Primary Industries covering agricultural, fisheries and water management interests.

Representatives from Local Land Services, WaterNSW and the Department of Industry (Economics Branch) may also attend meetings as observers, to provide advice on relevant matters within their area of expertise.

The key responsibilities of the IRP are to:

- ensure that proposed management rules achieve the objectives of the WM Act 2000
- provide information and analysis
- bring a balanced approach to the development of the plan: economic, social, environmental and cultural considerations.

The IRP provides whole-of-government oversight and review of the Upper Namoi Valley FMP and meets at key stages throughout the FMPs development:

- prior to targeted consultation
- prior to public exhibition
- prior to finalisation and commencement.

#### Prior to targeted consultation

The IRP reviewed the Draft Upper Namoi Valley FMP in December 2014 and supported its release for targeted consultation.

#### Prior to public exhibition

The IRP reviewed the Draft Upper Namoi Valley FMP and feedback from targeted consultation in July 2015.

No changes were made to the proposed management zones, but the IRP recommended changes to some of the rules and assessment criteria based on feedback from targeted consultation and further desktop and field validation activities.

The IRP recommended that:

- ecological, Aboriginal value and heritage-site enhancement works be included as a work permissible in MZ AD and MZ D
- rule specifications for access roads in MZ AD be increased to  $\leq 15$  cm in height with associated causeway requirements
- assessment criteria specifications for local flow velocities be altered to accommodate isolated localised increases of more than 50% as long as the average impact is  $\leq 50\%$  and the flow velocity at the property boundary is also not increased by more than 50%. Soil erodibility thresholds must also be considered
- localised higher velocity but continue to ensure that flow time boundary to boundary was unchanged.

The IRP also provided key considerations for the implementation of the Upper Namoi Valley FMP. These considerations will be incorporated into departmental guidelines and used by the department when assessing flood work applications.

### **Prior to finalisation and commencement**

The IRP reconvened after public exhibition to:

- consider stakeholder feedback
- recommend changes to the draft management zones, rules and assessment criteria based on feedback from public exhibition
- review and endorse final management zones, rules and assessment criteria prior to FMP commencement.

A total of 44 submissions were received in response to the public exhibition of the Draft Upper Namoi Valley FMP. From the 44 submissions received, 415 items of inquiry (IOI) were identified and collated.

The feedback received during public exhibition was considered by the IRP prior to finalising the FMP. Changes supported by the IRP are reflected in the finalised products in this report and the Upper Namoi FMP plan order.

On 13 September 2017, the IRP approved changes to the rules and numerous property-scale changes to the boundary and management zones for the Draft Upper Namoi Valley FMP in response to the review processes for feedback received to public exhibition.

On 31 January 2018, the IRP reviewed the feedback received to post-public exhibition consultation and approved changes to the plan in response to the feedback received to post-public exhibition consultation.

On 25 September 2018, the IRP approved proposed minor wording changes in response to internal legal review of the plan.

## **Plan finalisation and commencement**

After endorsement by the IRP in September 2018, the Upper Namoi Valley FMP was submitted to the Minister for Regional Water for in-principle approval and then to the Minister for the Environment to seek concurrence. The Upper Namoi Valley FMP was then submitted to the new Minister for Water, Property and Housing for final approval. The Upper Namoi Valley FMP commenced on 7 June 2019. Copies of the FMP can be obtained from the NSW Legislation website.

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# Glossary

**Aboriginal value enhancement work** is a flood work that is constructed only to benefit Aboriginal value assets that are listed in the Aboriginal Heritage Information Management System (AHIS), Aboriginal Water Initiative System (AWIS), Murray–Darling Basin Authority Aboriginal Submissions Database, NSW State Heritage Register, Commonwealth Heritage List or any other source deemed relevant by the minister.

**Aboriginal values** are sites, objects, landscapes, resources and beliefs that are important to Aboriginal people as part of their continuing culture.

**action plan** refers to a plan that may be developed to assess flood works for remedial action.

**Annual Exceedance Probability (AEP)** is the chance of a flood event of a given or larger size occurring in any one year, usually expressed as a percentage or a likelihood of one flood event in X years. For example, a flood event with an AEP of 5% means there is a 5% chance that a flood event of the same size or larger will occur in any one year.

**areas of groundwater recharge** are areas where water from a flood event leaks through the soil profile into the underlying aquifers.

**borrow** is an area of land where material is excavated or removed to construct a flood work at another location. The removal of material from this area results in a depression or 'hole' in the ground.

**connectivity** refers to the unimpeded passage of floodwater through the floodplain. Connectivity is important for in-stream aquatic processes and biota and the conservation of natural riverine systems.

**cultural asset** is an object, place or value that is important for people to maintain their connections, beliefs, customs, behaviours and social interaction.

**depth-velocity product** is a hydraulic model output that can be used to indicate areas of a floodplain where a significant discharge of water occurs during floods; that is, areas where flow velocity and/or water depth are relatively high.

**design flood** is a flood of known magnitude or annual exceedance probability (AEP), that can be modelled. A design flood is selected to design floodway networks, which are used to define management zones for the planning and assessment of the management of flood works on floodplains. The selection is based on an understanding of flood behaviour and associated flood risk. Multiple design floods may be selected to account for the social, economic and ecological consequences associated with floods of different magnitudes.

**discharge (or flow)** is the rate of flow measured in volume per unit of time (e.g. megalitres per day = ML/day).

**drain** a below-ground structure used to intercept surface water and remove water from land after a flood has passed or during a local rainfall event.

**ecological assets** are a wetland or other floodplain ecosystem, including watercourses that depend on flooding to maintain their ecological character. Areas where groundwater reserves are recharged by floodwaters are also considered to be ecological assets. Ecological assets are spatially explicit and are set in the floodplain landscape.

**Ecological enhancement work** is a flood work that is constructed only to benefit ecological assets that are recognised in or protected by a local, NSW state or Commonwealth environmental policy and/or legislation.

**ecological values (also known as ecological surrogates)** are surrogates for biodiversity that are used to prioritise the ecological assets and include fauna species and fauna habitat, vegetation communities and areas of conservation significance.

**Exceedances per Year (EY)** is the expected number of times in a year that the flood event will occur or be exceeded.

**ecosystem** is a biological system involving interactions between living organisms and their immediate physical, chemical and biological environment.

**existing development conditions** refers to the level of development at the commencement of this plan.

**fish passage** refers to connectivity that facilitates the movement of native fish species between upstream and downstream habitats (longitudinal connectivity) and adjacent riparian and floodplain areas (lateral connectivity). Areas that are important for fish passage include rivers, creeks and flood-flow paths.

**flood-dependent assets** refers to assets that have been identified in the plan as having important ecological and/or cultural features which rely on inundation by floodwaters to sustain essential processes.

**flood-flow corridor** is a hydraulic corridor that conveys flood flow through a management zone.

**flood structure** refers to any existing floodplain feature (such as a barrage, causeway, cutting or embankment) without a flood work approval for which a flood work approval is now required, from the commencement of the plan.

**flooding regime** refers to the frequency, duration, nature and extent of flooding.

**floodways** are areas where a significant discharge of floodwater occurs during small and large design floods.

**Flood Risk Management Plan (FRMP)** provides the preferred options relating to flood risk and provides the information necessary for adequate forward planning of flood prone land.

**Flood Risk Management Study (FRMS)** identifies and determines options in consideration of social, ecological and economic factors relating to flood risk and the management of flood prone land.

**flood study (FS)** is a comprehensive technical investigation of flood behaviour and defines the nature of flood risk.

**flood structure** refers to any existing floodplain feature (such as a barrage, causeway, cutting or embankment) without a flood work approval for which a flood work approval is now required, from the commencement of this plan.

**floodplain watercourses** include:

- (a) permanent flowing rivers and creeks, including those where the flow is modified by upstream dams
- (b) intermittent flowing rivers and creeks that retain water in a series of disconnected pools after flow ceases including those where the flow is modified by upstream dams, to the top of the natural bank regardless of whether the channel has been physically modified
- (c) flood channels or flood runners that run across or along floodplains during high-flow events.

**groundwater recharge areas** are areas where water from a flood event leaks through the soil profile into the underlying aquifers.

**heritage-site enhancement work** is a flood work that is constructed only to benefit heritage site assets that are listed in the Aboriginal Heritage Information Management System (AHIMS), Aboriginal Water Initiative System, Murray–Darling Basin Authority Aboriginal Submissions Database(AWIS), NSW State Heritage Register, NSW State Heritage Inventory, Historic Heritage Information Management Systems, Commonwealth Heritage List or any other source and/or database deemed relevant by the minister.

**heritage sites** are cultural heritage objects and places as listed on Commonwealth, NSW State and/or local government heritage registers or any other source and/or database deemed relevant by the minister.

**high-value infrastructure** includes but is not limited to houses/dwellings, infrastructure protection works, town levees, stockyards, sheds and pump sites. It does not include farm levee banks, irrigation development and fences.

**infrastructure protection works** are flood works that are for the protection of houses, stock yards and other major infrastructure, such as machinery sheds.

**management zones** are areas in the floodplain that have specific rules to define the purpose, nature and construction of flood works that can occur in those areas.

**natural flooding regime** refers to how flood waters moved over the floodplain before development (i.e. flood works and major storage dams), land-use changes and climate change.

**natural surface level** is the average undisturbed surface level in the immediate vicinity of a flood work.

**peak discharge calculation location** is a section of the floodplain where flow is calculated for the purpose of assessing the change in flow behaviour due to proposed flood works.

**pre-development conditions** refer to the natural flooding regimes.

**primary access road** is a road providing access from a public road to a permanently occupied fixed dwelling via a direct route.

**recharge** means the addition of water, usually by infiltration, to an aquifer.

**spoil** refers to waste material (such as dirt or soil) that is produced during the construction or modification of a flood work.

**stock refuge** refers to a flood work that is for the protection of stock in times of flooding.

**wetland** refers to areas of land that are wet by surface water or groundwater, or both, for long enough periods that the plants and animals in them are adapted to, and depend on, moist conditions for at least part of their lifecycle. They include areas that are inundated cyclically, intermittently or permanently with fresh, brackish or saline water, which is generally still or slow moving except in distributary channels. Examples of wetlands include lakes, lagoons, rivers, floodplains, swamps, billabongs and marshes.

**windrow** refers to a row or line of cut vegetation or other material.