



Department of
Primary Industries
Water

Rural floodplain management plans

Water Management Act 2000

Background document to the floodplain management plan for the Barwon-Darling Valley Floodplain 2017

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Contents

List of figures	iii
List of tables	iv
Abbreviations	v
Purpose	7
The Barwon-Darling Valley Floodplain	7
Flooding in the Barwon-Darling Valley Floodplain.....	10
Developing the plan	13
Step 1: Define the floodplain boundary	14
Step 2: Identify existing flood works	15
Step 3: Review existing rural floodplain management arrangements	16
Step 4: Determine the floodway network	18
Design floods.....	19
Hydrologic models	21
Hydraulic models	21
Hydraulic criteria for the floodway network.....	23
Step 5: Identify and prioritise floodplain assets	26
Ecological assets.....	26
Cultural assets.....	37
Step 6: Prepare a socio-economic profile	43
Study area geography	43
Demographic profiles.....	44
Step 7: Delineate management zones	46
Description of management zones	46
Hydraulic criteria.....	49
Ecological criteria	49
Cultural criteria	59
Criteria to better reflect current floodplain management arrangements.....	60

Summary of management zone criteria	61
Modifying a management zone	64
Step 8: Determine rules	64
Authorised flood works	65
Advertising requirements	70
Assessment criteria	70
Existing flood works and structures.....	76
Exemptions to flood work approvals	77
Step 9: Consider existing floodplain management arrangements	78
Floodplain boundary	79
Management zones	79
Rules (including assessment criteria)	80
Step 10: Assess socio-economic impacts	82
Phase one: preliminary assessment	83
Phase two: detailed analysis	88
Role of socio-economics in plan development	88
Consultation and review of the plan	89
Consultation process	89
Review	92
Plan finalisation and commencement	93
References.....	94
Glossary	99

List of figures

Figure 1:	The proposed Barwon-Darling Valley FMP boundary.....	8
Figure 2:	Floodplains designated under Part 8 of the <i>Water Act 1912</i>	10
Figure 3:	Ten steps used to develop rural floodplain management plans under the WMA 2000	14
Figure 4:	Overall footprint of constructed works	16
Figure 5:	History of floodplain management in the proposed Barwon-Darling Valley Floodplain	18
Figure 6:	The proposed Barwon-Darling floodway network	19
Figure 7:	The four reaches of the Barwon-Darling Valley Floodplain.....	22
Figure 8:	Depth velocity threshold map.....	25
Figure 9:	Identification of floodways using the depth-velocity threshold map versus inundation extent.....	25
Figure 10:	Ecological assets identified in the Barwon-Darling Valley Floodplain for the purposes of the draft Barwon-Darling Valley FMP	28
Figure 11:	Location and type of wetlands identified as ecological assets.	30
Figure 12:	Location and type of other floodplain ecosystems identified as ecological assets	32
Figure 13:	High-priority planning units selected in Marxan	35
Figure 14:	Relative priority (the selection frequency as an index of irreplaceability) of planning units (PU) based on the Marxan analysis (the sets of 100 Marxan runs) achieving a range of different representation targets for flood-dependent vegetation assets (60%, 70%, 80%, 90% and 100%) for the Barwon-Darling Valley Floodplain.....	36
Figure 15:	Map of the management zones in the Barwon-Darling Valley Floodplain	47
Figure 16:	Refinements to management zones based on ecological criteria	51
Figure 17:	Location of ecological management zone D assets, Reach 1	55
Figure 18:	Location of ecological management zone D assets, Reach 2	56
Figure 19:	Location of ecological management zone D assets, Reach 3	57
Figure 20:	Location of ecological management zone D assets, Reach 4	58
Figure 21:	Percentage breakdown of criteria used to delineate each management zone	62
Figure 22:	Percentage each management zone in the Barwon-Darling Valley Floodplain	62
Figure 23:	Existing floodplain management arrangements in the Barwon-Darling Valley FMP area.....	79

List of tables

Table 1:	Annual exceedance probability (AEP) for historic flood events at selected locations in the Barwon-Darling.....	20
Table 2:	Hydraulic models in each floodplain reach	22
Table 3:	Summary of criteria used to delineate the hydraulic categories in the floodway network	23
Table 4:	Regional vegetation maps and studies and the assembly rules used for the compilation of a seamless composite vegetation map for the Barwon-Darling Valley Floodplain.....	27
Table 5:	Hydro-ecological functional groups that comprise wetlands and other floodplain ecosystems in the Barwon-Darling Valley Floodplain and their flooding frequency requirements (Source: Optimum watering requirements adapted from Roberts and Marston 2011 and Rogers and Ralph 2011)	33
Table 6:	Description of study area geographies used in socio-economic profile.....	43
Table 7:	Demographic information per socio-economic geography.....	44
Table 8:	Criteria to include assets in recommended management zones.....	50
Table 9:	List of floodplain assets classified as management zone D.....	52
Table 10:	Cultural criteria to include cultural assets in recommended management zones (Zone).....	59
Table 11:	Compilation of management zone criteria	62
Table 12:	Rules for authorised works by management zone.....	65
Table 13:	Categories of impacts that flood-work applications must be assessed against to be approved by management zone.....	71
Table 14:	State-wide exemptions under the Water Management (General) Amendment (Flood Work Approvals) Regulation 2015.....	77
Table 15:	Summary of assessment criteria in current floodplain management arrangements in the Barwon-Darling Valley Floodplain	82
Table 16:	Summary of rule changes between the Base Case and the proposed Barwon-Darling Valley FMP	84
Table 17:	Impact table of proposed Barwon-Darling Valley FMP	86
Table 18:	Changes recommended for consideration by the IRP as a result of feedback received during targeted consultation.....	91

Abbreviations

ABS	Australian Bureau of Statistics
AEP	Annual exceedance probability
AHIMS	Aboriginal Heritage Information Management System
ASDST	Aboriginal Sites Decision Support Tool
ARI	Average Recurrence Interval
ATWG	Aboriginal Technical Working Group
AWIS	Aboriginal Water Initiative System
DEM	Digital Elevation Model
DPIW	NSW Department of Primary Industries, Water
Barwon-Darling Valley FMP	Floodplain Management Plan for the Barwon-Darling Valley Floodplain 2017
DVP	Depth-velocity product
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EY	Exceedances per year
FM	Flexible Mesh
FMP	floodplain management plan
FPWEC	First Peoples' Water Engagement Council
GVAP	Gross Value of Agricultural Production
HHIMS	Historic Heritage Information Management System
IPW	Infrastructure Protection Work
IQQM	Integrated Quantity and Quality Model
IRP	Interagency Regional Panel
IRSAD	Index of Relative Socio-economic Advantage and Disadvantage
LiDAR	Light Detection and Ranging
MDB	Murray-Darling Basin
MZ A	Management Zone - Major discharge areas, defined floodways
MZ B	Management Zone - Flood storage and secondary flood discharge zone
MZ C	Management Zone - Flood fringe and flood protected developed areas
MZ CU	Management Zone - Urban areas
MZ D	Management Zone - Special protection zone
NBAN	Northern Murray-Darling Basin Aboriginal Nations
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

SF	Selection frequency
TAG	Technical Advisory Group
TSC Act	<i>Threatened Species Act 1995</i>
VIS	NSW Vegetation Information System
WA 1912	<i>Water Act 1912</i>
WMA 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 *Rural Floodplain Management Plans: Technical manual for plans developed under the Water Management Act 2000* (the Technical Manual) has been applied across the draft Barwon-Darling Valley Floodplain. This document should be read in conjunction with the Technical Manual and the draft *Floodplain Management Plan for the Barwon-Darling Valley Floodplain 2017* (draft Barwon-Darling Valley FMP).

The Barwon-Darling Valley Floodplain

This document relates to the area known as the draft Barwon-Darling Valley Floodplain, as shown in Figure 1. The upstream limit of the floodplain is at Mungindi on the Barwon River, at the New South Wales, Queensland border and the downstream limit is approximately 20 kilometres downstream of Louth on the Darling River. The northern boundary and part of the southern boundary of the floodplain are confined to higher ground and include a limited extent of contributing influence streams. The remaining parts of the southern boundary are aligned to boundaries of other rural floodplain management plans (FMPs). The Barwon-Darling Valley Floodplain makes up 1.7 per cent of the Barwon-Darling catchment and one per cent of the Murray Darling Basin (MDB). The Barwon-Darling Valley Floodplain covers 1.1 million hectares.

The Barwon-Darling Valley Floodplain is characterised by low relief and elevation. Climatic conditions are extremely variable, including variable flow discharges with large areas of the catchment often subject to prolonged drought periods. High summer temperatures, averaging more than 33°C, are a feature of the floodplain, with extremes well above 40°C and Australia's second highest temperature of 52.8°C recorded at Bourke in 1877 (Thoms, Sheldon and Crabb 2004).

Major tributaries to the Barwon-Darling Valley Floodplain include the Macintyre, Gwydir, Namoi, Castlereagh, and Macquarie rivers. These systems enter the Barwon-Darling River upstream of the township of Bourke. Downstream of Bourke and further west, the Paroo and Warrego rivers contribute intermittent flows to the Darling River and can provide significant volumes during flood events, raising the duration of high flow events in the Barwon-Darling River (Cooney 1994).

For most of the time, 'low' flow conditions dominate the Darling River with major floods periodically interrupting these dry periods, however flows decrease downstream of Bourke due to the lack of contributions from tributaries and increased rates of evaporation (Thoms et al. 2004).

Although considered 'unregulated', the Barwon-Darling River is not technically free-flowing. It is regulated by a number of headwater storages on tributaries in both NSW and Queensland and by the Menindee Lakes Storage on the lower Darling River (437 kilometres upstream from its confluence with the Murray). There are also numerous weirs along the entire length of the river, so that at low flows the river consists mostly of a series of weir-pools (Bowling and Baker 1996).

Tributary headwater dams and water extraction have subjected the Barwon-Darling River to significant impacts, with over one third of its average annual flow being diverted from the river or its tributaries (Thoms et al. 1996). The Darling River upstream from Menindee is greatly affected by headwater dams, low-level weirs and water extraction, both on upstream regulated and unregulated tributaries and on the Darling itself (Thoms et al. 2004). Flows in the system, have been modified by large-scale water extractions for irrigation.

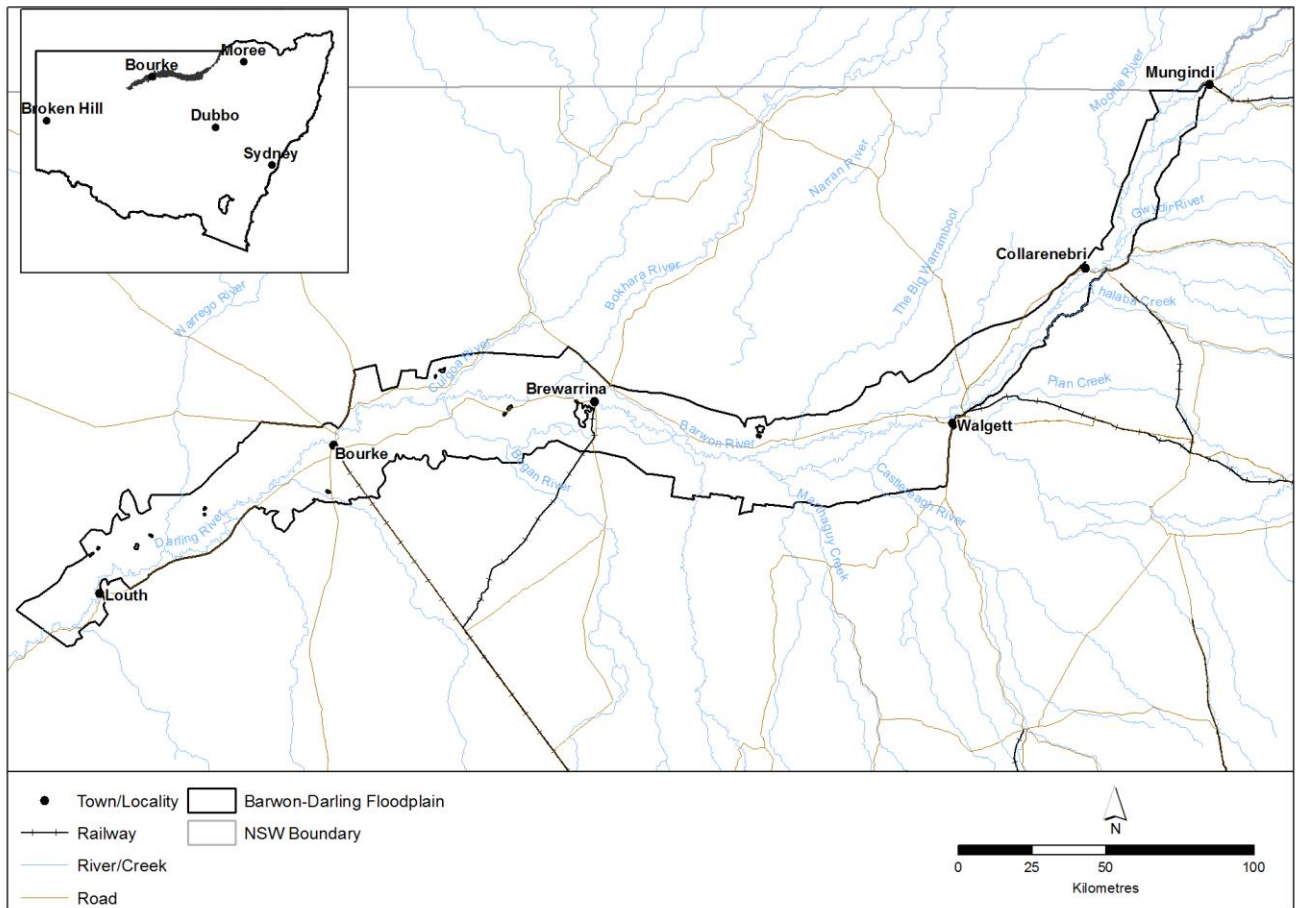


Figure 1: The proposed Barwon-Darling Valley FMP boundary

The Barwon-Darling Valley Floodplain has been influenced by the development of grazing, irrigated cropping, water extraction, road and rail infrastructure and some urbanisation. Over the past 100 years the Barwon-Darling River has suffered from reduced water flows and quality due to water diversion, uncontrolled stock, and polluted run-off from towns, salinity, sedimentation and blue-green algae (WCMA 2009). Still, the floodplain retains significant ecological values.

Characteristically, the floodplain has grey cracking clay soils, drainage lines of varying definition, riverine woodlands fringing the main watercourses and many wetlands including floodplain billabongs, anabranches and lagoons (Brennan et al. 2002). The floodplain supports a broad range of fauna. It also has a rich Aboriginal heritage and contains many sites of Aboriginal importance, some of which are sustained by periodic flooding.

The ecological significance of the Barwon-Darling Valley Floodplain includes:

- wetlands along the river and several deflation basin wetlands (geological depressions formed by erosion when soil is shifted by the wind);
- major waterbird breeding habitat sites at lakes and other wetlands along the floodplain which are watered at a variety of flows;
- the Barwon-Darling River channel and associated riparian habitats support a wide variety of ecosystems and a number of fish species, including bony herring and golden perch;
- a diverse range of flora species including river red gum, black box, river cooba, coolibah and lignum;
- a range of fauna including species listed under the *Environment Protection and Biodiversity Conservation Act 1999* such as Murray cod, Latham's snipe, rainbow bee-eater and superb

parrot, and the NSW *Threatened Species Act 1995* (TSC Act) such as the blue-billed duck, the brolga and the grey falcon (CEWO 2013);

- as part of the Lowland Darling River Aquatic Ecological Community (NSW DPI 2011), the *Fisheries Management Act 1994* declares the main Barwon-Darling River from Mungindi to its junction with the Murray as endangered.

Agricultural production is a significant component of the Barwon-Darling Valley Floodplain economy. To enhance the agricultural productivity, works have been built on the floodplain to improve land used for grazing, dryland cropping and irrigated cropping. Typically, works such as levees, roads, banks and supply channels 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 or flow of floodwaters, are referred to as flood works. Approximately 45,700 hectares (four per cent) of floodplain area is protected by flood works in the Barwon-Darling Valley Floodplain.

In many instances, flood works have contributed positively to the agricultural productivity of land in Australia. However, flood works can cause major changes to flooding patterns, particularly when built in an uncoordinated manner.

For instance, flood works can cause flows to be redirected onto adjacent properties, or flood levels and velocities to be increased. These changes can result in crop losses, erosion, scour and flood damages, even in areas that are traditionally relatively flood-free. In some instances, flood works can influence flows many kilometres upstream and downstream beyond the original work location. Changes to flooding behaviour can also negatively impact floodplain ecosystems by blocking or redirecting flow away from flora and fauna that are dependent on flooding or towards species or cultural sites that are impacted by flooding.

The NSW Government has been responsible for rural floodplain management planning in the Barwon-Darling Valley Floodplain since the early 1980s. Although there are no gazetted FMPs within the Barwon-Darling Valley Floodplain there are a number of designated floodplains (see Figure 2), with current floodplain management guided by *Guidelines for Floodplain Development Darling River Little Bogan Confluence to Yanda Creek Confluence* (WRC 1986a), *Guidelines for Floodplain Development Darling River Yanda Creek Confluence to Louth* (WRC 1986b) and *Rural Flood Study Darling River Floodplain (Bogan River Confluence to Louth)* (URS 2009).

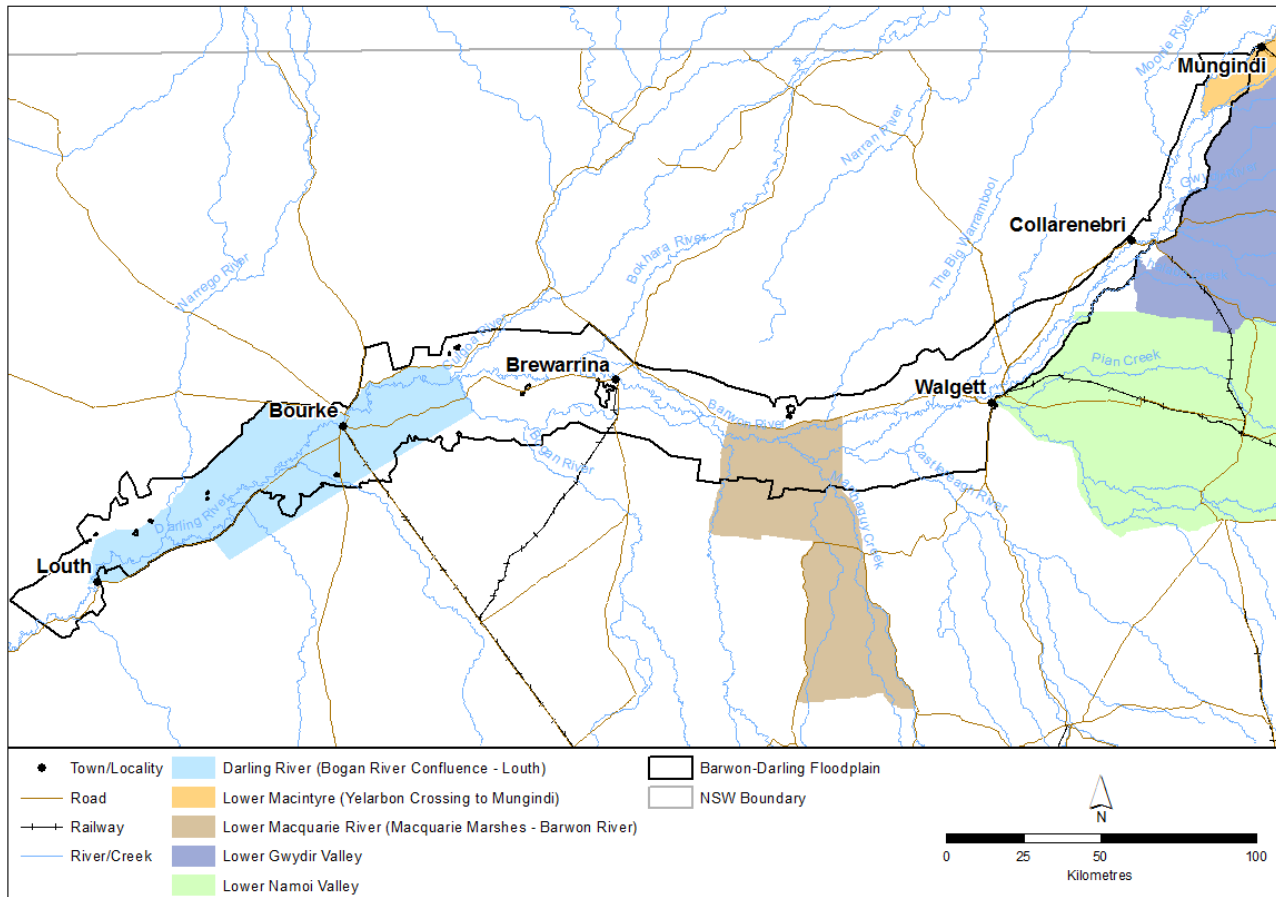


Figure 2: Floodplains designated under Part 8 of the *Water Act 1912*

To build on floodplain management planning to-date, the draft Barwon-Darling Valley FMP has been prepared in accordance with the floodplain planning and environmental protection provisions under the *Water Management Act 2000* (WMA 2000). The FMP will aim to coordinate flood-work development to protect flooding behaviour while minimising risk to life and property from the effects of flooding. The Barwon-Darling Valley FMP will provide management zones and rules to be used when determining flood-work development approvals for new flood works, and amendments to existing flood works. Existing floodplain management arrangements that apply to the Barwon-Darling Valley Floodplain have been reviewed and incorporated where relevant into the design of the management zones, rules and assessment criteria to determine flood-work applications within the draft Barwon-Darling Valley FMP.

Flooding in the Barwon-Darling Valley Floodplain

The flooding regime in the Barwon-Darling Valley Floodplain is complex, as flood flows can arise from a number of sources. Flooding can originate from southern and central Queensland via the Culgoa, Birrie, Bokhara and Warrego rivers and from the Macintyre and Dumaresq rivers along the border between Queensland and NSW. Floodwaters can also originate from the north western and central river valleys of NSW including the Gwydir, Namoi, Castlereagh, Macquarie and Bogan rivers. Floods can also arise from a combination of all of the above sources.

The percentage of the total long-term flow from the six major flow contributors to the Barwon-Darling catchment is as follows (URS 2008):

- Macintyre (35%)
- Gwydir River (10%)
- Namoi River (25%)

- Macquarie and Castlereagh rivers (5%)
- Culgoa River system (20%)
- local rainfall events and minor contributions from the Warrego and Paroo rivers (5%).

The relative contributions of the tributaries have varied for the different historical flood events. The inflows from the southern tributaries are generally greater than those from the northern tributaries. In most floods, the largest inflow has been from the Namoi River; however the largest inflow in the 1990 event was from the Bogan River.

Occasional relatively short periods of high flow result in the river overtopping its banks and inundating part or all of the floodplain. Flood duration can range from a few hours to months with some areas of the floodplain, such as deep billabongs adjacent to the main channel, remaining inundated for several years.

Mungindi to Calmundi Weir

The floodwaters that flow downstream towards Mungindi originate from the Macintyre catchment, which is characterised by a complex drainage network straddling the NSW/Queensland border. These floodwaters inundate vast areas, and the length of time for floodwaters to reach Mungindi from Boggabilla is in the order of ten days. This timing may vary according to factors such as the location of rainfall on the Macintyre catchment and the vegetation cover (WRC 1981). The historical flood of April 1890 was the highest flood recorded at Mungindi, whilst the February 1976 and April 1988 were the second and third highest respectively.

Downstream of Mungindi, the overbank flows of Whalan Creek, the Boomi and Barwon rivers merge and flow in a south-westerly direction towards Collarenebri. Gil Gil Creek can influence flood behaviour south of Mungindi. Gil Gil Creek eventually joins the Boomi River downstream of Mungindi. The Little Weir River enters the Barwon River from the right bank, midway between Mungindi and the Boomi River confluence with the Barwon. Downstream of the Boomi River confluence, tributary inflows occur from the right bank via the Moonie River.

Between the Moonie River confluence and Walgett, complex and widespread flooding occurs on the left bank of the Barwon River, resulting from tributary flow from the Gwydir and Mehi rivers and Thalaba Creek.

Calmundi Weir to Namoi River Junction (DLWC 2001)

The Barwon-Darling Valley Floodplain in the vicinity of Calmundi Weir on the Barwon River is typically about 10 kilometres wide, including the Thalaba Creek and Pagan Creek anabranches. Substantial inflows from the Lower Namoi Floodplain to the east occurred at two locations during the 1998 flood. The Barwon-Darling Valley Floodplain is generally separated by high ground to the east from Pian Creek which is an effluent watercourse of the Namoi River. Flows between the Barwon River and Pian Creek occur in the vicinity of "Eurie" and "College Green". Around Walgett the floodplain is connected with the Namoi River.

Outflows from the Barwon River to the west occur in major floods, principally into Sparkes Warrambool which re-joins the Barwon River downstream of Walgett.

Namoi River Junction to Macquarie River Junction (DLWC 2001)

Extensive left (south) bank overflows occurred along the Namoi River upstream of Walgett in 1998. These overflows spread south of the town over a width of up to 20 kilometres. The floodwaters were conveyed in a westerly direction through the Cumbadoon Warrambool system to reach the Castlereagh River.

Downstream of Walgett, left bank overflows of the Barwon River are conveyed via the effluent creek system of Euromlin, Wanourie and Womat Creeks to the Castlereagh River.

The Castlereagh River carries the Namoi River and Barwon River overflows, as well as run-off from its own catchment, to the Macquarie River which flows into the Barwon River just upstream of the “Miralwyn” development. There is also a flow path to the south of “Miralwyn” from the Macquarie River catchment to Marra Creek via Ginghet Swamp.

Right (north) bank overflows of the Barwon River may also be substantial but are generally less extensive than left bank overflows in this reach. Upstream overflows from Sparkes Warrambool re-enter the river and there are also inflows from the Big Warrambool.

Macquarie River Junction to Bogan River Junction (DLWC 2001)

Overflows of the right bank of the Barwon River occur into the Yambie Swamp area north of “Miralwyn”.

There are major overflow systems from both the left and right banks of the Barwon River commencing about 10 kilometres downstream of the Marra Creek junction. Overflows to the south are conveyed via Tarrion Creek to join the Bogan River about 30 kilometres south-west of Brewarrina. Overflows to the north are conveyed via Cato Creek to join the Bokhara River about 10 kilometres north of Brewarrina. There are extensive floodplains associated with the Tarrion Creek and Cato Creek flows as well as the Barwon River flows upstream and downstream of Brewarrina.

The interaction of Barwon River flows with Bokhara River and Culgoa River inflows from the north and Bogan River inflows from the south also leads to an extensive floodplain area.

Bogan River Junction to Warrego River Junction (DLWC 2001)

Extensive floodplain inundation occurred in this reach in 1998. The area east of Bourke was affected by flows in the Little Bogan River as well as by flows in the Darling River. The main flow path at Bourke was in the Darling River and the Big Billabong to the north of the town; however there was also a substantial flow path to the south of the town. This path was also highly active in 1974 and 1976 when there were large flows from upstream in the Barwon-Darling River, as well as in 1990 when the major flow contribution was from the Bogan River.

Warrego River Junction to downstream of Louth (Weir 21) (SMEC 2012)

Flooding in this area is primarily confined to the right bank of the Darling River and during Darling River flood events some floodwaters cross the Warrego River in the area upstream of its confluence. While the floodplain in the Warrego confluence area is relatively wide, some isolated high spots exist on the right bank floodplain in this area.

Significant water features in the area adjacent to the Warrego confluence include the Ross Billabong (upstream of the confluence) and Talowa Billabong (downstream of the confluence).

The width of the floodplain during the 1974 flood in the area adjacent to Louth and in the area of Weir 21, downstream of Louth, was in the order of 10 kilometres to 15 kilometres wide.

Key changes to the natural flooding regime

The natural flooding regime of the Barwon-Darling Valley Floodplain has been altered over the years by the construction of weirs, flood works, town levees, and major roads/railways, along with vegetation clearing for farming and irrigation works. The modified/developed flood regimes of the main contributing valleys such as the Macintyre, Gwydir, Namoi, and Macquarie also influence the character of the current Barwon-Darling flood regime. Works such as the ones mentioned above, along with associated water extraction, are the main types of development contributing to the overall changes in regime. This regulation of the system has altered the seasonal flow regime, reduced frequency and extent of flooding and reduced channel complexity.

The surface waters of the Barwon-Darling catchment show long-term variability, with water resource development also having the potential to change long-term flow variability. Thoms and Sheldon (2000) compared Integrated Quantity and Quality Model (IQQM) outputs of simulated ‘reference’

flows with simulated 1993/94 levels of development flows for the period 1963-96 for four NSW gauging stations at Mungindi, Walgett, Bourke and Wilcannia, and observed the following:

- water resource development has had a major impact on annual flows, with an average reduction of 32.5 per cent and 44.5 per cent in mean and median annual volumes of water respectively, with the biggest reduction seen at Walgett.
- low flows have increased but higher flows have decreased
- flow seasonality has also been altered with summer peaks being reduced by up to 56 per cent from irrigation diversions
- water resource development has also influenced the size of different flood events, for example, flows with more than two exceedances per year (EY) have experienced a significant reduction in size, and floods that occur every two years or more have also been reduced.

Demand for irrigation water from the Darling River has markedly reduced flows compared with those prior to settlement. Changes to the general level of river flows have resulted from increased extractions and irrigation development on tributaries, whilst low flows have been influenced by the local irrigation industry. This reduction in flows has major consequences for flood-dependent ecosystems as it results in increased time intervals between flood events and a reduction in flood duration (Kingsford 2000; Thoms et al. 2004; Jenkins and Boulton 2007).

Several local river health issues relating to the sharing of water between instream and consumptive uses have occurred in the Barwon-Darling in recent years. Declines in river health are the result of a number of factors, but changed river flows are considered to be important contributors to such declines. The Department of Land and Water Conservation (1998) listed the following environmental impacts associated with changed river flows in the Barwon-Darling:

- greater frequency of blue-green algal blooms
- riverbank instability, slumping and changes in channel form
- reduced fish breeding and migration opportunities
- decreased wetland inundation, and
- impacts on natural processes, including the decline in food production to support fish and bird populations.

Developing the plan

The draft Barwon-Darling Valley FMP was developed by the NSW Office of Environment and Heritage (OEH) and the NSW Department of Primary Industries, Water (DPIW) in consultation with the Barwon-Darling Technical Advisory Group (TAG) and Aboriginal Technical Working Group (ATWG). The plan development was based on consensus decision-making and technical methodologies.

In addition to the TAG, an Interagency Regional Panel (IRP) made up of representatives from DPI Agriculture, DPIW and OEH review the FMP prior to:

- targeted community consultation
- public exhibition
- finalisation of the FMP.

The draft FMP was developed through a 10 step process which is outlined in the following sections (see Figure 3). As well as the 10 steps, there are two main consultation activities that occur as part of the development of the FMP. These are targeted consultation and public exhibition where community feedback on the boundary, management zones, rules and assessment criteria in the FMP is invited.

Targeted community consultation on the draft management zones and rules in the draft Barwon-Darling Valley FMP occurred during October 2015 and February 2016. Outcomes from the targeted consultation are provided in this document in 'Consultation and review of the plan'.

In March 2016, the IRP reviewed and endorsed the draft Barwon-Darling Valley FMP management zones and rules for public exhibition. The IRP will also review submissions made during public exhibition and are responsible for endorsement of the final management zones and rules. Further details on the IRP review process are outlined in 'Consultation and review of the plan'.

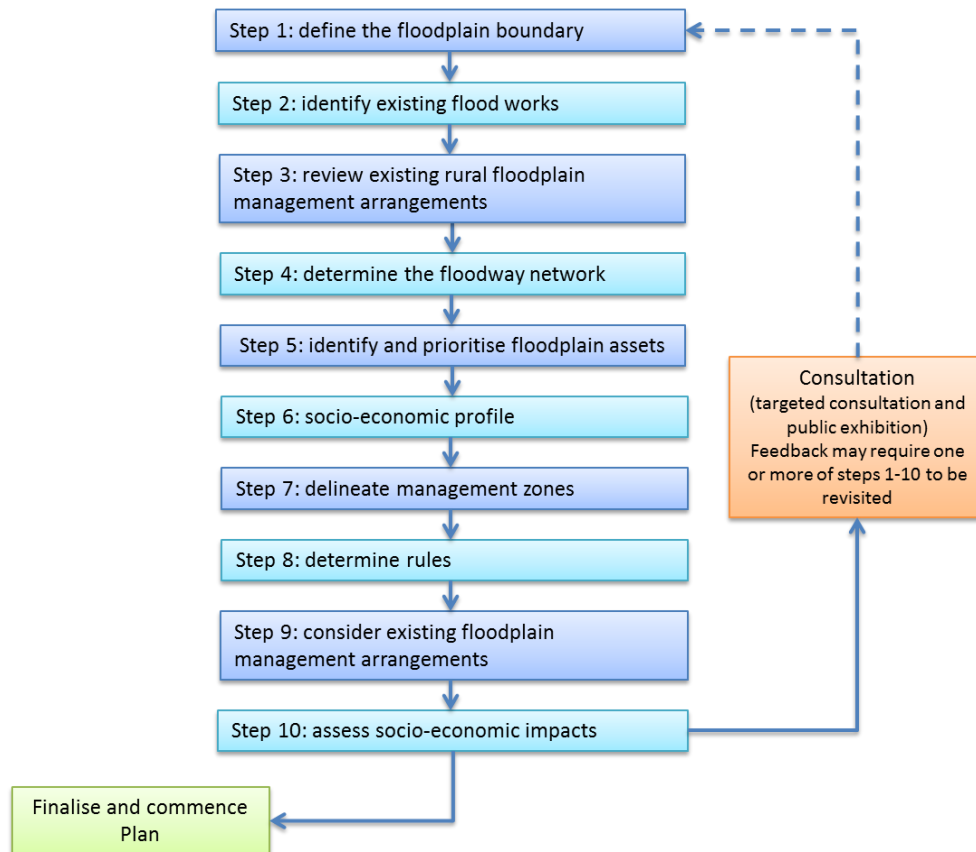


Figure 3: Ten steps used to develop rural floodplain management plans under the WMA 2000

Appendix 1 contains a detailed table of the 10 steps including the input/process and output/outcome related to each step.

Step 1: Define the floodplain boundary

The Barwon-Darling Valley FMP applies to the area defined as the Barwon-Darling Valley Floodplain. The Barwon-Darling Valley Floodplain boundary covers 1.1 million hectares. When compared to the existing Part 8 designated floodplains, the overall extent of boundary change is significant, with the addition of approximately 765,400 hectares (see Figure 2).

The Barwon-Darling Valley Floodplain boundary was delineated based on the consideration of the following:

- **Designated floodplains and floodplain development guidelines**

Existing and potential floodplain developments in the Barwon-Darling were identified from existing designated floodplain areas (see below) designated under Part 8 of the *Water Act 1912* (WA 1912). The WA 1912 was repealed in 2015 and all existing designated floodplains under this Act have transitioned across to the WMA.

- Bogan River Confluence to Louth designated floodplain, rural flood study (URS 2009)

- Lower Macquarie designated floodplain
- Lower Macintyre designated floodplain
- Small sections of the Lower Gwydir and Lower Namoi designated floodplains
- Little Bogan River to Yanda Creek floodplain guidelines, (WRC 1986a)
- Darling River – Yanda Creek to Louth floodplain guidelines, (WRC 1986b)

- **Hydraulic effects of development**

The floodplain was extended to include additional flood works that were outside the existing designated floodplain areas to meet the objectives of the Barwon-Darling Valley FMP and to assist with the coordination of all flood works across the extent of major flooding.

- **Cadastral and administrative relevance**

Where appropriate, the floodplain was aligned with significant cadastral features (e.g. property, parish, county, LGA and State boundaries; roads and railways) to simplify administration and to provide clarity to water users.

- **Planning legacy (unregulated water sharing plans (WSPs))**

Where appropriate, the boundary was aligned with unregulated WSP boundaries to ensure consistency with boundaries of water management plans under the WMA, ease of administration and increased clarity for water users.

- **Floodplain harvesting**

The floodplain boundary included areas identified through the Floodplain Harvesting Project's expression of interest process for floodplain harvesting licences and potential floodplain harvesting structures. This will ensure consistency with the NSW Floodplain Harvesting Policy (NSW DPI 2013), which only applies to floodplain harvesting activities on properties where all or part of that property lies within the designated floodplain.

Other FMP floodplain boundaries

- The Barwon-Darling Valley Floodplain was aligned with FMP boundaries of the Border Rivers, Gwydir, Lower Namoi and Macquarie valleys to provide consistency with other water management plan boundaries under the WMA 2000.

- **Landscape features**

Where appropriate, the boundary was aligned with significant landscape features, such as weirs, to assist ease of administration and to provide clarity for water users.

Step 2: Identify existing flood works

Approximately 45,700 hectares (four per cent) of floodplain area is enclosed by flood works in the Barwon-Darling Valley Floodplain (Figure 4).

Individual works are not shown in the footprint areas but may include:

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

Limited height works were 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 WMA 2000. Supply channels and storages may be identified as water supply works and flood works.

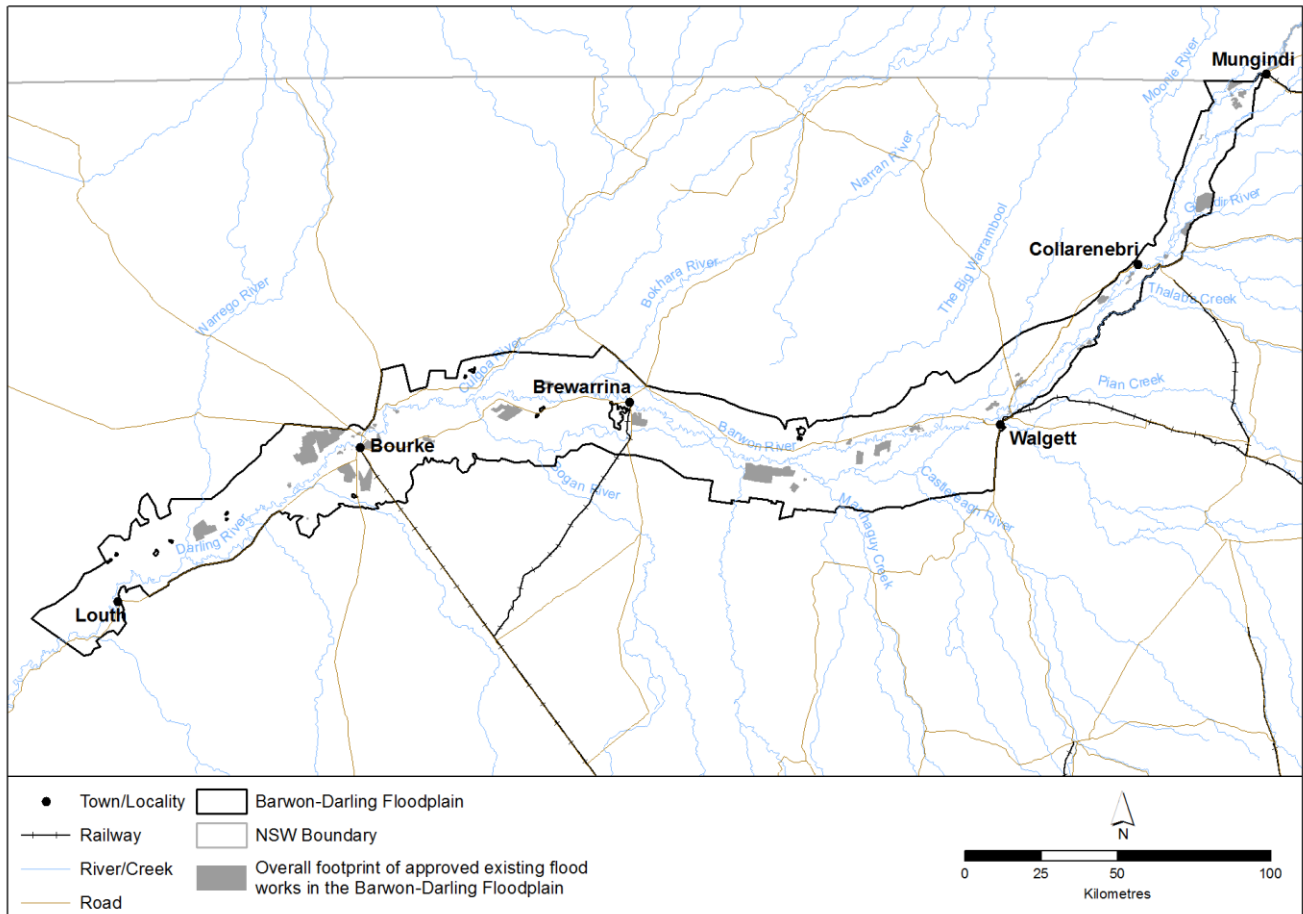


Figure 4: Overall footprint of constructed works

Step 3: Review existing rural floodplain management arrangements

Existing rural floodplain management arrangements in the Barwon-Darling Valley Floodplain include (Figure 5) rural floodplain development guidelines, a flood study and a rural FMP Scoping Study that are all non-statutory. There are currently no statutory FMPs in the Barwon-Darling Valley Floodplain. When the Barwon-Darling Valley FMP is enacted it will supersede all current rural floodplain management arrangements in the Barwon-Darling Valley Floodplain.

Floodplain management plans

There are no gazetted FMPs in the Barwon-Darling Valley Floodplain.

Floodplain development guidelines

The following two guidelines were produced in the Barwon-Darling Valley Floodplain:

- Guidelines for Flood Plain Development Darling River Little Bogan confluence to Yanda Creek confluence (WRC 1986a)
- Guidelines for Flood Plain Development Darling River Yanda Creek confluence to Louth (WRC 1986b)

A very small portion of the downstream limits of the Macintyre Floodplain Development Guidelines extend into the upstream limits of the Barwon-Darling Valley Floodplain, in the vicinity of Mungindi.

Supporting reference documents

The following studies have been used as supporting references to assist with flood work determinations:

- Flood Study Report – Rural Flood Study Darling River Floodplain (Bogan River Confluence to Louth) (URS 2009)
- Compendium of Data - Rural Flood Study Darling River Floodplain (Bogan River Confluence to Louth) (URS 2008)
- Barwon-Darling River Floodplain Management Plan – Walgett to Bourke, Final report on Scoping Study (DLWC 2001).

A detailed history of floodplain management in the Barwon-Darling Valley Floodplain is outlined in Appendix 2.

Existing rural floodplain management arrangements in the Barwon-Darling Valley Floodplain were reviewed to determine their respective:

- 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.

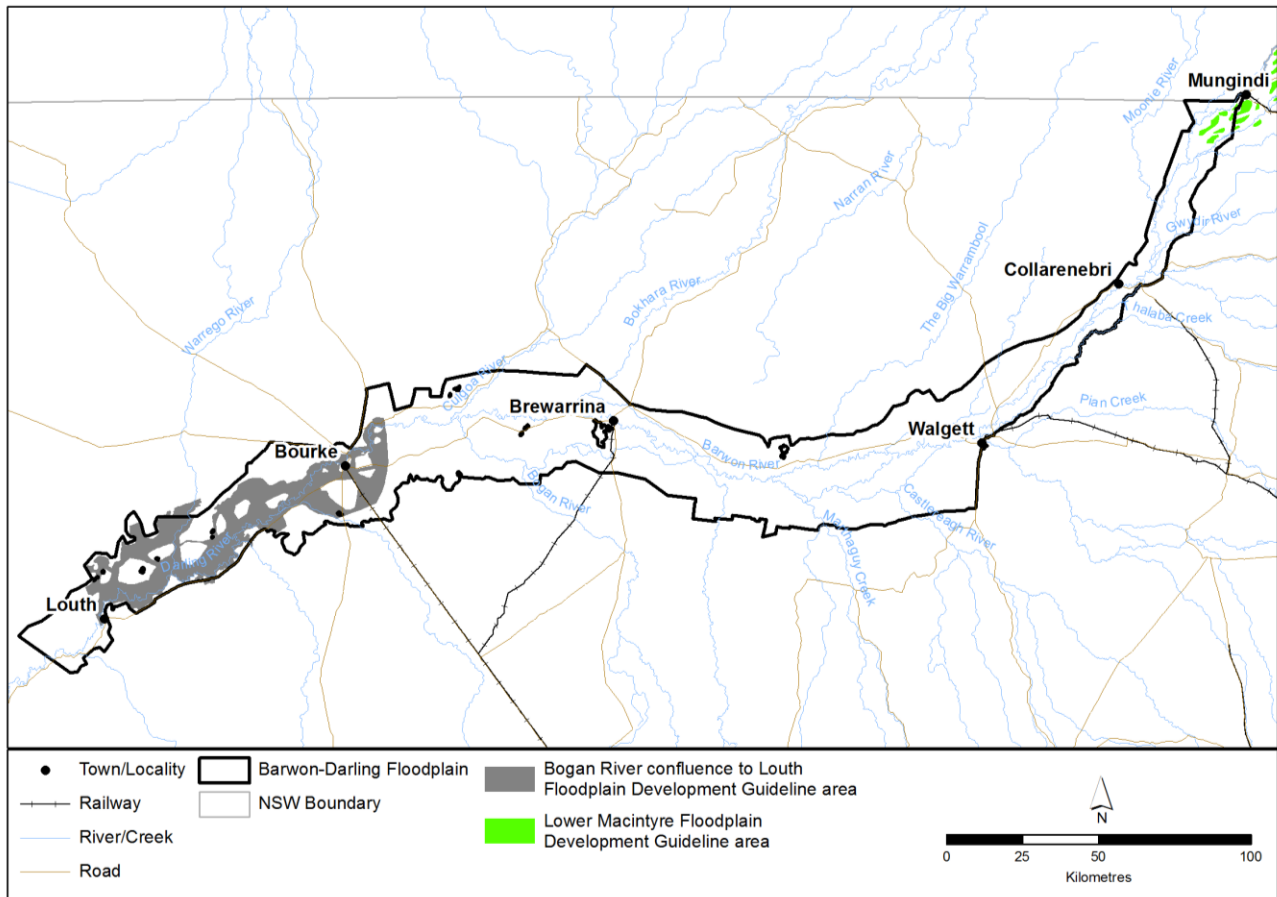


Figure 5: History of floodplain management in the proposed Barwon-Darling Valley Floodplain

Step 4: Determine the floodway network

Step 4 involved selecting floods of different magnitudes (design floods) and constructing hydrologic and hydraulic models to simulate the movement of those floods through the river channels and floodplain. This modelling data as well as additional data, such as flood imagery, was used to map the floodway network.

The Barwon-Darling floodway network (see Figure 6) is comprised of two hydraulic categories:

- floodways, which are areas where a significant discharge of floodwater occurs
- inundation extent, which includes areas of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood.

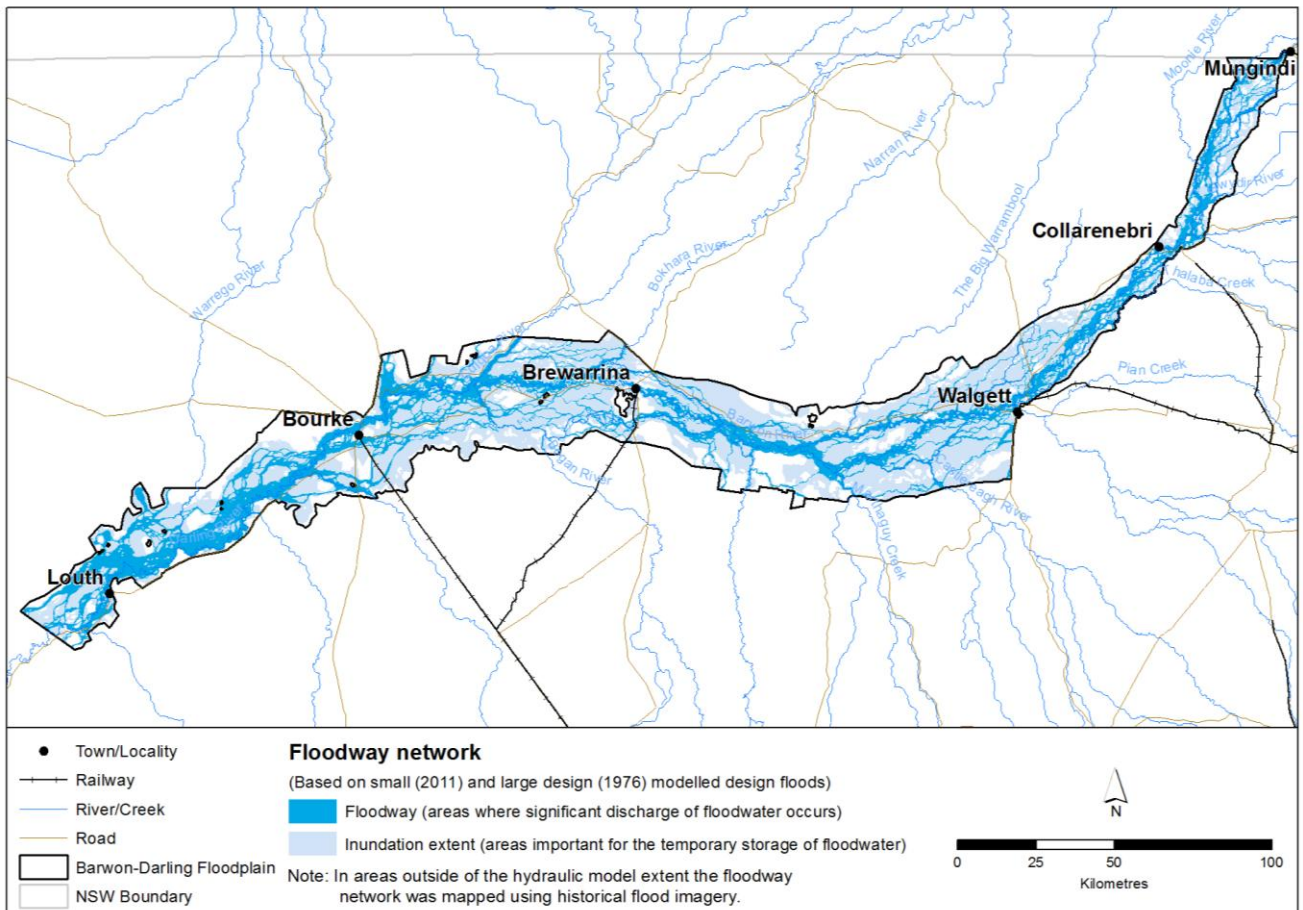


Figure 6: The proposed Barwon-Darling floodway network

The floodway network was the hydraulic basis for determining the management zones, rules and assessment criteria of the draft Barwon-Darling Valley FMP.

Design floods

A design flood is a flood of known magnitude or Annual Exceedance Probability (AEP) that can be modelled. A design flood forms the basis of the floodway network and this information is used as the hydraulic basis when developing the management zones. Selection of a design flood 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.

Two design floods were selected for the draft Barwon-Darling Valley FMP:

- large design flood – February 1976 (1.4% AEP @ Walgett or 1.15% AEP @ Bourke)
- small design flood – November 2011 (17% AEP @ Walgett and Bourke).

A flood frequency analysis was undertaken to assist with the selection of the design floods (Table 1). The flood frequency analysis was used to determine the relationship between peak flood discharge at a location of interest and the likelihood that a flood event of that size or greater would occur (see Appendix 3 for more details on design floods and how the flood frequency analysis results were obtained).

Table 1: Annual exceedance probability (AEP) for historic flood events at selected locations in the Barwon-Darling

Location (Gauging Station number)	Reason for gauging station selection	Flood event AEP (%)						
		1974	1976	1996	1998	2011	2012	2013
Barwon River at Mungindi (416001)	Long period of record, located at the top of the floodplain and top of Reach 1	4	0.95	6	4.5	14	25	13
Barwon River at Collarenebri (422003)	Located near the centre of Reach 1	10	7	6	3	13	1.7	25
Barwon River at Walgett (422001)	Long period of record, located near the centre of Reach 2	2.1	1.4	11	5.6	17	4.4	33
Barwon River at Brewarrina (422002)	Long period of record, located in the centre of Reach 3	3	2.9	14	5.6	20	6	50
Darling River at Bourke (425003)	Long period of record, located near the beginning of Reach 4	1.1	1.15	20	3.6	17	2.9	50
Darling River at Louth (425004)	Located at Louth and near the downstream end of Reach 4	2.6	2.3	25	5.6	20	9.1	50

The large design flood (February 1976) was used to delineate floodways with significant discharge and to determine the extent of the floodway network. The large design flood was selected because:

- it is a recent large flood and therefore likely to be in the collective memory of floodplain users
- it is representative of large floods in the Barwon-Darling Valley Floodplain, and
- there is a significant amount of information available for the event.

Other advantages of choosing the 1976 event for the large design flood are:

- streamlined modelling, by having the same flood throughout the whole Barwon-Darling Valley Floodplain
- same large design flood as used in the draft Macintyre FMP, and
- similar flood magnitude as the large design flood (2012) adopted for the Gwydir Valley FMP.

The small design flood (December 2011) is a 14 per cent AEP flood event at the Mungindi gauge and 20 per cent AEP flood event at the Louth gauge. This smaller event was selected to ensure that critical flow paths to floodplain assets are identified in the floodway network.

The small design flood was selected because it:

- approximated a 12 per cent AEP (1 in 8) event across the Barwon-Darling Valley Floodplain, which was selected in the Sustainable Rivers Audit as an indicator of river health associated with high overbank flows (see Davies et al. 2012), and
- will contribute to the protection of ecological assets and ecosystem functions in the Barwon-Darling Valley Floodplain that require environmental watering, according to the environmental objectives outlined in the Basin Plan's environmental watering plan and consistent with the

environmental objectives outlined in annual environmental water portfolio plans for the Northern Unregulated Rivers developed by the Commonwealth Environmental Water Office.

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 flow hydrographs at specified locations (Laurenson, Mein and Nathan 2010).

The Barwon-Darling River can receive flood producing water from a number of tributaries, with larger floods occurring when several tributaries are in flood at the same time. The majority of the tributaries along the left bank of the Barwon River have been modelled up to large flood flows for their respective floodplain management plans (Macintyre, Gwydir, Namoi and Macquarie) and their flows into the Barwon-Darling are relatively well gauged. The other major tributaries are also gauged, including; the Culgoa, Bokhara, Warrego, and Bogan rivers.

There are a number of other smaller ephemeral tributaries, such as the Yanda, Mulga, Ledknapper Creeks and the Big Warrambool that can contribute flow to the Barwon-Darling. However the flow volume of these creeks is comparatively small and they are unlikely to have a significant impact on flood heights or flow distribution. Another important consideration is that these creeks drain local semi-arid catchments and flow from these creeks may fill and recede well before flood producing waters arrive from the larger, gauged tributaries for the same rainfall event.

For these reasons, no hydrological modelling was undertaken for the Barwon-Darling Valley Floodplain as the major inflows were derived from gauges, upstream modelling or from hydraulic modelling from adjoining FMP floodplains. Some calculations of potential flow were made (using the Rational Method) to ensure that the floodways from the ungauged tributaries are accounted for in the floodway network.

Hydraulic models

The Barwon-Darling Valley Floodplain was divided into four reaches for hydraulic modelling purposes (Figure 7). A MIKE 21 FM model was created for each of the four reaches. MIKE 21 FM is a 2 dimensional hydrodynamic model using MIKE 21 and Flexible Mesh (FM) bathymetry. The models utilise a range of elevation data sources including LiDAR data resampled to a 20 metre grid. A finer mesh resolution was used to represent all major water courses with a coarser mesh used to represent the floodplain. The crest level of major features such as roads and railway embankments were included in the model mesh.

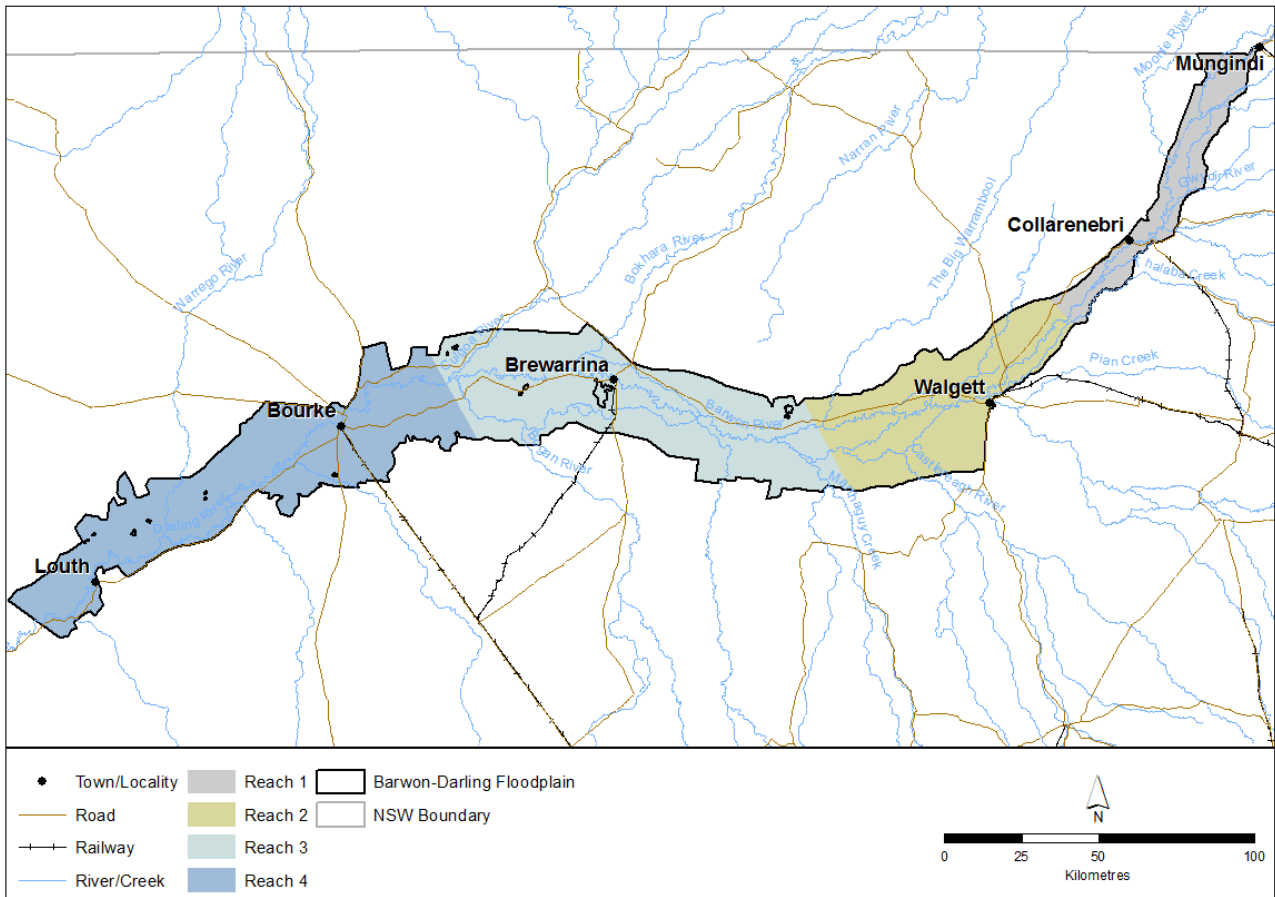


Figure 7: The four reaches of the Barwon-Darling Valley Floodplain

The hydraulic models used to develop the draft Barwon-Darling floodway network are outlined in Table 2. For information on hydraulic model networks, boundaries, structures, hydraulic parameters and model calibration, see Appendix 4.

Hydraulic model outputs used to develop the Barwon-Darling floodway network were:

- a depth-velocity product map from the large design flood
- inundation extents of the small and large design floods.

These outputs were used to determine whether an area subjected to flooding was a floodway or area important for floodplain pondage and the appropriate width of identified 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.

Table 2: Hydraulic models in each floodplain reach

Floodplain model	Model description
Reach 1 – Mungindi to	A MIKE 21 FM model was built from Mungindi to upstream of Tara. The major tributary

upstream of Tara	inflows within this reach include Gil Gil Creek, Barwon and Gwydir River. All protected areas including the township of Collarenebri were excluded from the mesh.
Reach 2 – Upstream of Tara to Geera	A MIKE 21 FM model was built from Tara to Geera. The major tributary inflows include Pian Creek, Barwon and Namoi rivers. All major protected areas were excluded from the mesh, including the township of Walgett.
Reach 3 – Geera to Warraweena	A MIKE 21 FM model was built from Geera to Warraweena. The major tributary inflows include the Bogan, Bokhara and Culgoa rivers. All major protected areas were excluded from the mesh, including the township of Brewarrina.
Reach 4 – Warraweena to downstream of Louth	A MIKE 21 FM model was built from Warraweena to downstream of Louth. The major tributary inflows for this reach include the Warrego River, Mulga and Yanda creeks. All major protected areas were excluded from the mesh, including the township of Bourke.

Model calibration

Hydraulic models were calibrated using selected historic flood events that are around the design flood magnitude and that activate all likely flow paths. The models were calibrated against a range of data sources, which are listed in the Technical Manual.

Hydraulic criteria for the floodway network

The small and large design floods provide the hydraulic basis for delineating the floodway network. Hydraulic criteria to develop the floodway network was determined through consultation with the TAG and local stakeholders. From this consultation, several hydraulic criteria options were developed. Each option proposed a target depth-velocity threshold that would be used to delineate floodways. An impact analysis of each option was also undertaken. The IRP used this information to adopt the option that provided the greatest hydraulic flood connectivity balanced with socio-economic considerations. The hydraulic criteria endorsed by the IRP and used to delineate the floodway network are described in Table 3. Once the thresholds were decided, applying the criteria in the spatial context remained a complex and iterative process requiring specialist input from practitioners with skills in interpreting flood data and floodplain geomorphology, and in understanding the importance of hydraulic controls and conveyance (Thomas and Golaszewski 2012).

Table 3: Summary of criteria used to delineate the hydraulic categories in the floodway network

Hydraulic category	Criteria
Floodways	<ul style="list-style-type: none"> • Areas that have a depth-velocity product (DVP) of greater than or equal to 0.3m²/s for the large design flood (Feb 1976) • Areas that support tributary flows and outer floodplain floodways that have a DVP of greater than or equal to 0.1m²/s for the large design flood (Feb 1976) • Parts of the small design flood extent (Dec 2011) that ensure continuity of floodways
Inundation extent	<ul style="list-style-type: none"> • Flood extent of the small (Dec 2011) and large design flood (Feb 1976) • In areas outside the hydraulic model extent flood imagery from the 2012 flood event and NSW water count and water prevalence data (Fisher et al. 2016; Danaher & Collett 2006; Auscover Remote Sensing Data Facility 2016) derived from Landsat satellite imagery.

Validation of the mapped floodway network was undertaken to ensure high level mapping accuracy. The following information was used to validate the floodway network:

- depth-velocity product maps for the large design flood (February 1976)
- discharge and velocity values along flow paths
- inundation extents for small (December 2011) and large (February 1976) design floods.

- derived Landsat flood frequency and extent mapping products (Fisher et al. 2016; Danaher & Collett 2006; Auscover Remote Sensing Data Facility 2016)
- flood aerial photography and satellite imagery
- spatial watercourse layers
- rural floodplain development guidelines
- local knowledge obtained from floodplain communities, and floodplain and environmental managers
- existing flood-work development.

The following sections provide more detail on how the hydraulic criteria for floodways and inundation extent were developed for the Barwon-Darling Valley Floodplain.

Floodways

Floodways were derived using the DVP from the large design flood, calculated by a series of hydraulic models. The models utilised inflows from gauges and overland flow from upstream modelling where available. The model bathymetry was determined using a range of elevation data sources including LiDAR, ADS40 and SRTM.

The expected velocity variation with depth for a large incised low-gradient floodplain channel across the Barwon-Darling Valley Floodplain was investigated to determine an appropriate threshold for identifying floodways (see Figure 8). A DVP of 0.1 square metres per second would require a depth of approximately 0.5 metres which would have a velocity of approximately 0.23 metres per second. As the Barwon-Darling River is a low-gradient floodplain characterised by depth rather than velocity that experiences high flow discharges and flood levels during large flood events, adoption of a DVP of equal to or greater than 0.1 square metres per second would result in majority of large sections of the floodplain that extend onto the alluvial plain being assigned as floodways. Rather, floodways were identified as any areas with a DVP of equal to or greater than 0.3 square metres per second (on average this threshold would equate to 0.85 metres depth and 0.36 metres per second velocity) for the large design flood (1976). This threshold captured major rivers and creeks and other flow paths where there is a significant flood water conveyance

Floodways identified using the target DVP threshold were further refined by considering the DVP in tandem with flow velocity. In this way, the floodway network also included areas where:

- flow velocity was relatively higher than in other areas of the floodplain regardless of depth
- there was significant depth but relatively low velocity.

Floodways derived from the target DVP threshold were compared with the inundation extent of the small design flood. This comparison was undertaken to ensure that areas of the floodplain activated during small floods were identified as floodways, irrespective of whether they reached the selected DVP threshold. Such areas are also likely to be the first floodways activated during large flood events. For instance, Figure 9 shows that although the large design flood would activate both floodway A and B, only floodway B would be identified as a floodway using the DVP threshold. By considering the inundation extent of the small design flood, floodway A would be picked up in the floodway network as a floodway. Such floodways may be important for connecting flood-dependent ecological and cultural assets to floodwater during smaller floods.

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 the selected DVP threshold were also a consideration. This is discussed further in Step 10.

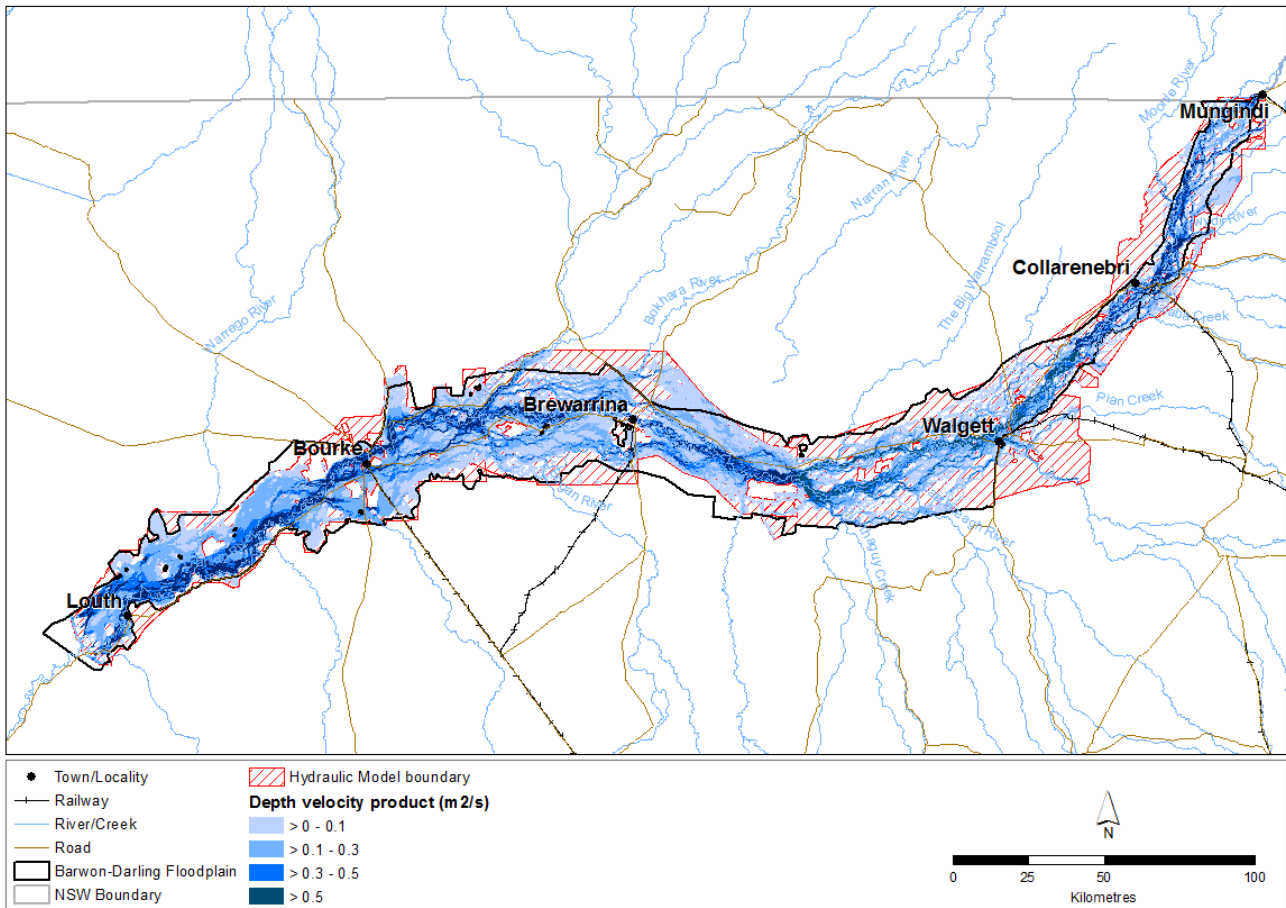


Figure 8: Depth velocity threshold map

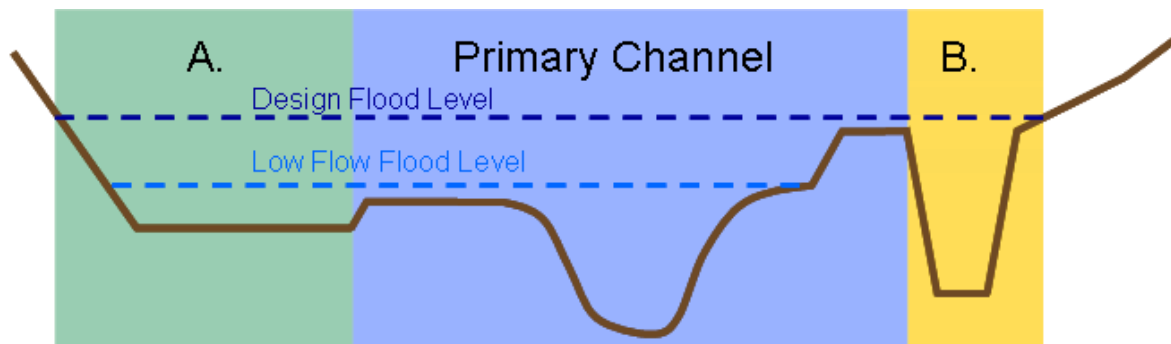


Figure 9: Identification of floodways using the depth-velocity threshold map versus inundation extent

Inundation extent

Hydraulic modelling produced the inundation extent of the large design flood across the floodplain. Where the flood extent was reliable, its outer limits were used to determine the extent of the floodway network; however, where topographic data was not sufficient to accurately map the extent of the flood, the limits to the floodway network were determined by using aerial and satellite flood imagery that was captured for the design event.

Areas within the extent of the design event are considered important for providing temporary pondage during large floods. Areas beyond the extent of the design flood 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.

Step 5: Identify and prioritise floodplain assets

Step 5 was undertaken to identify and prioritise the many unique and diverse ecological and cultural floodplain assets found in the Barwon-Darling Valley Floodplain and to inform the design of the management zones and rules.

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 draft Barwon-Darling Valley FMP considered three types of ecological asset, including wetlands, other floodplain ecosystems and areas of groundwater recharge (see Figure 10); however, areas of groundwater recharge are not mapped due to data limitations.

Native vegetation mapping was predominantly used to identify wetlands and other floodplain ecosystems. Approximately 505,366 hectares (or 46 per cent of the floodplain) was identified as native vegetation that is flood-dependent. A number of different regional vegetation maps and previous studies were utilised to identify semi-permanent wetlands, floodplain wetlands (flood-dependent shrubland wetlands), and other floodplain ecosystems, including flood-dependent forest/woodland (wetlands) and flood-dependent woodlands of the Barwon-Darling Valley Floodplain.

Each of the vegetation communities identified were collated into hydro-ecological functional groups. The following regional vegetation maps were used to create a composite vegetation map for the Barwon-Darling Valley Floodplain:

- Survey and mapping of Darling Floodplain vegetation between Tilpa and Brewarrina (Shultz, Gowans and Westbrooke 2014)
- Vegetation of the Condamine-Balonne floodplain systems of New South Wales Mapping and survey of plant community types (Eco Logical Australia 2015)
- Survey of Vegetation and Vegetation Condition of Toorale (Gowans, Milne, Westbrooke, and Palmer 2012)
- Vegetation and Floristics of the Barwon Nature Reserve (Hunter 2010)
- Pre-clearing and Existing Vegetation Mapping of the NE section of Bourke Shire (DIPNR 1998a)
- Existing Vegetation Mapping of the Western Division section of Walgett Shire, Northern Floodplains, Far Western New South Wales (DIPNR 1998c)
- Existing Vegetation Mapping of Brewarrina Shire, Northern Floodplains, Far Western New South Wales (DIPNR 1998b)
- Vegetation Mapping - Walgett Shire (East) North West NSW (Peasley and Walsh 1999)
- The natural vegetation of north-western New South Wales (Pickard and Norris 1994)
- BRG-Namoi Regional Native Vegetation Mapping (OEH 2015).
- Gwydir Wetlands and Floodplain Vegetation Mapping (Bowen and Simpson 2009)
- Composite Vegetation Map for the Border Rivers-Gwydir Catchment (Eco Logical Australia 2008).

In areas where existing vegetation mapping overlapped, the separate datasets were examined to

select the coverage with superior representation of native vegetation patterns. Vegetation maps were ranked on reliability assessed using the following considerations:

- more recent studies were considered more reliable than older studies
- fine scale nature reserve studies were regarded as more reliable than coarse-scale studies
- studies with more intensive field sampling were regarded as more reliable than those that were based on sparse field sampling.

Maps with the highest assembly rank took precedence over those with lower ranks. Table 4 lists the existing regional vegetation maps and studies and the assembly rank used for the compilation of a seamless composite vegetation map for the Barwon-Darling Valley Floodplain

Table 4: Regional vegetation maps and studies and the assembly rules used for the compilation of a seamless composite vegetation map for the Barwon-Darling Valley Floodplain

Vegetation mapping dataset name (Reference)	NSW Vegetation Information System Number	Rank	Proportion of FMP area (%)	Area (ha)
Vegetation of the Condamine-Balonne floodplain systems of New South Wales Mapping and survey of plant community types (Eco Logical Australia 2015)	-	1	15	161,000
Survey and mapping of Darling floodplain vegetation between Tilpa and Brewarrina (Schultz et al 2014)	4186	1	27	295,082
The Border Rivers Gwydir and Namoi regional vegetation map version 2 (OEH 2015)	4204	1	14	150,216
Vegetation survey and mapping of Toorale National Park (Gowans et al 2012)	4027	2	5	59,971
Vegetation and Floristics of the Barwon Nature Reserve (Hunter 2010)	-	3	1	7,377
Gwydir Wetlands and Floodplain Vegetation Mapping (Bowen and Simpson 2009)	3922	4	<1	13
Preclearing and Existing Vegetation Mapping of the NE section of Bourke Shire DIPNR 1998a and NFRPC (2004a)	1660	5	<1	1,456
Preclearing and Existing Vegetation Mapping of Brewarrina Shire, Northern Floodplains, Far Western NSW (DIPNR 1998b)	1658	6	14	150,435
Existing Vegetation Mapping of the Western Division section of Walgett Shire, Northern Floodplains, Far Western NSW (DIPNR 1998c and NFRPC 2004c)	1662	7	15	162,113

Vegetation mapping dataset name (Reference)	NSW Vegetation Information System Number	Rank	Proportion of FMP area (%)	Area (ha)
Vegetation Mapping - Walgett Shire – East, North West NSW (Peasley and Walsh 1999)	804	8	9	102,539
Composite Vegetation Map for the Border Rivers-Gwydir Catchment (Eco Logical Australia 2008)	3801	9	<1	45
The natural vegetation of North Western NSW (Pickard and Norris 1994)	825	10	<1	6,733

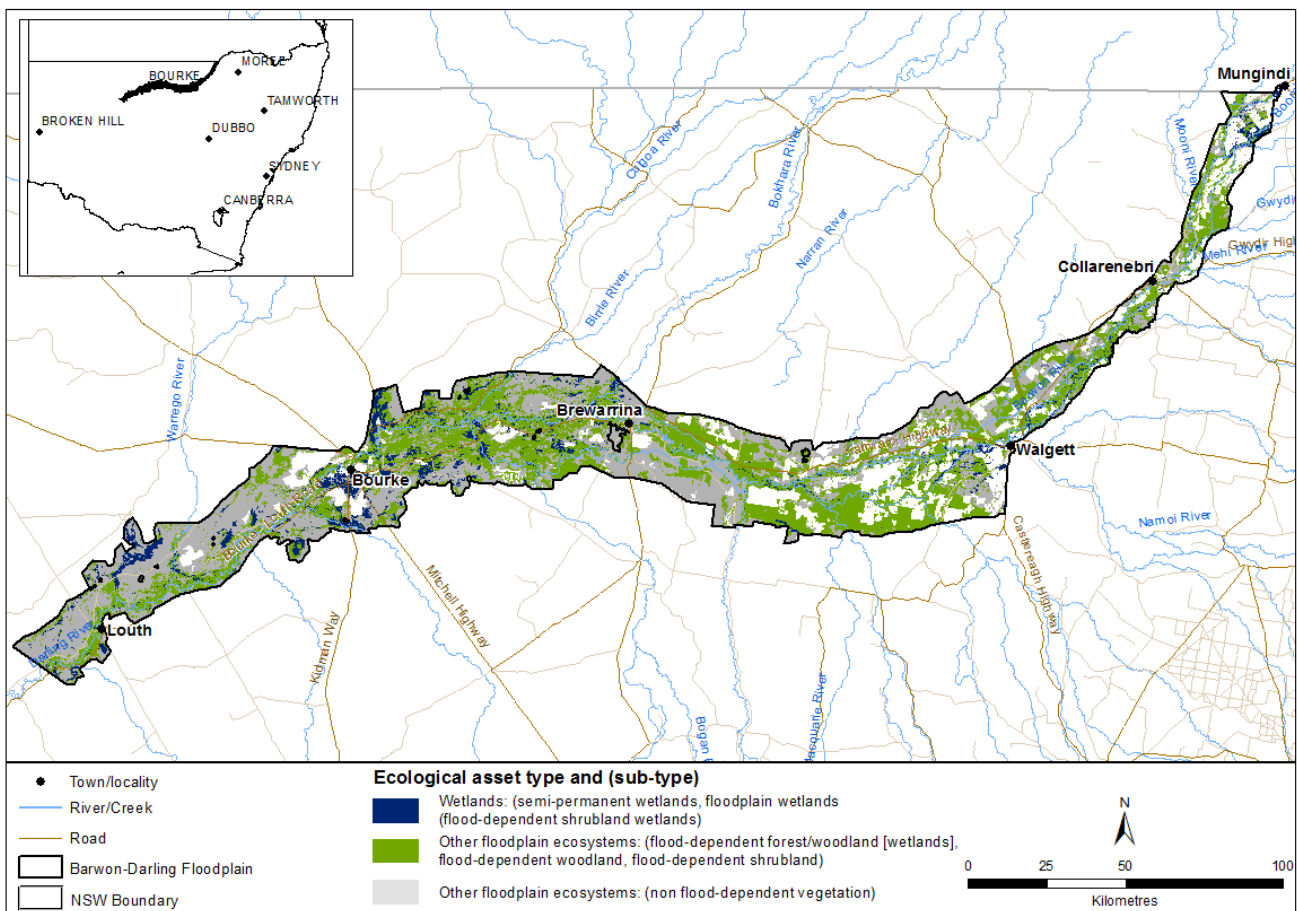


Figure 10: Ecological assets identified in the Barwon-Darling Valley Floodplain for the purposes of the draft Barwon-Darling Valley FMP

Ecological asset type – wetlands

The ecological asset, *wetlands*, is comprised of floodplain watercourses, semi-permanent wetlands and floodplain wetlands (see Figure 11).

Floodplain watercourses include:

- permanent flowing rivers and creeks¹, including those where the flow is modified by upstream dam(s), to the top of the natural bank regardless of whether the channel has been physically modified
- intermittent flowing rivers and creeks that retain water in a series of disconnected pools after flow ceases¹, including those where the flow is modified by upstream dam(s), to the top of the natural bank regardless of whether the channel has been physically modified
- flood channels or flood runners that run across or along floodplains during high-flow events¹
- billabongs, lakes and lagoons that are fed by floodwater.

Semi-permanent 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):

- 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)
- Permanent and semi-permanent freshwater lakes wetland of the inland slopes and plains (PCT 238).

Floodplain wetland (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:

- Canegrass swamp tall grassland wetland of drainage depressions, lakes and pans of the inland plains (PCT 24)
- Lignum shrubland wetland on floodplains and depressions of the Mulga Lands Bioregion, Channel Country Bioregion in the arid and semi-arid (hot) climate zones (PCT 25)
- Eurah shrubland of inland floodplains (PCT 115)
- Nitre Goosefoot shrubland wetland on clays of the inland floodplains (PCT 160)
- Golden Goosefoot shrubland wetland in swamps of the arid and semi-arid (hot summer) zones (PCT 161)
- 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 flood-dependent fauna such as nesting waterbirds, fish, amphibians and turtles.

¹These floodplain watercourses were picked up in the floodway network and were not re-identified in the ecological assessment.

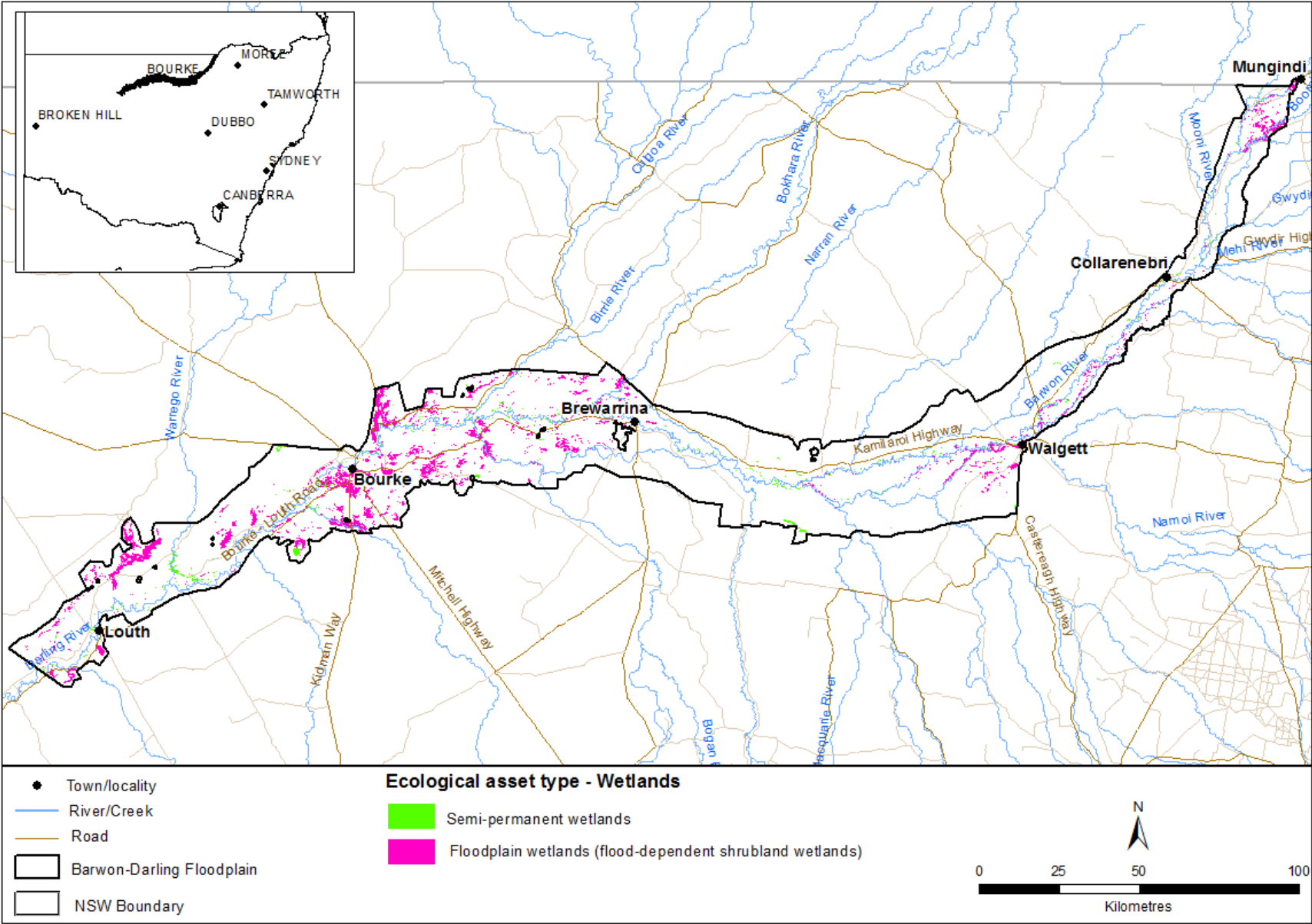


Figure 11: Location and type of wetlands identified as ecological assets.

Ecological asset type – other floodplain ecosystems

The ecological asset, *other floodplain ecosystems*, is comprised of flood-dependent forest/woodland (wetlands), flood-dependent woodlands and non-flood-dependent vegetation (see Figure 12). Flood-dependent forest/woodland (wetlands) requires flooding at intervals of between one and three years for forests or up to two to four years for woodlands (Roberts and Marston 2011). Flood-dependent forest/woodland (wetland) contains the following vegetation community:

- River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion (PCT 36).

Flood-dependent woodland requires flooding at least once every ten years (Roberts and Marston 2011). Flood-dependent woodland contains the following vegetation communities:

- Black Box woodland wetland on NSW central and northern floodplains including the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion (PCT 37)
- Black Box low woodland wetland lining ephemeral watercourses or fringing lakes and clay pans of semi-arid (hot) and arid zones (PCT 38)
- Coolibah - River Coobah - lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion (PCT 39)
- Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains (PCT 40)
- Poplar Box - Coolibah floodplain woodland on light clay soil mainly in the Darling Riverine Plains Bioregion (PCT 87).

The flood-dependent forests and woodland may provide habitat for flood-dependent fauna including waterbirds and frogs.

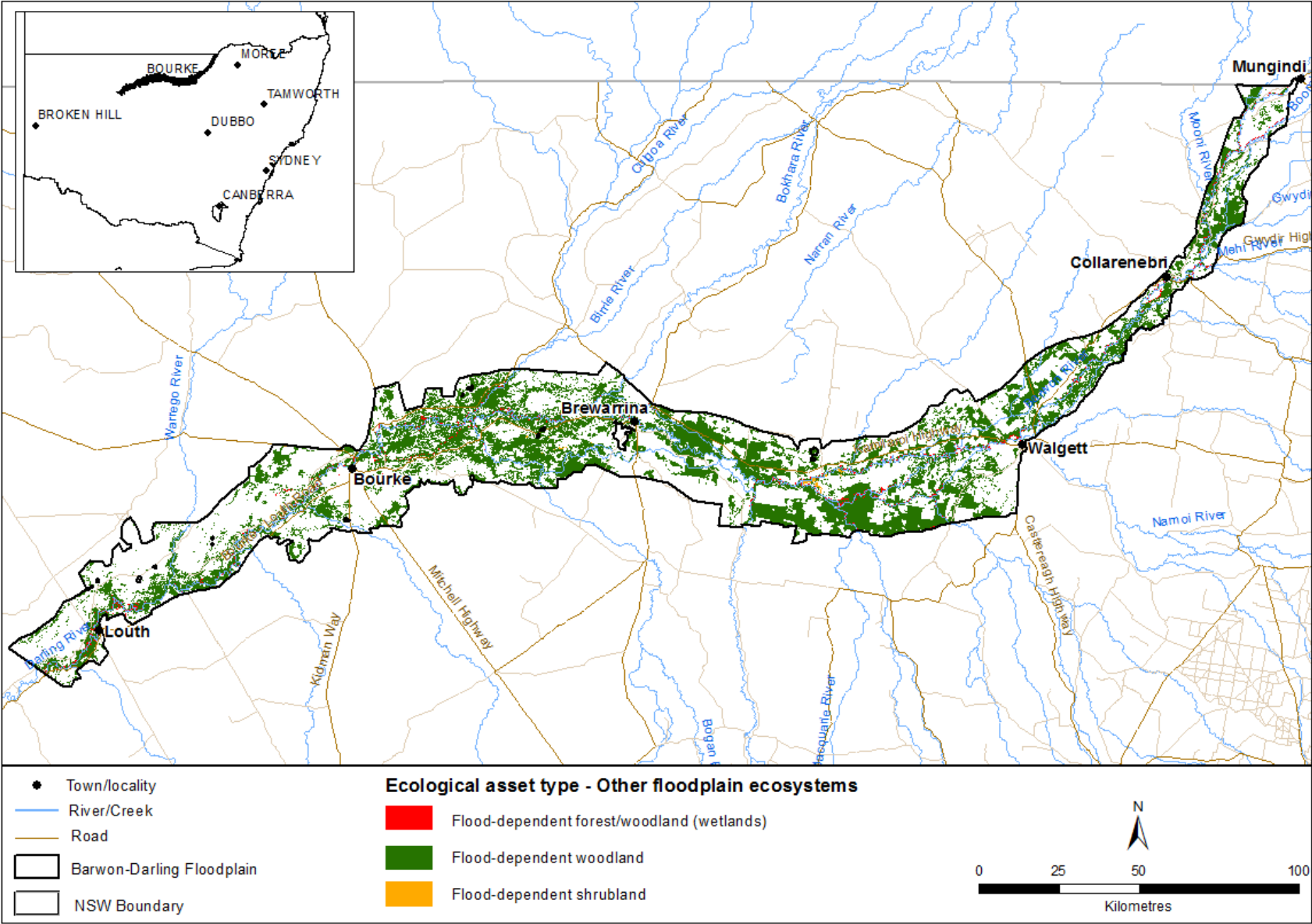


Figure 12: Location and type of other floodplain ecosystems identified as ecological assets

Ecological asset type – groundwater recharge

There is limited available spatial information related to the distribution of groundwater recharge areas in the Barwon-Darling Valley Floodplain.

CSIRO (2008) indicate that groundwater recharge depends on land use and soils, with groundwater levels showing a clear response to flood events. CSIRO (2008) document the following in relation to groundwater recharge in the Barwon-Darling:

- The Great Artesian Basin alluvial system is recharged by rainfall infiltration, flood recharge and throughflow from up-gradient sources in the east such as the Namoi region (although this throughflow is likely to be saline).
- Vertical leakage from flood inundation is a significant recharge mechanism for the Narrabri Formation near the junction of the Castlereagh and Barwon rivers.
- The Barwon and Darling rivers have a range of gaining and losing reaches dependent upon groundwater depth and varying hydraulic conductivity.

The draft Barwon-Darling Valley FMP will assist in maintaining flood-sourced groundwater recharge by protecting as natural a flood-flow distribution as practicable and maintaining core floodplain inundation. This will improve the likelihood and duration of natural groundwater recharge areas being subjected to natural flood inundation. If further information on flood-sourced groundwater recharge areas becomes available, the draft Barwon-Darling Valley FMP may need to be reviewed to ensure that they are adequately considered in the design of the management zones and rules.

Flood dependency of wetlands and other floodplain ecosystems

The distribution of vegetation communities in the Barwon-Darling Valley Floodplain may reflect the water regime (Casanova and Brock 2000; Porter and Kingsford 2007; Shultz et al. 2014). Vegetation in the immediate vicinity of the Darling River is in contrast to the drier environments of the surrounding plains, sand dunes and ridges (Westbrooke, Leversha and Kerr 2004). The time-scales 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). The recent studies of Gowans et al. (2012) and Shultz et al. (2014) provided some information about vegetation community watering requirements and implications of changed watering regimes on floodplain vegetation communities between Tilpa and Brewarrina.

The flood dependency of ecological assets in the Barwon-Darling Valley Floodplain was a key consideration informing FMP management zone delineation which 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. Wetlands and other floodplain ecosystems were categorised into hydro-ecological functional groups according to the flooding requirements of the dominant or canopy in a vegetation community to maintain their ecological character 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 5). It was assumed that floodplain watercourses would require water every year or more often to maintain their ecological character.

Table 5: Hydro-ecological functional groups that comprise wetlands and other floodplain ecosystems in the Barwon-Darling Valley Floodplain and their flooding frequency requirements (Source: Optimum watering requirements adapted from Roberts and Marston 2011 and Rogers and Ralph 2011)

Ecological asset	Description (hydro-ecological functional groups)	Vegetation/watercourse class	Ideal watering frequency
Wetlands	Floodplain watercourses	Drainage lines	Annual or near annual
		Lagoons	
		Billabongs	

		Waterholes	
		Lakes	
		Common reed	
		Cumbungi	
	Semi-permanent wetland	Tussock rush	Annual or near annual
		Ribbed spikerush	
		Water couch	
		Canegrass	
		Eurah [^]	
	Floodplain wetland (Flood dependent shrubland wetland)	Golden goosefoot	Every year to 1 in 5 years
		Lignum	
		Nitre goosefoot [^]	
		River cooba	
	Flood-dependent forest/woodland (wetland)	River red gum	1 in 3 to 1 in 5 years
Other floodplain ecosystems	Flood-dependent woodland	Coolibah woodland	1 in <10 years
		Black box woodland	

[^] Nitre goosefoot (*Chenopodium nitrariaceum* (F. Muell.) F. Muell. ex Benth.) shrubland wetland grades into lignum communities in wetter sites where drainage is impaired. No specific watering requirements have been documented by Rogers and Ralph (2011) or Roberts and Marston (2011) for this floodplain shrubland vegetation community, however, is likely to require periodic flooding for maintenance and persistence (Shultz et al. 2014). Eurah (*Eremophila bignoniiflora* (Benth.) F. Muell.) generally occurs in periodically flooded areas of floodplains and drainage lines (Cunningham et al. 1981) chiefly in black box, and river red gum communities. No specific watering requirements have been documented by Rogers and Ralph (2011) or Roberts and Marston (2011). Watering requirements are likely to be similar to coolibah woodlands and protection of river flows and flooding regimes to these vegetation communities would benefit eurah seedling establishment (Shultz et al. 2014).

Prioritisation of ecological assets

Ecological assets were prioritised to select the assets that best represent biodiversity in the Barwon-Darling Valley Floodplain. High-priority assets were then considered in the design of the management zones to protect their flood connectivity. Ecological assets were predominantly prioritised by the Barwon-Darling TAG during workshops in September and November 2014.

As outlined in the technical manual, the targets determined by the TAG were used to drive the selection of priority assets using 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 and Possingham 2000; Possingham, Ball and Andelman 2000; Ball, Possingham and Watts 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 Barwon Darling Floodplain, the TAG endorsed conservation targets of 100 per cent for each asset type to ensure their future persistence. As a result the *Marxan* analysis determined that all ecological assets were a high priority. Nevertheless, the prioritisation method was undertaken in full for completeness and to provide information on the relative conservation

Selection frequency score

Another output of the Marxan software runs is the selection frequency score (Figure 14). The number of times a planning unit was selected in each of the 100 runs was counted to measure the relative importance of planning units. The selection frequency score provides feedback on how likely it is a specific area will be included in an efficient solution. When a planning unit is never selected it is attributed with a frequency score of 0, while those that are always selected will have a selection frequency equal to the maximum number of runs of the Marxan software (e.g. the highest possible frequency score for a planning unit is 100, based on 100 runs). Areas with a high frequency score are consistently important in the solutions. They are highly irreplaceable and have fewer substitutes if conservation objectives are to be achieved efficiently.

The optimal set of planning units mapped from Marxan identified parts of the Barwon-Darling Valley Floodplain which are important for achieving a range of conservation targets and included parts of the floodplain which are essential for maintaining connected riparian ecosystems and protecting flood-dependent species and habitats. These focal areas of the floodplain were identified systematically at the landscape-scale using a variety of spatial ecological data which represent biodiversity patterns.

Additional information, including the distribution of mapped flood-dependent vegetation boundaries which represent the 'real' distribution of native vegetation species at discrete sites, hydraulic assessments and cultural heritage assets are also considered to guide demarcation of final floodplain management zones. In combination with the optimal set of planning units, these components formed part of the larger decision framework for determining the floodplain management zones in the Barwon-Darling Valley Floodplain.

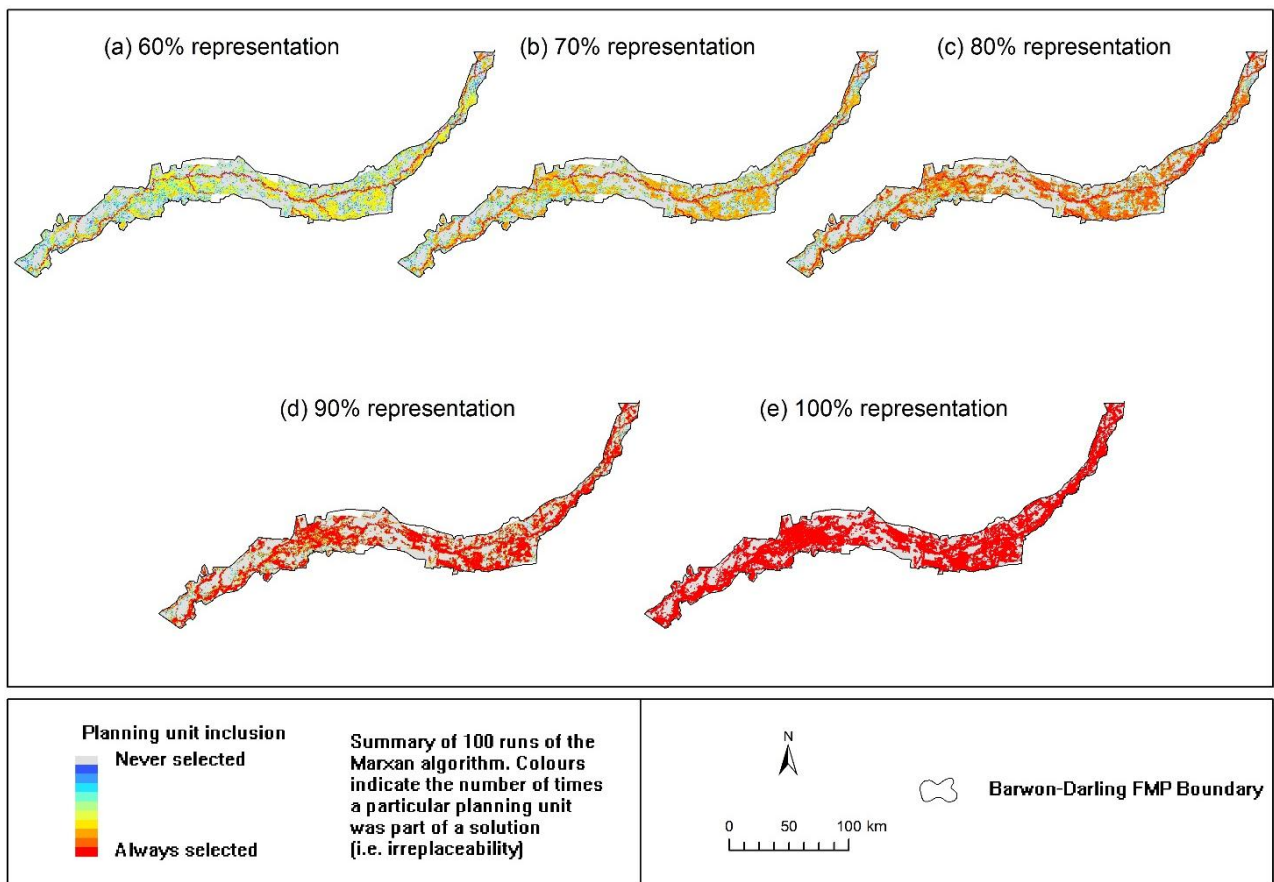


Figure 14: Relative priority (the selection frequency as an index of irreplaceability) of planning units (PU) based on the Marxan analysis (the sets of 100 Marxan runs) achieving a range of different representation targets for flood-dependent vegetation assets (60%, 70%, 80%, 90% and 100%) for the Barwon-Darling Valley Floodplain

Cultural assets

The proposed Barwon-Darling Valley Floodplain contains assets that have Aboriginal and cultural heritage value (cultural assets). The draft Barwon-Darling 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.
- Heritage sites - cultural heritage objects and places as listed on Commonwealth, state and local government heritage registers.

Cultural asset type – Aboriginal values

Aboriginal people have been living in the Murray-Darling Basin for at least 36,000 years, including living on lands surrounding the basin's rivers and lakes for at least 9,000 years based on archaeological evidence from middens (Blame and Hope 1990). Evidence of use of wetland areas, based on the presence of hearths, middens, canoe scars, and stone tool-making sites, adds significantly to the heritage values Aboriginal people recognise on the floodplain (WCMA 2010). Aboriginal sites that may be found on the lunettes and banks of wetlands and in the vicinity of the Darling River and intersecting streams include:

- open or living sites (camp sites)
- scarred or carved trees (bark removed for tools/utensils or ceremonial markings)
- artefact scatters associated with living sites or hunting places
- rock art including painted, pecked or abraded surfaces
- manufacturing places (quarries, grinding grooves)
- sacred/ceremonial places including burial sites
- Dreamtime, story-telling and oral history places (WCMA 2010).

The Barwon-Darling 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; however, Aboriginal values were generally found to include:

- wetlands and river channels, which were an important focus of settlement
- 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 cooba, river red gum, coolibah, Mitchell grass and native millet)
- sites with scarred trees
- long-lasting waterholes of 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 draft Barwon-Darling 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. Catchment Management Authority, National Parks and Wildlife Service, DPIW and Office of Environment and Heritage)

- targeted consultation with members of the Aboriginal community with knowledge of values connected with the floodplain
- consultation with the ATWG, that was comprised of Aboriginal people with cultural connection to the floodplain, and
- context setting using existing spatial information about the potential distribution of unidentified values using the Aboriginal Sites Decision Support Tool (ASDST) (Appendix 8).

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
 - State Heritage Register
 - Interim Heritage Orders
 - State Agency Heritage Registers
 - heritage items in Local Environmental Plans
- Australian Heritage Database (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 advises and advocates 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* from 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 MDB.

The proposed Barwon-Darling Valley FMP does not address cultural water; however, cultural water will likely be a component of the WSPs being developed by DPIW, 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 overarching 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 will allow DPIW 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 a database of cultural features which are water dependent. All cultural values and features identified in this study will be included in the Aboriginal Water Initiative System (AWIS), for follow-up investigations of their water requirements and the production of condition report cards by the Aboriginal Water Initiative team. The AWIS must be consulted as part of the flood work assessment process.

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 draft Barwon-Darling Valley FMP, heritage sites were divided into historic heritage sites and Aboriginal heritage sites.

Commonwealth, state and local government heritage databases include:

- Australian Heritage Database
- Murray Darling Basin Authority Aboriginal Submissions Database
- NSW AWIS
- NSW AHIMS
- NSW Historic Heritage Information Management System (HHIMS)
- NSW State Heritage Inventory

Flood dependency of Aboriginal values and heritage sites

During the development of the draft Barwon-Darling Valley FMP, flood dependency of cultural assets was established so that consideration could be given to how changes to the flooding regime may impact the assets across the floodplain.

Flood dependency – Aboriginal values

Flood dependency of the Aboriginal values nominated by the Aboriginal community was determined through 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.

Flood-dependent Aboriginal values included sites that are not necessarily flood-dependent, but where the purpose or location of the site is flood-dependent; 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.

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 and determine if this was dependent on, or connected with floodwater.

The following historical assets listed on the NSW Heritage inventory, were not identified as being flood-dependent but were considered in relation to potential flood impacts during the design of management zones in the draft Barwon-Darling Valley FMP:

- Bourke Weir Darling No 19A (Darling River, 20 miles below Bourke) is a 40 year old weir constructed as part of the Darling River Weir Scheme to provide domestic and stock requirements to the local Bourke region. The weir continues to service the needs of the local area which contributes to its value.
- Davidsons Lock and Weir (4 miles below Bourke by river) is a rare example of an important form of industrial technology. The Bourke Lock was the first to be built in Australia and the only one on the Darling River. Built in 1897, it was an attempt to make the river transport system more reliable, and was initiated by the river merchants. The weir still plays a vital role in the supply of water for irrigation. The remains of the lock are an important relic of the Lock and Weirs history and today is a tourist attraction.
- Barwon Bridge, Bridge Road (MR70), Brewarrina, is a significant technical accomplishment and was an important component of the historic river traffic of the Murray - Darling system. The Brewarrina bridge is the second oldest of four early movable bridges built across the Darling - Barwon River system. The bridge at Brewarrina which was furthest upstream is a tangible reminder of the penetration of the early river traffic.
- Brewarrina Weir Darling No 15 was constructed in 1968 to provide domestic and stock water requirements. The structure is a reinforced concrete weir situated on the Darling River on the outskirts of Brewarrina. The structure is slimline and clean in design. Its natural setting and pool contributes to the aesthetic appeal of the structure. The Weir is representative of a reinforced concrete weir constructed during the late 1960's in rural NSW to combat drought. The structure continues to be in use which contributes to its significance.
- Calmundi Weir is located on the Darling River, however the structure is assessed as having little heritage significance at this time as it fails to satisfy the relevant requirements of the NSW heritage criteria but has local value .
- Collarenebri Weir constructed in 1966 as part of the Drought Relief Programme introduced by Jack G. Beale (Minister for Conservation from 1965). In addition, the local community uses the weir for fishing and recreation.
- Walgett Weir dates to an early period of development in water regulation in the area.
- Walgett Two-Mile Creek Underbridge is a rare example of a timber through truss from the post-Whitton era, built by the PWD railway construction branch in the early 20th century. It is a highly visible and accessible example of early 20th century bridge technology used as an economical solution in the development of a Pioneer line.

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 to living trees (e.g. coolamon scars) that are flood-dependent species
- fish traps
- ceremony and dreaming sites located within or surrounded by floodplain vegetation¹
- Aboriginal resource gathering sites

Prioritisation of Aboriginal heritage sites

High-priority Aboriginal heritage sites that are dependent on flooding are relatively rare in the floodplain and have high Aboriginal community importance. Each of these sites were considered in the design of the draft management zones to maintain condition of the site and to protect their flood connectivity. The type of Aboriginal heritage site including the process for identifying these high-priority cultural assets is outlined below.

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 several recordings of fish traps in the region. The largest and most significant of these is the one adjacent to Brewarrina, and listed as an Aboriginal place.

Ceremonial sites

A search of the AHIMS database identified thirty three ceremony sites recorded within the floodplain. Some of these have little physical remains on the landscape today but were well known in historic times. Others were recorded in detail by Etheridge (1918) in the early 20th century². One in particular contained a grove of over 80 trees with intricate designs carved into them.

Resource gathering sites

The AHIMS data also identified thirty four Aboriginal resource gathering sites. Some of these were known to have been used during historic times, while others have contemporary on-going use. Each of these sites involved plant or animal resources that were flood-dependent.

Aboriginal heritage sites 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 but have been identified as sensitive Aboriginal heritage sites of high community importance. Where identified, these cultural assets will be an additional consideration for licensing staff when assessing flood-work applications. The type of Aboriginal heritage site that is classified as sensitive to disturbance is outlined below.

¹ 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.

Aboriginal burials

There are 34 Aboriginal burials recorded within the floodplain, 27 of which occur adjacent to the main channel.

Aboriginal shell middens

There are 54 occurrences of Aboriginal shell middens in the floodplain, all of which occur downstream of Brewarrina. These resources were utilised during flood periods and are associated with lagoons filled during floods.

Earth-mound sites

There are several earth-mound sites recorded in the floodplain, all of which are adjacent to the main channel. These sites are closely associated with harvesting resources during flood periods.

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 on-going process.

Discussions were held in person with community members with printed maps that they could annotate. The maps were left with these people to give them a chance to consider the requirements of the plans, and follow-up discussions were held in the months following.

The consultation process identified a number of areas where the significance of Aboriginal values warranted an exclusion of further flood works. In some cases, this was because of the importance and sensitivity of important sites. In other cases, it concerned areas of relatively intact land that were rich with sites associated with living in the floodplain or where contemporary cultural activities are undertaken.

The areas were digitised and were used to inform the design of the management zones in the plan. The areas identified and their associated values will be stored in a database of flood-dependent Aboriginal values being established by DPIW, and managed by the Aboriginal Water Initiative. The database will be used by DPIW 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 Barwon-Darling Valley Floodplain was determined in this step to effectively consider the social and economic impact of development controls in the floodplain and flood risk to life and property from the effects of flooding. The socio-economic profile is detailed in Appendix 9 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 informs the baseline profile include:

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

Information from this assessment is used in the socio-economic impact analysis of the proposed plan, 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 use on the Barwon-Darling Valley Floodplain (see Table 6 for a description and Appendix 9 for maps showing the areas).

Table 6: Description of study area geographies used in socio-economic profile

Geography	Size (hectares)	Description
Barwon-Darling Valley Floodplain Economy	8,025,600	Includes the Barwon-Darling rural and urban floodplains as well as the adjacent areas in the catchments that engage with the economy of the region. Located between the regional centres of Moree, Dubbo and Broken Hill and the Queensland border. Most goods and services consumed in this area are sourced from Bourke, Brewarrina, Collarenebri, Lightning Ridge and Walgett, or other small townships in this area.
Barwon-Darling Rural Floodplain	4,777,900	The rural floodplain area downstream of Mungindi along the Barwon and Darling rivers to Weir 21, approximately 25 km downstream of Louth, bounded by the Border Rivers, Gwydir River and Namoi River floodplains in the east and the Macquarie floodplain in the south. This area will be directly impacted by the Barwon-Darling Valley FMP. The community residents who live and work in this area are predominantly agricultural 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 regional centres.
Barwon-Darling Urban Floodplain	n/a	Incorporates the townships of Bourke, Brewarrina, Collarenebri and Walgett. Flood water management in urban areas of NSW is provided under the <i>Local Government Act</i> (1993). 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 Barwon-Darling Valley Floodplain economy, the Barwon-Darling rural floodplain, and the Barwon-Darling urban floodplain; on population including the Indigenous community, on sex and age ratios; on household weekly incomes; and on labour participation rates and employment by industry sector; is drawn from the Australian Bureau of Statistics (ABS) Census of Population and Housing 2011 Statistical Area level 1 (SA1) data (ABS 2011a). The SA1 areas are the smallest unit for release of Census data. The SA1 boundaries combine to form the boundary of the Barwon-Darling Valley Floodplain economy and the urban floodplain areas. The Rural Floodplain area is defined as parts of 5 SA1 areas. Regional population trends for the 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 rankings for the LGA and SA1 areas is drawn from the ABS Census of Population and Housing 2011 Socio-economic Indexes for Areas (SEIFA) (ABS 2011b).

Agricultural production is a significant component of the Barwon-Darling Valley Floodplain Economy. The ABS Agricultural Census 2011 (ABS 2011c) provides comprehensive data on both dry land and irrigated agricultural production at the Statistical Area level 2 (SA2). SA2 areas are a general-purpose medium sized area built from whole SA1s. The SA2 communities of the Barwon-Darling Valley Floodplain Economy include parts of the SA2 regions of Bourke – Brewarrina, Walgett – Lightning Ridge and Moree Region.

Demographic profiles

Demographic information is provided in Table 7 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 7: 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)
Barwon-Darling Valley Floodplain Economy ¹	10,690	72	34.5	110	59 ²
Barwon-Darling Rural Floodplain	1, 800 ³	n/a	15.6	119	53 ²
Barwon-Darling Urban Floodplain	5, 150	n/a	49.3	98	57 ²
State average	n/a	n/a	2.5	97	52

- ¹ The information about population is based on ABS collection district (CD) boundaries that do not match the boundary of the Barwon-Darling Valley Floodplain economic areas (rural and urban floodplains). Therefore the total of the Barwon-Darling rural and urban populations do not equal the overall Barwon-Darling Valley Floodplain Economy.
- ² may be overstated.
- ³ based on 3.8 people per 100 square kilometres based on the ABS Census 2011

The age by sex distribution of the Barwon-Darling Valley Floodplain economy and the Barwon-Darling rural floodplain community reveals an under representation in the 15 to 45 age groups, as compared to the under 15 and over 45 age groups of the NSW population.

Employment by industry

Employment in the Barwon-Darling Valley Floodplain economy is predominantly within the agricultural, forestry and fishing sector, with 23.5 per cent of employment (920 persons, with this number including employment in a large agricultural area that is not on the rural floodplain). In contrast, the NSW state agriculture sector engages 2.2 per cent of the workforce. The next most significant employment sectors are health care and social assistance, education and training and public administration and safety, with 13.8 per cent, 12.7 per cent, and 11.6 per cent of employment respectively. Employment in the Barwon-Darling rural floodplain is dominated by the agriculture, forestry and fishing sector, with 55.4 per cent of the workforce or 510 persons, working in the agricultural industry. In contrast, employment in the Barwon-Darling urban floodplain is dominated by the service sectors of public administration and safety, health care and social assistance, and education and training.

Income

The proportion of low income households in the Barwon-Darling Valley Floodplain economy, Barwon-Darling rural floodplain and Barwon-Darling urban floodplain was 38 per cent, 22 per cent and 29 per cent respectively, compared with the NSW state proportion of 23 per cent. The medium income households' proportion of 53 per cent for the Barwon-Darling Valley Floodplain economy, 60 per cent for the Barwon-Darling rural floodplain and 60 per cent for the Barwon-Darling urban floodplain, are close to the NSW proportion of 56 per cent. The proportion of high income households within these three areas (9 per cent, 18 per cent and 10 per cent) are each lower than the NSW state proportion of 21 per cent.

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.

The IRSAD scores for key regions are (see Appendix 9):

- Local Government Area of Bourke (A) is in the 3rd decile
- Moree Plains (A) is in the 2nd decile
- Local Government Areas of Brewarrina (A) and Walgett (A) are in the 1st decile of NSW, demonstrating distinct relative disadvantage at a large scale
- The Barwon-Darling Rural Floodplain areas are generally within deciles 4 to 7, indicating that they are neither advantaged nor disadvantaged, or are relatively marginally advantaged, excepting the SA1 surrounding Brewarrina (decile 1) which is substantially disadvantaged
- The index scores for the smaller SA1 areas representing the townships are all within deciles 1 to 3 indicating that they are relatively disadvantaged, excepting one SA1 on the south of Bourke (decile 4) and two SA1s on the east of Walgett (decile 4 and 6).

Production

Agricultural production is the significant economic activity of the region's economy, occupying 86 per cent of the farm holdings in the Barwon-Darling Valley FMP area. The Gross Value of Agricultural Production (GVAP) in 2010-2011 in the Barwon-Darling Valley FMP area, using a farm holding area of 946,200 hectares, is estimated to be \$122 million or 1.1 per cent of total NSW GVAP. The gross value of broadacre cropping, estimated at \$105 million, constitutes 86 per cent of the GVAP of the FMP area production using 138,800 hectares or 15 per cent of the area. The highest value producing individual broadacre crops are wheat yielding \$36 million and cotton yielding \$55 million or 30 per cent and 45 per cent of the total FMP area GVAP, respectively. Livestock and livestock products yield \$15 million, accounting for 12 per cent of GVAP while using 85 per cent of the area.

There was an estimated total of 18,200 hectares of irrigated land in the Barwon-Darling Valley FMP area in 2010-2011. This area of irrigated land constitutes approximately 1.6 per cent of the

Barwon-Darling Valley FMP farm holding area. It is estimated that 92,000 megalitres of water was extracted for agricultural irrigation across the regions in 2010-2011. The majority of the irrigation water used in 2010-2011 was applied to cotton, using 84,500 megalitres or 92 per cent, at an estimated average rate of 5.6 megalitres per hectare.

Step 7: Delineate management zones

In Step 7, the nature and location of the management zones proposed for the Barwon-Darling Valley Floodplain was determined using hydraulic, ecological and cultural criteria as well as criteria to ensure the draft 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 five draft management zones for the Barwon-Darling Valley FMP.

Description of management zones

The draft Barwon-Darling Valley FMP contains five management zones (Zone):

- MZ A – Major discharge areas, defined floodways (336,500 hectares or 31 per cent of the floodplain)
- MZ B – Flood storage and secondary flood discharge zone (535,400 hectares or 49 per cent of the floodplain)
- MZ C – Flood fringe and flood protected developed areas (217,000 hectares or 20 per cent of the floodplain)
- MZ CU – Urban areas managed by local council (1400 hectares or less than one per cent of the floodplain)
- MZ D – Special environmental and cultural protection zone (5400 hectares or less than one per cent of the floodplain)

A map of the management zones is shown in Figure 15 and a summary description is provided below. More detailed maps are provided in Appendix 10.

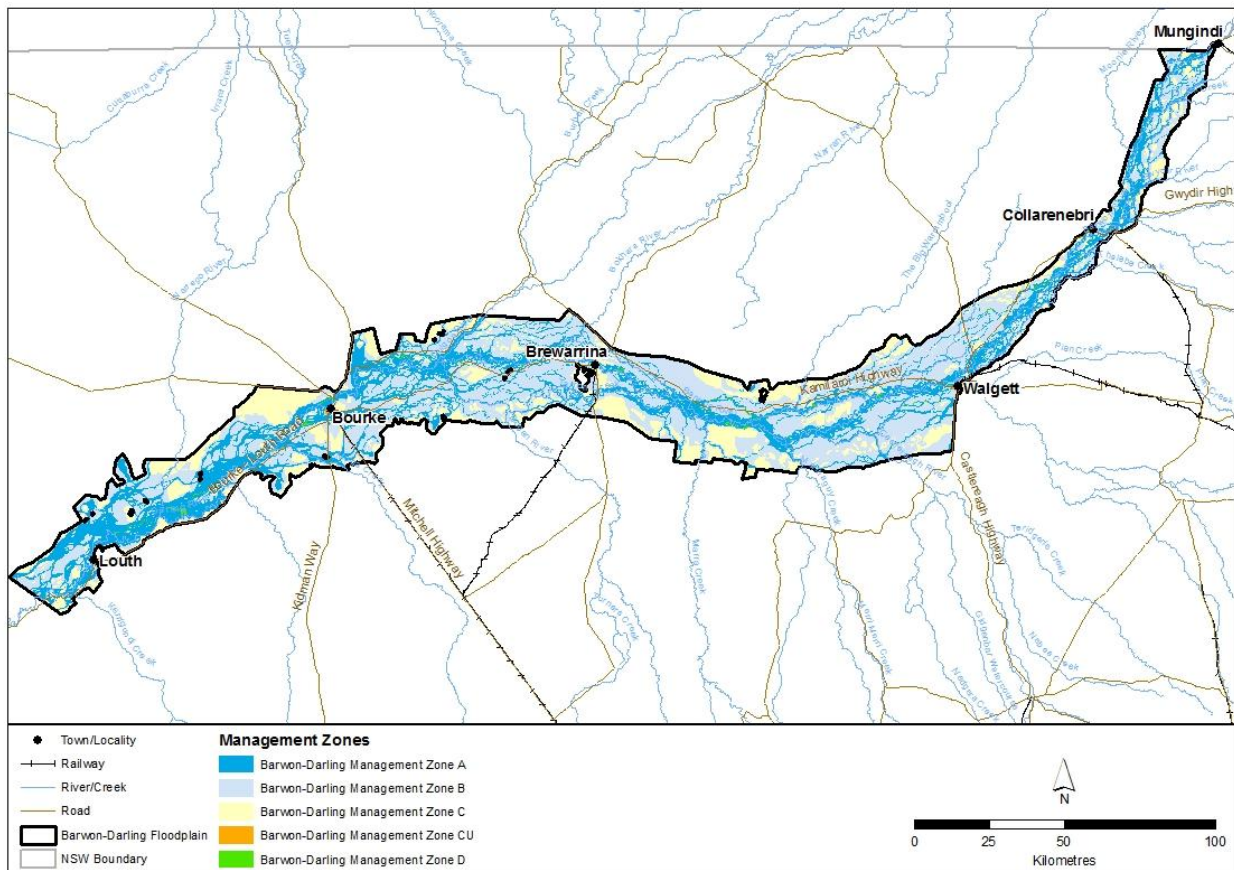


Figure 15: Map of the management zones in the Barwon-Darling Valley Floodplain

Management Zone A – major flood discharge areas and defined floodways

Draft MZ A covers 336,500 hectares or 31 per cent 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 high depth-velocity thresholds. MZ A includes floodways that have a depth-velocity threshold of greater than or equal to 0.3 square metres per second (on average this threshold would equate to 0.85 metres depth and 0.36 metres per second velocity) for the large design flood (1976).

Floodplain connectivity is provided for in MZ A by incorporating:

- greater than or equal to 0.1 square metres per second for tributary flow paths and outer floodplain floodways.
- parts of the small design flood extent (2011),

MZ A 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 development to prevent flood flow redistribution, increased flood velocities and flood levels. MZ A was designed to ensure there is continuity of flow and flow paths and assist in maintaining the overall flow distribution on the floodplain.

MZ A is also important for the conveyance of floodwater to highly dependent ecological and cultural assets. MZ A 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 A was also designed to provide flood connectivity to floodplain wetland (flood-dependent shrubland wetlands) and flood-dependent forest/woodland (wetlands).

MZ A 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 A. 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.

Where the Barwon-Darling joins another FMP, floodways in the Barwon-Darling have been aligned to ensure floodway continuity and protection between floodplains. Adjoining floodplains include: Border Rivers, Gwydir, Lower Namoi and Macquarie. Where FMPs are in early stages of development (e.g. Border Rivers and Macquarie) alignment with these floodplains may occur post public exhibition of the Barwon-Darling Valley FMP.

Management Zone B – flood storage and discharge areas for design floods

Draft MZ B covers 535,400 hectares or 49 per cent of the floodplain. It includes areas 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 is defined by the modelled inundation extent of the large design flood (1976).

MZ B included ecological assets that have a moderate level of flood dependency. MZ B may include areas of floodplain wetland (flood-dependent shrubland wetlands), flood-dependent forest/woodland (wetlands) which were not captured entirely within MZ A and areas of flood-dependent woodlands. MZ B also includes cultural assets such as modified trees that are likely to only be flood connected during moderate and large floods.

MZ B is important for the conveyance of floodwater to floodplain assets during larger flood events. This 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 areas and existing developed areas

Draft MZ C covers 217,000 hectares or 20 per cent of the floodplain. It contains flood fringe and flood protected developed areas. This zone includes areas protected by flood works that are unlimited height and are not overtopped by water during moderate to large floods.

Ecological assets that are highly flood-dependent were not recommended for inclusion in MZ C. However, ecological assets that occur in this zone may include areas of floodplain wetland (flood-dependent shrubland wetlands), flood-dependent forest/woodland (wetlands) and flood-dependent woodlands occurring adjacent to floodplain watercourses in flood fringe areas. Some of these assets may occur in developed areas which are potentially disconnected from flooding.

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

The rules and assessment criteria of MZ C are less restrictive than other management zones as MZ C includes areas where flood-work development is unlikely to have a significant effect on flood behaviour. Nevertheless, an assessment of flood connectivity to semi-permanent wetlands, floodplain wetlands (flood-dependent shrubland wetlands), flood-dependent forest/woodland (wetlands) and flood-dependent woodlands must be undertaken as part of the flood work assessment process in each of the management zones.

Management Zone CU – Urban areas managed by Local Council (hereafter MZ CU)

Draft MZ CU covers 1400 hectares which is less than one per cent of the floodplain. It captures urban areas that are covered by either a flood study, flood risk management study, flood risk management plan or that are protected by flood mitigation works such as town levees.

It includes parts of Walgett, Brewarrina, Bourke, Collarenebri and Louth 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 environmental and cultural protection zone

Draft MZ D covers 5400 hectares or less than one per cent 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. To ensure the ongoing health/condition of these significant assets is maintained or improved only Aboriginal value, ecological and heritage site enhancement works can be built. There are 50 MZ D areas (Figures 16 to 20) as listed in Appendix 11.



Image 1. An example of a MZ D area of the Barwon-Darling Valley FMP. Big Billabong, Bourke. (S.Hunter, OEH, Feb 2016)

Hydraulic criteria

Preliminary management zones were established based on hydraulic criteria, which were developed from information on flood behaviour contained in the floodway network (Table 3 and Figure 6). The following three hydraulic categories were the basis of MZ A, B and C:

- floodways are the hydraulic basis for MZ A
- inundation extent up to the large design flood is the hydraulic basis for MZ B
- flood fringe (i.e. areas outside the floodway network) is the hydraulic basis for MZ C

MZ CU and MZ D do not have a hydraulic basis

Ecological criteria

Management Zone A and B ecological criteria

Ecological criteria was developed to ensure that wetlands, watercourses, floodplain ecosystems and areas of groundwater recharge 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 A and MZ B to incorporate hydro-ecological functional groups based on optimum watering requirements (Step 5), including:

- floodplain watercourses including billabongs, waterholes, lakes and anabranches (MZ A)
- mapped flood-dependent native vegetation identified as high-priority semi-permanent wetlands which require annual or near annual flooding to maintain their ecological character (MZ A)
- hydraulic connections through ecological assets identified as high-priority floodplain wetland (flood-dependent shrubland wetlands) and flood-dependent forest/woodland (wetlands), which have variable flooding requirements but generally require flooding at least every 1-5 years to maintain their ecological character (MZ A)
- key fish passage areas which were identified using the predicted current distributions of Silver Perch (*Bidyanus Bidyanus*), Olive Perchlet (*Ambassis agassizii*), Eel Tailed Catfish (*Tandanus tandanus*) and Purple Spotted Gudgeon (*Mogurnda adspersa*) provided by NSW Fish Community Status and Threatened Fish Species Data (Aquatic Biodiversity Value Mapping Project – NSW DPI 2015) (MZ A)
- outer floodplain vegetation, including flood-dependent woodland and flood-dependent shrublands which have a flooding requirement of more than 5 years to maintain their ecological character (MZ B).

The breakdown of these management zone recommendations is presented in Table 10. Note that management zone recommendations were not made for groundwater recharge areas due to limited available data.

Once recommendations were made and endorsed by the TAG, a spatial analysis was undertaken to determine if the assets were captured in the recommended management zone. Where assets were not captured in the recommended management zone (see Table 8, Figure 16) manual edits were made to the management zones and using interpretation of LiDAR DEM, hydraulic modelling, and water count and water prevalence data.

From undertaking the spatial analysis high-priority ecological assets such as inner floodplain semi-permanent wetlands were found to occur within channels or depressions in close proximity to floodways (MZ A) as these vegetation communities depend on frequent flooding to survive and maintain their condition. Similarly, ecological assets such as flood-dependant forest – river red gum (*Eucalyptus camaldulensis*) are inner floodplain vegetation communities predominately found along or adjacent to the banks of watercourses and primary channels, such as the consistent patterns of vegetation identified by Shultz et al. (2014) and Eco Logical Australia 2015 including the presence of River Red Gum tall open forest (PCT 36) occurring along the Darling, Little Bogan and Bogan rivers and the majority of this vegetation community were identified as already having connection to floodways (MZ A).

Outer floodplain vegetation, such as flood-dependent woodlands –coolibah and black box (*Eucalyptus largiflorens*) woodlands were found to extend from the inner floodplains across the landscape into MZ B, which are parts of the floodplain that experience a wide range of inundation frequency and duration.

Where MZ A could not be amended to connect recommended asset types, these assets will be protected through application of the management zone rules and assessment criteria (Step 8) as part of the flood work assessment process.

Table 8: Criteria to include assets in recommended management zones

Asset	Description	Management Zone (Zone) recommendation	Criteria for management zone (Zone) inclusion
Wetland	Watercourses	MZ A	Include whole of mapped area in MZ A.

	Semi-permanent wetland	MZ A (entire mapped area)	Include whole of mapped area in MZ A.
	Floodplain wetland (flood-dependent shrubland wetlands)	MZ A (mapped area at least connected)	Ensure vegetation connected to MZ A if not wholly within MZ A.
	Flood-dependent forest/woodland (wetlands)	MZ A (mapped area at least connected)	Ensure vegetation connected to MZ A if not wholly within MZ A.
Other floodplain ecosystems	Flood-dependent woodland	MZ B	No modification made. May be distributed across the floodplain in a range of wet and dry environments
Areas of groundwater recharge	Likely recharge	MZ A or B	No modification required due to limited accuracy of data. Determine approximate groundwater recharge area covered by MZ A.

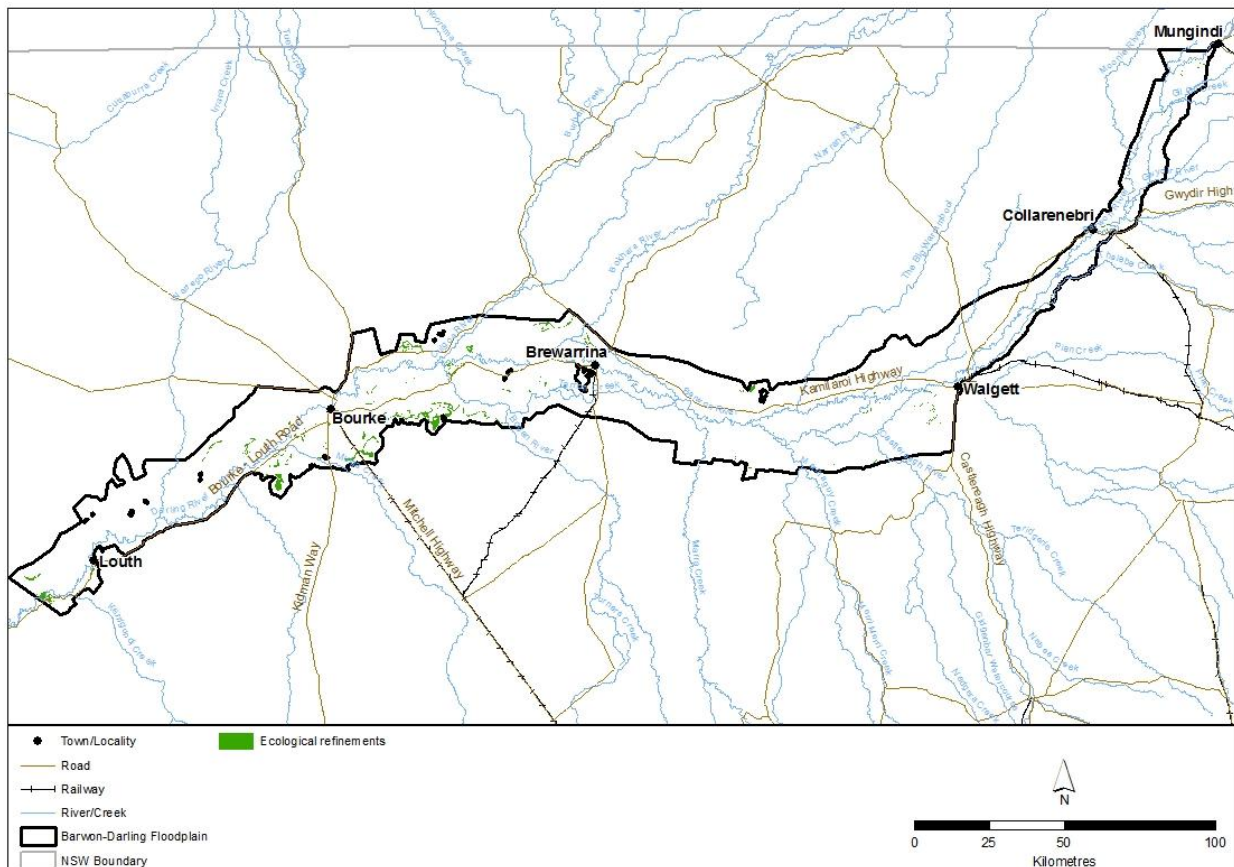


Figure 16: Refinements to management zones based on ecological criteria

Management Zone D ecological criteria

MZ D was based on floodplain assets of special value that have high flood dependency, high ecological or cultural value. These assets may also have been identified as features susceptible to conversion or loss of flood connectivity due to flood-work development. Fifty assets were recommended to become MZ D (Figures 17 to 20). Forty nine of the MZ D assets have high ecological value and a description of the ecological significance of each MZ D asset is provided in Table 9. A detailed description of MZ D assets is provided in Appendix 11.

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
- has been mapped, recognised in or protected by a local, state, or commonwealth environmental policy
- has been reviewed by a technical expert panel
- is susceptible to conversion or loss of flood connectivity due to flood-work development
- is listed as a significant lagoon or wetland in Schedule 4 of the WSP for the Gwydir Unregulated and Alluvial Water Source 2012.

Table 9: List of floodplain assets classified as management zone D

Ecologically significant asset	Ecological significance	Area (ha)*	Zone	Easting	Northing
Briery Anabranh	Functional capacity to act as an aquatic drought refuge	417	55	533823	6665290
Briery Water	Recognised in commonwealth environmental policy (MDBA 2010)	227	55	522808	6670460
Broadsheet Lagoon on Wombat Creek		49	55	561584	6663570
Butti Lagoon	Functional capacity to act as an aquatic drought refuge	18	55	665700	6742260
Canary Lagoon	Functional capacity to act as an aquatic drought refuge Recognised in commonwealth environmental policy (MDBA 2010)	65	55	576526	6675920
Collymongle Lagoon		67	55	667408	6742760
Duck Egg Swamp		16	55	375896	6647940
Eight Mile Lagoon		466	55	389888	6666120
Elephant Waterhole	Functional capacity to act as an aquatic drought refuge	68	55	550712	6661140
Euromlin Lagoon		63	55	596958	6673250
First Lagoon		13	55	666292	6740750
Fish Holes Lagoons		203	55	636001	6712220
Gidgin Lagoon		38	55	590041	6672120
Half Moon Lagoon		32	55	593343	6672720
Herding Yard Lagoon		22	55	577733	6677530
Horseshoe Lagoon (A)	Functional capacity to act as an aquatic drought refuge	79	55	422284	6689030
Horseshoe Lagoon (B)		38	55	543506	6667940
Kier Lagoon	Recognised in commonwealth environmental policy (MDBA 2010)	87	55	559370	6671820
Louth Waterhole	Functional capacity to act as an aquatic drought refuge	61	55	305872	6618820

Ngemba Old Mission Billabong	Functional capacity to act as an aquatic drought refuge and waterbird feeding and breeding habitat	115	55	495326	6684170
Orange Tree Lagoon	Functional capacity to act as an aquatic drought refuge	118	55	375524	6656050
Piano Creek Lagoons		162	55	442551	6686280
Polygonum Swamp	Functional capacity to act as an aquatic drought refuge and waterbird feeding and breeding habitat	24	55	440301	6686210
Ross Billabong	Functional capacity to act as an aquatic drought refuge and waterbird feeding and breeding habitat	816	55	399396	6673540
Ryan's Lagoon on Mulga Creek	Recognised in commonwealth environmental policy (MDBA 2010).	123	55	351067	6640280
Second Lagoon	Functional capacity to act as an aquatic drought refuge	30	55	379939	6657040
Sparkes Warrambool		166	55	665914	6741190
Talowla Billabong	Functional capacity to act as an aquatic drought refuge	343	55	620135	6703510
The Big Billabong	Recognised in commonwealth environmental policy (MDBA 2010)	99	55	333095	6631670
Toothia Billabong		22	55	396767	6673540
Turee Lake		30	55	571449	6676000
Ulah Lagoon		84	55	412835	6685530
Unnamed lagoon 1		3	55	581514	6675360
Unnamed lagoon 2		3	55	669953	6751040
Unnamed lagoon 3	Functional capacity to act as an aquatic drought refuge	19	55	666131	6754390
Unnamed lagoon 4		15	55	640027	6712910
Unnamed lagoon 5		31	55	665203	6742800
Unnamed lagoon 6		20	55	665967	6750470
Unnamed lagoon 7		6	55	643457	6715820
Unnamed lagoon 8		24	55	672345	6767220
Unnamed lagoon 9		21	55	671544	6765900
Walgett Lagoon		56	55	643340	6717560
Warraweena Lagoon	Functional capacity to act as an aquatic drought refuge and waterbird feeding and breeding habitat.	485	55	605554	6678620
	Recognised in commonwealth environmental policy (MDBA 2010)				
Waterholes at Big Waterhole Creek	Functional capacity to act as an aquatic drought refuge	40	55	423935	6687260
Weerabilla Lagoon		26	55	648890	6721060

Wigelroy Lagoon	60	55	661149	6736620
Yambacuna Lagoon	59	55	600812	6673090
Yambie Lagoon	88	55	462212	6685350
Yambie Swamps	317	55	531576	6671540

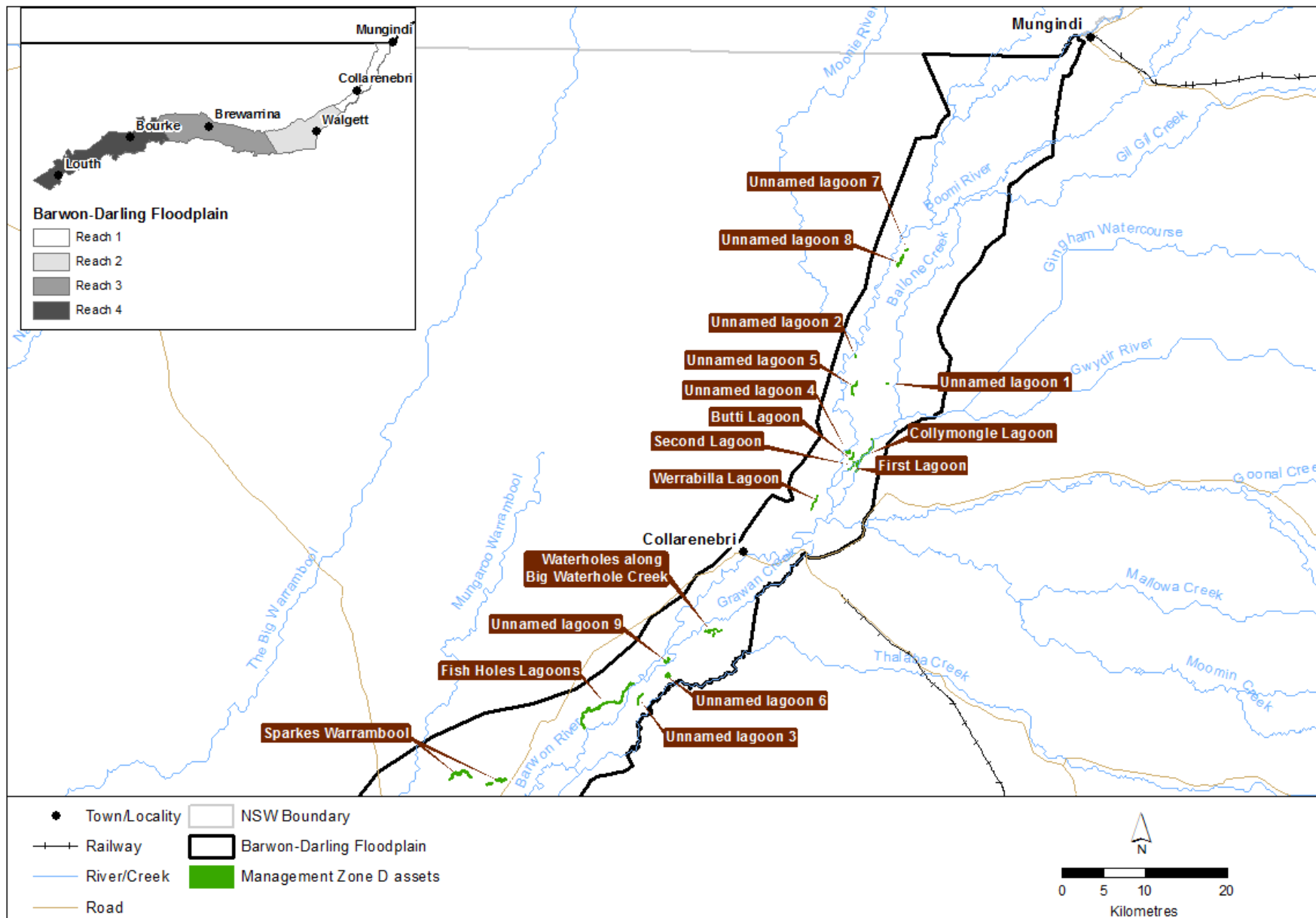


Figure 17: Location of ecological management zone D assets, Reach 1

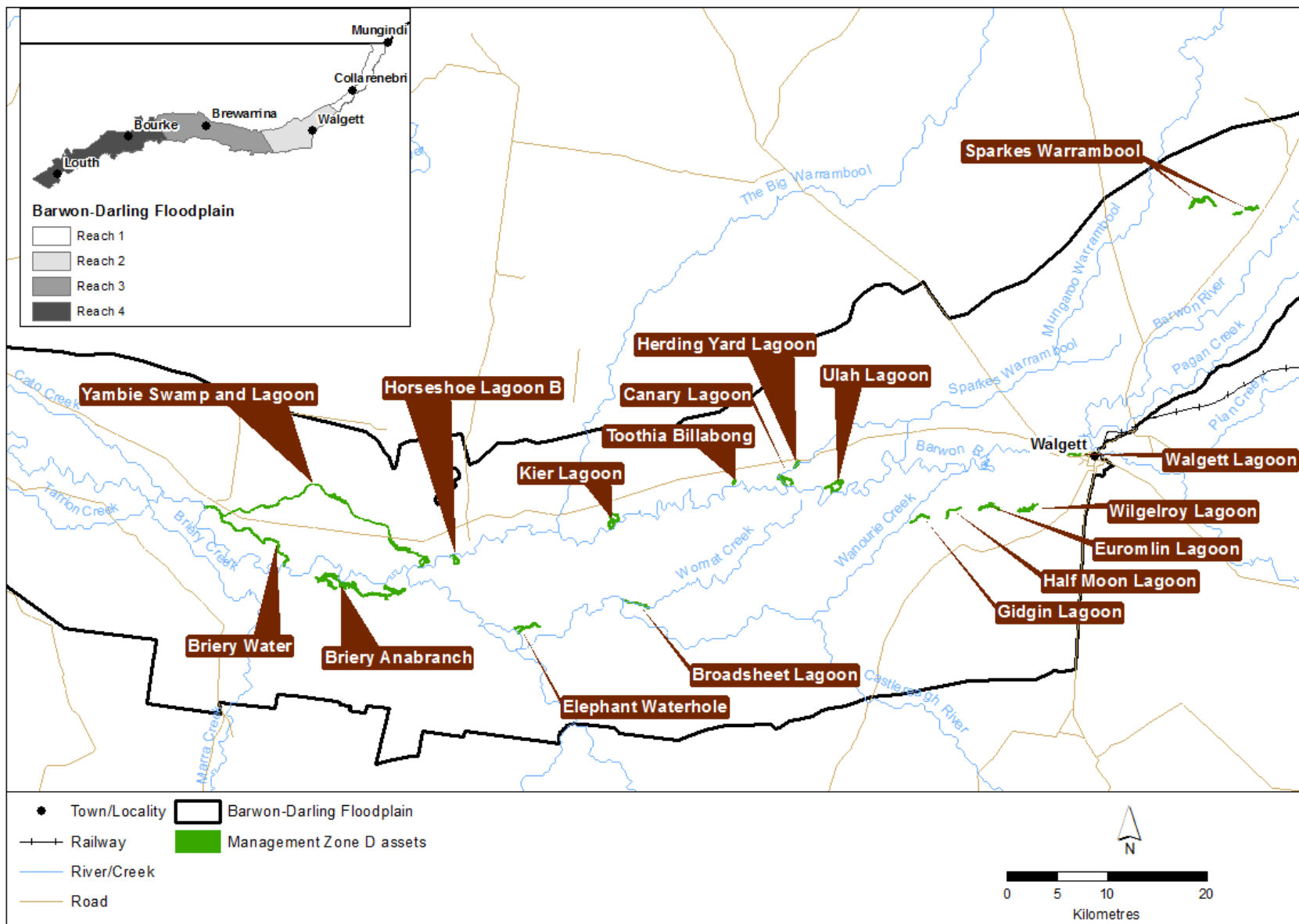


Figure 18: Location of ecological management zone D assets, Reach 2

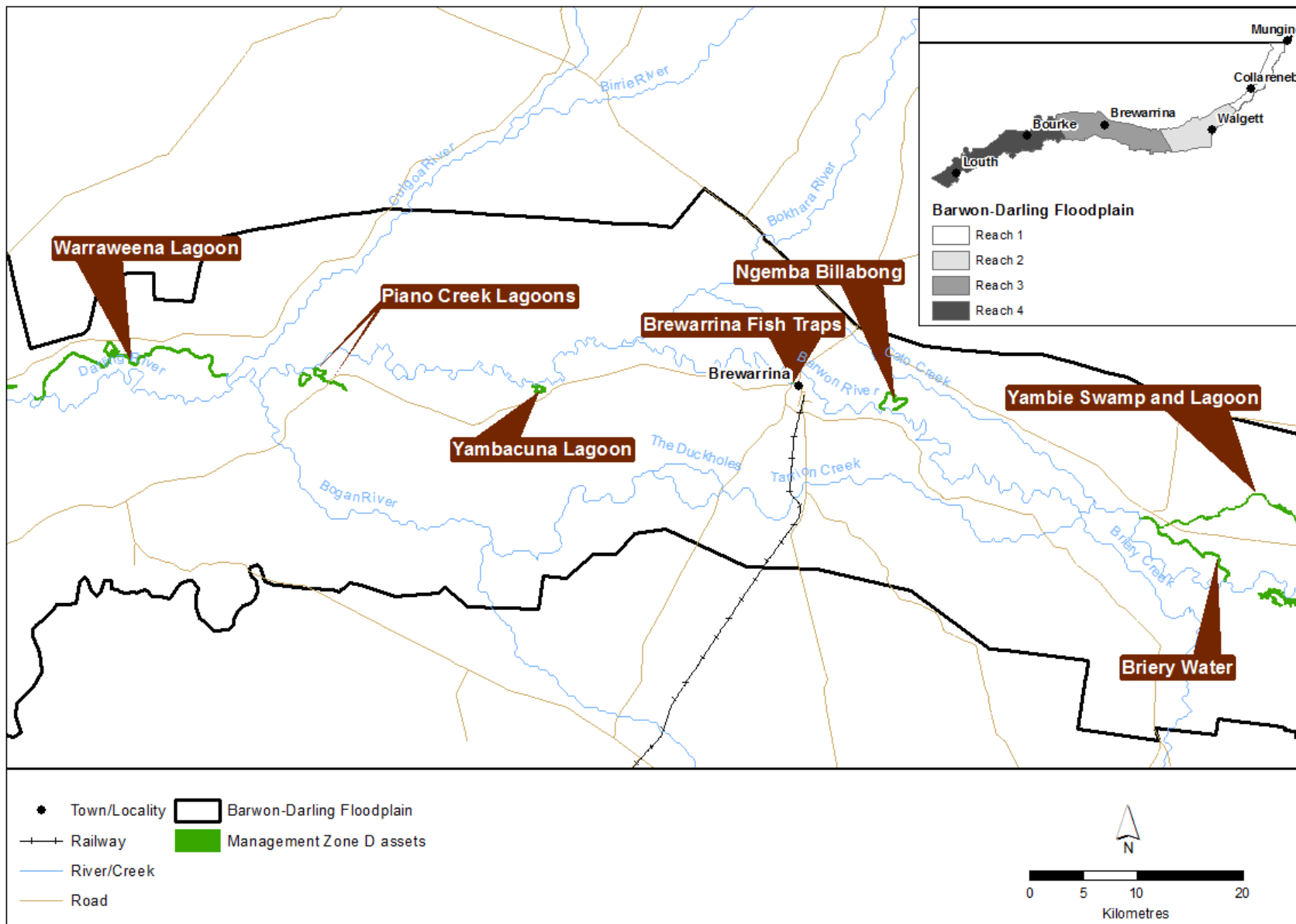


Figure 19: Location of ecological management zone D assets, Reach 3

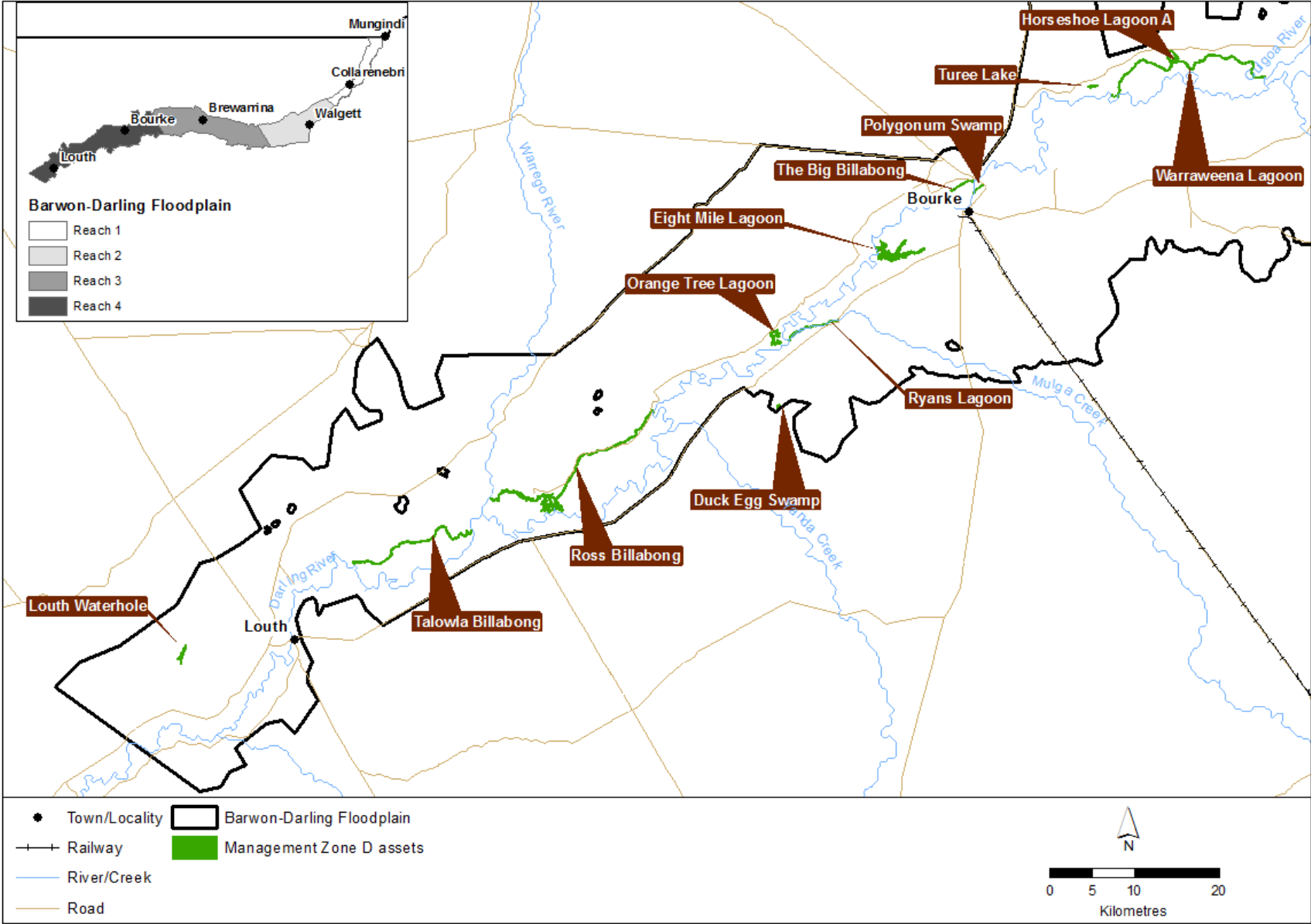


Figure 20: Location of ecological management zone D assets, Reach 4

Cultural criteria

Cultural criteria was developed to ensure that flood-dependent Aboriginal heritage sites and values are not impacted by flood behaviour changes caused by flood-work development. Historic heritage sites that are not flood dependent were not included as part of the cultural criteria for management zone delineation (Table 10).

Flood dependency of Aboriginal values and heritage sites determined in Step 5 was used to develop cultural criteria for refining management zones (Table 10). A number of important flood dependent Aboriginal values identified by the community were recommended for inclusion in MZ A or MZ D. To this effect, additions were made to MZ A and MZ D based on cultural assessment outputs from Step 5. MZ B 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. Further detail is outlined below.

Table 10: Cultural criteria to include cultural assets in recommended management zones (Zone)

Asset	Type	Description	Management zone (Zone) recommendation	Criteria for management zone inclusion
Aboriginal values	Scarred trees	Living/flood-dependent vegetation	Variable – refer to vegetation	Include area in recommended MZ if within 100 m
	Places identified by the community	Twenty-eight areas identified. Some flood-dependent, others linked to flooding.	MZ A	Ensure MZ A at least intersects flood-dependent places identified
	Fish traps	Flood-dependent	MZ A or D	Include whole of mapped area in MZ A or D
Heritage sites	Bridges	Not flood-dependent	n/a	n/a
	Weirs	Not flood-dependent	n/a	n/a
	Locks	Not flood-dependent	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 10). MZ A 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 A was only amended when the record was within 200 metres of a hydraulic floodway.

Other Aboriginal values and Aboriginal heritage sites

Refinements were made to the management zones based on Aboriginal values and heritage sites as indicated in Table 11 when the:

- Aboriginal values are highly flood-dependent and:
 - identified on AWIS database and/or
 - 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 and to account for data accuracy and confidence the above criteria were field validated against expert recommendations. Where hydraulic justification could not be made to amend the management zones, application of management rules and assessment criteria through the flood work assessment process will 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 fifty MZ D assets, one asset, the Brewarrina Fish Traps, was based purely on cultural criteria. The Brewarrina Fish Traps were included in the National Heritage List on 3 June 2005. The area is a significant meeting place for Aboriginal people and continues to be utilised to date. Another asset, the Brewarrina Ngemba Billabong Indigenous Protected Area (IPA) has been included as a MZ D asset based on both cultural and ecological criteria. The Brewarrina Ngemba Billabong IPA has been declared a World Conservation Union (IUCN) Category V and VI protected area which is managed mainly for landscape conservation and recreation and for the sustainable use of natural ecosystems (Maclean, Bark, Moggridge, Jackson and Pollino 2012). Furthermore, an undisclosed number (due to cultural sensitivities) of MZ D assets also have high cultural value. Information on the cultural significance of these sites cannot be provided due to cultural sensitivities; however, the criteria used to delineate MZ D is 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 warrambools 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.

A detailed description of MZ D assets is provided in Appendix 11.

Criteria to better reflect current floodplain management arrangements

The purpose of this stage was to amend management zones to better reflect current floodplain management arrangements. All management zones were reviewed for consistency with existing floodplain management studies and guidelines. This included review and consideration of identified floodway areas within existing guidelines in developing and refining the boundaries of MZ A. The majority of MZ A aligned with existing floodways in the guidelines. In areas where current and proposed floodplain management arrangements could not be aligned, as outlined in Step 9, the changes reflect improvements in our understanding of the floodplain and flood behaviour, improvements in spatial knowledge of existing flood-work development and a more consistent approach to floodplain management across the floodplain.

Urban areas in the floodplain (MZ CU)

MZ CU includes urban areas where flood risk is managed by local councils in accordance with Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). In order for an urban area to be declared as MZ CU the following criteria must be satisfied:

- urban area must be protected by a town levee or,
- urban area that is not flood protected must be covered by a flood study or a floodplain risk management plan or study

In the Barwon-Darling Valley FMP, the following towns are proposed to be included in MZ CU:

- Louth
- Bourke
- Brewarrina
- Walgett
- Collarenebri

Summary of management zone criteria

Each of the management zones were based on a combination of the criteria except for MZ B, CU and MZ D. MZ A was primarily based on hydraulic criteria but also includes the extent of semi-permanent wetlands and key fish passage areas. Modifications were made to include ecological and cultural assets located outside floodways in MZ A. Similarly, MZ C was predominately based on hydraulic criteria but also incorporated existing floodplain development (included under existing floodplain management arrangements in Figure 21). A breakdown of the criteria, represented as a percentage, for each management zone, is provided in Figure 21.

Figure 22 outlines the percentage that each management zone occupies in the Barwon-Darling Valley Floodplain. As it can be seen from this figure MZ B is the largest zone, occupying 49 per cent of the total floodplain area. MZ CU and MZ D were the smallest zones both occupying less than one per cent of the total floodplain area.

A summary of the criteria for delineating management zones is provided in Table 11.

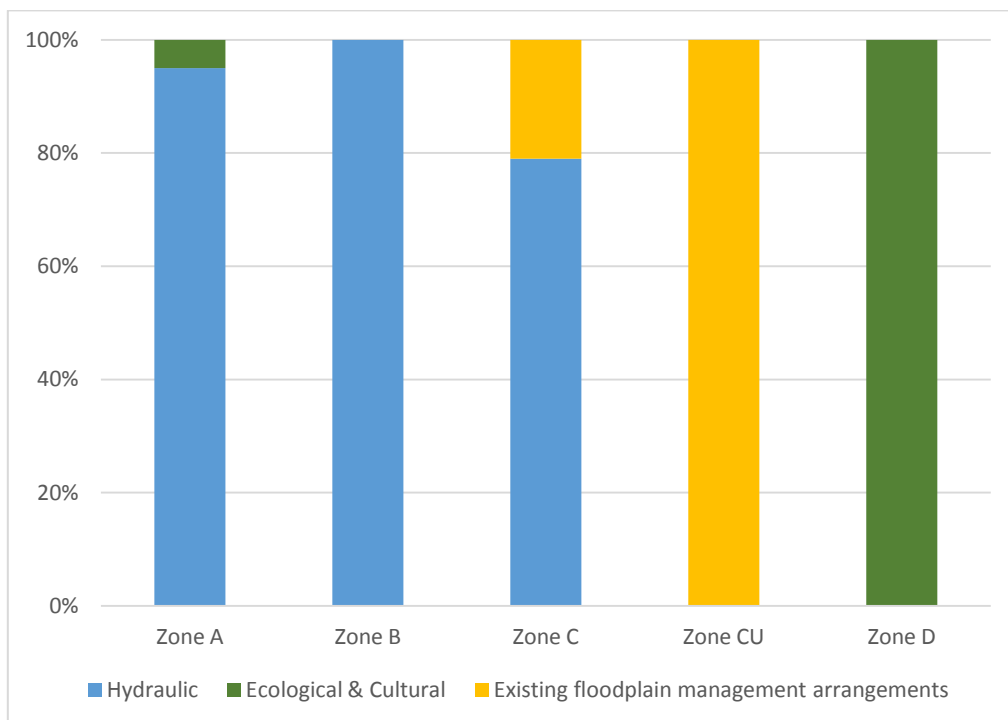


Figure 21: Percentage breakdown of criteria used to delineate each management zone

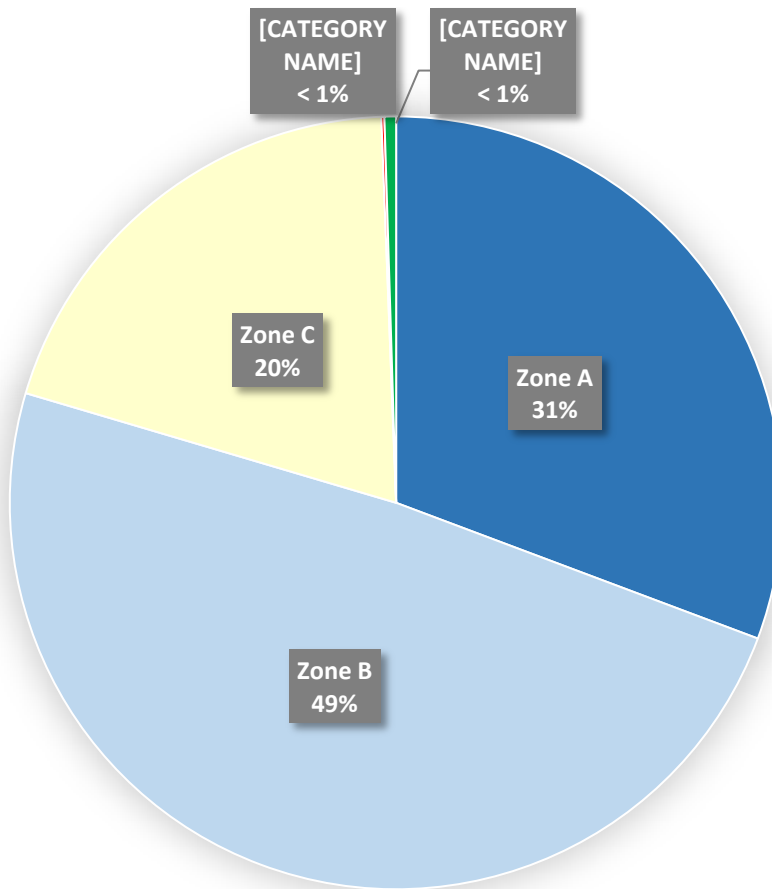


Figure 22: Percentage each management zone in the Barwon-Darling Valley Floodplain

Table 11: Compilation of management zone criteria

MANAGEMENT ZONE A

Hydraulic criteria

MZ A includes major discharge areas that have a depth-velocity product of greater than or equal to $0.3 \text{ m}^2/\text{s}$ for the large design flood (1976).

Floodplain connectivity was provided for by incorporating:

- parts of the small design flood extent (2011) and/or
- floodplain areas that have a depth-velocity product of greater than or equal to $0.10 \text{ m}^2/\text{s}$ for the large design flood (1976).

To ensure that conditions on the ground are adequately represented, the above criteria were road tested against the following additional data:

- flood aerial photography and satellite imagery (2012 flood - spot imagery)
- spatial watercourse layers, topographical mapping, ADS40 DEM and LiDAR
- previous floodplain management plans and development guidelines
- local knowledge obtained from floodplain communities and floodplain/environmental managers.

Ecological criteria

MZ A includes, where there is hydraulic justification:

- semi-permanent wetland
- connections to/through floodplain wetland (flood-dependent shrubland wetlands) and flood-dependent forest/woodland (wetlands)

- tracts of floodplain land within low-lying areas bordering a watercourse that contain floodplain wetland (flood-dependent shrubland wetland) or flood-dependent forest/woodland (wetlands)
- key fish passage areas identified using NSW Fish Community Status and Threatened Fish Species Data - Aquatic Biodiversity Value Mapping Project (NSW DPI 2015)

Cultural criteria

MZ A includes, where there is hydraulic justification:

- floodplain areas with Aboriginal values that are highly flood-dependent that were identified during direct community consultation with the local Aboriginal community and/or are listed on the AWIS and AHIMS databases
- locations for scarred/carved trees that are living flood-dependent vegetation that generally require flooding at least every five years to maintain their ecological character and cultural value
- locations for heritage sites that are flood dependent and are cultural heritage objects and places as listed on Commonwealth, state and local government heritage registers.

Current floodplain management arrangements criteria

Existing floodplain development guidelines prepared to support assessment for applications under Part 8 WA 1912 were reviewed but no changes were made to MZ A due to improvements in flood behaviour knowledge and available data. MZ A was also reviewed against FMPs developed under the WMA 2000, such as the Gwydir, Macquarie and Lower Namoi FMPs. Where management zones were developed for these floodplains the Barwon-Darling MZ A was made congruent with bordering MZ A's in these FMPs.

MANAGEMENT ZONE B

Hydraulic criteria

MZ B includes the inundation extent of the small and large design floods and any areas protected by existing flood works that are overtopped by the large design flood.

To ensure that conditions on the ground are adequately represented, the above criteria were road tested against the following additional data:

- flood aerial photography and satellite imagery
- spatial watercourse layers, topographical mapping, ADS40 DEM and LiDAR
- previous floodplain management plans and development guidelines
- local knowledge obtained from floodplain communities and floodplain/environmental managers.

Ecological criteria

MZ B includes, where there is a hydraulic justification, flood-dependent woodland and to a lesser degree flood-dependent forest/woodland where there was no hydraulic justification for inclusion in MZ A.

Cultural criteria

MZ B includes, where there is hydraulic justification, locations for scarred/carved trees that are living and located within flood-dependent woodland.

Current floodplain management arrangements criteria

MZ B was made congruent with MZ B of the bordering Gwydir, Macquarie and Lower Namoi FMPs. MZ B includes some area of the floodplain that are enclosed by existing flood works that are designed to be overtopped during moderate to large floods.

MANAGEMENT ZONE C

Hydraulic criteria

MZ C includes flood fringe areas of the floodplain that are outside the large design flood and areas enclosed by existing flood works that are not designed to be overtopped during flooding.

Ecological criteria

The basis of MZ C was not ecological. However, some ecological assets that have been enclosed by existing approved flood works are located in MZ C.

Cultural criteria

The basis of MZ C was not cultural. However, some cultural assets that have been enclosed by existing approved flood works are located in MZ C.

Current floodplain management arrangements criteria

Existing flood-work development identified in floodplain management guidelines were incorporated into MZ C.

MANAGEMENT ZONE CU

Hydraulic criteria

The basis for MZ CU was not hydraulic.

Ecological criteria

The basis of MZ CU was not ecological.

Cultural criteria

The basis of MZ CU was not cultural.

Current floodplain management arrangements criteria

MZ CU includes floodplain areas that are included within existing urban flood studies, flood risk management studies, or flood risk management plans or that are protected by flood mitigation works such as town levees.

MANAGEMENT ZONE D

Hydraulic criteria

The basis for MZ D was not hydraulic.

Ecological criteria

MZ D includes assets that are a location of landscape feature, such as a swamp, marsh, lagoon, anabranch or billabong with a high degree of floodwater dependency, and:

- a high degree of habitat complexity
- a history of supporting a diversity or abundance or waterbird, native fish or frog populations
- the functional capacity to act as an aquatic drought refuge
- recognition in, or protected by a local, state or commonwealth environmental policy.

Cultural criteria

MZ D includes areas that have a high degree of floodwater dependency, such as swamps, marshes, lagoons, billabongs, rocky bars or warrambools and have significance to the Aboriginal community, including spiritual, archaeological or resource use-values. These areas were listed on a heritage register or were a place that was recognized for its cultural significance by several senior knowledge holders in the Aboriginal community.

Current floodplain management arrangements criteria

MZ D was reviewed for consistency with existing plans, however, the basis for MZ D did not include existing floodplain management planning arrangements

Modifying a management zone

Part 10 Amendment of this Plan in the draft Barwon-Darling 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.

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 flood 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 A and MZ D.

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

- specify the physical nature of flood works
- specify advertising triggers
- are assessment criteria to determine the acceptable impacts of flood works
- relate to existing flood structures and works in MZ A and MZ D.

The finalised Barwon-Darling Valley FMP will be supported by assessment guidelines to assist licensing officers when assessing flood-work applications using the rules.

The rules proposed in Step 8 should be considered in conjunction with the state-wide exemptions, which are detailed in a section below.

Authorised flood works

The types of flood works that can be applied for in each management zone (authorised 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 authorised flood works. This approach ensures clarity on authorised flood works and will enable a streamlined assessment process. Where rules are not specified in a management zone all flood works are authorised via application. These flood works are categorised as other (non-specified) flood works. Seven types of flood works were identified for the Barwon-Darling Valley Floodplain:

- Aboriginal value, ecological 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
- infrastructure protection works – to minimise risk to life and property
- limited height flood protection works that are less than or equal to 80 centimetres in height – generally used for crop and land protection against smaller floods
- private access roads – to ensure landholders have basic provisions to access property
- stock refuges – to account for animal welfare and to minimise a landholder's potential to lose stock to floodwaters
- supply channels – to ensure supply channels reach water sources so landholders can access water rights
- other (non-specified) flood works that are generally used for crop and land protection against larger floods.

Authorised flood works by management zone

In MZ A 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 management zones. The restrictions on authorised 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 authorised flood works in each management zone are outlined in Table 12

Table 12: Rules for authorised works by management zone

MANAGEMENT ZONE A

- Aboriginal value enhancement work
- access road
- ecological enhancement work
- heritage site enhancement work
- infrastructure protection work
- stock refuge
- supply channel below the natural ground surface

MANAGEMENT ZONE D

- Aboriginal value enhancement works
- ecological enhancement works
- heritage site enhancement works

MANAGEMENT ZONE B, C and CU

All types of flood works are authorised.

The rules that specify the physical nature of authorised flood works in MZ A and MZ D are described in detail below.

Aboriginal value enhancement works

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

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

Justification for specifications

An Aboriginal enhancement work is an important new type of work that enables the protection of locations or landscape features that have Aboriginal value. These types of works are authorised 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 WMA 2000, clause 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 WMA 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.

Access roads

In MZ A access roads must be:

- no more than 50cm in height above the natural surface level at any location, or
- a primary access road no more than 100 cm in height above the natural surface level at any location, 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
- constructed so that the borrow associated with the construction and maintenance of the access road is located on the downstream side of the road and is of no greater depth than 50 cm below the natural surface level.

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

Justification for specifications

Initially, it was recommended that access roads be no higher than 30 centimetres in MZ A. However, during targeted consultation in October 2015 landholders raised concerns that the nature of flooding in the Barwon-Darling Valley Floodplain is characterised by deeper longer lasting floods and 30 centimetre high access roads would be inundated or washed out during flood events preventing access to properties. As a result, access roads are now proposed to be authorised up to 50 centimetres and for primary access roads, roads can be authorised up to 100 centimetres in height in MZ A.

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 2006). 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 and represent current best practice principles. The positioning of the borrow pit on the downstream side and limiting the depth to 50 centimetres 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.

Ecological enhancement work

In MZ A and MZ D, ecological enhancement works must provide a positive outcome for an ecological or cultural asset that is mapped, recognised in or protected by this Plan, or a local, State or Commonwealth environmental policy.

Justification for specifications

An ecological enhancement work is an important new type of work that provides a positive outcome for the environment. These types of works are authorised in MZ A and MZ D areas as they will provide a positive outcome for the environment, consistent with the WMA 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.

Heritage site enhancement works

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 one of the following databases:

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

Justification for specifications

Heritage site enhancement work is an important new type of work that enables the protection of Aboriginal or heritage locations in the floodplain that have recognised significance. These types of works are authorised in MZ A and MZ D areas as they will provide a positive outcomes to flood-dependent heritage sites. This rule is consistent with the objects of the WMA 2000, clause 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 WMA 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.

Infrastructure protections works (IPW)

In MZ A, IPWs must:

(1) on landholdings less than or equal to 20 hectares, be no more than 10 per cent of the total area of the landholding

OR

(2) on landholdings greater than 20 hectares, be no more than the greater of the following:

- two hectares
- one per cent of the size of the landholding.

AND

(3) on all landholdings, not block more than five per cent of the width of MZ A at the location of the works.

Justification for specifications

IPWs are important flood works that provide for the protection of life and property from the effects of flooding. The thresholds selected for the works ensure that flood behaviour is not significantly affected by a work of this nature.

IPWs can be built to different areas depending on the total size of the landholding where the work is being built. This is to cater for the practicality of larger properties being likely to have more infrastructure servicing their land.

On properties no larger than 20 hectares, IPWs can cover an area that is up to 10 per cent of the area of the property. For example, if a property is 10 hectares, proposed IPWs can cover an area that is no more than one hectare. This rule was made to be consistent with the Gwydir Valley FMP 2016.

On properties larger than 20 hectares, IPWs can be whichever is the larger of the following two options (1) either two hectares in size or (2) one per cent of the total area of the property. For example, if a property is 25 hectares the proposed IPW can be no more than two hectares in size. Whereas, if a property is 300 ha in size, the proposed IPW can be no more than three hectares in size. This rule was made to be consistent with the Gwydir Valley FMP 2016.

The rule requiring IPWs to not block more than five per cent of the width of MZ A at the location of the works was referenced from the Gwydir Valley FMP 2016 and was used in interim working policies adopted by DPIW prior to this. This rule provides greater certainty to landholders wishing to construct an IPW by specifying a threshold for how much of MZ A can be blocked.

Stock refuges

In MZ A, stock refuge must be:

- no more than 10 hectares in area in any single location, and
- no more than five per cent of the total area of the landholding, and
- no more than five per cent of the width of MZ A at any location.

Justification for specifications

To avoid flood flow redistribution impacts, stock refuges are regulated and subjected to an assessment process. The thresholds are consistent with those used in the Gwydir Valley FMP 2016 (NOW 2014).

Supply channels

In MZ A, supply channels must be:

- below the natural ground surface, and
- constructed in such a way as to allow for the adequate passage of floodwater and to adequately prevent the diversion of floodwater, and
- constructed and maintained so that the spoil is windrowed parallel to the direction of flow such that it does not block more than five per cent of the width of MZ A OR is levelled to a no more than 10 centimetres in height.

Justification for specifications

Ensuring that supply channels are below the natural ground level reduces the potential for the work to affect the distribution or flow of floodwater during flood events. It is still a requirement to construct the supply channel so that there is adequate passage of floodwater and to adequately prevent the diversion of floodwater. This is because, during small floods, a supply channel could potentially capture and divert flow from its natural flow path. It may be required that a siphon or gate be put in place at the low point(s) of the supply channel to enable timely floodwater passage and/or drainage on the floodplain. Construction of siphons or equivalent structures will enable floods to pass through or under these works. It is also possible that the spoil from the construction and maintenance of a supply channel will act as an above-ground flood work. To minimise the chance of spoil influencing flood flow, it is required to windrow the spoil to the specifications in the rules or to ensure it is levelled to no more than 10 centimetres in height. It is

also required that the encroachment of spoil into active discharge areas is limited to minimise any impacts on flooding.

In areas of the proposed Barwon-Darling Valley Floodplain, below ground supply channels did not require approval if they had an existing approval under Part 2 of the WA 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.

Advertising requirements

The draft Barwon-Darling Valley FMP does not require advertising for works deemed to be minor in nature. 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 A and MZ D are minor in nature and therefore flood-work applications in these management zones do not need to be advertised.

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

- flood-work applications that do not require advertising,
- 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 B, a flood work does not require advertising if it is:

- no more than 80 centimetres in height
- used as a stock refuge and is no more than five per cent of the total area of the landholding, and no more than 10 hectares in size in any single location
- used to protect infrastructure and the area enclosed by the flood work accounts for no more than one per cent of the total area of the landholding

In MZ C there are no restrictions on the types of authorised flood works. As MZ C includes flood fringe and existing developed areas flood-work applications do not require advertising as there is a low risk that flood works will impact third parties. However, in some instances, such as removal of an existing flood work that has the potential to have significant flood redistribution impacts, the Minister may request a flood work to be advertised.

In MZ CU there are no restrictions on the types of authorised flood works. The majority of flood works likely to be applied for in MZ CU will be exempt from requiring a flood work approval under the WMA 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 13).

Table 13: Categories of impacts that flood-work applications must be assessed against to be approved by management zone

Assessment criteria		MZ A	MZ B	MZ C/CU	MZ D
Ecological and cultural impacts	Flood connectivity to ecological assets (including fish passage)	✓	✓	✓	✓
	Flood connectivity to Aboriginal values	✓	✓	✓	✓
	Flood connectivity to heritage sites	✓	✓	✓	✓
	Heritage site impacts	✓	✓	✓	✓
Social (drainage) impacts	Drainage impacts	✓	✓	✓	✓
	Redistribution	N/A	✓ [#]	^	N/A
Local hydraulic impacts	Flood levels	N/A	✓ [#]	^	N/A
	Velocity	N/A	✓ [#]	^	N/A
Cumulative hydraulic impacts	Redistribution	✓	✓ [#]	^	✓

^ 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 draft Barwon-Darling 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 draft Barwon-Darling 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 draft Barwon-Darling 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?

Potential ecological and cultural impacts were considered to ensure that flood-dependent assets are not harmed by changes to flood connectivity caused by flood works. This assessment criteria was considered because the management zones were designed at a strategic scale. It is therefore needed to have assessment criteria to account for the complex network of flow paths at the property scale that may have been missed in the management zone map. Many of these smaller flow paths are important for maintaining the ecological or cultural 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. Therefore, flood connectivity that facilitates fish passage will be specifically dealt with in the assessment criteria. 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 and Harris 2000; Humphries, Serafini and King 2002).

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 will be identified in the FMP and the information made available to DPIW licensing officers. 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 by licensing staff. Licensing staff will have access to maps of the floodplain assets and will draw on available mapped information as well as observations made on the ground. Licensing staff will also be required to check state and Commonwealth heritage registers to identify any heritage sites within the local area of a flood-work application. Licensing officers will consider flow paths that may be active

across a range of floods, including the small and large design floods. Landholders will not have to provide information on ecological and cultural impacts in their flood work applications.

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 adequate drainage on adjacent landholdings and other landholdings that may be affected by the proposed flood work.

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) and the proposed Border Rivers and Lower Namoi Valley FMPs.

How will the criterion be applied?

The drainage impacts assessment criterion will be assessed by licensing staff. Licensing staff will have access to topographical maps and flood photography as well as observations made on the ground. Licensing officers will consider local topography to minimise the likelihood of new flood works changing local drainage lines in a disruptive manner. Licensing officers may consider local flooding patterns across a range of floods, including the small and large design floods. Landholders will not be required to provide information on drainage impacts in their flood-work applications.

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 B is discretionary. The use of the assessment criteria to assess applications for all types of flood works in MZ C and MZ CU is also discretionary. For flood work applications that require advertising in MZ B, the assessment criteria are mandatory.

In MZ B, 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 five per cent in the local area when compared to the peak flood flow under existing development conditions for a range of flood scenarios including, at minimum, the relevant large design flood
- increase flood levels by more than 20 centimetres in the local area when compared to flood levels under pre-development and existing development conditions for a range of flood scenarios including, at minimum, the relevant large design flood
- increase flow velocity by more than 50 per cent on the landholding under application or in the local area when compared to flow velocity under pre-development conditions for a range of flood scenarios including, at minimum, the relevant large design flood, unless:
 - increases by more than 50 per cent are 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 per cent, and
 - flow velocity is not increased by more than 50 per cent at the boundary of the landholding under application
- 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 large design flood
- increase flow velocity by an amount that is likely to have more than minimum impact on soil erodibility, taking into account the ground cover, on the landholding under application or in the local area.

In MZ C (and for non-exempt works in 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 B. 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 hydrology, 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 Macintyre floodplain policy (internal DPIW policy) and the Gwydir Valley FMP 2016 (NOW 2014). Criteria were also developed through consideration of the proposed Border Rivers, Lower Namoi and Upper Namoi Valley FMPs.

How will the criteria be assessed?

Hydraulic local impacts assessment criteria will be assessed by licensing staff using information provided by the landholder as part of the flood work application. To assist with preparation of the

required technical detail, DPIW will maintain and provide records of the current level of development as well as the 2015 level of development. The hydraulic local impacts will be assessed by comparing:

- pre-development conditions (refers to the floodplain without flood-work development)
- existing conditions (refers to the floodplain and level of flood-work development at the time that the draft Barwon-Darling Valley FMP was made)
- proposed conditions (the proposed work and existing conditions combined).

Specifically:

- flood flow redistribution is to be assessed by comparing proposed conditions with existing conditions and must not exceed the allowable threshold
- flood level increases are to be assessed by comparing greenfield conditions with existing and then proposed conditions and summing the impacts to make sure the allowable threshold is not exceeded
- flow velocity increases are to be assessed by comparing greenfield conditions with existing and proposed conditions to make sure the allowable threshold is not exceeded.

Cumulative hydraulic impacts

Description of the criteria

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

In MZ B, Zone C and MZ CU, the cumulative hydraulic impact assessment criteria limits the redistribution of flood flow across the floodplain. The large design flood is to be used for the assessment, and redistribution is to be limited to less than or equal to five per cent of the peak flow in this event at any of the Peak Discharge Calculation Points as defined by the Minister. All flood work applications received for MZ B must be assessed against this criterion when compared to redistribution under existing development conditions. If required by the Minister, a flood work application in MZ C or MZ CU must also be assessed against this criterion, which will typically be using floods larger than the design flood such as the 1 in 100 AEP flood. The use of this assessment criteria to assess applications for minor works (i.e. those that do not require advertising) in MZ B is discretionary. The use of this assessment criteria to assess applications for all types of flood works in MZ C and MZ CU is also discretionary. For flood work applications that require advertising in MZ B, these assessment criteria are mandatory.

In MZ A and MZ D, the cumulative hydraulic impact assessment criteria is in place to ensure that the potential cumulative impacts of works in these management zones are assessed in conjunction with existing works on the property where the work is to be located. All flood works in MZ A and MZ D must be assessed against this criterion.

In MZ A 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.

And,

In MZ B, 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 five per cent at any of the Peak Discharge Calculation Points as defined by the

Minister, when compared to redistribution under existing development conditions for a range of flood scenarios including, at minimum, the relevant large design flood.

In MZ C (and for non-exempt works in MZ CU), flood work applications may be required to demonstrate that they adhere to the assessment criterion specified above for MZ B. The flood scenarios used to assess the application are not prescriptive and may be determined by the Minister.

Why are cumulative hydraulic impacts considered?

Current estimates are that the area protected by flood works (hereafter *developed areas*) makes up approximately 45,700 hectares (four per cent) of the Barwon-Darling 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 proposed Barwon-Darling 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?

The thresholds for the hydraulic cumulative impacts have been determined by comparing the modelling results from the current floodplain conditions with a greenfield modelling scenario, where all flood works had been removed from the model bathymetry.

The two scenarios were compared at cross-sections at key locations within the floodplain. The basis for the assessment was the peak flood flow for the large design flood event.

It was found that some redistribution has likely occurred due to existing flood works, and that this redistribution is variable across the floodplain; however, limitations with representing the pre-development floodplain in the model 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 B, 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 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 in 100 AEP flood as well. Information on the 1 in 100 AEP flood will need to be obtained from DPIW. DPIW will maintain records of the current level of development as well as the 2015 level of development and will provide these in order to assist with the assessment.

For MZ A 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.

Existing flood works and structures

Rules to either license eligible existing flood structures or to modify the licences of eligible existing flood works were required in MZ A or MZ D where the proposed Barwon-Darling Valley FMP restricts the types of authorised flood works.

The inclusion of these rules allows Licensing officers to accept applications for existing works that do not comply with the rules for MZ A 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 A or MZ D if all of the following criteria are met:

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

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

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

- the flood work was constructed as at the date of commencement of this Plan, and
- the proposed modification to the flood work will reduce the impact of the work on flow patterns (distribution of flows, drainage, depth or velocity) in MZ A 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 A and MZ D, whichever is applicable.

Exemptions to flood work approvals

During Step 8, consideration is given to works that are exempt from requiring a flood work approval as set out in the *Water Management (General) Regulation 2011* (such works are hereafter referred to as *state-wide exemptions*).

In the proposed Barwon-Darling Valley FMP area, state-wide exemptions apply as indicated in Table 14.

Table 14: State-wide exemptions under the *Water Management (General) Amendment (Flood Work Approvals) Regulation 2015*

State-wide exemptions under <i>Water Management (General) Regulation 2011</i>	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	Management zones B, C and CU

high flood risk area under a development authorisation granted by the council	
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 and CU
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 zones 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 zones 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 draft Barwon-Darling Valley FMP.

The existing floodplain management arrangements referred to below and in Figure 23, are floodplain areas:

- covered by floodplain guidelines (*hereafter*, Guideline area)
- part of the original Part 8 designated floodplain (designated under section 166 of the WA 1912) (*hereafter*, designated areas)
- new areas added to the proposed floodplain (*hereafter*, New areas added to the floodplain).

As there are currently no statutory FMPs in the Barwon-Darling the introduction of the floodplain boundary, management zones and rules including assessment criteria, and the improved consideration of ecological and cultural floodplain assets will result in changes to current management practices. These 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. The Barwon-Darling Valley FMP will bring floodplain management into alignment with the WMA 2000.

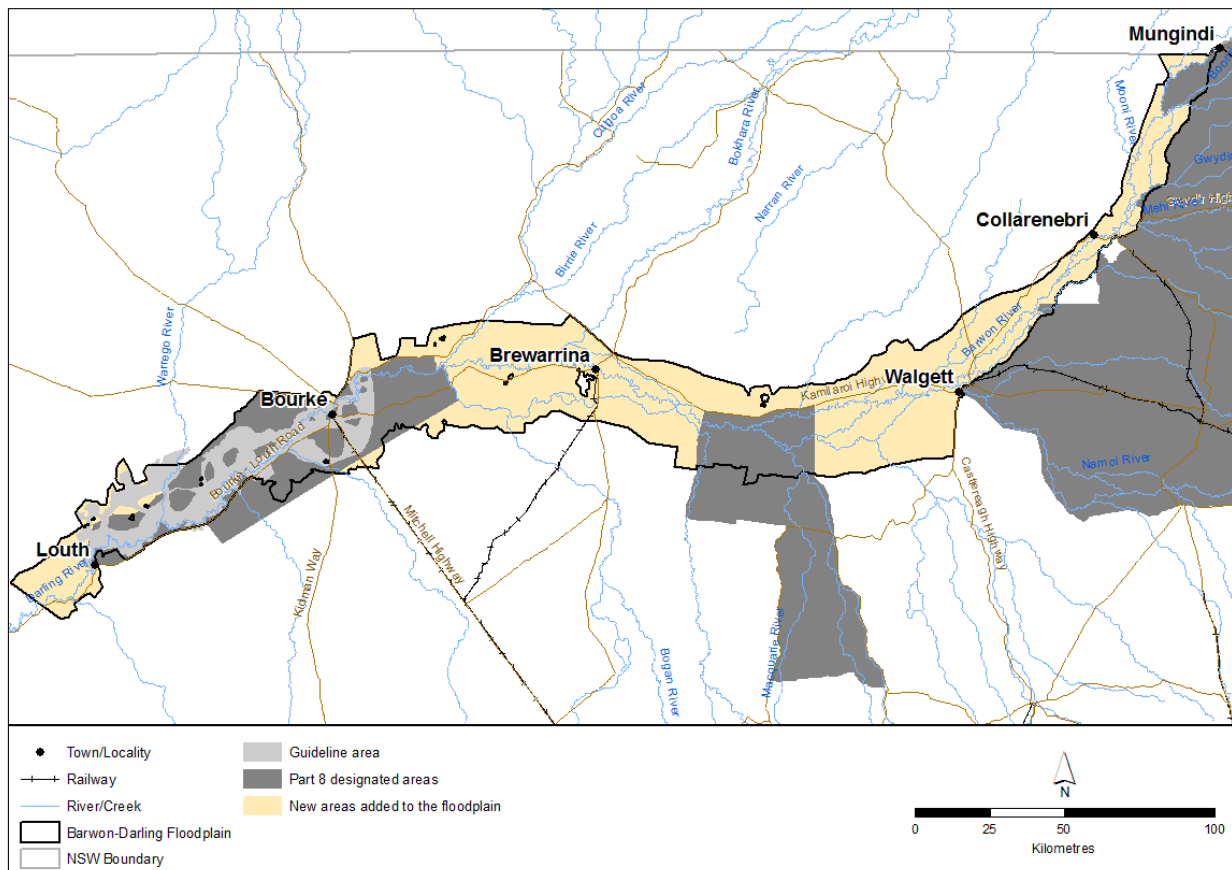


Figure 23: Existing floodplain management arrangements in the Barwon-Darling Valley FMP area

Floodplain boundary

Designated areas were a primary consideration when delineating the proposed Barwon-Darling Valley Floodplain boundary. The Barwon-Darling Valley Floodplain was partially aligned with the Bogan River Confluence to Louth designated floodplain; Lower Namoi designated floodplain; and the Lower Gwydir designated floodplain (Figure 24). When compared to the existing designated floodplains, the overall extent of boundary change is significant, with the addition of 765,400 hectares. The rationale for all the boundary changes is detailed in Step 1.

Management zones

The draft Barwon-Darling Valley FMP introduces the use of management zones in floodplain management. Current floodplain management arrangements include floodways in the Guideline area which are used, through the application process, to guide the location and nature of flood-work development. The floodways were designed to remain unobstructed. Areas outside of the floodways in the Guideline area were identified as being suitable for flood-work development. Existing floodways in the Guideline area were compared against the proposed management zones to determine the level of change. New areas added to the floodplain outside of the Guideline area do not have mapped floodways or management zones.

As described in Step 7, the draft Barwon-Darling Valley Floodplain has five different management zones based on hydraulic, ecological and cultural criteria and criteria to better reflect existing management arrangements. The hydraulic criteria were based on the floodway network.

The proposed management zones in the draft Barwon-Darling Valley Floodplain differ from existing floodplain management arrangements as a result of:

- 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 from using the latest modelling techniques with new hydraulic models being developed and existing models being updated.

The floodways identified in existing Guideline area are equivalent in principle to the hydraulic criteria used to develop MZ A. However, the data used to develop MZ A is more sophisticated and better represents flooding behaviour. Another key difference is that ecological and cultural assets were considered in the design of MZ A. Ecological and cultural assets were incorporated into the management zones to reflect the greater emphasis that the WMA 2000 places on protecting the floodplain environment.

The areas outside the floodway in the Guideline area are equivalent in principle to the hydraulic criteria used to develop MZ B and Zone C.

Key differences are that:

- the non-floodway network areas under the guidelines also contain flood fringe and developed areas that form MZ C in the draft Barwon-Darling Valley FMP
- ecological and cultural assets were identified and prioritised and considered in the design of MZ B (see Step 7).

MZ CU was designed 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*.

MZ D is a new type of management zone in the proposed Barwon-Darling 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 between the Guideline area and designated areas rules and the rules of the proposed Barwon-Darling Valley FMP. These changes are described below.

Change to authorised flood works

Change has not occurred in MZ B, MZ C or MZ CU. Under the Guideline area, designated areas and the proposed Barwon-Darling Valley FMP. A landholder can apply for any type of flood work to be built in areas that are equivalent to MZ B, MZ C or MZ CU.

Change has occurred in MZ A and MZ D and is outlined below.

Management zone A

Under current management practices, a landholder can apply for any type of flood work to be built in areas that correspond to MZ A areas. The draft Barwon-Darling Valley FMP only allows flood work applications in MZ A for five different types of authorised works. Under current assessment practices, works other than those authorised in the proposed FMP would be unlikely to be approved. This is because areas corresponding to MZ A (floodway network areas) need to satisfy stringent assessment criteria before being approved. By limiting applications to certain authorised works in the draft Barwon-Darling Valley FMP, landholders save time and money by applying only for those works likely to be approved.

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 draft Barwon-Darling Valley FMP will only allow flood work applications in MZ D for Aboriginal value, ecological and heritage site enhancement works. By limiting applications to certain authorised works in the draft Barwon-Darling Valley FMP, landholders save time and money by applying only for those works likely to be approved.

Changes to advertising requirements

Advertising flood works gives interested parties the opportunity to comment on a flood work application and for that comment to be considered during the assessment. The intention of advertising rules is that if a flood work is minor or is in an area of the floodplain where the potential for the flood work to impact on flood behaviour is minimal, then it should not need to be advertised.

Advertising requirements have been updated in the draft Barwon-Darling Valley FMP to reflect changes made to the types of flood works that will be considered for approval. Some of the proposed rules 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.

Under existing floodplain management arrangements, advertising was required in all areas of the Barwon-Darling Valley Floodplain, including designated areas and the Guideline area. This was because there was not sufficient information available to determine the scale of flood behaviour impacts from proposed flood-work developments. However, as the Barwon-Darling Valley FMP incorporates sophisticated hydraulic, ecological and cultural information, advertising requirements have been refined and are linked to certain management zones and the nature of flood works. In this way, the draft Barwon-Darling Valley FMP is less restrictive in areas covered by designated areas, the Guideline area and new areas added to the floodplain, where advertising is required. The following outlines advertising requirements for each management zone in the Barwon-Darling Valley FMP:

- *MZ A*: flood-work applications do not require advertising. This is because the types of flood works that can be applied for are minor in nature and unlikely to impact flooding patterns.
- *MZ B*: flood-work applications that are minor in nature do not require advertising unless requested by the Minister. All other flood work applications require advertising because of the potential for the work to impact on flood behaviour, floodplain connectivity and neighbouring properties.
- *MZ C and CU*: flood work applications do not require advertising, unless specified by the Minister, as it is unlikely that a flood work in this area would impact on flood behaviour, floodplain connectivity or neighbouring properties.
- *MZ D*: flood-work applications do not require advertising, as the only allowed works (Aboriginal value, ecological and heritage site enhancement works) must result in a positive outcome for the environment and satisfy rigorous assessment criteria.

Changes in assessment criteria

A summary of the types of assessment criteria considered in current floodplain management arrangements is provided in Table 15. These assessment criteria have been incorporated into the Barwon-Darling Valley FMP. Assessment criteria that have been explicitly addressed in the rules are highlighted in green. To varying degrees, all existing assessment criteria have been

considered in the development of the management zones and rules of the Barwon-Darling Valley FMP.

Table 15: Summary of assessment criteria in current floodplain management arrangements in the Barwon-Darling Valley Floodplain

Criteria highlighted in green have been explicitly incorporated into the Barwon-Darling Valley FMP as assessment criteria. All the assessment criteria were considered during the development of the draft management zones.

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
	Cost of the works	Soil condition and structure	Pondage and flow duration
	Infrastructure damage	Fish passage	Redistribution
	Equity	Cultural sites	Flow velocities
	Land use and restrictions	Groundwater recharge	

Existing flood works and structures

In parts of the Barwon-Darling Valley Floodplain that were not covered by a designated area or Guideline area these areas may not have required an approval under Part 8 of the WA 1912 for works that are now considered a flood work under the Barwon-Darling Valley FMP. The draft rules in the Barwon-Darling Valley FMP enable existing works that do not meet the specifications to be an authorised work to be licensed, so long as they meet certain criteria. This enables landholders to apply for a flood work approval under the WMA 2000 for those types of works that did not necessarily require a controlled work approval under the WA 1912.

For licensed works that do not comply with the rules of MZ A and MZ D, the Barwon-Darling Valley FMP allows modification of these works to reduce their impact on flow patterns. Under existing management arrangements, modification of such works that would result in an increased impact would not be 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 draft Barwon-Darling Valley FMP to determine the negative socio-economic impacts of the proposed plan. Phase one has been completed and was undertaken prior to community consultation; the results are outlined below. Phase two 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 draft Barwon-Darling Valley FMP. The second phase is a detailed assessment that will only occur if phase one 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; and
- 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.

The focus of this assessment is the enumeration of the negative effects of the implementation of the proposed FMP that will be quantified in 2011 dollars. Because benefits of the proposed FMP are not enumerated it is not a Benefit Cost 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. 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 one: preliminary 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 proposed Barwon-Darling 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 proposed Barwon-Darling Valley FMP construct was quantifiable, this was determined in 2011 dollars. Where significant impacts are indicated by this preliminary assessment, a detailed analysis is developed; however, there were no significant impacts identified.

As the preliminary assessment occurred prior to community consultation, the effect of change was assessed against the management zone areas and rules that were proposed at the stage of targeted consultation. These areas and rules have been altered as a result of targeted consultation, however because the area of MZ A is now less than previously proposed and the rules have been made less restrictive, the effect of change will be less than what was assessed in the preliminary assessment.

Comparing Base Case and Plan rules

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

- flood work approvals will continue under the floodplain management provisions of the WMA 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 their general awareness of environmental issues
- flood works will continue to be approved in areas outside the floodway networks identified in FMPs and guidelines
- the approval rate of flood works within the floodway networks identified in FMPs and guidelines will decline as cumulative impacts approach acceptable limits.

Note, there are no existing FMPs prepared under Part 8 provisions of the WA 1912 or floodplain management provisions of the WMA 2000 in the Barwon-Darling Valley Floodplain.

The impact of the Barwon-Darling Valley FMP was assessed for the whole floodplain (1.1 million hectares). Depending on the location of affected land, there may be particular areas that are anticipated to be relatively heavily impacted by the proposals.

A brief summary of the rules under the Base Case are presented in Table 16.

Table 16: Summary of rule changes between the Base Case and the proposed Barwon-Darling Valley FMP

Base case	Barwon-Darling Valley FMP construct
<p>Flood work across the whole floodplain required application for a WMA 2000 flood work approval under similar criteria to Part 8 of the WA 1912.</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 WMA 2000.</p>
<p>Floodway network</p> <p>In an identified floodway in a Guideline area or a suspected unidentified floodway in a non-guideline area, the applicant is required to provide a floodplain engineers report identifying that the hydraulic parameters¹ are not exceeded. All applications are deemed to be non-complying and require advertising and objections are to be considered before possible approval. Flood work applications are unlikely to be approved in floodway networks.</p> <p>There are no existing FMPs in the Barwon-Darling Valley Floodplain. All flood-work applications must be advertised.</p>	<p>MZ A provides for flood work approvals by application that is one of the following:</p> <ul style="list-style-type: none"> • an access road up to 30 centimetres above natural surface level, or • a supply channel below the natural surface level, or • stock refuge, or • an infrastructure protection work, or • Ecological, Aboriginal value and heritage site enhancement works, or • Existing works – licensed and unlicensed. <p>Applications do not require advertising.</p> <p><i>Note: socio-economic assessment was undertaken prior to proposal to increase road height in February 2016. Initial road height of 30 cm would have a greater impact than proposed road height allowances of 50 cm for 'all other roads' and 1 m for 'primary access roads'. See Step 8: Determine Rules for more information on the proposed road rule</i></p> <p>MZ D provides for a prohibition of flood work approvals except for:</p> <ul style="list-style-type: none"> • Ecological, Aboriginal Value and heritage site enhancement works, or • Existing works – licensed and unlicensed
<p>Areas outside the floodway network</p> <p>As there are no existing FMPs in the Barwon-Darling Valley Floodplain, the applicant is required to provide a floodplain engineers report identifying that the hydraulic parameters¹ are not exceeded. All applications are deemed to be non-complying and require advertising and objections are to be considered before possible approval.</p>	<p>MZ B provides that flood work approvals or modifications by application does not require advertising if it is one of the following:</p> <ul style="list-style-type: none"> • no more than 50 centimetres in height above the natural surface level, or • stock refuge, or • infrastructure protection works. <p>All other flood works require advertising.</p> <p>The application must not be approved if it exceeds the assessment criteria defined in the Plan.</p> <p>State-wide exemptions apply in this Management Zone. See DPIW website for the list of exemptions.</p> <p><i>Note: socio-economic assessment was undertaken prior to proposal to increase advertising height to 80 cm in February 2016. Initial advertising height of 50 cm would have a greater impact than the proposed advertising height of 80 cm.</i></p> <p>MZ C provides for flood work approvals by application if they meet the assessment criteria.</p> <p>The application does not require advertising.</p> <p>State-wide exemptions apply in this Management Zone. See DPIW website for the list of exemptions.</p>

¹Hydraulic parameters are based on hydraulic criteria defined under Part 8 of the WA 1912 that have been transferred to flood work assessments under the WMA 2000 and are consistent with the rules and assessment criteria in the proposed Barwon-Darling Valley FMP.

Impact of rule changes

Management Zone A

MZ A floodways in the Barwon-Darling Valley FMP are initially defined by hydraulic criteria, including the depth-velocity product from the flood modelling.

As there were no existing FMPs in the Barwon-Darling Valley Floodplain all flood work applications would require advertising and detailed technical assessment prior to authorisation. It is also highly unlikely in floodway areas in the Base Case scenario that any works other than those permissible in MZ A would have been approved. It is expected that flood work approvals in this area are not likely to be substantially negatively affected by the Barwon-Darling Valley FMP.

MZ A in the Barwon-Darling Valley FMP includes areas in addition to the hydraulic floodways that are important for flood connectivity to significant flood-dependent vegetation or are areas of flood-dependent vegetation. These areas are known as ecological or cultural amendments to MZ A. Land included as the ecological or cultural amendment to MZ A will be subject to significant change under the Barwon-Darling Valley FMP. If the Barwon-Darling Valley FMP had not been developed (the Base Case), it is likely that flood work proposals in these areas would have been assessed in general accordance with the rules in the adjacent management zone, usually MZ B. However, with the addition of these areas as ecological asset connectors and areas of cultural significance to MZ A, these areas are now subject to MZ A rules that provide for only: approved access roads up to 30 centimetres above surface level, stock refuge, infrastructure protection works, supply channels below the natural surface level, ecological, Aboriginal value and heritage site enhancement works and existing works – licensed and unlicensed (see Table 16 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 Barwon-Darling Valley FMP.

Management Zone B

Floodplain land that is outside MZ D and MZ A, but is within the large design flood area will become the flood storage and secondary flood discharge, MZ B.

As there are no existing FMPs under the Base Case scenario in the Barwon-Darling Valley Floodplain all flood work applications would require advertising. However, the Barwon-Darling Valley FMP has reduced advertising requirements through the specification of minor works in MZ B. Minor works such as; limited height flood works, stock refuge and infrastructure protection works subject to size conditions, can be approved without advertising. This change is expected to provide additional benefits to landholders and streamline the assessment process. Flood works in excess of the size limits in MZ B will require advertising which is the same requirement as the Base Case.

Specification of the types of works that require advertising will not incur any additional costs to landholders. Furthermore, where a flood-work application satisfies the criteria for a minor work there will be a reduction in application processing time as applications will not be subject to third party objections.

It is expected that flood work approvals in this category may be positively affected by the Barwon-Darling Valley FMP.

Management Zone C

Areas above the design flood or afforded protection by approved works will be in MZ C. Flood-work applications in MZ C may be required to meet assessment criteria but will not require advertising. This is a positive change from the Base Case, whereby flood-work applications that required advertising across the Barwon-Darling Valley Floodplain will not require advertising under the Barwon-Darling Valley FMP. Flood work approvals in this category may be marginally positively affected by the Barwon-Darling Valley FMP.

Management Zone CU

This management zone includes the areas managed by Local Council. The hydraulic, ecological or cultural criteria are not applicable in these areas.

It is expected that there will not be any substantially negative impacts in this area.

Management Zone D

MZ D is a special ecological and cultural protection zone. This MZ includes ecological or cultural areas that are highly significant. The inclusion of this MZ in the Barwon-Darling Valley FMP is to ensure that flood connectivity to these assets are maintained and protected. All the assets included in this management zone are associated with water bodies. Ecological, Aboriginal values and heritage site enhancement works and existing works - unlicensed and licensed flood works are permitted in this management zone. Any proposed work would also require a controlled activity approval under the WMA 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 management zone are not likely to be substantially negatively affected by the Barwon-Darling Valley FMP.

Summary of negative impacts

Considering the changes from the Base Case to the Barwon-Darling Valley FMP the negative impacts identified is the lost access by landholders to all but limited applications in the ecological asset connector and cultural significance to MZ A. The details of the impacts are presented in Table 17.

Table 17: Impact table of proposed Barwon-Darling Valley FMP

		Ecological asset connector and Area of Cultural Significance
Total area (ha)		3,387 (East of Brewarrina)
Possible land use		Cropping
Representative land use		Wheat
Impact		Lost access to complying works other than: Infrastructure protection works, access roads, and supply channels below the natural surface level.
Who is impacted		Landholder
Quantifiable (\$)		Yes
Data sources		GIS – area; ABS - Wheat \$ GVAP
Scale : extent and intensity*	Plan	Negative, Low
	Regional	Negative, Low
	Local	Negative, Low
	Owner	Negative, Medium
Likelihood and duration*	Plan	Low, Permanent
	Regional	Low, Permanent
	Local	Low, Permanent
	Owner	Low, Permanent

*Impact: assess each factor with the other three factors held constant. Magnitude: Low, Medium, High.

Impacted area

The total area of ecological and cultural refinements to MZ A (flood-dependent vegetation) from outside the modelled hydraulic floodway networks is estimated to be 22,787 hectares. However, this whole area is not impacted by the Barwon-Darling Valley FMP as not all of the area is

suitable for dryland cropping. Based on local governmental knowledge it is assumed that the Eastern side of the Barwon-Darling Valley FMP area starting from halfway through the Brewarrina Shire is suitable for dryland cropping. It is estimated that 3,387 hectares, 15 per cent of the total area of ecological asset connector and cultural significance in MZ A, is in that region.

This area is adjacent, in close proximity to or connects with the hydraulic floodway network. This amounts to about 0.3 per cent of the total 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 Barwon-Darling 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 (NVA) 2003*.

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. However, in the absence of any information on the proportion of the area that could practically be developed for reliable cultivation, we assumed that all of this area, 3,387 hectares, 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 value of economic impacts

The financial impact of the restrictions imposed on the area of flood-dependent vegetation and of cultural significance in MZ A can be estimated using data on the area of land suitable for regular dryland cropping and the Gross Value of Agricultural Production (GVAP). This land in the Barwon-Darling Valley Floodplain may be used for many summer or 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 (3,387 hectares) is assumed to be continuous wheat production.

The estimated Gross value and Area of 'Wheat for grain' produced in the Barwon-Darling Valley Floodplain was \$541 GVAP per hectare. These estimates were prepared as part of the Socio-economic profile of the Barwon-Darling Valley Floodplain 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 proposed FMP will be compared to the total GVAP for the Barwon-Darling Valley FMP to identify the level of significance.

The area of flood-dependent vegetation and cultural significance in MZ A is largely adjacent to or flowing to watercourses 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, 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 3,387 hectares of cropping land could potentially produce \$1.83 million per year in the Base Case with flood protection. Without flood work protection under the FMP this area would potentially produce \$1.37 million per year from cropping - a reduction of \$0.46 million (a result of an additional 1 in 4 crop failure). The upper limit of the net impact of the implementation of the proposed FMP on the area of private cropping due to flood-dependent vegetation and cultural significance within MZ A is estimated to be a reduction of \$0.46 million. This is very small, 0.49 per cent of the total GVAP for the Barwon-Darling Valley Floodplain of \$94 million.

Sensitivity analysis

This analysis is sensitive to the assumed frequency of crop failure, the cropping area within the area of flood-dependent vegetation and cultural significance to MZ A 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 \$0.92 million or 0.98 per cent of regional GVAP. 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 \$0.31 million or 0.33 per cent of regional GVAP.

The estimated impact is expected to be an over estimate due to much of the 3,387 hectares, identified in the analysis as holding potential for continuous wheat production, is currently used for grazing because 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 1,694 hectares, due to incorrect classification as suitable for regular cropping or inability to crop due to other restrictions such as the NVA 2003, the estimated impact would be reduced to \$0.23 million or 0.24 per cent 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 flood-dependent vegetation and cultural significance in MZ A would probably have a discounted land value due to flooding frequency.

Phase two: detailed analysis

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 proposed Barwon-Darling Valley FMP rules (estimated to be a reduction of 0.37 per cent of the total GVAP for the Barwon-Darling Valley Floodplain area) is of low significance for the regional economy, no further investigation is currently proposed. However, if there are other major issues raised during the public exhibition period that may warrant further detailed assessment, a phase two analysis will be undertaken.

Summary

Considering the changes from the Base Case to the proposed Barwon-Darling Valley FMP, the following key negative impacts were identified:

- lost opportunities to get approval in the area of flood-dependent vegetation and cultural significance in MZ A for works other than limited infrastructure protection works, access roads, stock refuges and supply channels below the natural surface level.

The impact of the Barwon-Darling Valley FMP is estimated to be a small reduction of 0.49 per cent of the total GVAP for the Barwon-Darling Valley Floodplain area and therefore no further investigation is currently proposed.

This is the estimated upper limit economic impact considering that it is unlikely that all of the area of flood-dependent vegetation and cultural significance within MZ A (Eastern side of the Barwon-Darling Valley FMP area starting from halfway through Brewarrina Shire) suitable for regular cultivation could be cropped.

Community consultation occurred as part of targeted consultation and will occur for public exhibition of the draft Barwon-Darling Valley FMP. Any potential socio-economic impacts and/or options identified by the community as part of public exhibition will be 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.

Role of socio-economics in plan development

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

Socio-economic advice has influenced the development of the Barwon-Darling 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,
- ensuring socio-economic impacts were included in the criteria for 'reasonable consistency' with previous floodplain management arrangements,
- incorporating, wherever possible, areas with approved existing flood-work development into MZ C,
- 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 whilst 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,
- 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.

Public exhibition

Community consultation will occur as part of public exhibition of the draft Barwon-Darling Valley FMP. The community will have the opportunity to provide feedback on potential socio-economic impacts of the management zones and rules for the draft Barwon-Darling Valley FMP. Potential socio-economic impacts and/or options identified by the community will be included in the socio-economic impact analysis to be undertaken post public exhibition, where appropriate. If major concerns are raised during public exhibition of the draft Barwon-Darling Valley FMP, a more detailed socio-economic impact assessment may also be required.

Consultation and review of the plan

DPIW is responsible for the review and consultation processes throughout the development of the draft Barwon-Darling 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 draft Barwon-Darling Valley FMP at key stages throughout the FMPs 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 and rules
- targeted consultation: engagement of targeted community groups for feedback on the proposed boundary, management zones and rules

- public exhibition: formal public exhibition of the draft Barwon-Darling 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) principles (DEC 2006)
- an Aboriginal Community Engagement Framework for 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 DPIW, OEH, DPI Agriculture, Local Land Services and DPI Fisheries.

The TAG was engaged throughout the FMP development process through a combination of email correspondence and face-to-face meetings. The TAG officially met five times from July 2013 to June 2015 to:

- delineating the floodplain boundary
- develop the draft management zones and rules
- identify cultural and ecological assessments and targets
- identify design floods and hydraulic modelling parameters
- identify socio-economic considerations.

Information provided by the TAG was incorporated into the development of the draft Barwon-Darling 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/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. It was designed to have flexible membership in order to adapt to the moving focus of plan development in different valleys. A number of 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
- review draft management zones, rules and assessment criteria.

Information provided by the ATWG was incorporated into the development of the draft FMP and is outlined in Steps 5, 7 and 8.

Aboriginal community

Local Aboriginal communities were engaged by an OEH Aboriginal Natural Resource Officer through informal meetings. The aim of these informal meetings 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 this engagement, the OEH Aboriginal Natural Resource Officer collected spatial information on cultural assets that are dependent on flooding. These were later analysed as part of Step 5 to be factored in to 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 draft Barwon-Darling Valley FMP boundary, management zones and rules. Targeted consultation was undertaken with stakeholders at Mungindi, Walgett, Brewarrina and Bourke in October 2015 and February 2016.

The objectives of targeted consultation were to:

- provide background to key stakeholders as to why the Floodplain Management Plans were being developed, how they were developed, what management zones and rules are proposed in the draft Barwon-Darling Valley Floodplain and how stakeholders could provide feedback, and
- 'road test' the proposed Barwon-Darling plan boundary, management zones and rules.

Targeted consultation involved the following key stakeholder groups and individuals within the Barwon-Darling Valley Floodplain:

- graziers, dryland and irrigation landholders and organisations
- Aboriginal Community representatives
- environmental representatives
- Local and State Government representatives
- local agronomists and consultants.

As a proportion of the total items of inquiry received, 27.78 per cent collectively related specifically to the draft Barwon-Darling Valley FMP boundary, management zones, rules and assessment criteria.

The suggestions in Table 18 were reviewed and incorporated as recommendations for consideration by the Interagency Regional Panel (IRP) following feedback from targeted consultation.

Table 18: Changes recommended for consideration by the IRP as a result of feedback received during targeted consultation.

Rule/assessment criteria No.	Rule/assessment criteria proposed at targeted consultation	Change to rule/assessment criteria as a result of feedback	Justification
1.	That access roads must be constructed at a height ≤ 30 cm above the natural surface level	To allow, through application, access roads: <ul style="list-style-type: none"> • up to 50 cm above the natural surface level or • up to 100 cm above the natural surface level as long as the access road is a primary access road and • has appropriate causeways and borrow treatment. 	Landholders raised concerns that the nature of flooding in the Barwon-Darling Valley Floodplain is characterised by deeper longer lasting floods and 30 centimetre high access roads would be inundated or washed out during flood events preventing access to properties.

Public exhibition

The draft Barwon-Darling Valley FMP is on public exhibition from Monday 31 October 2016 to Friday 9 December 2016. The objectives of this consultation will be to provide background to stakeholders on:

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

The draft Barwon-Darling Valley FMP is available on the DPIW website and is displayed at regional locations within the FMP area. Submissions are accepted in writing, submitted electronically or by post.

The feedback received during public exhibition will be considered by the IRP prior to finalising the FMP.

Aboriginal stakeholders

Aboriginal community members will be invited to public exhibition of the draft FMP. Aboriginal community members will be informed of how the information they provided about cultural assets has assisted the delineation of draft management zones and rules that aim to protect the passage of floodwater to these features, and thus maintain their cultural value. Community members are invited to provide feedback on the draft management zones and rules.

Consultation with Aboriginal community representatives will occur at locations within the FMP area as a part of public exhibition of the draft Barwon-Darling Valley FMP.

Review

Interagency Regional Panel

The Interagency Regional Panel (IRP) was established to review the boundary, management zones and rules contained in the draft Barwon-Darling Valley FMP. The IRP consists of one representative from OEHL to cover environmental interests and two representatives from the Department of Primary Industries: one from DPI Water and another DPI representative covering agricultural, fisheries and water management interests.

Representatives from Local Land Services, Water NSW and the Department of Trade and Investment (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 WMA 2000
- provide information and analysis
- bring a balanced approach to the development of the FMP: economic, social, environmental and cultural considerations.

The IRP provides whole-of-government oversight and review of the development of the draft Barwon-Darling Valley FMP and meets at key stages throughout the FMP development:

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

Prior to targeted consultation

The IRP reviewed the draft Barwon-Darling Valley FMP in September 2015 and supported its release for targeted consultation. proposed management construct and feedback from targeted consultation in September 2015.

Prior to public exhibition

The IRP reviewed the draft Barwon-Darling Valley FMP and feedback from targeted consultation in March 2016.

The IRP recommended that:

- rule specifications for access roads in MZ A be increased to ≤ 50 cm in height with associated causeway requirements and additional provisions be included for primary access roads to ≤ 100 cm in height with associated causeway requirements
- rule specifications for advertising height trigger thresholds in MZ B be increased to 80 cm in height.

The IRP also provided key considerations for the implementation of the draft Barwon-Darling Valley FMP. These considerations will be incorporated into assessment guidelines and used by licensing staff when assessing flood work applications.

Prior to finalisation and commencement

The IRP's involvement post public exhibition will include:

- consideration of stakeholder feedback
- recommendation of changes to the draft boundary, management zones and rules based on feedback from public exhibition
- review and endorsement of final boundary, management zones and rules prior to FMP commencement.

Plan finalisation and commencement

The IRP will be reconvened after public exhibition to review outcomes and to recommend changes to the boundary, management zones and rules based on community feedback.

The FMP will then be submitted for endorsement to the Minister for Natural Resources, Lands and Water who is required to seek concurrence with the Minister for the Environment prior to commencement of the FMP.

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Glossary

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

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 (AHIMS), Aboriginal Water Initiative System (AWIS), Murray Darling Basin Authority Aboriginal Submissions Database, NSW State Heritage Register or Commonwealth Heritage Register.

annual exceedance probability is the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 ML/d has an AEP of 5%, it means there is a 5% chance (that is a one-in-20 chance) of a 500 ML/d or larger events occurring in any one year.

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 instream 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.

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).

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 for the improvement, conservation and protection of ecological assets and is not for an agricultural purpose.

ecological values (aka ecological surrogates) are surrogates for biodiversity that are used to prioritise the ecological assets and included fauna and fauna habitat, vegetation communities and areas of conservation significance.

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

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

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 or cultural features which rely on inundation by floodwaters to sustain essential processes.

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

Flood Risk Management Study provides preferred options relating to flood risk and provides the information necessary for adequate forward planning of flood prone land.

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 Barwon-Darling Valley FMP.

flood study is a comprehensive technical investigation of flood behaviour and defines the nature of flood risk.

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

floodplain watercourses include:

- (a) permanent flowing rivers and creeks, including those where the flow is modified by upstream dam(s),
- (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 dam(s), to the top of the natural bank regardless of whether the channel has been physically modified, and
- (c) flood channels or flood runners that run across or along floodplains during high flow events.

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

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

heritage sites are cultural heritage objects and places as listed on Commonwealth, state and local government heritage registers.

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 (AWIS), Murray Darling Basin Authority Aboriginal Submissions Database, NSW State Heritage Register, NSW State Heritage Inventory, Historic Heritage Information Management Systems or Commonwealth Heritage Register.

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 surface level is the average undisturbed surface level in the immediate vicinity.

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.

windrow refers to a row or line of material.