RURAL FLOODPLAIN MANAGEMENT PLANS

# Background Document to the Floodplain Management Plan for the Border Rivers Valley Floodplain 2020—Appendices

*Water Management Act 2000*

August 2020

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# Contents

# Abbreviations

| Abbreviation | Description |
|---|---|
| ABS | Australian Bureau of Statistics |
| ABARES | Australian Bureau of Agricultural and Resource Economics and Sciences |
| AEP | annual exceedance probability |
| AHIMS | Aboriginal Heritage Information Management System |
| ARR | Australian Rainfall and Runoff |
| ASDST | Aboriginal Sites Decision Support Tool |
| Border Rivers Valley FMP 2020 | Floodplain Management Plan for the Border Rivers Valley Floodplain 2020 |
| BVT | BioMetric vegetation type |
| CMA | Catchment Management Authority |
| COAG | Council of Australian Governments |
| DEM | digital elevation model |
| DERM | Queensland Department of Environment and Resource Management |
| DNRM | Queensland Department of Natural Resources and Mines |
| DoI – Water | former NSW Department of Industry – Water |
| EPBC Act | *Environment Protection and Biodiversity Conservation Act 1999* |
| FMP | floodplain management plan |
| FPWEC | First Peoples' Water Engagement Council |
| GVAP | gross value of agricultural production |
| GRC | Goondiwindi Regional Council |
| IRP | Interagency Regional Panel |
| IRSAD | Index of Relative Socio-economic Advantage and Disadvantage |
| LiDAR | light detection and ranging |
| LGA | local government area |
| ML | megalitres |
| MODIS | Moderate Resolution Imaging Spectrometer |

| Abbreviation | Description |
|---|---|
| NDVI | Normalised Difference Vegetation Index |
| NSW | New South Wales |
| NSW DPI | NSW Department of Primary Industries |
| OEH | former NSW Office of Environment and Heritage |
| PCT | plant community type |
| QFCI | Queensland Floods Commission of Inquiry |
| Qld | Queensland |
| Qld WA 2000 | *Queensland Water Act 2000* |
| RAFTS | Runoff Analysis and Flow Training Simulator |
| ROC | receiver operator characteristic |
| SDM | species distribution model |
| SEIFA | Socio-economic Indexes for Areas |
| SRTM | Shuttle radar topography mission |
| TAG | Technical Advisory Group |
| TSC Act | *Threatened Species Act 1995* |
| URBS | Unified River Basin Simulator |
| WA 1912 | *Water Act 1912* |
| WM Act | *Water Management Act 2000* |
| WSP | water sharing plan |

# Appendix 1: Interim floodplain management policy for the Macintyre floodplain

Department of
**Infrastructure, Planning and Natural Resources**

**DIPNR -Floodplain Management – Macintyre Valley**

Draft- *Interim Policy 2004*

## Aim

The following outlines the Department's Interim Floodplain Management Policy for the area of the Macintyre Valley Floodplain as designated under Part 8 of the Water Act. The interim policy is to be consistent with the Governments Flood Prone Land Policy which is concerned with the impact of flooding and flood liability on individual owners and occupiers of flood prone land and the reduction of private and public losses resulting from floods.

The interim policy also aims to provide consistency between Part 8 approvals and provide technical and policy guidance to consultants. It is to be used to assist the department in assessing specific developments and is not intended to replace any existing Floodplain Management Plans.

## Legislative and Planning Controls – Part 8

The relevant section of the Water Act which relates to development on the floodplain is Part 8 [*Water Amendment (Flood Control Works) Act 1999*]. Part 8 applies to structural works within a Designated Floodplain or which can affect the flow of floodwaters to or from any river, lake, or defined watercourse. Structural works, referred to in Part 8 as 'controlled works', are those works which landholders propose to undertake including: any earthwork, embankment, levee, farm road, drain, waterway or dam. Existing controlled works are also covered by Part 8. All controlled works require approval from DIPNR.

Under the *Water Amendment (Flood Control Works) Act 1999*, Section 166C, the Ministerial Corporation, in exercising its functions under this Division with respect to approvals, must have regard to such matters as it considers relevant, including (but not limited to) the following:

(a) the contents of any floodplain management plan or any other relevant Government policy,

(b) the need to maintain the natural flood regimes in wetlands and related ecosystems and the preservation of any habitat, animals (including fish) or plants that benefit from periodic flooding,

(c) the effect or likely effect on the water flows in downstream river sections,

(d) any geographical features, or matters, of Aboriginal interest that may be affected by a controlled work,

(e) the effect, or likely effect of a controlled work on the passage, flow and distribution of any waters,

(f) the effect or likely effect of a controlled work on existing dominant flood ways or exits from flood ways, rates of flow, flood water levels and the duration of inundation,

(g) the protection of the environment,

(h) any other matter relating to the desirability or other wise of a controlled work.

It is to be noted that the Water Management Act (2000) is being phased in gradually and will eventually replace Part 8 of the Water Act (1912), including the Water Amendment Act (1999). The phasing in of the Water Management Act (2000) will need to be considered.

# Responsibilities of the Applicant

The applicant is responsible for the supply of all information to allow the Department to make an assessment of the proposal.

Supporting information will be required for all applications for Approval. This will need to address the matters listed in Section 166C as above, and any other matter that the Department considers relevant. The information must be sufficient to allow the Department to make a proper assessment of the merits of the proposal. Information considered to be necessary is outlined in the document "Flood Management Studies – Supporting Information", although further information may be required.

# Design Criteria

## Floods to be considered

Historically for the floodplain areas of the Macintyre Valley the design flood used has been the *February 1976* event. Variations to this design event may be considered in certain circumstances (for example limited height development) and in those cases the worst case scenario needs to be assessed. The design event and other events that also need to be considered are:

- **Design Event**: February 1976 (1:50-80 yr)
- **Large Events**: 1:100 yr (or in special circumstances the PMF)
- **Moderate Events**: 1:20-50 yr
- **Drainage**: < 2 yr

Points to be considered in any investigation also include:

1. In the first instance the "Guidelines for Macintyre River and Whalan Creek Floodplain Development Boggabilla to Mungindi" are to be adopted as the plan delineating floodways.
2. The flow distribution depicted by these guidelines can normally be used to determine the 'accepted flow distribution'. If challenged or questionable results are found from using the guidelines, the undeveloped scenario is to be used for comparison purposes.
3. The cumulative effects must also be considered which include loss of storage affecting the attenuation of flood peaks along the floodplain and any incremental changes to depth, velocity or flow distribution which may have previously occurred due to existing approved development. This will entail comparing the proposal against the undeveloped scenario or greenfields scenario (refer to assessment criteria below).
4. In analysing the effect of development on the flood wave, any proposed encroachment into delineated floodways cannot be assessed in isolation. The hydraulic effects of encroachment need to be compared against the "no-development" scenario ensuring that the cumulative impacts will be no greater than the 'guidelines' scenario.
5. To ensure equity occurs if development guidelines are not available or development is proposed outside the guidelines then the impact and analysis of the proposal shall be in a manner so that the neighbouring properties are not disadvantaged if they themselves wish to

either undertake similar development or not develop. That is the impact on flooding shall not be spread across neighbouring properties.

6. Works within agreed floodway areas. No above ground works will be allowed within floodway areas. If velocities and other considerations allow irrigation to be undertaken within the floodway areas, then any works are to be along the edges of, and not intrude into, the floodway.

# Assessment Criteria

## Allowable Afflux

Effect on water levels: Alignments are to be consistent with the current guidelines. Where the guidelines are not applicable, the allowable afflux or peak water level increase will be assessed as part of a merit based approach. Factors considered in assessing the acceptable increase will include the location of public and private infrastructure such as dwellings, roads etc.

- A water level increase of less than 100mm off the property, compared with the undeveloped case, would normally be acceptable except in cases where other adverse effects were likely (such as houses affected, redistribution of flows).
- The Department would normally consider an increase in water level of more than 200 mm off the property compared to the undeveloped case not to be an acceptable impact (this is consistent with the Border Rivers Floodplain Hydraulic Analysis undertaken for the Queensland side).
- between these two levels, the proposal would be assessed on its merits, considering all aspects.

## Allowable Velocity

Flood control works should not significantly increase velocities of flood flow in defined floodways (a significant increase can be considered as 50% increase over natural conditions). Velocities should be of an order that does not cause erosion and siltation under various land uses (Table A1.1).

**Table A1.1: Maximum Permissible Velocities**

| Ground Condition | Maximum Permissible Velocity (m/s)* |
|---|---|
| Bare soil | 0.4 |
| Crop | 0.6 |
| Native tussocky grass | 0.8 |

* Values based on soil classification – medium to heavy clay, highly pedal with moderate dispersibility (Soil Conservation Service of NSW).

## Allowable Flow Distribution

No overall flow redistribution is to occur in the area of the development. For the purpose of this policy the “area of the development” is to finish at the downstream boundary of the neighbouring property. No overall flow redistribution is considered as +/- 2% as determined against the “acceptable distribution” (the Guidelines). However, where hydraulic modelling shows that the guidelines have already caused a redistribution of 5% or more compared with the undeveloped or greenfields scenario, no further redistribution (0%) will be allowed.

## Environmental Considerations

The department must consider the likely environmental impacts under Part 5 of the Environmental Planning and Assessment Act when assessing applications for Approval of controlled works. The applicant is required to provide an assessment of the likely environmental impacts. The applicant may be required to prepare an Environmental Impact Statement (EIS) if the environmental impact is likely to be significant.

If an application is consistent with the guidelines (as outlined previously) environmental assessment is still required. Key factors and considerations in the assessment include:

### Wetlands

Wetlands are biodiverse and productive ecosystems that are adapted to periodic wetting and drying. The functioning of wetlands must be ensured when assessing any development. Flow distribution to wetlands is not to be affected and wetland functions are not to be degraded.

### Geomorphology

Development works must be located to ensure that:

- There are non-scouring velocities.
- there is no potential concentration of flows in rivers and streams which may affect river stability.

### Floodplain Vegetation

The main species of floodplain vegetation rely on flooding for their long - term maintenance. Controlled works can affect species populations (of plants and associated fauna) by restricting floodwater access. The significance of potential impacts should be checked against outcomes in the Regional Vegetation Management Plan.

### Fish habitat

The newly inundated floodplain provides an abundant and varied array of habitat types for both adult and larval fish. Controlled works should not block fish passage, cause fish to be stranded or cause immature fish to be destroyed.

### Threatened species

Potential impacts on threatened plant and animal species (including fish) and communities need to be considered when assessing applications. If a controlled work is likely to have a significant impact on a threatened species, the applicant must prepare a Species Impact Statement (SIS)

### Matters of Aboriginal interest

Aboriginal sites such as scarred or carved trees may rely on flooding for long-term sustenance. Aboriginal site assessment would be required as part of an application for a controlled work in some cases (for example, where a work is proposed in an area of known sensitivity). Barwon Aboriginal representatives must be consulted on this.

### Groundwater

Major recharge of groundwater occurs during floods. Recharge is dependent on soil permeability and hydraulic head. The potential impact that a controlled work would have on recharge by restricting flood inundation needs to be considered.

### Buffer Zones:

Vegetated buffer zones protect water quality by trapping sediment and nutrients. Suitable buffer zones are required between any development and watercourses. As a guide the following width should be considered which is consistent with the RVMP

- 250 metres: Macintyre River (B1 Schedule)
- 100 metres: All other streams and creek. (B2 Schedule)
- 50 metres: For all water courses not listed in the schedules.

### Tailwater Management and Storm Runoff

In all cases the proposal should comply with EPA Guidelines and meet the following:

- No tailwater is to be discharged to watercourses or to leave the farm.
- Natural watercourses may not be used for tailwater collection or recirculation.
- There should be a minimum storage/surge capacity of 0.1 megalitres per hectare of irrigable area to catch first flush runoff.
- discharge of stormwater onto a neighbour's land is to be according to conditions prevailing pre-development.

## Related Legislation, Policies and Plans

All applications must comply with existing policies and legislation including but not limited to the following:

- Environmental Planning and Assessment Act
- Regional Environmental Plans
- Local Environmental Plans
- Regional Vegetation Management Plans and Native Vegetation Conservation Act (1997)
- Riparian Zone Policy
- Management Plans Developed by the Catchment and River Management Committees.
- NSW State Wetland Policy.
- Threatened Species Conservation Act (1995)
- Fisheries Management Act (1994) and Fisheries Management Amendment Act (1997)
- National Parks and Wildlife Act (1979)
- NSW State River and Estuaries Policy.
- Any other local government plan and policies.

# Appendix 2: Rural floodplain management planning approach under the *Water Management Act 2000*

**Table A2.1. Approach to rural floodplain management planning under the WM Act**

| Step | Key Inputs/Process | Key Outputs/Outcomes |
|---|---|---|
| 1 – define the floodplain boundary | • Information on the nature and extent of flooding over time<br>• Floodplains designated under Part 8 of the *Water Act 1912*<br>• Other statutory boundaries and infrastructure features (for example Water Sharing Plans, roads, floodplain harvesting registrations of Interest) | Map of floodplain boundary to be designated under the *Water Management Act 2000* (WM Act) |
| 2- identify existing flood works | • Flood work licences<br>• Area of land protected by flood works identified from spatial data such as flood imagery, LiDAR and aerial photography<br>• Local knowledge of licensing staff | • Map of area of land protected by flood works<br>• Number of existing approved flood work licences |
| 3 – review existing rural floodplain management arrangements | • First generation floodplain development guidelines and studies (non-statutory)<br>• Second generation rural floodplain management plans (*Water Act 1912*) | Information on and analysis of key aspects of existing rural floodplain management arrangements |
| 4 – determine the floodway network | • Design floods<br>• Flood frequency analysis<br>• Hydrological/Hydraulic model input<br>• Flood imagery<br>• Existing floodway networks (Step 3)<br>• Local knowledge | • Map of floodway network, including floodways, inundation extent and areas outside the floodway network<br>• Better understanding of existing flooding regime |
| 5 – identify and prioritise floodplain assets | • Identified from peer-reviewed literature, relevant legislation, policies, databases and registers<br>• Various spatial data (for example PCT mapping)<br>• Optimum watering requirements<br>• Conservation significance of assets determined from Technical Advisory Group and Marxan<br>• Cultural assets also identified from Aboriginal Technical Working Group and community consultation | • Definition and maps of ecological and cultural assets<br>• Grouping of ecological assets based on optimum watering requirements<br>• Understanding of flood-dependency of cultural assets<br>• Map of high-priority floodplain assets |

| Step | Key Inputs/Process | Key Outputs/Outcomes |
|---|---|---|
| 6 – prepare a socio-economic profile | • Secondary data sources (ABS, ABARES, State departments)<br>• Local knowledge | Understanding of the baseline profile of the floodplain, including stakeholder identification |
| 7 – delineate management zones | • Hydraulic criteria based on information from Steps 1, 2 & 4<br>• Criteria to ensure appropriate consistency between current and management options based on information from Step 3<br>• Ecological and cultural criteria based on information from Step 5<br>• Analysis to ensure equity based on information from Step 6<br>• Feedback from consultation | Definition and map of management zones, which will generally result in four zones:<br>• Major flood discharge<br>• Flood storage and secondary flood discharge<br>• Flood fringe and existing development<br>• Special ecological and cultural protection |
| 8 – determine rules | • Understanding of management zones<br>• Existing types of flood works<br>• Existing and potential flooding problems<br>• Rules from existing rural FMPs<br>• Feedback from consultation | Rules and assessment criteria covering:<br>• Authorised flood works<br>• Acceptable impacts<br>• Advertising requirements<br>• Existing flood works and structures |
| 9 – consider existing floodplain management arrangements | Information on existing floodplain management arrangements gathered in Step 3 is compared against the FMP to determine the extent of change. | Extent of change between existing rural floodplain management arrangements and the FMP is determined |
| 10 – assess socio-economic impacts | • Economic data<br>• Area under irrigated crop<br>• Gross margins<br>• Prices<br>• Hydrology data | Social and economic impacts assessed against the base case |

# Appendix 3: History of floodplain management in the Border Rivers Valley Floodplain

Floodplain management planning in the Border Rivers Valley Floodplain, and indeed the whole of New South Wales (NSW), has evolved in response to changing community needs; changes to land and water use; an increased awareness of the importance of floodplain ecology and changes to the legislative and policy framework which govern water management.

A detailed history of floodplain management in the Border Rivers Valley Floodplain is outlined below.

## Pre-1970s

Before the 1970s, the NSW Government was not actively involved in managing flood work developments because agriculture was dominated by low-intensity grazing and there was an absence of earthworks that would affect flooding in the landscape.

In 1912, the NSW Government began to take on a legal responsibility for water management by enacting the *Water Act 1912* (WA). At this time, the legislation did not relate to works on flood-prone land remote from a river or lake. However, Part 2 of this Act did provide for the licensing of works which could affect the distribution of floodwaters flowing in, to or from, or contained in, a river or lake. The enactment of the WA 1912 did not initially change floodplain management in the Border Rivers. However, this Act would become the principal driver of floodplain management after amendments were made in subsequent decades in response to changes in flood patterns caused by flood works.

From 1960 to 1970, there was a proliferation of uncoordinated channels and levees over large tracts of natural floodplain due to:

- a major program of large dam construction, which led to expectations of an assured water supply,
- the consequential replacement of low intensity grazing by intensive irrigation,
- a change in Government policy, which encouraged private irrigation development.

## 1970 to early 1980s

During the early to mid-1970s, major flood events revealed that uncoordinated flood works were causing major changes in traditional flood patterns in many locations. These changes resulted in heavy crop losses and flood damage was experienced in areas that had previously been relatively flood free.

Primarily in response to the major flood events of the early 1970s, the *Water Resources Commission Act* was enacted in 1976 to investigate, formulate and implement flood mitigation strategies on a whole-of-valley basis. Under the provisions of this legislation, Guidelines, which were levee/floodway schemes, were prepared for the worst-affected areas. The approach aimed to provide floodways of adequate hydraulic capacity and continuity by restoring or maintaining as far as practical, the natural patterns of flood channels for the effective conveyance of flood flows. Flood protection of developed land was accomplished with the construction of levees bordering the floodways and was funded and implemented by the benefiting landholders. In the Border Rivers Valley Floodplain, the following set of Guidelines was developed under this Act:

- Guidelines for Macintyre River and Whalan Creek flood plain development Boggabilla to Mungindi (Water Resources Commission New South Wales 1981).

While the Guidelines were developed under this Act, they are non-statutory. The generalised network of floodways for the Border Rivers Valley Floodplain region were delineated on plans that also identified property boundaries and named the respective landholders. Opportunity was provided for the community to comment on the Guidelines.

The general principles that applied in the development of the Guidelines, and generally in the development of leveeing a floodway scheme, are as follows:

- any system of floodways should conform as closely as is reasonably possible to the natural drainage pattern;
- land could be protected only if impacts to other properties could be mitigated;
- floodways should discharge from a holding as closely as practicable to the location of natural floodways;
- the exit of floodwater from floodways should be at rates and depths similar to those which would have been experienced under natural conditions;
- care must be taken to ensure that sufficient pondage is retained on the floodplain so that the flood wave is not unduly accelerated to downstream areas and its height increased;
- provision should be made for local drainage from protected areas, but the design of such drainage is the responsibility of individual landholders.

Other issues to consider included:

- the possibility of scour within floodways. Where land is cleared and ploughed for cultivation its susceptibility to scour and erosion is increased. Broad floodways were recommended in these areas to prevent flow concentration and subsequent scour. Safeguards against scour were a consideration.
- land use type. Certain land use types may impede flows. For example, dense tall crops such as sorghum may impede flood flows leading to increased flood levels. A more desirable crop for a floodway may be a lower crop such as wheat, or a grazing land use.
- potential adverse impacts of flood works on neighbouring properties.

# 1984 – 1985

In 1984, the *Flood Prone Land Policy* was introduced to overcome the potential sterilisation of floodplains resulting from rigorous planning controls introduced in the 1977 Environment and Planning Circular No 15. The policy aims to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible. The policy requires a merit approach to be adopted for all development decisions; for both mainstream and overland flooding to be addressed using strategically generated floodplain risk management plans; flood mitigation works and measures to reduce the impact of flooding; and for action to minimise the potential for flood losses to be balanced by the application of ecologically sensitive planning and development controls.

The WA 1912 was also amended in 1984 to include Part 8, which allowed the Ministerial Corporation to control all private works, on the banks of rivers and lakes and on proclaimed floodplains, which could affect the distribution of floodwaters (referred to as controlled works). Controlled works include earthworks, embankments and levees, as well as access roads, irrigation channels and dams. This provision in the legislation allowed for the designation of floodplains, which are areas where controlled-work approvals must be obtained. This provision in the legislation also allowed for the preparation of coordinated floodplain management guidelines for the designated flood affected areas that identify floodways and the suitable location of levees in consultation with landholders and local government. The introduction of Part 8 of the WA 1912

heralded the beginning of the NSW Government's involvement in legally controlling flood-work development and planning to prevent future flood works from causing or exacerbating flooding problems.

The *Lower Macintyre (Yelarbon Crossing to Mungindi)* floodplain was designated under Section 166 Part 8 of the WA 1912 on 31 July 1985 to capture existing and potential floodplain developments within the floodplain.

# 1986

## New South Wales

In 1986, the *Floodplain Development Manual* was published to support the NSW Government's *Flood Prone Land Policy*. The manual related to the management of flood liable land in accordance with section 733 of the *Local Government Act 1993* which exempted Councils from liability. The manual applies to urban and rural floodplains across NSW.

## Queensland

Sinclair Knight and Partners Pty Ltd prepared *Guidelines for development of the Queensland Border Rivers floodplain from Yelarbon to Mungindi* on behalf of the Queensland Water Resources Commission, Waggamba Shire Council and Goondiwindi Town Council to complement those prepared for the Macintyre (NSW Border Rivers) floodplain by the NSW Water Resources Commission. Guidelines were identified for subregions of the study area, the objectives of which were similar to those of the NSW guidelines:

- Define a network of floodways within the study area
- Define the type and extent of development which could be permitted in the defined floodways
- Define a network of flood protection works (in the form of levee banks) and other works which could be constructed by landholders
- Achieve the above without detriment to any individual landholder or community, and whilst minimising interference of flood protection works on the natural flooding pattern and study area characteristics.

# 1980s – 1990s

The Interstate Levee Committee was established in the 1980s to coordinate the approach to levee construction in the Border Rivers region. It was comprised of representatives from relevant NSW and Qld State agencies and Qld local councils. Due to the lack of recently constructed levees, this committee has not met since the late 1990s. Nevertheless, there is a history of cross-border cooperation and information exchange regarding floodplain management.

# 1990 – 1999

In 1995, a general regulation to Part 8 of the WA 1912 was gazetted that prescribed railways (together with associated bridges and railway works) that are vested in Rail Access Corporation, and roads (together with associated bridges and road works) that are vested in a council or in the Roads and Traffic Authority as exempt from needing a controlled-work (flood work) approval.

In 1999, Part 8 of the WA 1912 was amended to allow for more strategic coordination of controlled works through the preparation of statutory rural floodplain management plans for valleys faced with pressure from development, such as the Gwydir, Namoi and Macquarie (s.166a). The amendments made rural floodplain management plans the statutory basis for determining flood control works in order to overcome difficulties with assessment of works on an ad-hoc basis. The

amendments also allowed for areas not designated as part of a floodplain to be covered by Part 8 of the WA 1912. This meant that works in these areas were now required to be assessed if they could potentially affect flood flow into and out of a stream and affect flooding. Section 166C of the WA 1912 provides guidelines for the assessment of such works. It was also required that rural plans be developed in accordance with the provisions and policies of the *NSW Floodplain Development Manual* and *NSW Flood Prone Land Policy*. Up until this point, the floodplain development guidelines produced were non-statutory. The new strategy was developed in response to strong community support for a change in the then current practice. A key objective was to develop the floodplain management plans using community-based floodplain management committees. The process for developing the plans included undertaking:

- flood studies to define the nature and extent of flooding and flood-related issues in technical terms
- floodplain risk management studies to evaluate options in consideration of social, environmental and economic factors to address existing and future flood risk and flood management issues
- rural floodplain management plans to outline strategies to manage flood risk and flood management issues and support the natural functions of the floodplain environment.

To facilitate the revised strategy, a $5 million program was jointly funded by the Natural Heritage Trust and State funding to develop plans in 18 inland rural areas across 30,000 square kilometres. The amendment was to outline a new process to deliver strategic outcomes to manage flood control works on inland floodplains where these works did not require Council consent under rural zonings. Where rural floodplain management plans and development guidelines exist, rural plans replaced the out-dated development guidelines. This is did not however occur in the Border Rivers valley, as no rural floodplain management plans were made at this time due to the comparative lack of development pressure in the valley at this time.

The approval of controlled works (referred to as flood works for the purpose of the Border Rivers Valley FMP 2020 and including earthworks, embankments or levees) that were likely to affect the flow of water to or from a lake or river, or prevent land from being flooded, or on a designated floodplain (under Part 8 of the WA 1912) were governed by the predecessors to NSW Department of Industry – Water (DoI – Water) (formerly NSW Department of Primary Industries, Water). The approval of controlled works in the Lower Macintyre designated floodplain is subject to the Part 8 conditions.

# 2000

## NSW *Water Management Act 2000*

In 2000, the *Water Management Act 2000* (WM ACT) was enacted to replace the WA 1912 and a range of other Acts dealing with water management to achieve sustainable and integrated management for all water-based activities, including water use, drainage, floodplains and groundwater. The WM ACT is the culmination of the NSW water reform process driven by the Council of Australian Governments (COAG). The WM ACT contains floodplain management provisions that relate closely to existing provisions under the amended Part 8. Section 29 and 30 detail the core and additional provisions to be considered when developing floodplain management plans. The core provisions require plans to deal with:

- identification of the existing and natural flooding regimes in the area, in terms of the frequency, duration, nature and extent of flooding
- the identification of the ecological benefits of flooding in the area, with particular regard to wetlands and other floodplain ecosystems and groundwater recharge

- the identification of existing flood works in the area and the way they are managed, their benefits in terms of the protection they give to life and property, and their ecological impacts, including cumulative impacts
- the risk to life and property from the effects of flooding.

The general water management principles of the WM ACT also require that the cumulative impacts of water management licenses and approvals, and other activities on water sources and their dependent ecosystems, be considered and minimised.

### Queensland *Water Act 2000*

The Queensland *Water Act 2000* (Qld WA 2000) is the legal instrument which governs the means of water allocation and management in Queensland (Queensland Government 2017). The Qld WA 2000 was amended to ensure consistency with National Water Reform commitments and to improve efficiency and response to water resource services (Queensland Government 2017). The Qld WA 2000 has links to floodplain management in the following ways (see section '2011-2014'):

- The Act provides a definition of "levee"
- 2016 Qld State-wide levee framework sits under the Act.

## 2001

In 2001, the *Floodplain Development Manual* was revised to make it consistent with a series of improvements to both policy and practice, including the need to:

- consider the full range of flood sizes up to and including the probable maximum flood when developing a floodplain risk management plan
- recognise existing, future and continuing flood risk on a strategic rather than ad-hoc individual proposal basis
- support local councils to manage local overland flooding in a similar manner to riverine flooding
- promote the preparation and adoption of local flood plans (prepared under the guidance of the State Emergency Service) that address flood readiness, response and recovery.

## 2004

### NSW *Macintyre Valley Draft Interim Policy 2004* (NSW Department of Infrastructure, Planning and Natural Resources)

The draft policy stipulates the following criteria and considerations for studies that support an application for new flood works under Part 8 of the WA 1912 for the Lower Macintyre designated floodplain:

- design criteria (for example design floods)
- assessment criteria (for example allowable afflux, velocity and flow distribution)
- environmental considerations (for example ecological and cultural assets for protection)
- relevant legislation, policies and plans.

The criteria and considerations outlined in the policy have been informed by an understanding of the management of the Border Rivers floodplain by both Queensland State and local and NSW State government agencies. See Appendix 1 for the Policy in full.

### *Waggamba Shire Council Local Law No. 26 (Levee Banks) 2004*

The Queensland local government area of Goondiwindi Regional Council (GRC) is the LGA adjacent to the Border Rivers Valley Floodplain. For most of the length of the Macintyre River, just upstream of Mungindi, where Balonne Shire Council local government area (LGA) borders the Border Rivers Valley Floodplain for the remainder of its length.

The local government area of GRC was previously governed by three different local government bodies: Goondiwindi Town, Waggamba Shire, and Inglewood Shire Councils. GRC is classed as a regional local government and was formed in 2008 based on the recommendation of the Local Government Reform Commission (see Local Government Reform Commission 2007). The western two-thirds of the LGA was the former Waggamba Shire, which surrounded Goondiwindi township.

Waggamba Shire Council inscribed a Local Law in 2004 which places legal conditions on the construction and maintenance of levee banks. Applications for the construction of levee banks in the GRC area are assessed against the criteria stipulated in the *Waggamba Shire Council Local Law No. 26 (Levee Banks) 2004*, and this will still be the case under the new Qld state-wide levee framework. In the GRC area under this law:

- Construction of levee banks without the permission of Council is prohibited,
- Construction and maintenance of levee banks is regulated by Council – performance criteria of a permitted levee bank is specified, together with recommended measures to achieve compliance with these criteria[1].
- Changes may be made to levee banks where in Council's opinion the levee bank or part thereof is likely to alter or does alter the natural drainage pattern to the extent that land, public works and services are impacted, and
    - the levee bank or part thereof is not the subject of a current permit, and
    - the levee bank or part thereof as it is constructed, is not consistent with the works authorized by the current permit
- Levee banks will not alter the overland flow of water in a way which injuriously affects land.

Goondiwindi Regional Council uses the local law to assess levee applications, considering the performance criteria with which a levee bank constructed or to be constructed must comply, and the measures recommended to achieve compliance with the performance criteria. The performance criteria and measures to achieve compliance were considered in drafting the rules and assessment criteria for flood works in the various management zones of the Border Rivers Valley FMP 2020.

## 2005 – 2009

In 2005, the *Floodplain Development Manual* was again updated and gazetted, as the manual relating to the development of flood liable land for the purposes of section 733 of the *Local Government Act 1993*. The updates reflect the significant change in the roles of State agencies and clarified some planning issues which had led to inconsistent interpretations. The manual supports the NSW Government's *Flood Prone Land Policy* in providing for managing human occupation and use of the floodplain considering risk management principles.

On 1 July 2009, following a reorganisation of Government Agencies, the licensing and compliance functions regarding Part 8 were transferred to the newly established Office of Water within the renamed Department of Environment, Climate Change and Water (DECCW).

[1] See Section 7 of the Local Law. The performance criteria and measures to achieve compliance with the criteria specified in the Law will be considered in the drafting of rules and assessment criteria for flood works in the Macintyre floodplain.

# 2010

In 2010, work commenced on the *NSW Healthy Floodplains Project*, a NSW government initiative, to reform the management of water on floodplains through the development of floodplain management plans as well as licensing of floodplain harvesting water extractions. In June 2012, Stage 1 of the Healthy Floodplains Project was awarded $36 million by the Commonwealth Government, with additional contributions by the NSW State Government.

# 2011 – 2014

## Qld WA 2000 and state levee framework

The Queensland Floods Commission of Inquiry (QFCI) was established on January 17 2011 following the large floods of December 2010 and January 2011 across the State of Queensland. More than 78% of Queensland was declared a disaster zone and more than 2.5 million people were affected by these floods (Queensland Floods Commission of Inquiry 2012).

The QFCI was asked to investigate and report on a number of issues[2] set out in in the terms of reference, including the:

- preparation and planning for the floods by governments, agencies and the community, and
- land use planning to minimise flood impacts.

The QFCI made 177 recommendations in total on these issues, published in the *Queensland Floods Commission of Inquiry Final Report* (2012), of which 123 related directly to the Queensland Government.

With regard to floodplain development and flood considerations (Chapter 7), the QFCI reviewed the legislative and policy controls in place during the 2010-2011 floods by the Queensland State and local government authorities for the construction of levees[3] .

The main findings of the review are as follows:

- there is no consistent, state-wide approach to the construction and regulation of levees
- there is little/no control on the construction of levees – landholders may construct levees at their own discretion in some areas
- Role of local government:
    - Local government has the option of controlling the conditions of levee construction through:
        - Planning schemes
        - Local laws
- Role of Qld State Government
    - State Government (specifically the Department of Environment and Resource Management (DERM), now the Department of Natural Resources and Mines (DNRM)) has no overarching role or responsibility regarding flood mitigation levees (with some exceptions)[4]

[2] Other issues set out in the terms of reference included the adequacy of the response to the floods, management of essential services, the adequacy of forecasts and early warning systems, insurers' performance of their responsibilities, and the operation of dams.

[3] Both Goondiwindi and Mungindi town levees were not overtopped during the 2010/2011 floods.

[4] The authority of DERM/DNRM as an assessment manager may be exercised in the event of 'taking or interfering with water' (which is likely to capture most, if not all, levees). In this instance these levees would require a development permit under the Sustainable Planning Regulation.

- State Government does provide information on request to councils to assist them to assess flood mitigation levees.
- State Government does not collate or hold comprehensive information on all levees in Queensland, as it does not consider itself responsible for them.

The QFCI made five recommendations that specifically relate to the regulation of levees (Table A3.1), which the Queensland Government implemented through the legislative framework of the state-wide regulation of levees.

The QFCI on finding that there is no consistent local and State government agency approach to the regulation of levee construction (Table A3.1), made recommendations in favour of consistent and state-wide levee regulation.

**Table A3.1: Recommendations relating directly to the regulation of levees by the Queensland Floods Commission of Inquiry**

| No. | Recommendation |
|---|---|
| 1 | Levees should be regulated. |
| 2 | The Queensland Government should consult with councils to determine an effective method for the regulation of the construction of levees in Queensland. In particular, the Queensland Government should consider:<br>• requiring a development permit for the construction of a levee by designating levees as assessable development in the Sustainable Planning Regulation 2009, or<br>• requiring, by way of a state planning policy or mandatory provision in the Queensland Planning Provisions, that councils nominate the construction of a levee as assessable development in their planning schemes. |
| 3 | The Queensland Government should consult with councils to formulate a definition of 'levee' to identify what should be regulated. |
| 4 | There should be a consistent process for the determination of applications to build levees. That process should include:<br>• consulting landholders who may be affected by the proposed levee<br>• obtaining or commissioning appropriate hydrological and hydraulic studies to assess the impacts of the proposed levee. |
| 5 | There should be a common set of considerations in the decision whether to approve an application to build a levee, including:<br>• the impacts of the proposed levee on the catchment as a whole<br>• the benefits of the proposed levee to the individual or entity applying to build the levee and to any nearby community as a whole<br>• any adverse impacts on other landholders, including the risk of levee failure<br>• the implications of the proposed levee for land planning and emergency management procedures<br>• whether any structural, land planning or emergency management measures can be taken to mitigate the adverse impacts of the proposed levee. |

Based on these recommendations (Table A3.1), the Queensland Government under the Qld WA 2000 has introduced laws to regulate the construction and/or modification of levee banks as they recognised the need to provide a consistent and effective method for levee regulation across the state[5]. Prior to the effect of this regulation on 16 May 2014, the construction and/or modification of levees was regulated by Qld local government councils. Only some Qld councils had regulations in

[5]. See http://www.dnrm.qld.gov.au/water/catchments-planning/levees for more information on the Qld State-wide framework for levee regulation.

place as there was no legal requirement for local government to regulate levees, and thus the approach to levee regulation was inconsistent across the state.

Compliance with this new state-wide regulation is a legal requirement for the construction of new levees or modification of existing levees across the state. A new definition of levees is contained in the amendments to the Qld WA 2000.

> A levee is an artificial embankment or structure which prevents or reduces the flow of water onto or from land.

The definition includes infrastructure that is connected with levee construction or modification, or that which is used in levee operations. Exclusions to the Qld definition of levees are similar to those excluded from the definition of flood works given by the NSW WM ACT. Below ground supply works, a type of water supply work or irrigation infrastructure, were identified as an exception to the levee definition under the Qld WA 2000. However, supply works, are considered as flood works under the Border Rivers Valley FMP 2020.

Amendments to the Qld WA 2000 provide that the construction of a new levee or the modification of an existing levee is now an 'assessable development' under the Qld *Planning Act 2016*. Any person planning to construct or modify a levee must now give consideration to the potential effects of their levee on flood behaviour, and its impact on other landholders and properties.

Three levee categories are defined by the state-wide framework (Table A3.2). All applications to build or modify Category 2 and 3 levees will be assessed by local council. The Qld Government has devised guidelines to assist landholders with their levee applications. The state-wide framework is still under review.

**Table A3.2: Levee categories and assessment managers under the Qld state-wide levee regulation framework.**

| Assessment Manager | Category 1 | Category 2 | Category 3 |
|---|---|---|---|
| Assessment level | Self-assessable | Code assessable | Impact assessable |
| Risk level/affected population | Low | Moderate/less than 3 people | High |
| Risk type | No off-property impacts | Impacts on property | Significant threat to life |
| Affected population | N/A | Less than 3 people | At least 3 people |
| Assessment manager | N/A | Local government | Local government. Qld State government as referral agency. |

# 2016

Part 8 of the WA 1912 was repealed in 2016 and replaced by the floodplain management provisions of the WM ACT. The floodplain management provisions under the WM ACT enabled the development of the *Floodplain Management Plan for the Border Rivers Valley Floodplain* (Border Rivers Valley FMP 2020). The Border Rivers Valley FMP 2020 will supersede all existing floodplain management arrangements in the Border Rivers Valley Floodplain. The designation of the Border Rivers Valley Floodplain will enable the administration and coordination of flood works in the floodplain.

# Appendix 4: Quadrants of floodway network

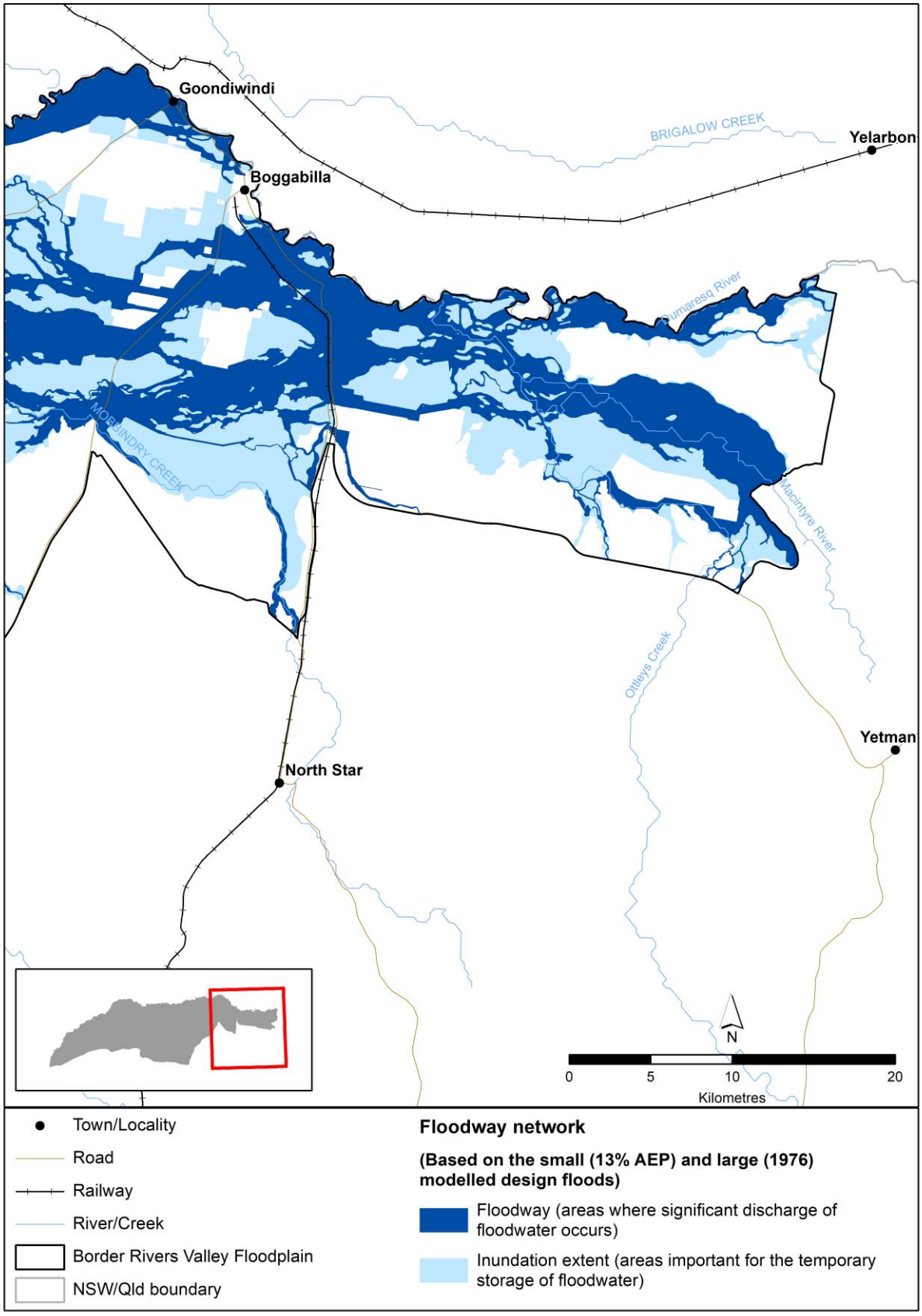


**Figure A4.1: Floodway network in the Border Rivers Valley Floodplain – quadrant one of four**

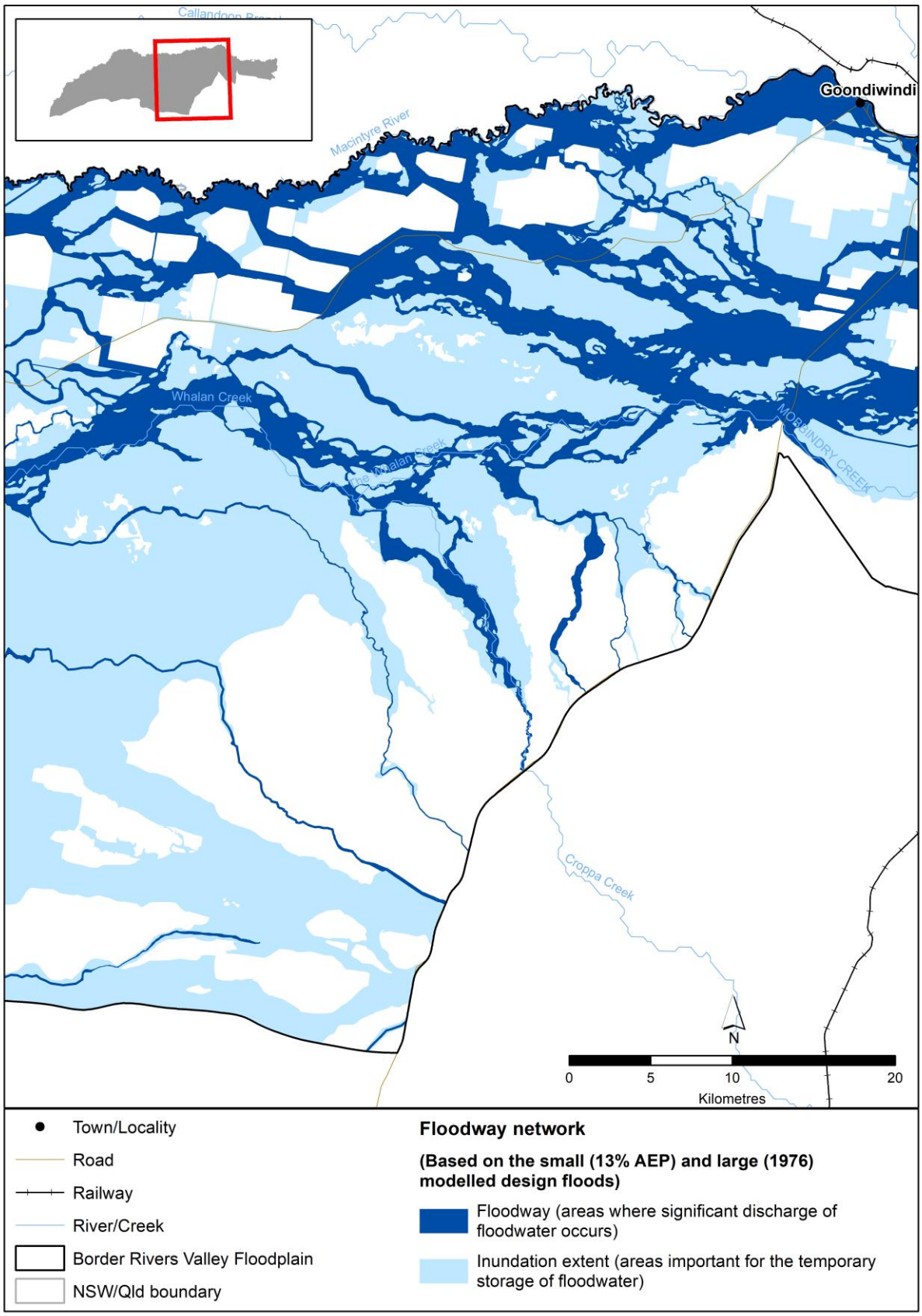


**Figure A4.2: Floodway network in the Border Rivers Valley Floodplain – quadrant two of four**

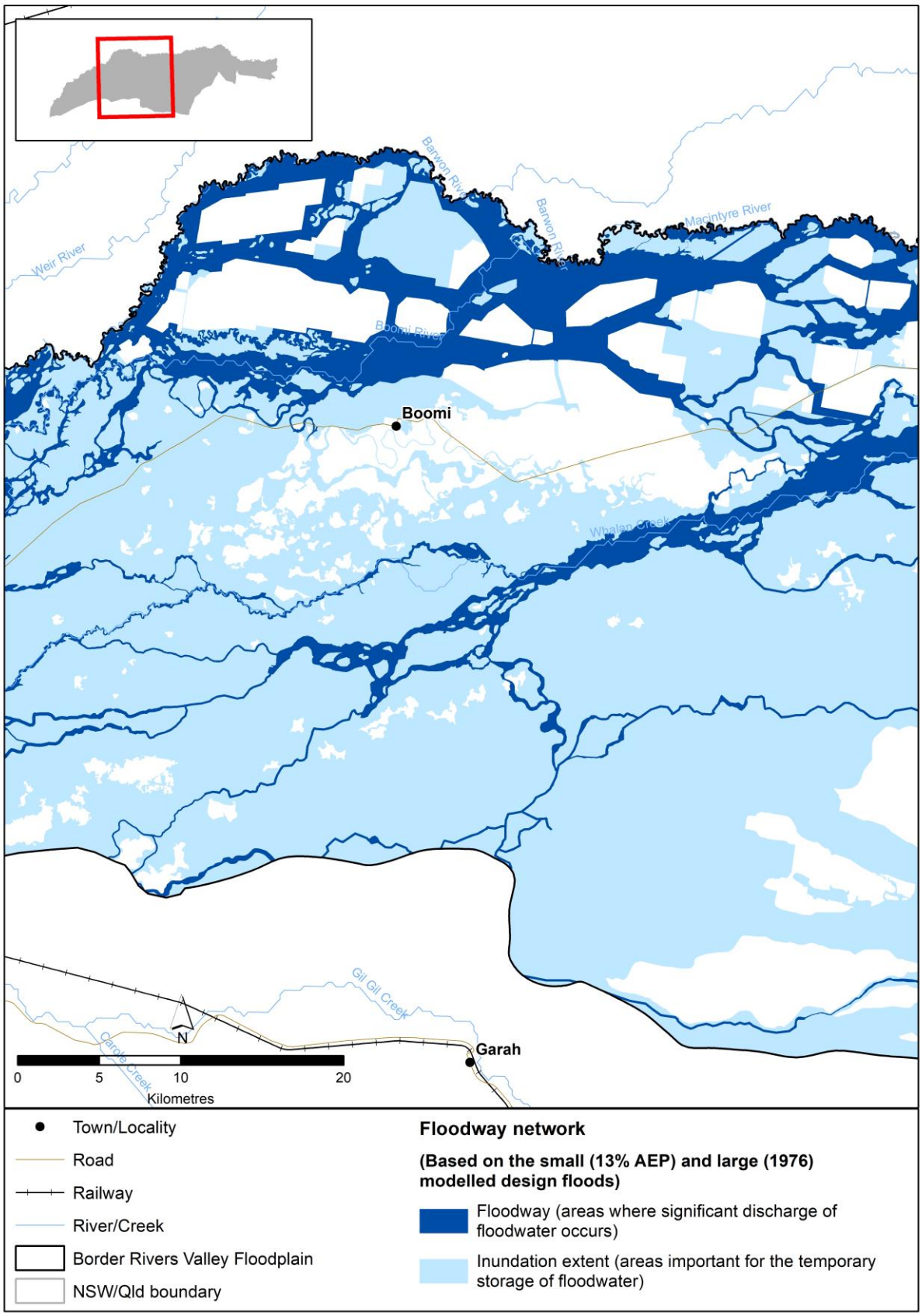


**Figure A4.3: Floodway network in the Border Rivers Valley Floodplain – quadrant three of four**

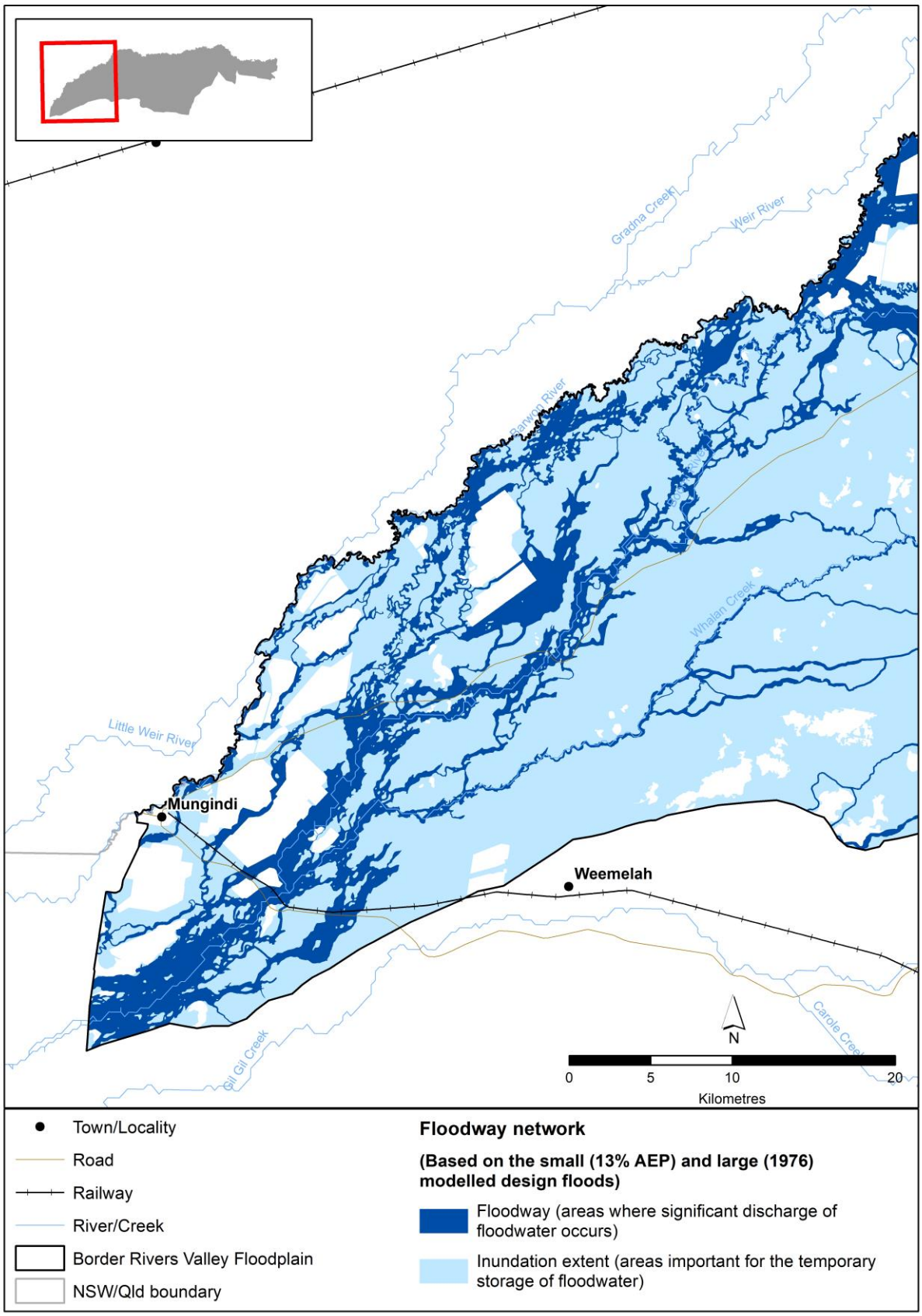


**Figure A4.4: Floodway network in the Border Rivers Valley Floodplain – quadrant four of four**

# Appendix 5: Design floods

As outlined in Step 4 of the main document, two design floods were selected for the Border Rivers Valley FMP 2020:

- large design flood – February 1976 (approximately 1% AEP @ Mungindi and 1.3% AEP @ Boggabilla), and
- small design flood – 13% AEP flood (equivalent to the January/February 2013 flood at Mungindi).

## Flood frequency analysis

A flood frequency analysis for gauging stations throughout the Border Rivers Valley Floodplain was undertaken to assist with the selection of the design floods for the Border Rivers Valley FMP 2020. The technique involved using observed peak flow (flood volume) data to calculate statistical information such as mean values, standard deviations, skewness, and recurrence intervals. These statistical data were then used to construct frequency distributions, which are graphs and tables that tell the likelihood of various flows as a function of recurrence interval or exceedance probability.

Annual flood series were used as data inputs because the values will likely be independent and the series can be easily extracted (Institution of Australian Engineers 1987). The annual flood series comprises the highest instantaneous rate of discharge in each year of record.

Annual flood series were obtained from six gauging stations throughout the Border Rivers Valley Floodplain (Figure A5.1). These stations were chosen based on their location, length of observed record, and the measure of reliability (Table A5.1). The annual flow series for each calendar year was extracted from Hydstra, a hydrological database administered by the department's Water Group. Gaps within the annual series were filled by first checking the daily flow record of a nearby gauge for a major flow event over the gap period. If no flow event occurred, it was assumed that the highest recorded peak was the highest peak for that year.

Flood flows experienced around Boggabilla may originate from the Whalan/Croppa Creek system as well as from the Macintyre River. Whalan Creek, in addition to carrying a large volume of overbank flow from the Macintyre, off-taking from the Macintyre approximately 15 kilometres upstream of Boggabilla, also drains the catchment of Croppa, Tackinbri and Mobbindry Creeks. To eliminate the influence of non-Macintyre River flood flows from the Whalan Creek, the annual series extracted for each of the gauging stations excludes flows from the Whalan Creek system.

A Log-Pearson Type III distribution was fitted to the annual data sets for the six selected locations within the Border Rivers Valley Floodplain. The Flike V4.50 flood frequency analysis software (Kuzera, University of Newcastle) was used to calculate a flood frequency analysis for each of the gauging stations selected (Figure A5.1). The Log-Pearson Type III probability distribution was selected as the appropriate mathematical model of flood frequencies to plot the annual series data following a comparison with a number of probability distributions, in line with the Institute of Engineers Australia's best management practices (refer to Australian Rainfall and Runoff, IEA 1987).

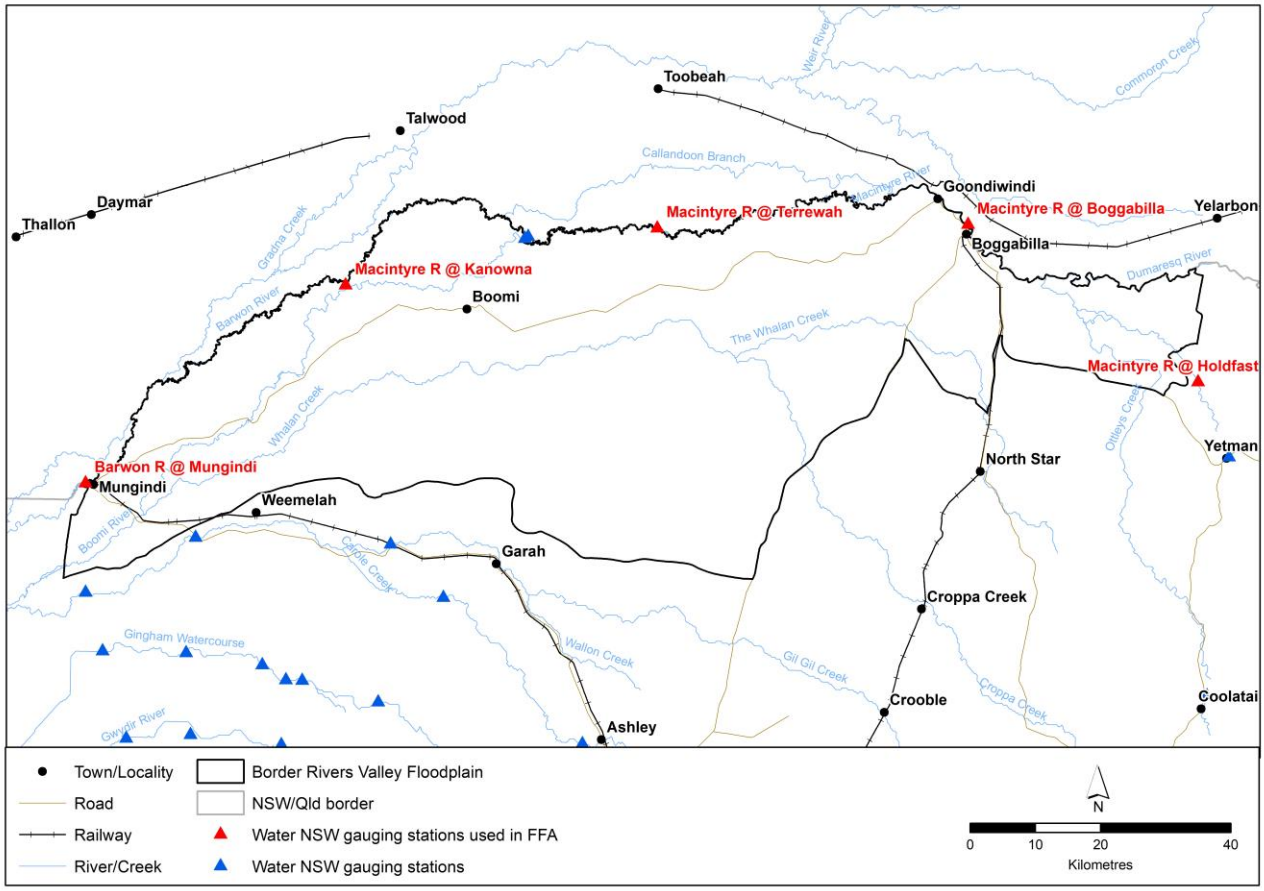


**Figure A5.1: Gauging stations used to flood frequency analysis in the Border Rivers Valley Floodplain**

**Table A5.1: Details of selected gauging stations within the Border Rivers catchment**

| Name | Station No. | Reason for selection | Period of annual flow series | No. of years | Percentage (%) of gauged flows |
|---|---|---|---|---|---|
| Macintyre River at Boggabilla | 416002 | Long period of record and located at the centre of the valley | 1896-2013 | 117 | 91 |
| Macintyre River at Terrewah | 416047 | Located approximately halfway between Boggabilla and Mungindi | 1985-2013 | 28 | 77 |
| Macintyre River at Kanowna | 416048 | Located approximately halfway between Boggabilla and Mungindi | 1988-2013 | 25 | 58 |
| Barwon River at Mungindi | 416001 | Longest streamflow record in Border Rivers Valley Floodplain capturing major floods of 1890 and 1976. Mungindi gauging station is located at the end of the system | 1890-2013 | 23 | 17 |
| Macintyre River at Holdfast (Yelarbon Crossing) | 416012 | Long period of record. Measures inflows into the Border Rivers Valley Floodplain | 1955-2013 | 58 | 47 |
| Dumaresq River at Glenarbon Weir | 416040 | Measures inflows into the Border Rivers Valley Floodplain. Selected to compare with flows at 416012 | 1986-2013 | 27 | 43 |

**Since the recorded flood peaks are only a small sample of peaks actually occurring over a longer period, an expected probability adjustment was made using the procedure set out in Australian Rainfall and Runoff (ARR) (IEA 1987). ARR (1987) recommends implementing the expected probability adjustment to remove bias from the estimate. The resulting frequency curves, along with 5% and 95% confidence limits for the four gauging stations within the Border Rivers Valley Floodplain are shown in Figure A5.2 to Figure A5.5. The AEPs calculated for various floods at the**

**selected locations within the Border Rivers Valley Floodplain using statistical data generated from the flood frequency analysis are shown in**

Table A5.2.

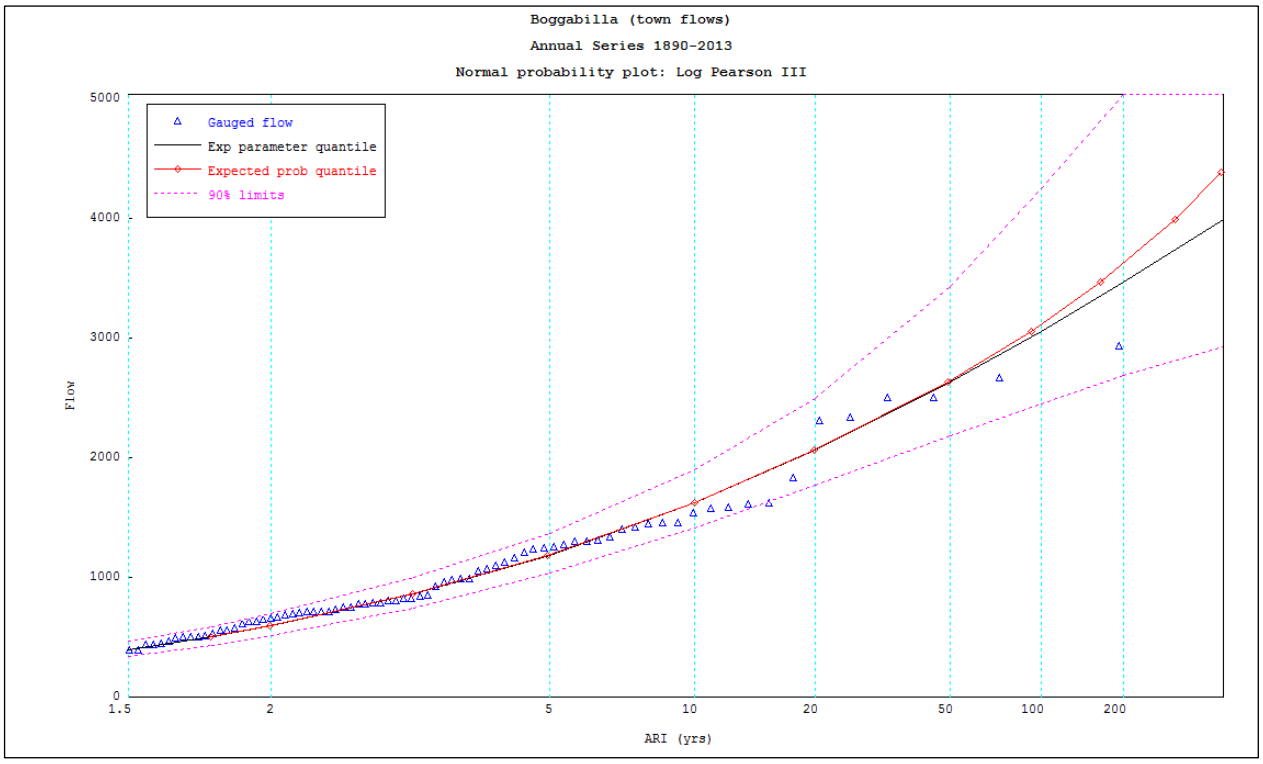


**Figure A5.2: Flood frequency curves for Boggabilla (416002)**

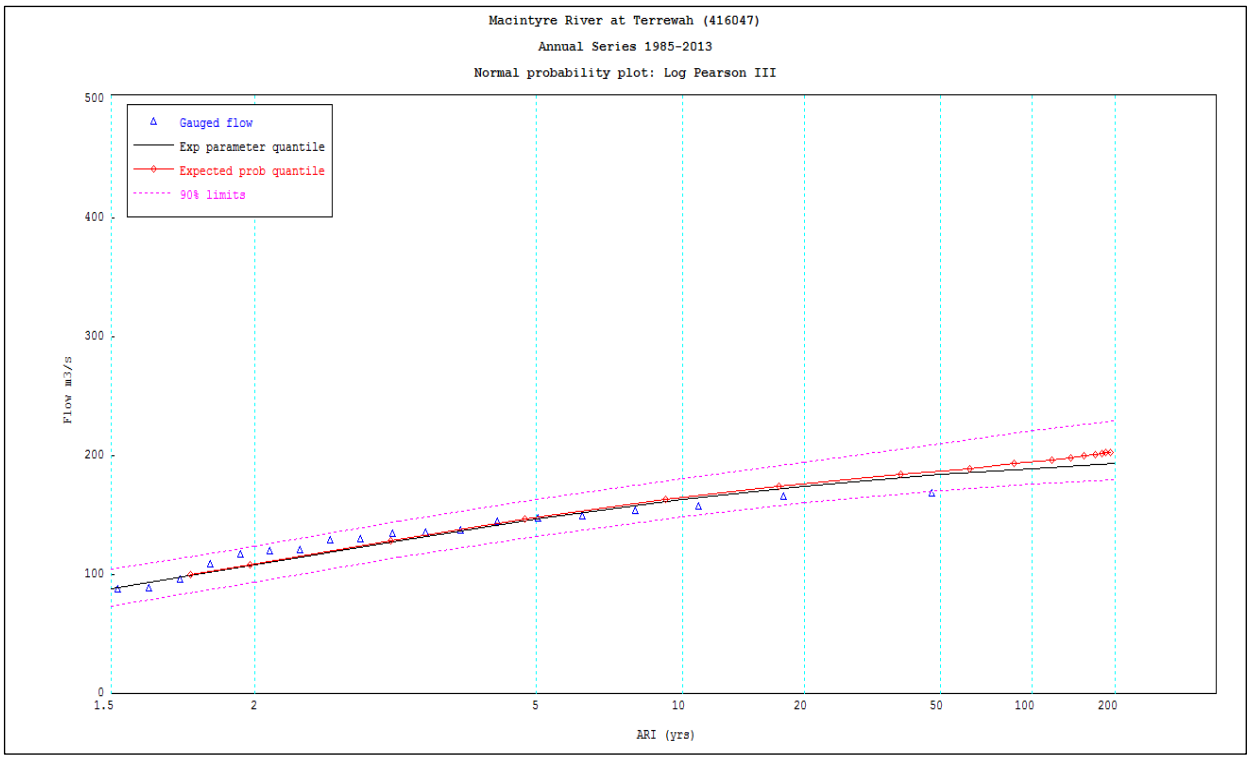


**Figure A5.3: Flood frequency curves for Terrewah (416047)**

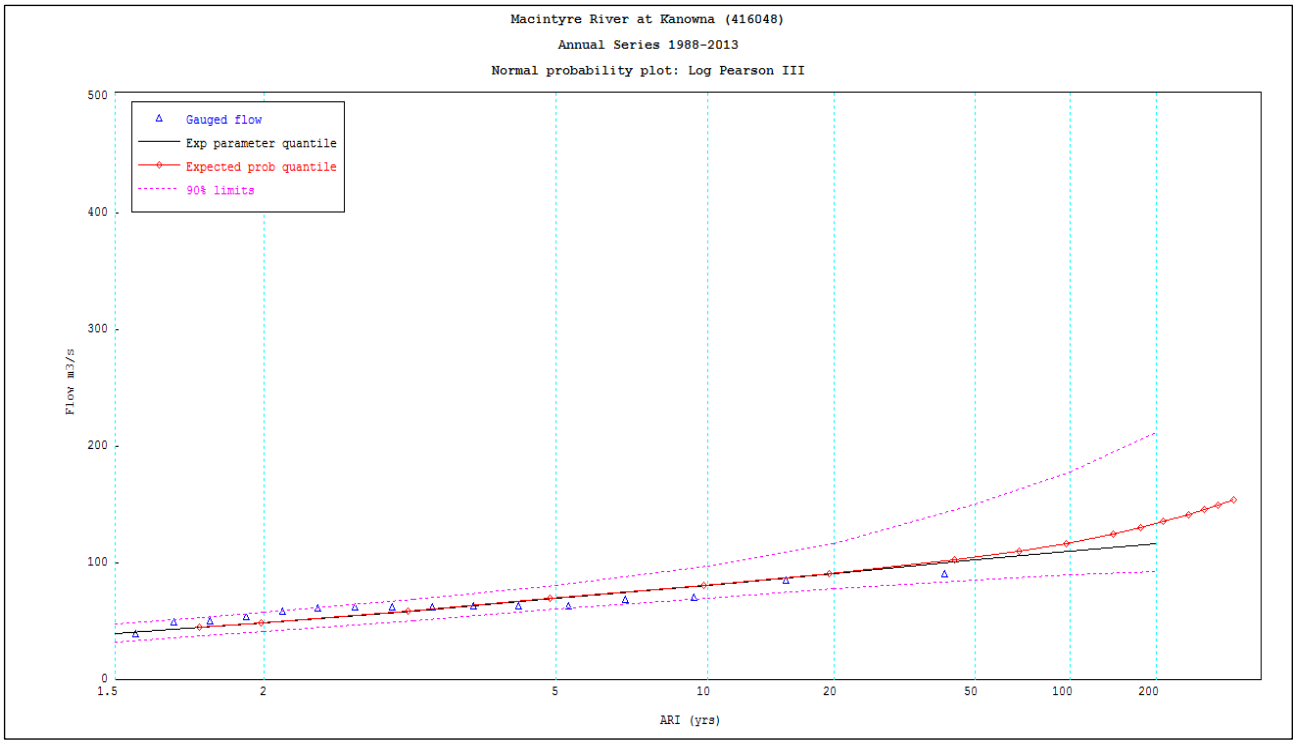


**Figure A5.4: Flood frequency curves for Kanowna (416048)**

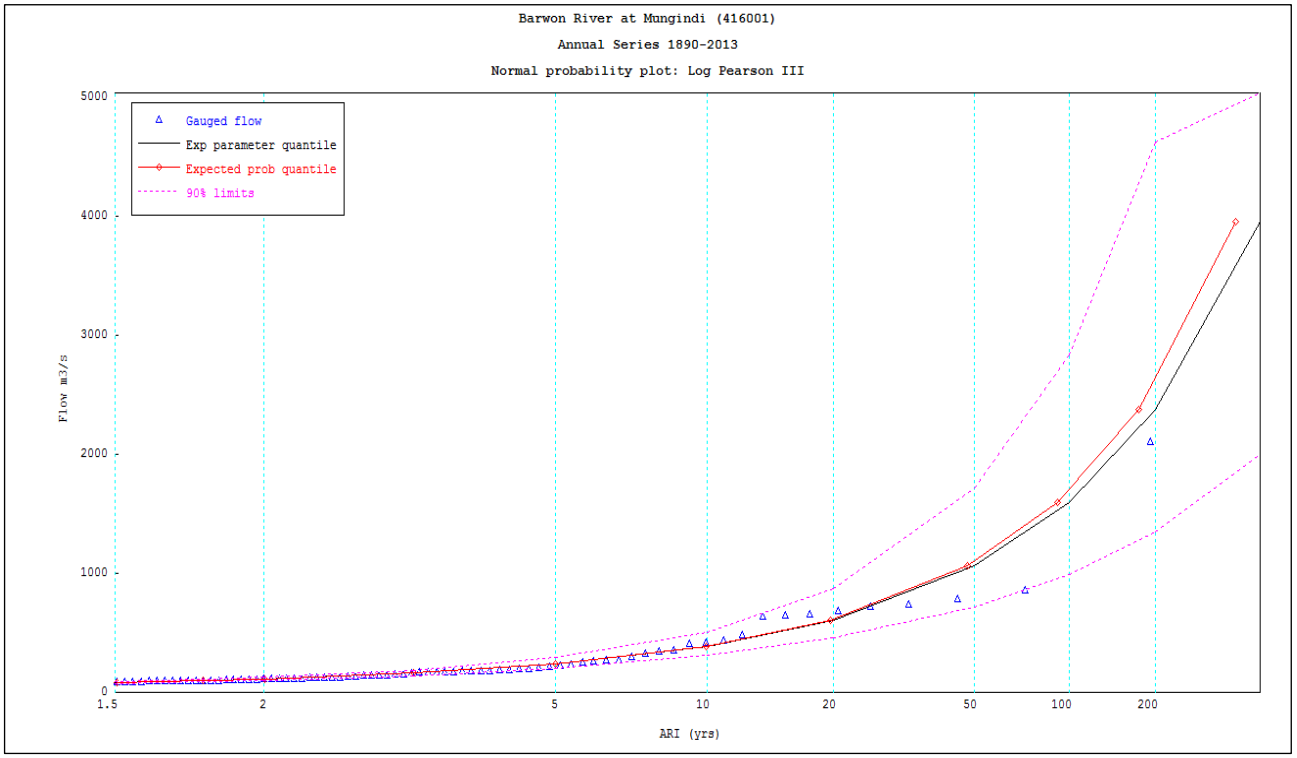


**Figure A5.5: Flood frequency curves for Mungindi (416001)**

**Table A5.2: Annual exceedance probability (AEP) for historic flood events at selected locations in the Border Rivers Valley Floodplain**

| Location (Gauging Station number) | Reason for gauging station selection | 1890 Flood event AEP (%) | 1976 Flood event AEP (%) | 1996 Flood event AEP (%) | 1998 Flood event AEP (%) | 2000 Flood event AEP (%) | 2001 Flood event AEP (%) | 2011 Flood event AEP (%) | 2013 Flood event AEP (%) |
|---|---|---|---|---|---|---|---|---|---|
| Dumaresq at Glenarbon weir (416040) | Measures inflows into the Border Rivers Valley Floodplain. Selected to compare with flows at 416012. | N/A | N/A | 12 | 17 | 50 | 20 | 2.9 | 25 |
| Macintyre at Holdfast – Yelarbon Crossing (416012) | Long period of record. Measures inflows into the Border Rivers Valley Floodplain | N/A | 3.1 | 11 | 12 | 5.6 | 33 | 12 | 50 |
| Macintyre at Boggabilla (416002) | Long period of record and located at the centre of the Valley | 2.4 | 1.3 | 2.4 | 6.7 | 12 | 25 | 1.9 | 33 |
| Macintyre at Terrewah (416047) | Located approximately halfway between Boggabilla and Mungindi | N/A | N/A | 6.3 | 6.7 | 20 | 17 | 12 | 25 |
| Macintyre at Kanowna (416048) | Located approximately halfway between Boggabilla and Mungindi | N/A | N/A | 7.7 | 5.6 | 33 | 20 | 25 | 33 |
| Barwon at Mungindi (416001) | Longest streamflow record in Border Rivers Valley Floodplain capturing major floods of 1890 and 1976.<br>Mungindi gauging station is located at the end of the system. | 0.5 | 1 | 6 | 4.5 | 50 | 33 | 14 | 13 |

# Appendix 6: Further detail on hydrologic and hydraulic modelling

## Hydrologic modelling

The hydrological modelling assessment for the Border Rivers Valley FMP 2020 utilised previously established Unified River Basin Simulator (URBS) and Runoff Analysis and Flow Training Simulator (RAFTS) models which formed part of the Border Rivers Floodplain Hydraulic Analysis (Lawson & Treloar, 1998). It is understood the URBS models were originally developed by the Bureau of Meteorology for the Weir River and Macintyre Brook, but extended across the broader Border Rivers Valley catchment for the purposes of defining flow conditions to the upstream extent of the hydraulic model. A summary is provided hereunder of the reported hydrological assessment from Lawson & Treloar (1998).

### Catchment Delineation

Sub-catchment models were developed for each of the major hydraulic model inflows as summarised in Table A6.1.

**Table A6.1: URBS Sub-catchment Models Developed**

| Model | Catchment area (km$^2$) |
|---|---|
| Dumaresq River | 9093 |
| Macintyre River | 6892 |
| Weir River | 4760 |
| Macintyre Brook | 3983 |
| Croppa Creek | 2401 |
| Commoron Creek | 2317 |
| Yarrill Creek | 2070 |
| Ottleys Creek | 1375 |

The development of each of the major sub-catchment models incorporated a further refinement of the catchment areas incorporating:

- 43 sub-areas for the Macintyre Brook;
- 50 sub-areas for the Macintyre River;
- 79 sub-areas for the Dumaresq River; and
- 21 sub-areas for the Weir River.

The stage-storage and discharge characteristics of the major storages in the catchment, including Pindari Dam, Glenlyon Dam and Coolmunda Dam, were included in the models to provide for the appropriate routing functions.

## Model Calibration

The principal calibration events adopted for the development of the hydrological models were the 1976 and 1996 floods. Available data from established gauging stations was used in the calibration process. The calibration largely focused on achieving a reasonable match between simulated and recorded water level hydrographs at the gauging stations.

Table A6.2 and Table A6.3 present a summary of the calibration comparing simulated and recorded peak flood levels at the available gauges for the 1976 and 1996 events respectively. Note there was no available stream gauging information for the Yarrill, Commoron and Ottleys Creek catchments.

**Table A6.2: 1976 Event Calibration Summary**

| Catchment | Gauging Station | Recorded Peak Flood Height (m) | Simulated Peak Flood Height (m) |
|---|---|---|---|
| Macintyre Brook | Terraine | 5.9 | 5.7 |
| | Inglewood CBM | 11.6 | 11.1 |
| | Inglewood | 11.8 | 11.8 |
| Dumaresq River | Bonshaw Weir | 7.9 | 7.8 |
| | Texas | 10.3 | 10.4 |
| | Oaky Creek | 5.4 | 5.3 |
| | Beebo | 5.0 | 5.0 |
| Macintyre River | Pindari Dam TW | 7.6 | 7.6 |
| | Ashford | 9.5 | 9.7 |
| | Wallangra | 8.6 | 8.6 |
| | Holdfast [(a)] | 8.9 | 9.4 |

Note (a) The Holdfast gauge on the Macintyre River appears to have stopped while floodwaters were still rising and accordingly the peak level not recorded

**Table A6.3: 1996 Event Calibration Summary**

| Catchment | Gauging Station | Recorded Peak Flood Height (m) | Simulated Peak Flood Height (m) |
|---|---|---|---|
| Macintyre Brook | Inglewood | 9.8 | 9.2 |
| | Booba Sands | 8.9 | 9.0 |
| Dumaresq River | Bonshaw Weir | 5.9 | 6.1 |
| | Texas | 7.4 | 7.7 |
| | Beebo | 4.7 | 4.5 |
| | Mauro | 8.5 | 8.5 |
| Macintyre River | Ashford | 5.3 | 5.2 |
| | Wallangra | 5.9 | 6.1 |
| | Holdfast | 8.4 | 8.5 |
| Weir River | Walter Gunn Bridge | 4.7 | 4.8 |

# Hydraulic modelling

BMT WBM undertook flood modelling of the Border Rivers area using the fully 2D software modelling package TUFLOW GPU. TUFLOW was developed in-house at BMT WBM and has been used extensively for over 20 years on a commercial basis by BMT WBM. The 2D model has distinct advantages over 1D and quasi-2D models in applying the full 2D unsteady flow equations. This approach allowed the modelling to include the complex interaction between watercourses and floodplains and converging and diverging flows.

After development of the TUFLOW model, quality assurance checks were made to ensure the model was accurately calibrated, validated and included the latest available information. As part of this process some improvements were made, including changes to Mannings n values assigned to vegetation areas, development delineation, and updates to inflow parameters for the Dumaresq River, Macintyre River, Macintyre Brook, Ottleys Creek, Croppa Creek, Commoron Creek, Yarrill Creek and Weir River.

## Extents and Layout

Consideration was given to the following elements in constructing the model:

- Topographical data coverage and resolution;
- Location of recorded data (for example levels/flows for calibration);
- Location of controlling features (for example dams, levees, bridges);
- Desired accuracy to meet the study's objectives; and
- Computational limitations.

The TUFLOW 2D model covers an area of approximately 1.1 million hectares extending from approximately 50 kilometres upstream of Boggabilla to 40 kilometres downstream of Mungindi (Figure A6.1). It includes approximately 480,600 hectares (86%) of the Border Rivers Floodplain. The area of the Border Rivers Valley Floodplain that could be included in the model was largely determined by the availability of LiDAR data. The model also includes approximately 498,000 hectares (45% of the total model area) in Queensland to allow simulation of the complex interactions between the Queensland and New South Wales parts of the Border Rivers floodplain.

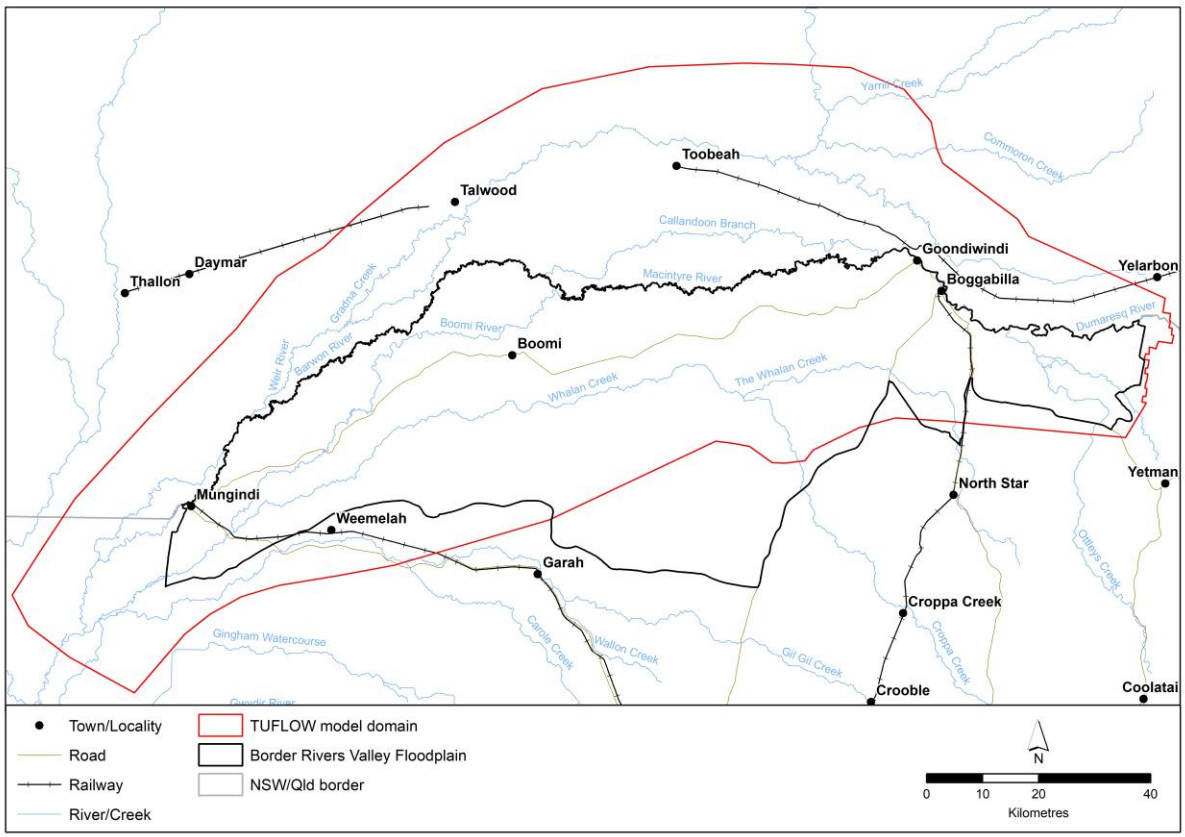


**Figure A6.1: TUFLOW Model area**

The model area is characterised by broad flat floodplain traversed by numerous watercourses. The principal watercourses include the Macintyre River, Weir River, Boomi River, and Barwon River. These are fed the following catchments:

- Croppa Creek,
- Ottleys Creek,
- Macintyre River,
- Dumaresq River,
- Macintyre Brook,
- Commoron Creek,
- Yarrill Creek, and
- Weir River.

## Base Topography

The channel and floodplain topography was defined using a high resolution digital elevation model (DEM) for greater accuracy in predicting flows and water levels and the interaction of in-channel and floodplain areas.

The ability of the model to provide an accurate representation of the overland flow distribution on the floodplain ultimately depends upon the quality of the underlying topographic model. For this model, a 10 metre by 10 metre gridded DEM was derived from a variety of LiDAR survey datasets, including the Macintyre 2013 and Gwydir 2013 datasets. This was supplemented to the north by some Queensland data. LiDAR data was available for the majority of the study area. Where LiDAR data was unavailable, SRTM 1-second (~30 m) resolution elevation data was used. This is typically

not of a sufficient accuracy for hydraulic modelling, however, in the context of this model it was used effectively for hydrological purposes.

Simulation of the TUFLOW model was undertaken at a grid resolution of 30 metres. This resolution was selected to give the necessary detail required for accurate representation of floodplain and channel topography and its influence on flood flows. Due to the relatively dry nature of the river channel, it was considered that the LiDAR data provided a reasonable representation of the in-channel topography. It should be noted that TUFLOW samples elevation points at the cell centres, mid-sides and corners, so a 30 metre grid results in DEM elevations being sampled every 15 metres.

## Topographic Controls

The study area is characterised by flat topography with a large number of linear features elevated above the floodplain. These features include road and rail alignments and levee banks associated with the irrigation supply and drainage infrastructure and farming practices. The largest of such features present barriers to flood flows and often have associated cross drainage infrastructure to transfer flows through them. The smaller features will act as hydraulic controls, resulting in flood water ponding behind them before spilling over the crest.

The 30 metre grid model resolution does not adequately capture topographical features at a finer scale than 30 metres. To ensure that the extensive network road and rail embankments was correctly represented within the model, breaklines were created representing elevations along the crests of the embankments from the LiDAR DEM. The breaklines were imported into the TUFLOW model to ensure that a continuous crest elevation is represented within the model topography. Water levels in the upstream model cells must exceed the crest of the embankment before spilling into the downstream cells. This approach ensures that the influence of the topographic controls across the floodplain is correctly represented.

The other key topographic detail that was required to be enforced within the TUFLOW model was the extent of developed agricultural land within the floodplain. Data detailing the extent and nature of approved development was used to identify unlimited development, which was raised out of the floodplain in the model, and limited height development, which was set to the appropriate elevation to allow floodwater to overtop the development in a major flood. The agricultural development areas were created for the 1976, 1996, and 2017 model scenarios. For historic scenarios, the development captured in the LiDAR was removed from the model if the scenario date preceded the development.

## Hydraulic Roughness

The development of the TUFLOW model required the assignment of hydraulic roughness for modelling resistance. A Manning's 'n' value of 0.04 was adopted for the entire model area, based on observed and modelled hydrographs on the model calibration process.

## Structures

There are a number of bridge and culvert crossings over the main channel alignments and tributaries within the model extents. These structures vary in terms of construction type and configuration, with varying degrees of influence on local hydraulic behaviour. Incorporation of these major hydraulic structures in the models provides for simulation of the hydraulic losses associated with these structures and their influence on peak water levels within the study area.

The larger structures have been modelled as flow constrictions within the 2D domain, with smaller structures modelled using 1D structures embedded within the 2D domain.

## Boundary Conditions

The model boundary conditions are derived as follows:

- Inflows - the catchment runoff was determined through the hydrological model and was applied to the TUFLOW model as flow vs. time inputs. These were applied at the upstream model limit.
- Downstream Rating– the downstream model limit adopted a normal flow boundary with resultant water levels being computed from model outflow, floodplain topography, and Manning's 'n' roughness parameters.

The model domain has been extended approximately 40 kilometres downstream of Mungindi to ensure that adopted boundary conditions have no significant influence on simulated flood conditions in the township.

## Model Calibration

The selection of suitable historical events for calibration of computer models is largely dependent on available historical flood information. Ideally the calibration and validation process should cover a range of flood magnitudes to demonstrate the suitability of a model for the range of design event magnitudes to be considered.

The 1976 and 1996 flood events were used for model calibration. The simulated inflow hydrographs were based on those adopted in the previous MIKE 11 hydraulic modelling. A summary of the modelled peak inflows is presented in Table A6.4.

The principal calibration dataset that was used to assess the hydraulic model performance was the observed flow hydrographs for the 1976 flood. These were available at Boggabilla and Goondiwindi, as shown in Figure A6.2 and Figure A6.3 respectively. The observed flow hydrographs were obtained from the February 1976 Flood Event Calibration Data figure from the Connell Wagner report.

**Table A6.4: Modelled peak inflows**

| Catchment name | 1976 flood (m3/s) | 1996 flood (m3/s) |
|---|---|---|
| Croppa Creek | 530 | 540 |
| Ottleys Creek | 400 | 380 |
| Macintyre River | 3,910 | 2,370 |
| Dumaresq River | 3,180 | 1,870 |
| Macintyre Brook | 2,040 | 1,220 |
| Commoron Creek | 360 | 370 |
| Yarrill Creek | 320 | 330 |
| Weir River | 1,710 | 450 |

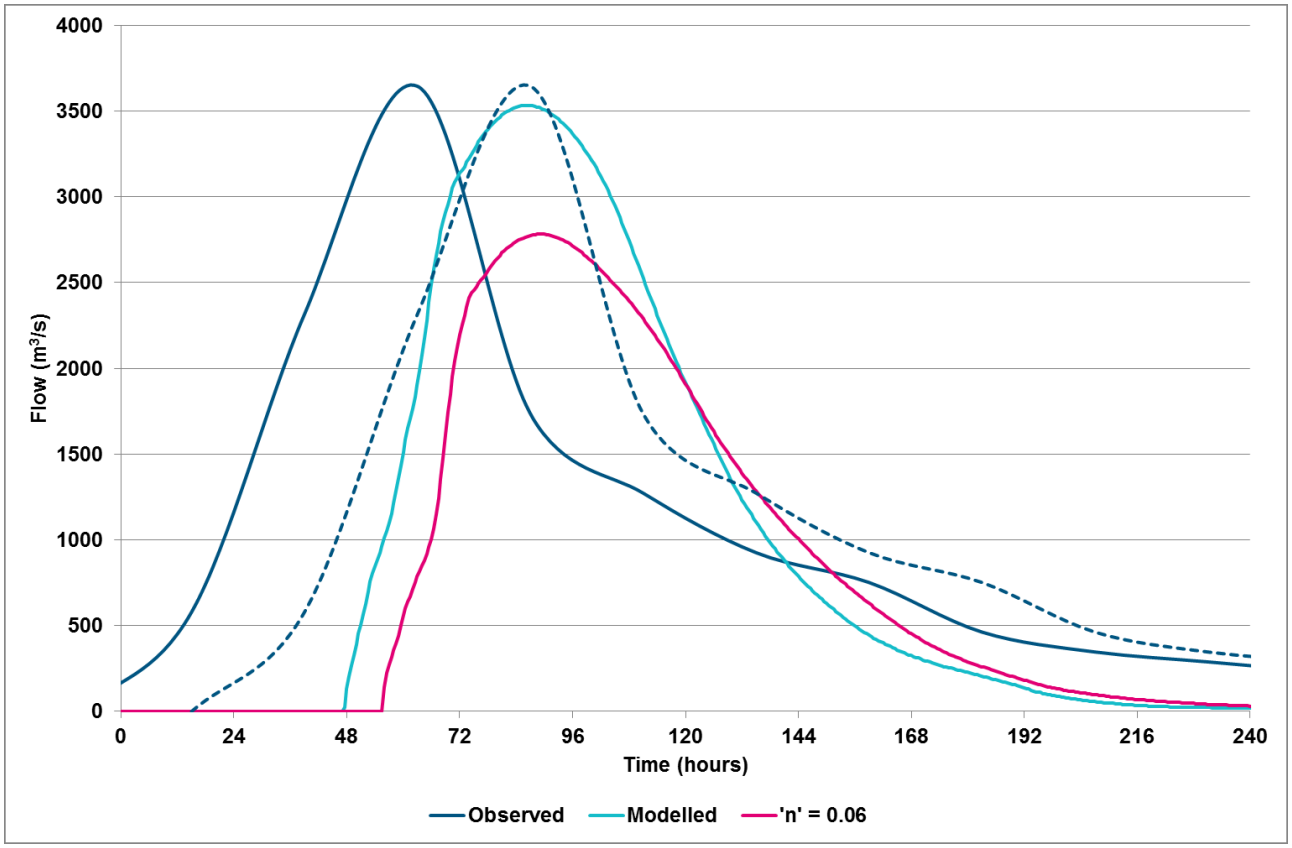


**Figure A6.2: February 1976 modelled flow calibration at Boggabilla.**

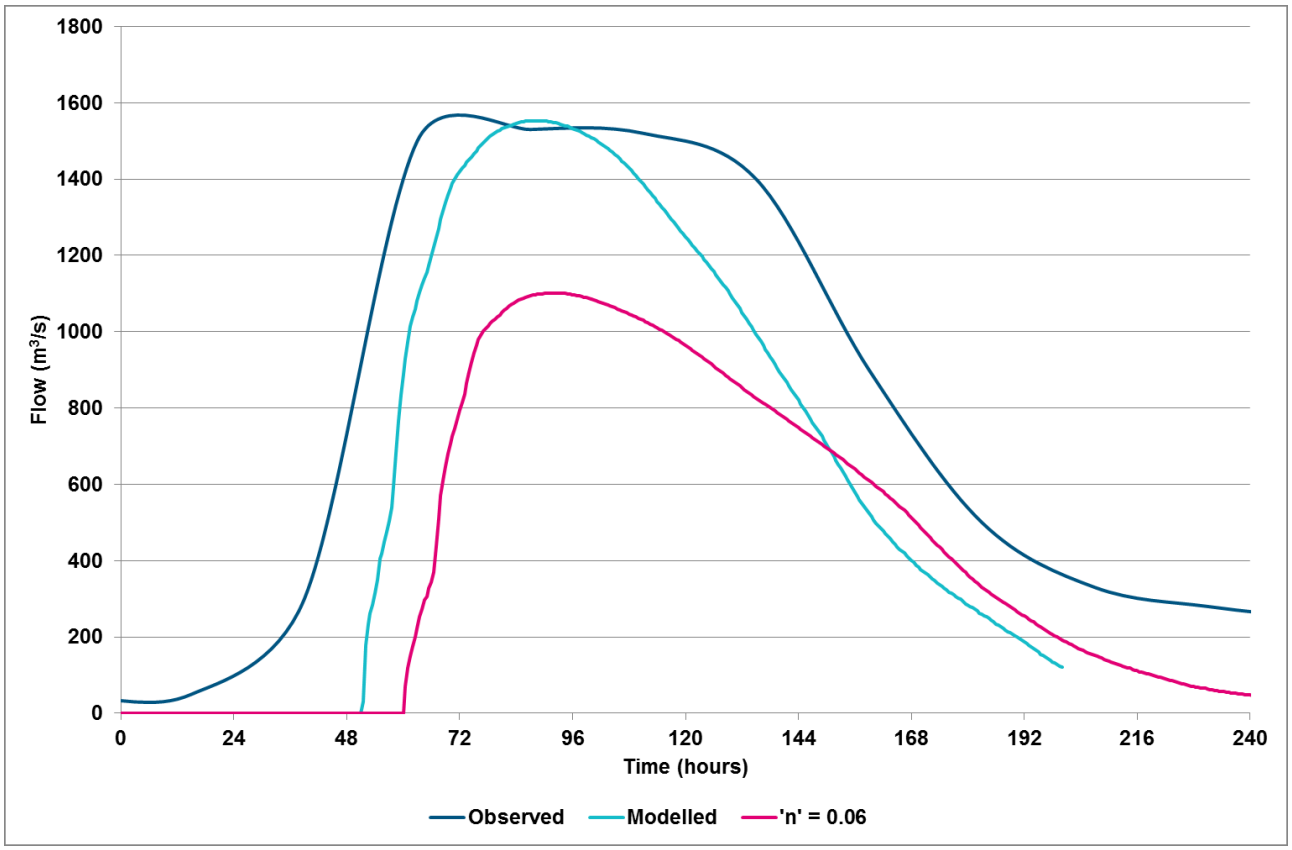


**Figure A6.3: February 1976 modelled flow calibration at Goondiwindi.**

Figure A6.2 shows a reasonably good match at Boggabilla between the observed and modelled peak flows when adopting the modelled Manning's 'n' roughness value of 0.04. The sensitivity of the model to the adopted roughness is presented through the comparative result when changing the modelled 'n' value to 0.06, which shows around a 20% reduction in modelled peak flow at Boggabilla. The timing of the observed flow hydrograph is unusual in that it peaks a day prior to the observed accompanying water level hydrograph. When adjusting the observed flow hydrograph by 24 hours to match the observed water level hydrograph, the timing of the hydrograph matches that which has been modelled.

Figure A6.3 shows a reasonably good match at Goondiwindi between the observed and modelled peak flows when adopting the modelled Manning's 'n' roughness value of 0.04. The sensitivity of the model to the adopted roughness is presented through the comparative result when changing the modelled 'n' value to 0.06, which shows around a 30% reduction in modelled peak flow at Goondiwindi. The modelled hydrograph volume is less than that of the observed hydrograph and could potentially be a function of the hydraulic model not accounting for direct rainfall or lateral catchment inflows downstream of the upstream model boundaries.

A number of surveyed flood marks were available across the study area for the 1976 and 1996 floods, as presented in Figure A6.4 and Figure A6.5 respectively. On average the modelled peak flood levels are around 180 millimetres lower than the surveyed levels for the 1976 flood and around 110 millimetres higher than the surveyed levels for the 1996 flood. However, there is no clear pattern as to the distribution of modelled levels that are higher or those that are lower than the available flood marks. It should be noted that flood levels can vary significantly over a relatively short distance in the presence of hydraulic controls and this uncertainty may contribute to the observed difference between the surveyed and modelled levels.

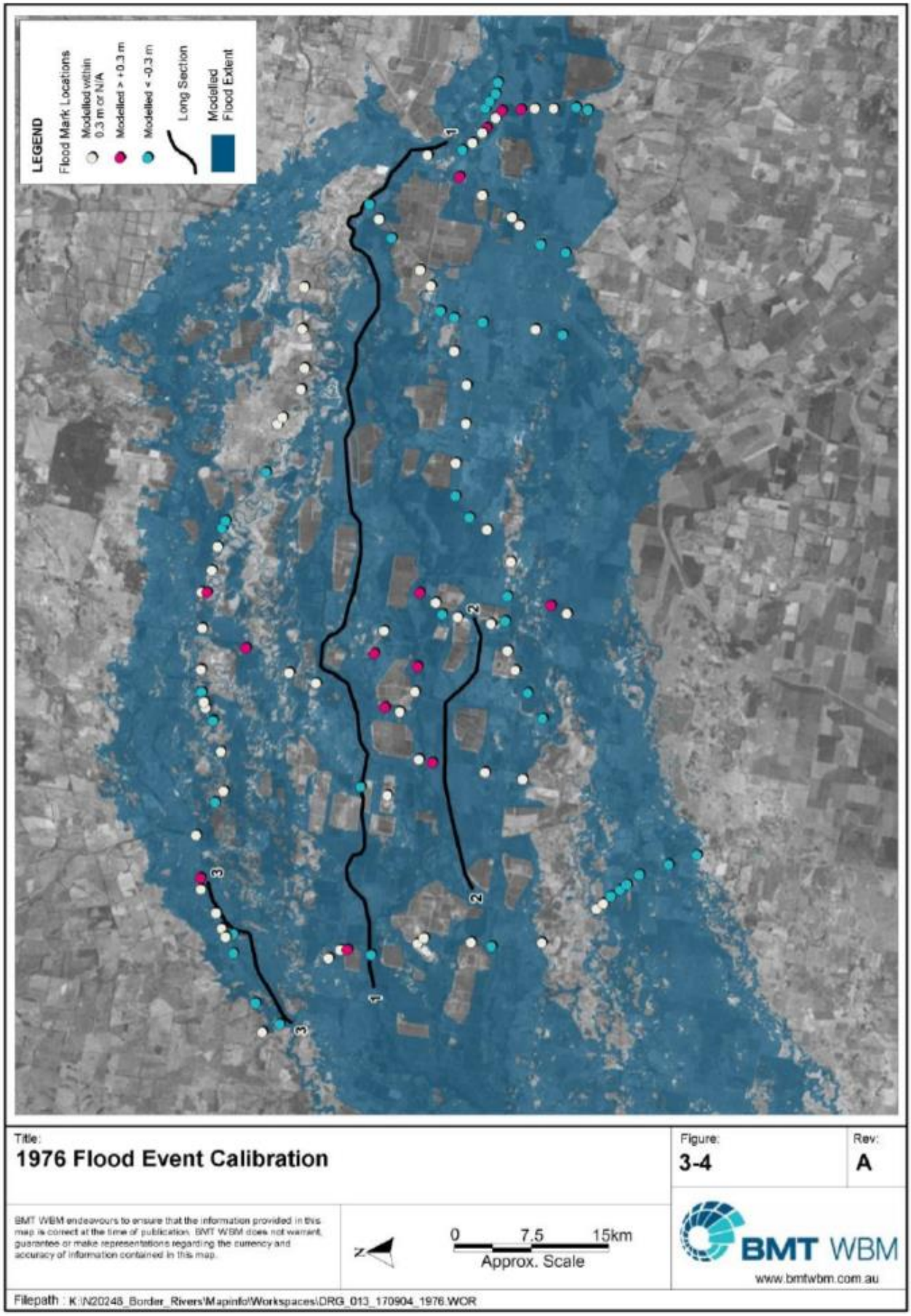


**Figure A6.4: Surveyed flood marks for the 1976 flood**

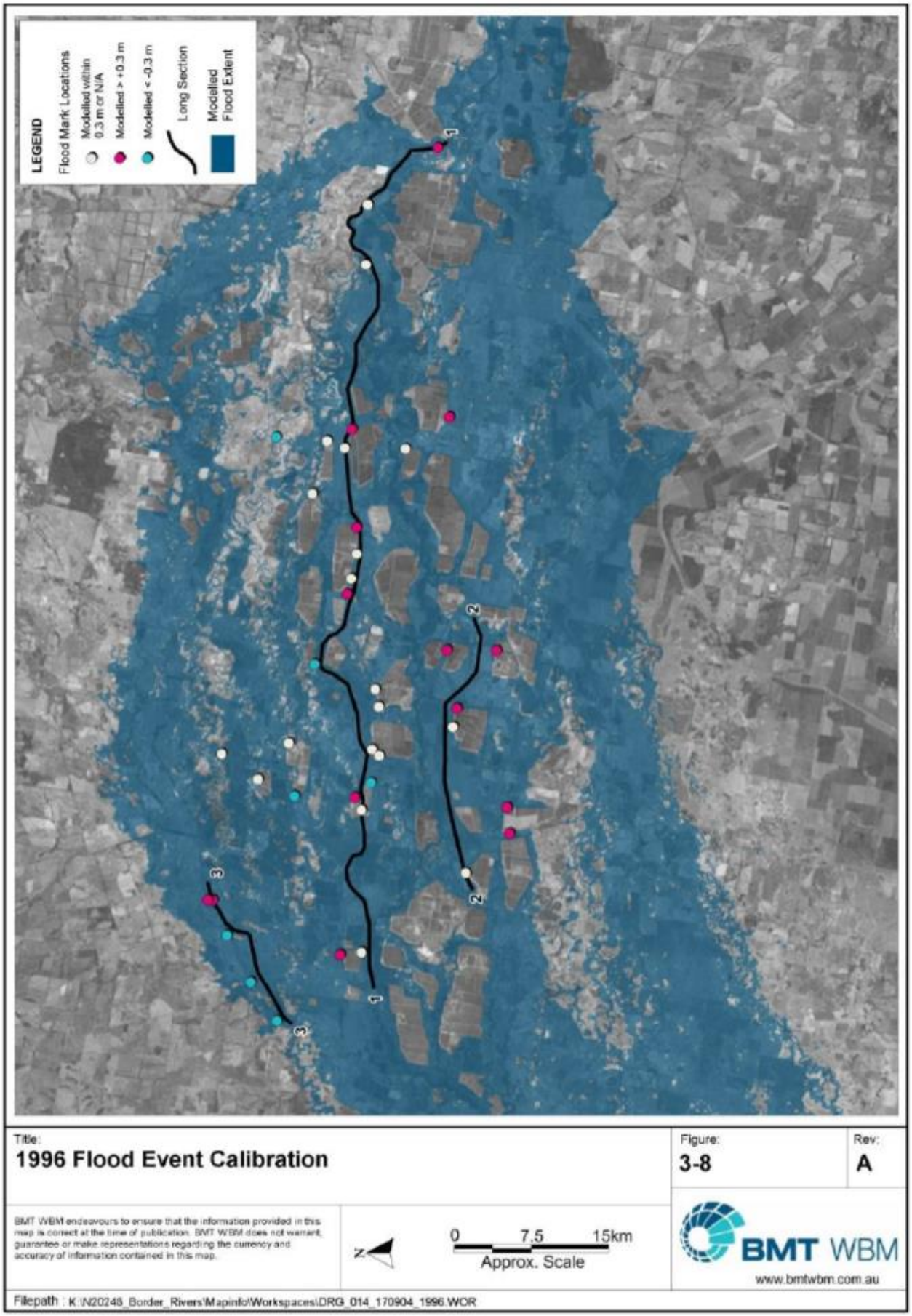


**Figure A6.5: Surveyed flood marks for the 1996 flood**

# Appendix 7: Overview of flood imagery

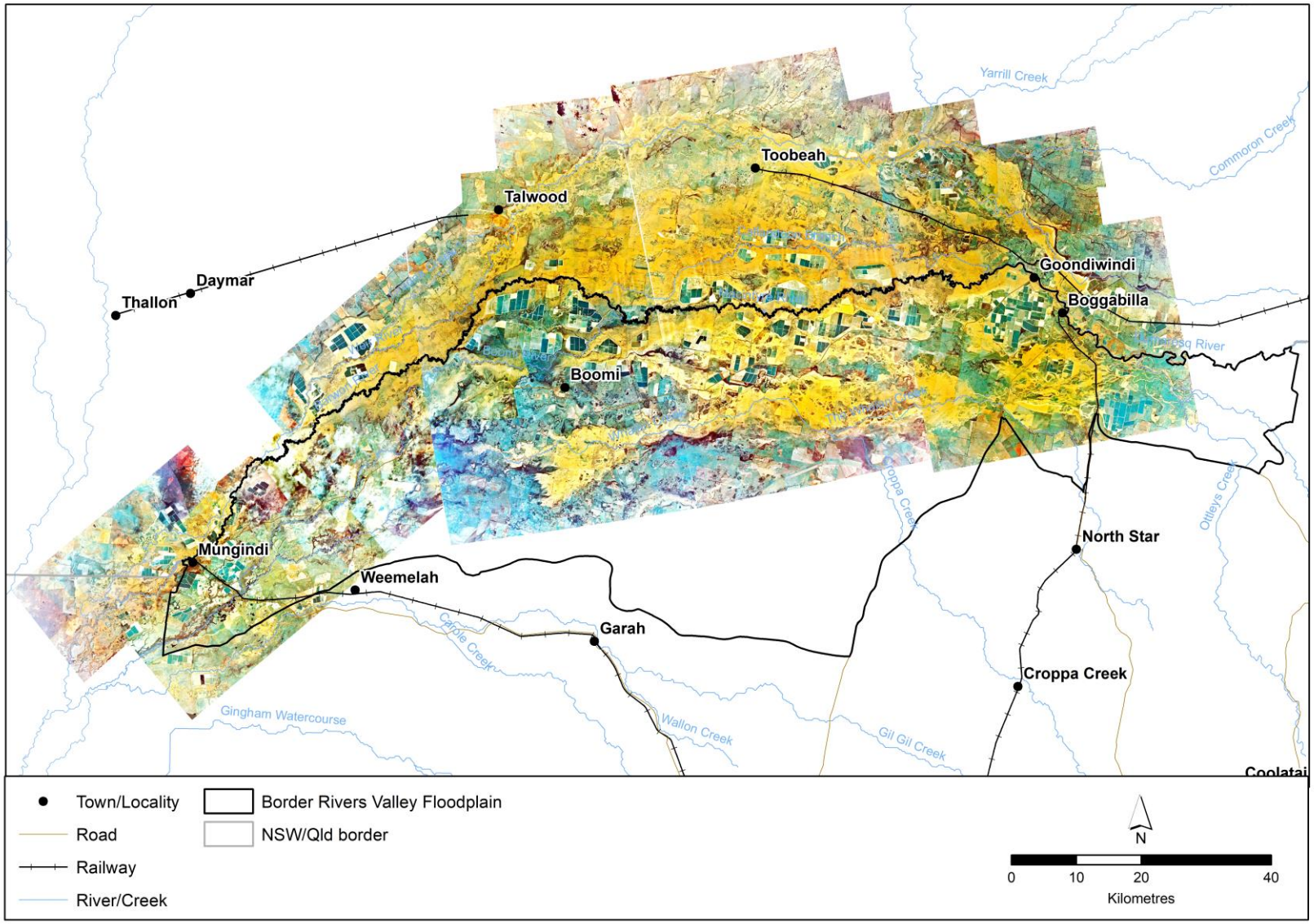


**Figure A7.1: Aerial imagery showing flooding in the Border Rivers Valley Floodplain in 1996**

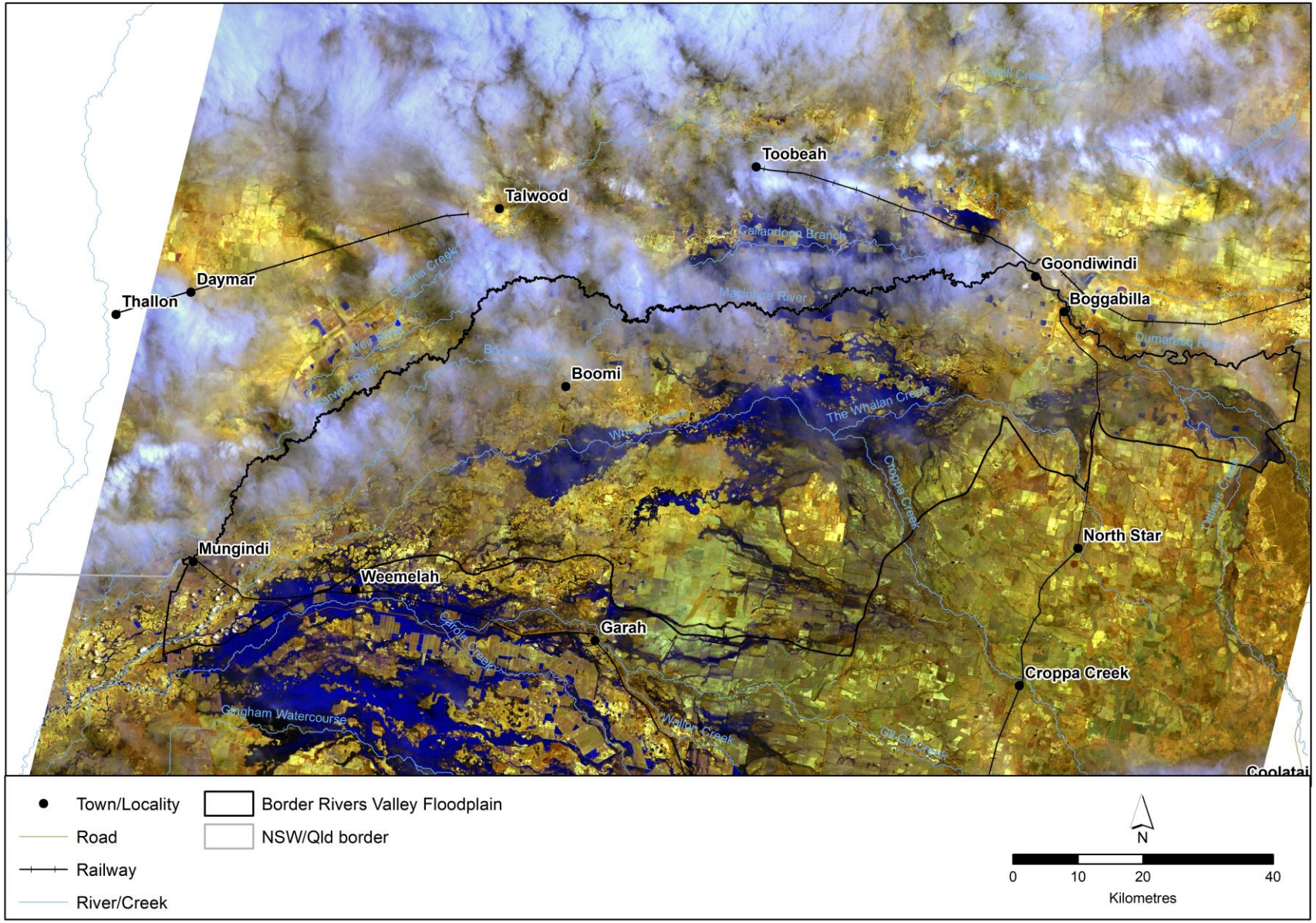


**Figure A7.2: Landsat 7 satellite image of flooding on 23 November 2000 in the Border Rivers Valley Floodplain**

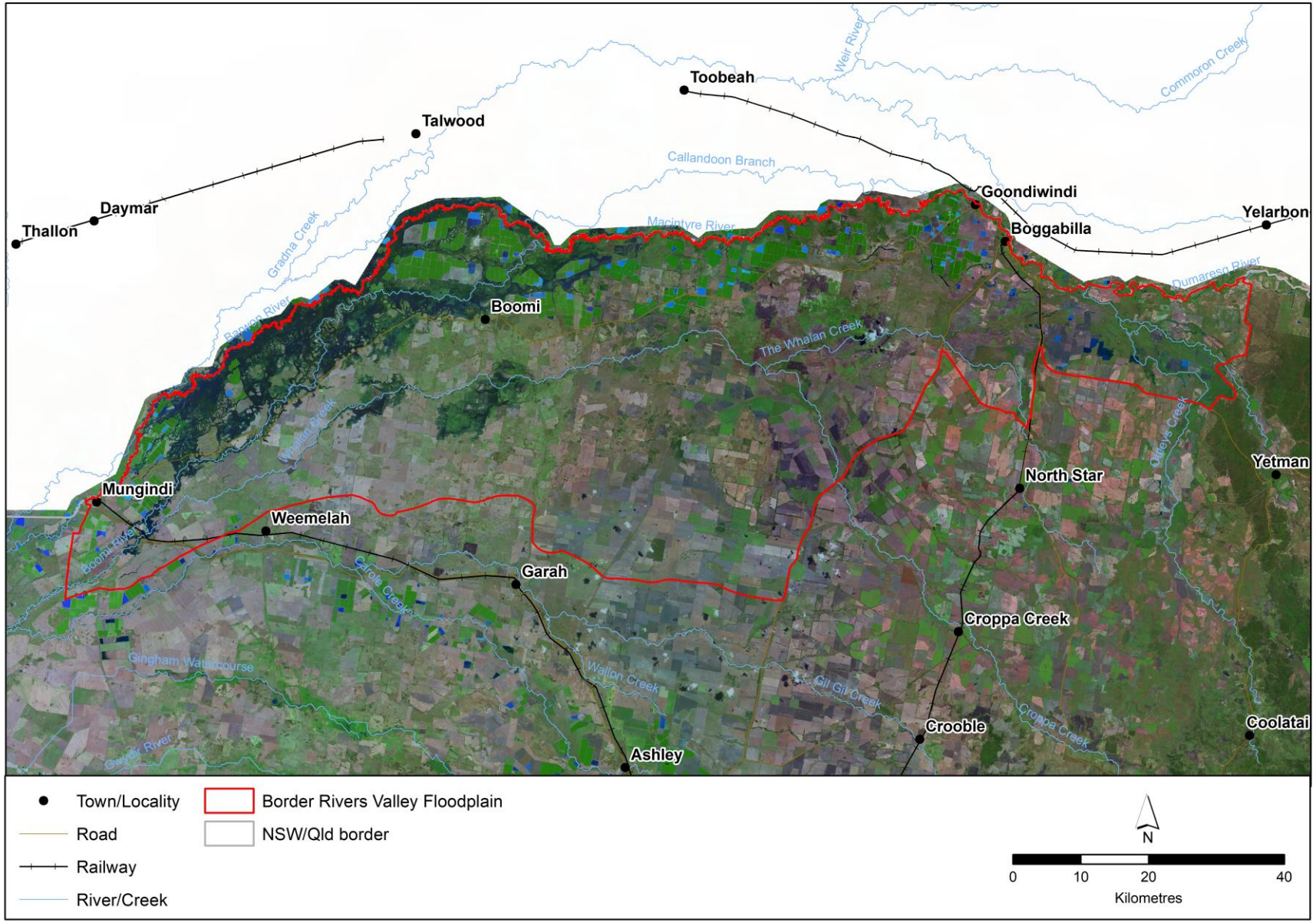


**Figure A7.3: SPOT imagery showing flooding in the Border Rivers Valley Floodplain from 2011**

# Appendix 8: Marxan prioritisation (planning units)

Planning units are area-based polygons which cover the entire study area. Marxan analysis is an iterative process involving several steps. The first step involves dividing the landscape into "planning units" which form the basis of the Marxan analysis. Planning units are small parcels of land of a pre-determined shape and size which could potentially be included in (or excluded from) the final Marxan solution. The Border Rivers Valley Floodplain was divided into 50 hectare hexagonal planning units (n = 11,404) using the Qmarxan plugin (Apropos Information Systems 2014) executed within Quantum GIS Version 1.8.0 software (QGIS Development Team 2013). These hexagonal-shaped planning units were selected to be the most appropriate shape and size for fine-scale floodplain management planning and they have been demonstrated to produce more efficient and less fragmented planning portfolios (Nhancale and Smith 2011). An additional advantage of the hexagonal-shaped planning units is that their consistent size may reduce area-related bias (Loos 2011).

Marxan planning units partition the floodplain landscape and are the basis upon which data on the abundance of conservation features is compiled within the entire planning region. The amount of each biodiversity feature in each planning unit was calculated using the Qmarxan plugin within Quantum GIS Version 1.8.0 software. The extent of all biodiversity features within each planning unit is assessed to determine the relative importance of individual planning units and this forms the basic Marxan data matrix.

Marxan can be parameterised to "lock in" (that is a planning unit may be forced into the final solution before the algorithm is run) or "lock out" (that is a planning unit may not be considered in the final solution), through the use of status codes. For example, wetlands of national importance, such as the Morella Watercourse/Boobera Lagoon/Pungbougal Lagoon wetland complex (Environment Australia 2001), were fixed into the solution (that is the planning unit is forced into the final solution), as these nationally significant wetlands provide drought refugia for a range of water-dependent species. Other ecological assets identified that were locked into the final solution for the Border Rivers Valley Floodplain include existing nature reserves which contain significant floodplain vegetation. For example:

- Boronga, Boomi and Boomi West Nature Reserves contain woodlands dominated by Coolibah (*Eucalyptus coolabah*), river red gum (*Eucalyptus camaldulensis*) and belah (*Casuarina cristata*) along watercourses (NPWS 2003),
- Budelah Nature Reserve, located in a region highly modified for agriculture, conserves the endangered ecological communities of Coolibah-black box woodland and carbeen open forest (NPWS 2010), in addition to the floodplain vegetation of coolibah-belah and river red gum – Coolibah woodlands, and
- Careunga Nature Reserve is entirely bound by cleared land and contains the non flood-dependent belah woodlands (NPWS 2004).

# Appendix 9: Marxan prioritisation (targets for ecological surrogates)

To represent biodiversity patterns of the Border Rivers Valley Floodplain, several key flood-dependent ecological surrogates were chosen for input into the Marxan process to identify priority ecological assets. Surrogates are needed because it is impossible to measure all aspects of biodiversity, so surrogate features are chosen as proxies for biodiversity patterns (Margules, Pressey and Williams 2002).

Surrogates were divided into two dataset types; area and point-based data and included sub-sets of taxa, assemblages, and/or environments and environmental variables (Margules and Pressey 2000, Margules et al. 2002). For each ecological surrogate, targets or conservation objectives, were established to specify the amount of an ecological surrogate that would be needed to be conserved to ensure the persistence of that surrogate (Margules and Pressey 2000). Targets provide a clear purpose for conservation decisions giving them accountability and defensibility (Pressey et al. 2003). Formulation of explicit targets may also be constrained by limited or undocumented information on biodiversity and habitat requirements (Pressey et al. 2003, Possingham et al. 2007). Targets were reviewed and selected for each of the ecological surrogates during a TAG meeting on 27 February 2014 with local experts.

## Area-based data sets (mapped vegetation)

Area-based data for vegetation was the primary ecological surrogate for the Marxan prioritisation. Mapped vegetation was chosen as a surrogate if it was dependent on flooding and/or provided habitat to flood-dependent fauna. The area-based data derived from mapped vegetation community types were grouped into the following flood-dependent 'hydro-ecological functional group' surrogate categories:

- Semi-permanent wetlands
- Flood-dependent shrubland wetlands
- Flood-dependent riverine woodland/forests (wetlands)
- Flood-dependent woodlands

Target setting for area-based surrogates was initiated at 30% of the pre-development area, below which there is a steep drop off in biodiversity (Ausseil et al. 2011). The 30% habitat area has also been recommended by the World Conservation Union (IUCN 2003). Generally, targets for vegetation surrogates were set at a high value to protect the flood connectivity to the remaining fragmented flood dependent vegetation which is of high conservation significance, as much of the Border Rivers Valley Floodplain has been extensively cleared for grazing and cropping.

To determine the percentage area of vegetation surrogates remaining in the Border Rivers Valley Floodplain, a pre-1750 vegetation reconstruction map (White 2002) was compared to the current spatial extent of mapped vegetation surrogates. Some of the mapped vegetation surrogates had no equivalent pre-1750 community.

The Border Rivers Valley Floodplain is a highly cleared agricultural landscape and it was found that belah woodland was cleared to below 30% of its pre-development area. The flood-dependent woodland Coolibah-black box surrogate was found to have 34% of its pre-development area remaining. The target was set at 100% for this vegetation surrogate to approximately meet the requirement of protecting 30% of the pre-development area. These Coolibah-Black Box Woodlands in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregion are an Endangered Ecological Community in NSW (OEH 2017) and were therefore afforded 100% targets in the Marxan prioritisation.

Although the semi-permanent wetland and floodplain wetland hydro-ecological functional group categories were found to have 45% of the pre-development area remaining, the target was set to

100% by experts in recognition of the ecological and cultural significance of these remaining areas and their requirement for protection to ensure annual or near annual flooding for their maintenance and long term persistence. Mapped semi-permanent wetland vegetation habitats were afforded with 100% targets in the Marxan prioritisation to ensure protection of waterbird feeding and breeding habitats in the Border Rivers Valley FMP 2020.

Comparisons were also made between vegetation surrogates and equivalent BioMetric vegetation types (BVTs) (OEH 2014a). BVTs were a list of vegetation communities that occur within each NSW catchment management authority (CMA) region. All vegetation surrogates excluding the following vegetation types were considered as over-cleared BVTs, that is, more than 70% of that vegetation type in the former Border Rivers Gwydir CMA region had been cleared:

- semi-permanent wetland class of Wetlands and marshes (which did not have a single BVT), and
- flood dependent shrubland class Eurah shrubland of inland floodplains.

BVTs were retired from the VIS Classification system on 21 August 2017 and were replaced with Plant Community Types (PCTs) to facilitate the development of state-wide PCT mapping. In the Border Rivers Valley Floodplain, the TAG endorsed conservation targets of 100% for most asset types to ensure their future persistence. The exception was the flood dependent shrubland class Eurah shrubland of inland floodplains (PCT 115) for which the TAG endorsed a conservation target of 80%. As a result the Marxan analysis determined that all ecological assets were a high priority.

# Area-based data sets (species distribution models)

Species distribution models (SDMs) are numerical tools that combine observations of species occurrence or abundance with environmental estimates. They are used to gain an understanding of species ecological requirements and to predict species' distributions across landscapes, sometimes requiring extrapolation in space and time. Correlative SDMs are often used as area-based surrogates to identify priority conservation areas in freshwater river ecosystems (Esselman and Allan 2011; Hermoso et al. 2013a). SDMs aim to estimate the environmental conditions that are suitable for a species by numerically relating known species occurrence records with suites of environmental variables of those locations.

SDMs provide a powerful way of overcoming sparseness of point based fauna distribution data by relating them to geographic or environmental predictors (Elith and Leathwick 2009). These predictive SDMs were used as area-based surrogates for Border Rivers Valley Floodplain fauna. Maxent v. 3.3.3k (Phillips, Dudik, and Schapire 2010) was used to predict the distribution of four frog species, three freshwater turtles, and one snake species in the NSW Murray-Darling Basin (Table A9.2). A common way to set species targets in conservation planning is to use a proportion of species distributions (for example Carvalho et al. 2010, Hermoso et al. 2013a, and Hermoso et al. 2013b). Marxan software was used to find an optimal set of planning units that represented at least 10% of each modelled species distribution (Table A9.2).

The environmental variables used to fit SDMs for the Border Rivers Valley Floodplain included topographic and bio-climatic variables, satellite-derived vegetation indices (that is MODIS NDVI) using species occurrence records but excluded occurrence records associated with human infrastructure (Table A9.3).

Species distribution models may overestimate the likelihood of a species occurring. It can be difficult to evaluate overestimation in species distribution models that use presence data only (Hernandez et al. 2006). The species distribution models for this project where evaluated using the Receiver Operating Characteristic (ROC) which evaluates overall fit and incorporates omission and commission error (Hernandez et al. 2006). In the species distribution models the area under the ROC curve was used to evaluate the models. In the Border Rivers prioritisation, the area under the ROC curve for all models on reserved test data ranged from 0.88 – 0.96, which is acceptable for

conservation planning (Pearce and Ferrier 2000). Nevertheless, the models were weighted lower (a 10% of sites target) than other mapped surrogates in the Marxan analysis to acknowledge that the actual distribution of species may be a subset of the modelled distribution.

**Table A9.2: Targets for area-based ecological surrogates (fauna species distribution models)**

| Asset Type | Surrogate | Total area (ha) | Target (% of area) | Fixed in solution | Justification |
|---|---|---|---|---|---|
| Frogs | Barking marsh frog (*Limnodynastes fletcheri*) | 96,359 | 10 | No | The realised niche is likely to be a subset of modelled areas |
| Frogs | Broad-palmed frog (*Litoria latopalmata*) | 160,911 | 10 | No | The realised niche is likely to be a subset of modelled areas |
| Frogs | Desert tree frog (*Litoria rubella*) | 131,782 | 10 | No | The realised niche is likely to be a subset of modelled areas |
| Frogs | Eastern sign-bearing froglet (*Crinia parinsignifera*) | 55,159 | 10 | No | The realised niche is likely to be a subset of modelled areas |
| Turtles | Broad-shelled turtle (*Chelodina expansa*) | 216,148 | 10 | No | The realised niche is likely to be a subset of modelled areas |
| Turtles | Eastern snake-necked turtle (*Chelodina longicollis*) | 95,247 | 10 | No | The realised niche is likely to be a subset of modelled areas |
| Turtles | Murray turtle (*Emydura macquarii*) | 130,385 | 10 | No | The realised niche is likely to be a subset of modelled areas |
| Snake | Red-bellied black snake (*Pseudechis porphyriacus*) | 34,639 | 10 | No | The realised niche is likely to be a subset of modelled areas |

**Table A9.3: Environmental variables used to fit SDM over the Border Rivers Valley Floodplain**

| Type | Resolution | Source | Description |
|---|---|---|---|
| Climate | 1 km | Bioclim[3] | Annual Mean Temperature |
| Climate | 1 km | Bioclim[3] | Mean Diurnal Range (mean of monthly temperature (max to min temp)) |
| Climate | 1 km | Bioclim[3] | Temperature Isothermality and Seasonality (standard deviation * 100) |
| Climate | 1 km | Bioclim[3] | Mean temperature of wettest quarter and driest quarter |
| Climate | 1 km | Bioclim[3] | Precipitation of driest month |
| Climate | 1 km | Bioclim[3] | Precipitation of seasonality (coefficient of variation) |
| Climate | 1 km | Bioclim[3] | Precipitation of wettest quarter, warmest quarter, and coldest quarter |
| Topography | 250 m | GA[4] | Altitude |
| Topography | 250 m | GA[4] | Built from nine second DEM derived streams database (Geoscience Australia 2011) |
| Topography | 250 m | GA[4] | Amount of upstream area (in number of cells) draining into each cell calculated from the 90 m SRTM elevation data |
| Vegetation[2] | 250 m | CSIRO | Annual mean Normalised Difference Vegetation Index (NDVI) calculated from the monthly Moderate Resolution Imaging Spectrodiometer (MODIS) NDVI (2000-2012) |
| Vegetation[2] | 250 m | CSIRO | Annual maximum NDVI calculated from the monthly MODIS NDVI (2000-2012) |
| Vegetation[2] | 250 m | CSIRO | Standard deviation of annual mean NDVI |

| Type | Resolution | Source | Description |
|---|---|---|---|
| Vegetation[2] | 250 m | CSIRO | Annual mean of the standard deviation of monthly NDVI (January 2000 – December 2012) |

1. All grids were resampled to 250 m
2. MODIS Normalized Difference Vegetation Index (NDVI). As the MODIS NDVI was available from Feb 2000, the mean January NDVI (2001 -2012) was used for January 2000 (NASA and Administration 2014).
3. Busby (1991)
4. Geoscience Australia (http://www.ga.gov.au/)

# Point-based occurrence data (fauna)

Ecological surrogates derived from point-based data for fauna included:

- eleven species of native freshwater fish,
- seven species of frogs,
- six species of reptiles,
- two species of mammal, and
- two species of waterbirds with known breeding locations[6].

These fauna species and assemblages were selected because they have a high dependence on floodwater. A score for presence or absence for the species was assigned to all planning units. If the point record was within a planning unit, the species was considered present. Point-based records of fauna observations were sourced from the BioNet Atlas of NSW Wildlife (OEH 2014b), Growns and West (2008), and from the NSW Freshwater Fish Research Database (accessed in 2014) which collates data from sites sampled by the NSW Department of Industry – Fisheries NSW over the last 20 years (NSW DPI 2013).

All point-based occurrence surrogates were given 100% targets (Table A9.4 to A9.7) as the number of records did not cover a large part of the landscape. It was decided that it was important to include the small number of sites where these wetland indicator species where known to occur.

Any data with a spatial accuracy of less than 100 metres or an association with a human artefact, such as a farm dam, was removed from the analysis. The search method was restricted to the Border Rivers CMA region for post-1980 records and amended to only consider records that were within the Border Rivers Valley FMP 2020.

[6] Waterbird observations were excluded from the prioritisation. Waterbirds are not obligate residents, but highly mobile and dispersive species which may require habitat in multiple landscapes and use floodplain landscapes at different temporal scales (Mackey et al. 2013, Gilmore et al. 2007). Known mapped sites of waterbird breeding were used from the Eastern Australia Waterbird Survey instead of occurrence data.

## Table A9.4: Point-based fauna surrogates (native freshwater fish) assigned with 100% target and number of occurrences in unique locations

| Fauna (native freshwater fish) surrogate | Rationale for selection | Number of unique locations |
|---|---|---|
| Olive perchlet (*Ambassis agassizii*) | Recorded in the Macintyre River (Medeiros 2004; Morris et al. 2001) and Border Rivers (Davies et al. 2012). Endangered population under the *Fisheries Management Act 1994* (NSW DPI 2014). Inhabits the vegetated edges of lakes, creeks, swamps, wetlands and rivers, where it is often associated with woody habitat and aquatic vegetation in areas with little or no flow, particularly backwaters (Lintermans 2007). | 4 |
| Silver perch (*Bidyanus bidyanus*) | Listed as a vulnerable species in NSW under the *Fisheries Management Act 1994* (NSW DPI 2014). Listed critically endangered under the *EPBC Act* in December 2013 (Department of the Environment 2014). There are reports of self-sustaining populations in the Macintyre River (NSW DPI 2006a) with potentially wide distribution (Butcher and Department of Primary Industries and Fisheries 2007), however little is known about the status of these populations. Prefers fast-flowing, open waters, especially where there are rapids and races. Modification of natural river flows has led to reduced opportunities for dispersal, spawning and migration (NSW DPI 2005) as this species requires flow pulses or floods for spawning (Humphries, King, and Koehn 1999) and major spawning occurs when floodplains are inundated (Rogers and Ralph 2011). Larvae and juveniles drift onto the floodplain after major flooding (Rogers and Ralph 2011). Construction of barriers to migration and recolonisation is also likely to be a cause of its decline (NSW DPI 2014). | 1 |
| Un-specked hardyhead (*Craterocephalus stercusmuscarum fulvus*) | Found in upland and slope sections of the Border Rivers (Davies et al. 2012) around the margins of large, slow-flowing, lowland rivers, and in lakes, backwaters and billabongs (Lintermans 2007). Associated with shallow vegetated areas with sandy or muddy substrate (Ralph, Spencer, and Rayner 2011). Wetland opportunists as they spawn and recruit in floodplain wetlands (and lakes, anabranches and billabongs) during in-channel flows (Young et al. 2003). | 4 |
| Unidentified carp-gudgeon (*Hypseleotris* spp.) | Occurs in slow-flowing or still waters, normally associated with macrophyte beds or other aquatic vegetation (Lintermans 2007). Regarded as a both as a wetland and low flow opportunist, since it tends to spawn and recruit during low flows and can utilise the main channels, floodplain wetlands and secondary channels during its life cycle | 12 |
| Spangled perch (*Leiopotherapon unicolor*) | Occurs in the Macintyre-Dumaresq River system (Butcher and Department of Primary Industries and Fisheries 2007; Medeiros and Arthington 2008) and slopes and lowland sections of the Border Rivers (Davies et al. 2012). Adapted to surviving in diverse environments including rivers, billabongs, lakes and waterholes in intermittent streams (Lintermans 2007). Flooding maximises recruitment, and reduced flooding and access to floodplains likely to disadvantage it (Lintermans 2007). | 18 |

| Fauna (native freshwater fish) surrogate | Rationale for selection | Number of unique locations |
|---|---|---|
| Murray cod (*Maccullochella peelii*) | Recorded in the Border Rivers (Davies et al. 2012). A species important in Aboriginal mythology associated with deep holes in rivers consisting of instream cover such as rocks, stumps, and fallen (Lintermans 2007). Listed as a vulnerable species under the *EPBC Act. F*lows are an important factor in the larval survivorship and subsequent recruitment of Murray cod (Cheshire and Ye 2008). Changes such as river modification, clearing riparian vegetation, erosion, reduced river flows and de-snagging rivers have contributed to the decline of available habitat (Kalatzis and Baker 2010). Appears to be exclusively restricted to riverine habitats across all stages of its life history (Humphries, Serafini, and King 2002; King 2004; Koehn and Harrington 2005). | 10 |
| Golden perch (*Macquaria ambigua*) | Recorded in the Border Rivers (Davies et al. 2012) and the Macintyre-Dumaresq River system (Butcher and Department of Primary Industries and Fisheries 2007). Migratory fish species capable of upstream movements of more than 1000 kilometres (Lintermans 2007). River regulation, including barriers to migration and recolonisation has disrupted migrations and breeding behaviour (Lintermans 2007) as this species requires flow pulses or floods for spawning (Humphries et al. 1999). Commonly spawns in lowland river reaches where large numbers of juveniles then live in nurseries in inundated floodplain and shallow lake habitats before migrating long distance upstream (Gehrke and Harris 2004). | 11 |
| Murray-Darling rainbow fish (*Melanotaenia fluviatilis*) | Prefers areas of instream vegetation in slow moving waters of rivers, billabongs and swamps (Lintermans 2007; NSW DPI 2012). Recorded in the Border Rivers (Davies et al. 2012). Loss of aquatic vegetation (spawning sites and cover) and cold-water pollution are potential threats (Lintermans 2007). Tends to spawn and recruit during low flows in channels, but it can also use floodplain habitats (Young et al. 2003). | 11 |
| Bony herring (*Nematalosa erebi*) | Recorded in the Border Rivers Valley (Medeiros and Arthington 2008) and slopes and lowland sections of the Border Rivers (Davies et al. 2012; Butcher and Department of Primary Industries and Fisheries 2007). Occurs in waterways of lowland and slope environments (NSW DPI 2006b). River regulation and cold –water pollution has reduced the abundance of the species (Lintermans 2007). A main channel generalist and a wetland specialist since it tends to spawn and recruit in the main channel during high and low-flow stages (Ralph et al. 2011). It also uses anabranches, billabongs and floodplain wetlands during its life-cycle (Young et al. 2003). | 16 |
| Australian smelt (*Retropinna semoni*) | Found in the Border Rivers (Davies et al. 2012, Butcher and Department of Primary Industries and Fisheries 2007). Barriers to fish passage may be fragmenting populations (Lintermans 2007). | 6 |
| Freshwater catfish (*Tandanus tandanus*) | Recorded in the Border Rivers Valley (Butcher and Department of Primary Industries and Fisheries 2007), found in lowland lakes and slow-flowing rivers (NSW DPI 2006b, Lintermans 2007) and is an endangered population under the *Fisheries Management Act 1994*. Found in the Border Rivers (Davies et al. 2012). Cold-water pollution below dams, barriers to movement, changes to natural flow regimes including loss of habitat due to alterations to flow patterns and flooding regimes have contributed to the decline of this species (Lintermans 2007; NSW DPI 2014). | 1 |

### Table A9.5: Point-based fauna surrogates (frogs) assigned with 100% target and number of occurrences in unique locations

| Fauna (frog) surrogate | Rationale for selection | Number of unique locations |
|---|---|---|
| Barking marsh frog (*Limnodynastes fletcheri*) | Has a strong preference for areas with emergent vegetation, such as spike rush and cumbungi; particularly after flooding (Wassens 2011; Croft 2012; Healey, Thompson, and Robertson 1997). | 6 |
| Broad-palmed frog (*Litoria latopalmata*) | This species is restricted to areas near permanent and semi-permanent waters (Anstis 2013).<br>The broad palmed frog occupies a range of habitats, including flood-dependent river red gum and black box (Wassens 2011). | 7 |
| Common eastern froglet (*Crinia signifera*) | Occurs in rain-fed depressions, semi-permanent wetlands, oxbow lagoons, creeks and rivers and man-made dams and infrastructure (Wassens 2011). | 2 |
| Desert tree frog (*Litoria rubella*) | Prefers temporary water bodies and is reliant on spring and summer flooding to create pools of water (Wassens 2011). Males call from tussocks or vegetation near water (Anstis 2013). | 5 |
| Eastern sign-bearing froglet (*Crinia parinsignifera*) | Occurs in rain-fed depressions, semi-permanent wetlands, oxbow lagoons, creeks and rivers and man-made dams and infrastructure (Wassens 2011). Favours water couch habitat (Healey, Thompson, and Robertson 1997) and may prefer to breed in deeper and more permanent pools than the Common Eastern Froglet (Lintermans and Osborne 2002). | 6 |
| Salmon Striped Frog (*Limnodynastes salmini*) | During their breeding season, this species is associated with flooded grasses and dams. The tadpoles prefer warmer, shallow water with vegetation cover (Anstis 2013). | 10 |
| Spotted grass frog (*Limnodynastes tasmaniensis*) | Prefers situations where there is considerable flooded vegetation such as tussocks and sedges (Lintermans and Osborne 2002). This species will colonise any temporary or permanent pond or grassland soak (Anstis 2013).During drought periods, adults congregate around permanent water (Wassens 2011). | 19 |

### Table A9.6: Point-based fauna surrogates (Reptiles) assigned with 100% target and number of occurrences in unique locations

| Fauna (reptile) surrogate | Rationale for selection | Number of unique locations |
|---|---|---|
| Broad-shelled turtle (*Chelodina expansa*) | Prefers lacustrine habitats and slow flowing water bodies and is more frequently represented in permanent lakes and billabongs connected to main river channels (Bower and Hodges 2014). | 3 |

| Fauna (reptile) surrogate | Rationale for selection | Number of unique locations |
|---|---|---|
| Eastern snake-necked turtle (*Chelodina longicollis*) | Occupies a broad range of freshwater aquatic environments, occurring in greatest abundance in shallow, ephemeral wetlands often remote from permanent rivers (Kennett et al. 2009). Riverine habitat modification for agricultural industries, urban development and changes in river flows and flood frequency may threaten populations of this species (Kennett et al. 2009). | 4 |
| Eastern water skink or Golden water skink (*Eulamprus quoyii*) | Usually found close to or on the shore of slow flowing creeks and estuaries. The Eastern water skink is often seen basking besides small creeks, larger stream and rivers, but however is not restricted to areas near freshwater (Cogger 2000). | 1 |
| Eastern water dragon (*Itellagama lesueurii*) | Found on the slopes and a range of Eastern Australia is at the western extent of its range in the Border Rivers Valley FMP 2020 (Cogger 2000). | 1 |
| Murray turtle or Macquarie turtle (*Emydura macquarii*) | Occurs primarily in rivers and waterbodies associated with rivers such as backwaters, oxbows, anabranches and deep, permanent waterholes on the floodplains (Chessman 1988). | 2 |
| Red-bellied black snake (*Pseudechis porphyriacus*) | Usually associated with streams, swamps and lagoons. It mostly feeds on frogs, but reptiles and small mammals are also eaten (Cogger 2000; Ayers, Mazzer, and Ellis 2004). | 5 |

### Table A9.7: Point-based fauna surrogates (mammal) assigned with 100% target and number of occurrences in unique locations

| Fauna (mammal) surrogate | Rationale for selection | Number of unique locations |
|---|---|---|
| Platypus (*Ornithorhynchus anatinus*) | Adapted to feed exclusively in an aquatic environment. The diet of platypus consists of aquatic insects and crustaceans in riverine environments (Faragher, Grant, and Carrick 1979; Grant 1982).<br>It is less common in the rivers and streams of the western slopes of the Great Dividing Range (Grant 1982), however, they are reported to occur in streams flowing through agricultural land in these areas (Lunney, Grant, and Matthews 2004).Its dependency on water bodies places it at risk of sudden declines due to anthropogenic habitat modification of stream, lake and wetland systems (Kolomyjec et al. 2013). | 2 |

| Fauna (mammal) surrogate | Rationale for selection | Number of unique locations |
|---|---|---|
| Water rat<br>(*Hydromys chrysogaster*) | Inhabits streams, rivers and wetlands throughout the Murray-Darling Basin (Scott and Grant 1997)<br>This species may be found in permanent, swampy or lacustrine habitats associated with major drainages (Dickman 2004). Water rats can occur in high numbers by permanent wetlands and prefer slower moving waters and dense vegetation cover (CSIRO 2004; Scott and Grant 1997).<br>The water rat is often associated with irrigation infrastructure and may be a vagrant at ephemeral waters travelling over three kilometres overland to exploit new resources (Scott and Grant 1997; Dickman 2004). | 1 |

# Appendix 10: Marxan prioritisation (constraint surface)

Marxan addresses the minimum-set problem, which is to meet a set of targets at the lowest cost. It minimises an objective function via a process of simulated annealing to select important parts of the landscape from a larger pool of potential area's (or planning units) taking into account planning-unit costs and the locations of the conservation features for protection (Ball et al. 2009). Efficiency is a core objective of Marxan. If efficiency is ignored, prioritisation is a simple procedure of conserving everything which may be impractical (Possingham, Grantham and Rondinini 2007). The use of a constraint surface in ecological prioritisation, therefore, allows Marxan to create efficient planning solutions. A cost efficient network of priority areas is also one that is comprehensive, representative and adequate for the least possible cost and is more likely to be defensible in light of competing interests (Wilson et al. 2009).

New South Wales land capability classes were used as a surrogate for inundation likelihood to derive the constraint surface for the Border Rivers Valley FMP 2020 (Emery 1986). The eight-class classification was based on an assessment of the biophysical characteristics of the land and the extent to which these will limit a particular type of land use and the technology available for land management (Emery 1986).

Low constraint classes were most likely to be associated with high inundation frequency areas, the central constraint class was more likely to fall in moderate inundation likelihood and the high constraint class was associated with a low likelihood of inundation. An inundation likelihood product could not be used as the constraint surface because it was not available covering the entire Border Rivers Valley FMP 2020. Seven land capability constraints classes were associated with inundation likelihood and given low to high constraint values for use in Marxan (Table A10.1 and Figure A10.1).

**Table A10.1: NSW land capability class and their constraint weightings**

| NSW Land Capability Class | Land Capability codes | Constraint value in Marxan |
|---|---|---|
| Nature Reserve | N.R | 0.45 |
| Other – land best protected by green timber, Cliffs, lakes or swamps and other lands unsuitable for agricultural and pastoral production | 7, 8 | 0.50 |
| Land suitable for grazing but no cultivation | 6 | 0.65 |
| Land suitable for grazing with occasional cultivation | 4, 5 | 0.75 |
| Land suitable for regular cultivation | 1, 2, 3 | 0.85 |
| Flood irrigation | FI | 1 |
| Urban area | U | 1 |

The constraint surface represented the ability to physically connect water to floodplain assets and was used to constrain the selection of planning units in the Marxan solution. The land capability constraint values were fitted to the planning unit layer to create the constraint surface. This was done by generating an area-weighted mean (AWM) of the constraint value to give each planning unit a single value (Figure A10.1).

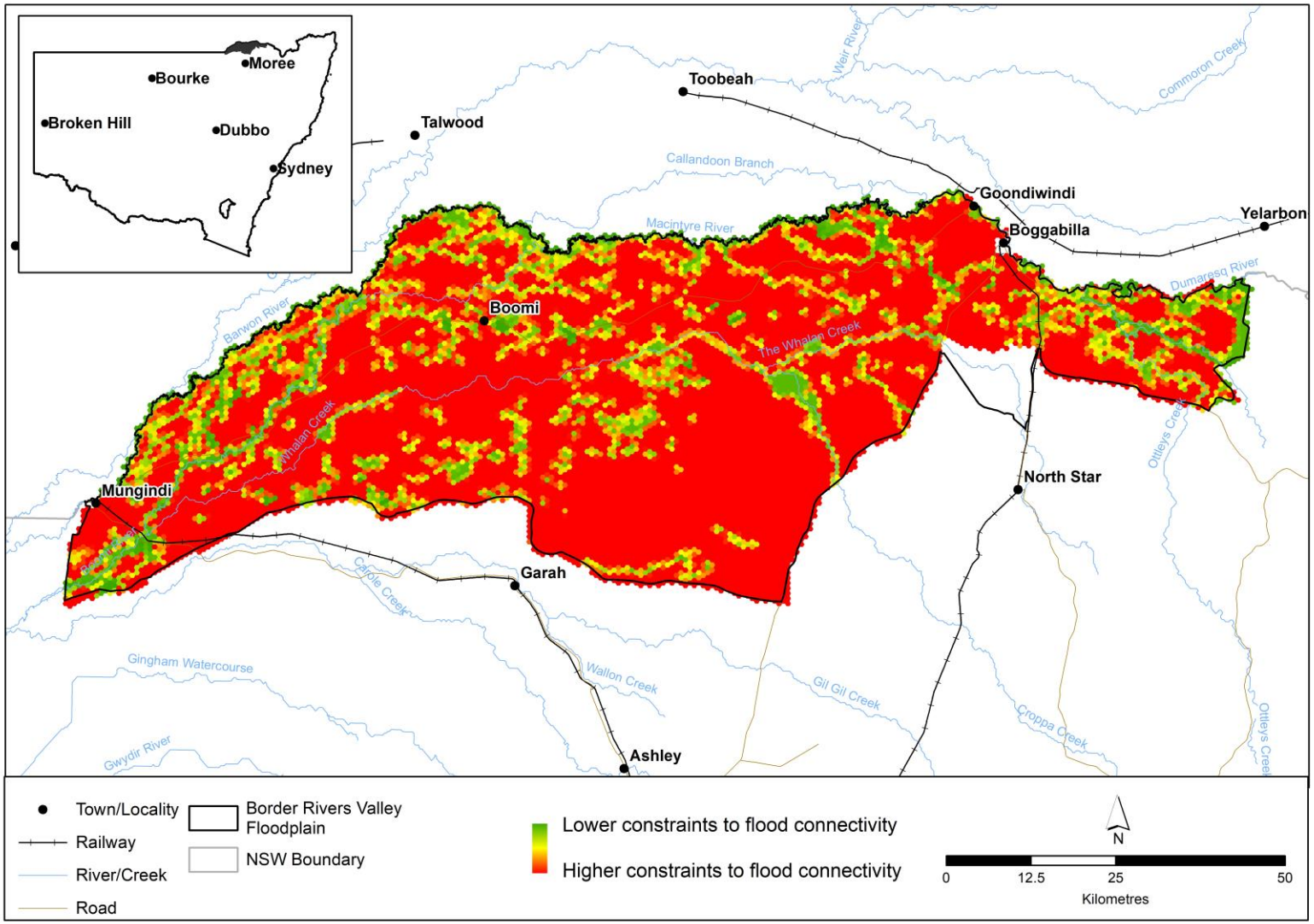


**Figure A10.1: Constraint surface for the Border Rivers Valley floodplain.**

# Appendix 11: Aboriginal values and water

## Cultural flows

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

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

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

The Border Rivers Valley FMP 2020 does not address cultural water. However, cultural water will likely be a component of the water sharing plans being prepared by the department.

## 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 (AWI) 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 allowed the department to start monitoring the success of water sharing plans in meeting their statutory requirements for performance indicators specific to Aboriginal people, including providing water for Native Title rights. The AWI ended in 2017 and internal departmental staff have carried on the work of the initiative in New South Wales.

All cultural values and features identified via the AWI in the making of the Border Rivers Valley FMP 2020 have been added to the Aboriginal Heritage Information Management System (AHIMS). The FMP includes provisions that the AHIMS database be consulted as part of the assessment and approval process of all flood work applications.

# Appendix 12: Aboriginal Sites Decision Support Tool

The Aboriginal Sites Decision Support Tool (ASDST) was developed to meet a critical need in regional planning: whole-of-landscape data describing Aboriginal site issues. There are two key components of the ASDST: landscape visualisation through the provision of visual products (GIS layers) that fill in data gaps in the Aboriginal Heritage Information Management System (AHIMS) data; and analysis, by generating information products designed to meet the need of incorporating Aboriginal site heritage information into regional, park, land and natural resource management planning.

The tool is based on and a leader in international best practice in archaeological site predictive modelling and has been successfully applied as part of a variety of projects across NSW (see further information the ASDST website (www.environment.nsw.gov.au/licences/AboriginalSitesDecisionSupportTool.htm).

## Landscape visualisation tool

A suite of state-wide products (GIS layers) of the ASDST have been developed to support regional scale context setting and strategic planning. These layers provide users with landscape context about:

- the original (pre-colonisation) potential distribution of AHIMS features
- the current potential distribution of AHIMS features
- the accumulated impact on AHIMS features across the landscape
- the reliability and validation priority of the ASDST products, and
- a classification of the landscape into areas with similar AHIMS feature profiles.

## Analytical tool

The analytical component of the ASDST generates information products (GIS layers, numerical reports and interpretive documents) that can be used to support regional planning for Aboriginal site heritage. The tool utilises modelled information about:

- accumulated impacts
- gap analysis, and
- representativeness.

In turn, this information can be used to report on issues including:

- degree of loss of different AHIMS features in the landscape
- assessment priority and developing survey strategies, and
- conservation priority.

For the Border Rivers Valley FMP 2020, the ASDST was used as a context-setting tool, to inform where there may be areas of potential flood-dependent sites, and where there are significant knowledge gaps arising from gaps in the systematic survey for flood-dependent Aboriginal sites. The ASDST data products were used to inform the identification of priority conservation areas for Aboriginal values.

Applicants are required to satisfy due diligence requirements under the *National Parks and Wildlife Service Act 1974*. The ASDST is an important tool that landholders can use prior to submitting a flood-work application to identify areas where there is a high likelihood of cultural asset occurrence. Where there is a high likelihood of cultural asset occurrence it is recommended that a cultural heritage assessment be undertaken prior to submitting a flood-work application to ensure that due diligence requirements are satisfied. More information on landholder due diligence requirements can be obtained from: http://www.environment.nsw.gov.au/licences/achregulation.html

# Appendix 13: Socio economic profile

## Background

The water management principles of the WM ACT require that planning on floodplains considers the socio-economic impacts of proposed flood-work management strategies to maximise the social and economic benefits to the community; to avoid and minimise the impacts of flood works on other water users; and to minimise the existing and future flood risk to human life and property arising from occupation on floodplains.

The Border Rivers Valley FMP 2020 contains management zones and rules that provide an equitable and consistent approach to controlling development on the floodplain. The management zones and rules are designed to minimise the impact that flood-work development may have on neighbouring properties, which will help to minimise the risk to life and property from the effects of flooding.

A socio-economic profile of the floodplain area was required so that the social and economic impact of development controls in the floodplain and flood risk to life and property from the effects of flooding can be effectively considered.

In addition, it is important that, before options about future water resource management can be developed, the floodplain area is understood and the ability of the community to absorb change is appreciated.

The objective of the profile of socio-economic factors was to assemble existing key socio-economic data which provided a general picture of the catchment in terms of its socio-demographic and economic structures.

Developing the profile, or 'snapshot', involved documenting the biophysical, social and economic conditions of the valley to help understand the floodplain. The main types of socio-economic information that informed the baseline profile included:

- geographies that are relevant to the socio-economic discussion of the floodplain,
- demographic profiles,
- household income statistics,
- employment statistics,
- economic wellbeing indicators, and
- agricultural production statistics.

The socio-economic profile analysis informed Steps 7, 8 and 10 of the preparation of the Border Rivers Valley FMP 2020. Information from this profile informed the development of management zones and rules (Steps 7 and 8). Information from this profile was also drawn upon in the socio-economic impact analysis (Step 10) that identifies and considers the potential socio-economic impacts associated with the implementation of the FMP. The socio-economic impact analysis was undertaken in coordination with the development of management zones and rules.

## Study area geography

There are several geographies that are relevant to the socio-economic discussion of flood management within the Border Rivers Valley Floodplain. As the Queensland/New South Wales State border is fully open with unfettered travel and commerce it is appropriate that the socio-economic profile considers both portions of the floodplain, while recognising that the Border Rivers Valley FMP 2020 is only in the NSW portion. The three areas examined were:

- the Border Rivers Floodplain Economy (NSW and Qld),
- the Border Rivers Rural Floodplain (NSW only), and

- the Border Rivers Urban Floodplain (NSW and Qld).

The Border Rivers Floodplain Economy area (2,418,380 ha) (Figure A12.1) includes the Border Rivers Rural and Urban Floodplains as well as the adjacent areas in the Gwydir, Barwon-Darling and Qld Border Rivers catchments that engage with the economy of the region. This area is located around the regional centre of Goondiwindi. Most goods and services consumed in the Border Rivers Floodplain Economy area are sourced from the regional centre of Goondiwindi or the small townships in this area.

The Border Rivers Rural Floodplain (727,712 ha) is the rural floodplain area downstream of Yetman along the Macintyre River to the Queensland Border, then only the NSW side of the Macintyre and Barwon rivers floodplains to just below Mungindi (Figure A12.2). The Border Rivers Valley Floodplain is bounded by the Gwydir Valley FMP 2016 in the south and the Barwon-Darling Valley FMP 2017 in the west. In the north, the New South Wales/Queensland border forms the boundary, but the Barwon and Macintyre rivers floodplain extends from Mungindi upstream to near Yelarbon. This Border Rivers Rural Floodplain area will be directly impacted by the Border Rivers Valley FMP 2020 (Figure A12.2). The community residents who live and work in this area are predominantly agriculturally 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 centre of Goondiwindi.

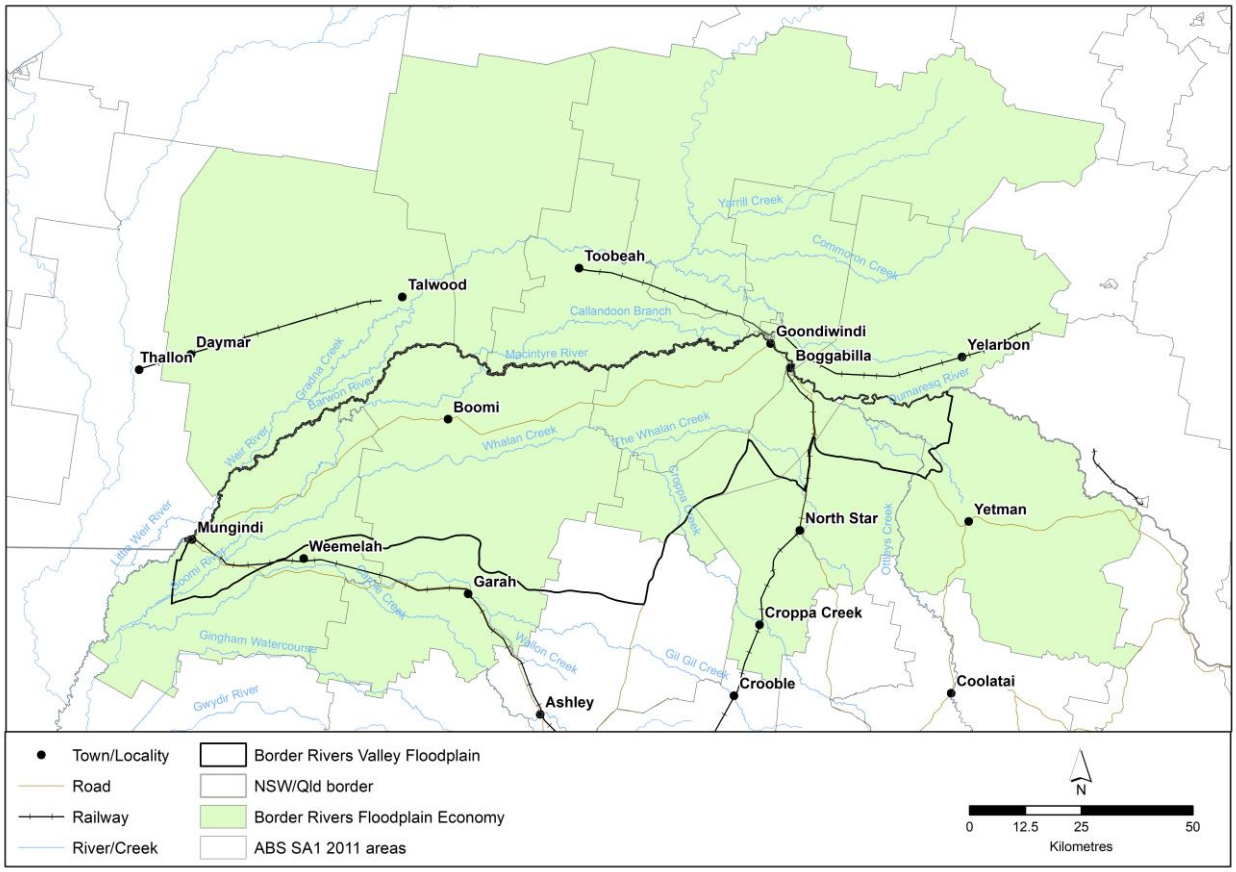


**Figure A12.1: Border Rivers Valley Floodplain and Border Rivers Floodplain Economy areas.**

The Border Rivers Urban Floodplain (3,000 ha) incorporates the regional centre of Goondiwindi (Qld) and the NSW townships of Boggabilla, Mungindi and Toomelah. While this area is situated on or adjacent to the Border Rivers Valley Floodplain, flood water management in NSW is provided under the Local Government Act (1993). In Queensland flood management in Goondiwindi is provided through local government under the Qld WA 2000 and the Planning Act (2016). 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.

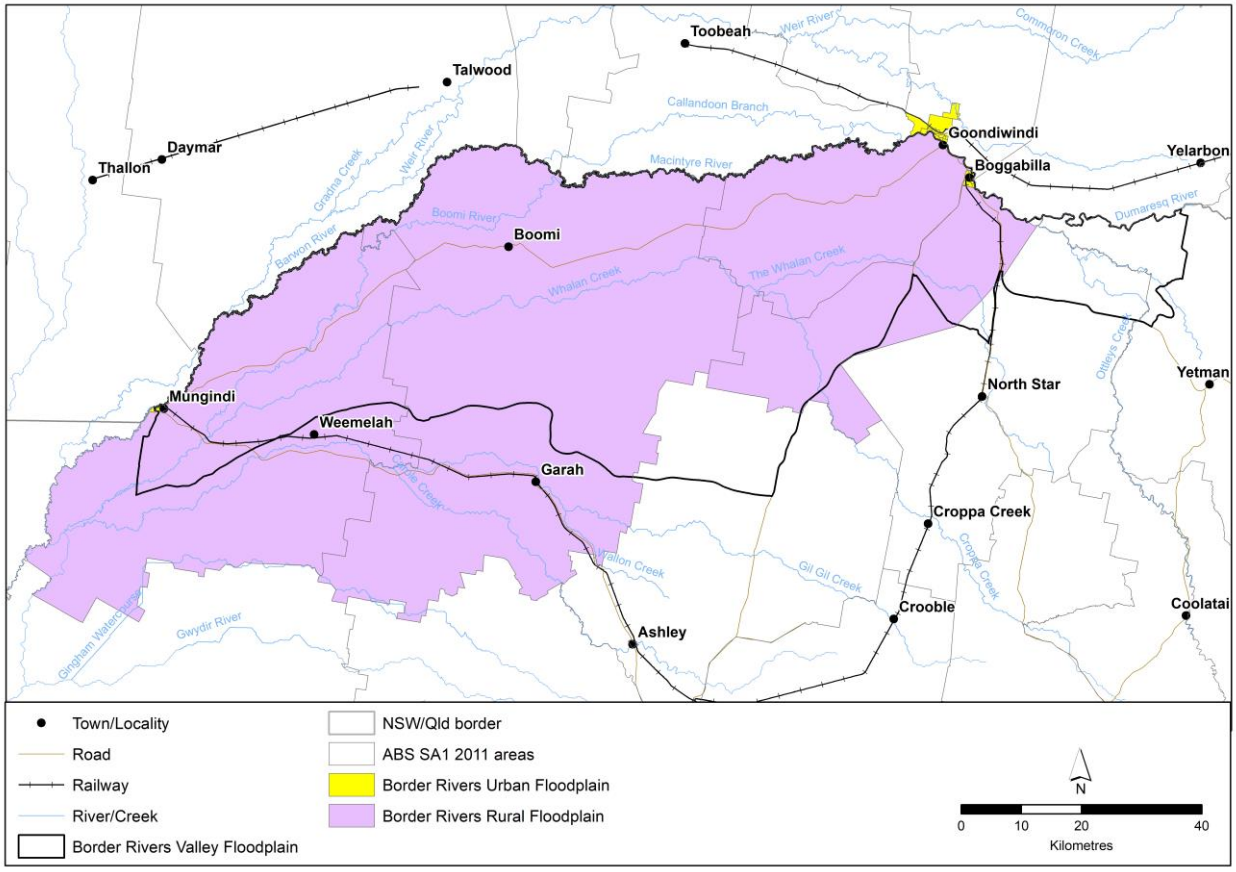


**Figure A12.2: Border Rivers Valley Floodplain and Border Rivers Rural and Urban Floodplain areas.**

# Data sources

Regional population trends for the Moree Plains (A) and Inverell (A) Local Government Areas have been drawn from the ABS Regional Population Growth 2013 data (ABS 2013).

Demographic data for the Border Rivers Floodplain Economy, the Border Rivers Rural Floodplain, and the Border Rivers Urban Floodplain; on population including Indigenous community, sex and age ratios; on household weekly incomes; and on employment, including employment and unemployment rates, labour participation rates, and employment by industry sector; is drawn from the ABS Census of Population and Housing 2011 SA1 data (ABS 2011a). The SA1 areas are the smallest unit for release of Census data. The boundaries of SA1 closely align with the boundary of the Border Rivers Floodplain Economy area and of the Rural and Urban Floodplain areas.

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

Agricultural production, derived from the floodplain, is a significant component of the 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) for two regions

that partially cover the Border Rivers Floodplain agricultural region. SA2 areas are a general-purpose medium sized area built from whole SA1s. An SA2 area represents a community that interacts socially and economically. The SA2 communities of the floodplain economy include the Moree Region and the Inverell Region-East.

# Demographic profiles

In general, regional populations have experienced gradual decline, however some have stabilised over recent years. The estimated population for the Inverell (A) Local Government Area, as measured from 2003, demonstrates a consistent low growth. Regional population trends since 2003 for the Moree Plains (A) Local Government Areas show a period of stability after a moderate decline. Regional population trends are presented in Figure A12.3.

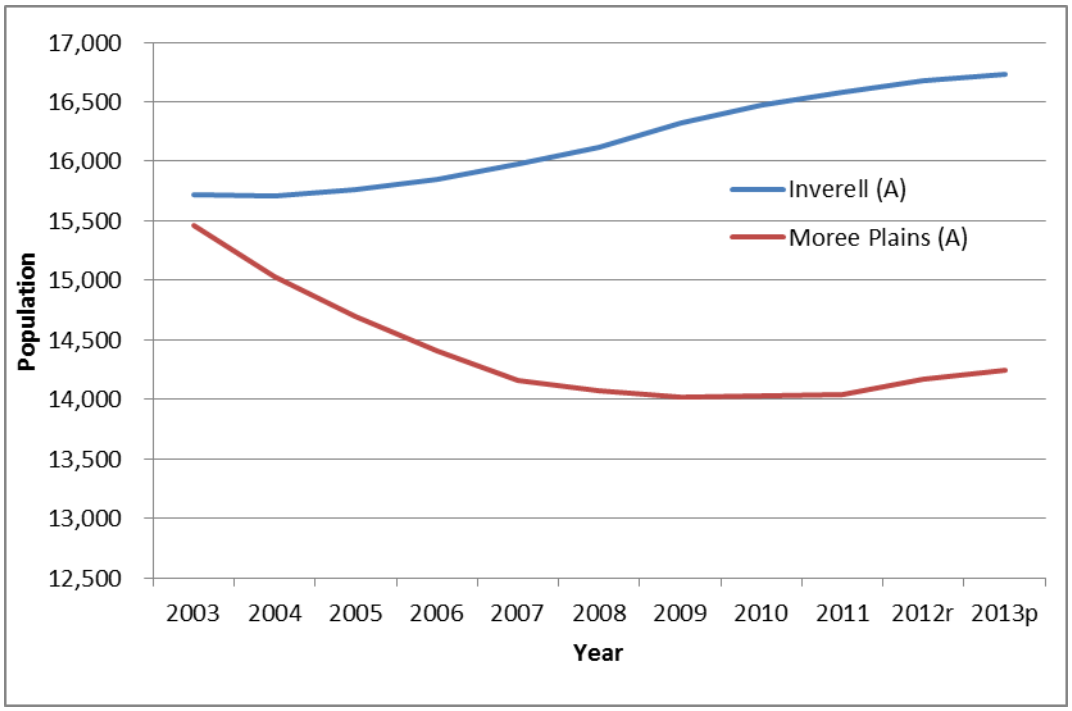


**Figure A12.3: Regional population trend by LGA 2003 – 2013.**

## Border Rivers Floodplain Economy

The economy of the Border Rivers Valley FMP 2020 area is interwoven with the economy of the adjacent north western community, drawing inputs from, passing outputs through and using services from the same business centres as the adjacent community. It is appropriate therefore to consider the socio-economic profile of the wider Border Rivers Floodplain Economy (Table A12.1).

The population of the Border Rivers Floodplain Economy area (Table A12.1) estimated to be 11,080 people, of whom 64% live in towns. This area is in both NSW and Qld. The major towns of this area are: Goondiwindi, Boggabilla and Mungindi. The overall Border Rivers Floodplain Economy total population is greater than the total of the Border Rivers Rural and Urban Floodplain populations as the boundary of the Border Rivers Floodplain Economy area includes areas in addition to the Rural and Urban Floodplain areas (see Table A12.1 and Figure A12.2).

The Indigenous community makes up 10.8% of the Border Rivers Floodplain Economy population, which is substantially higher than the NSW state proportion of 2.5%.

There is almost the same number of males and females living in the Border Rivers Floodplain Economy area; the sex ratio (the number of males per 100 females) is 101.

The dependency ratio of the Border Rivers Floodplain Economy, a measure of the number of the population that is not of working age per 100 persons of working age (aged 15-64), is 59. This dependency ratio should be read with the understanding that there are a considerable number of farmers over the age of 64 years working in the Agricultural sector.

The age by sex distribution of this community reveals an under representation in the 15 to 45 age groups, as compared to the under 15 and over 45 age groups and as compared to NSW. This under representation is demonstrated to a greater extent in the Rural Floodplain.

The age by sex distribution of the NSW and Qld Border Rivers Floodplain Economy is presented in Figure A12.4. The age by sex distribution of NSW is presented in Figure A12.5.

**Table A12.1: NSW & Qld Border Rivers Floodplain Economy demographic statistics**

| | Area | Total Population | Indigenous Population | Dependency ratio |
|---|---|---|---|---|
| New South Wales | 11,150 | 3,210 | 820 | 57 |
| Queensland | 13,030 | 7,870 | 380 | 60 |
| Total | 24,180 | 11,080 | 1,200 | 59 |

Source: ABS 2011a

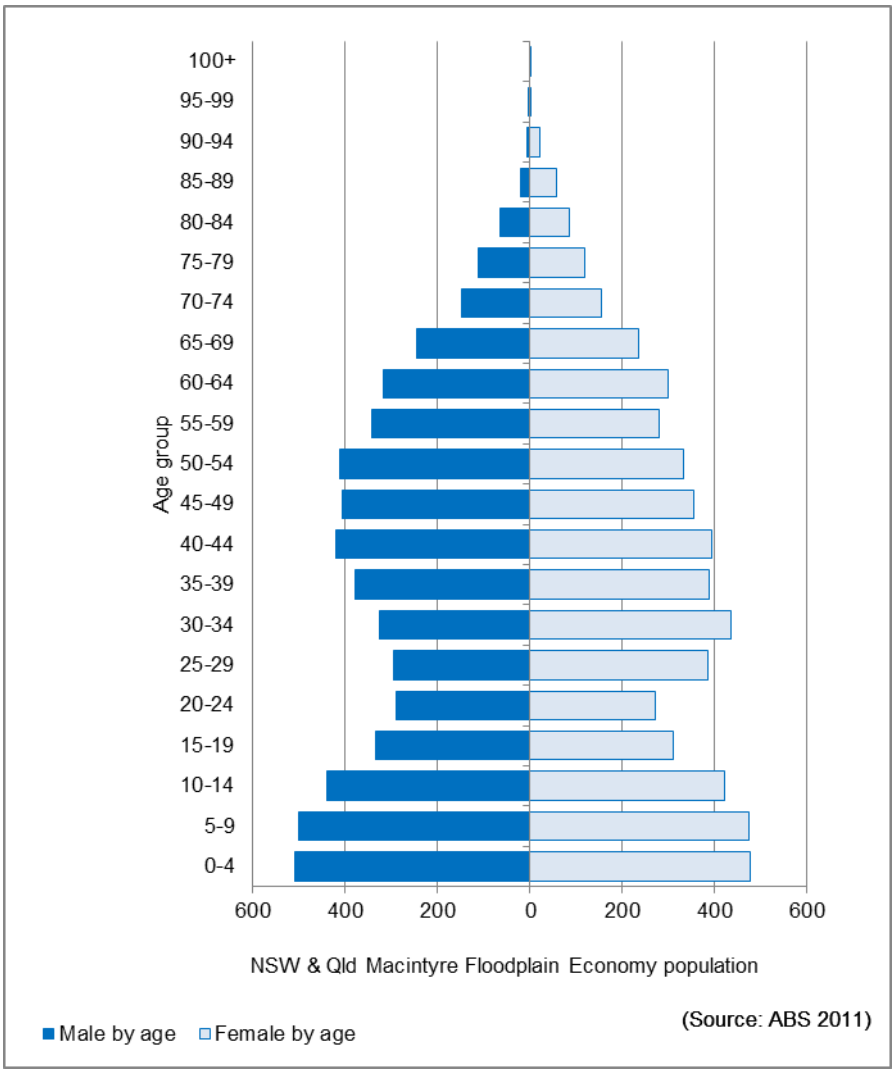


**Figure A12.4: Floodplain Economy by age group and sex 2011.**

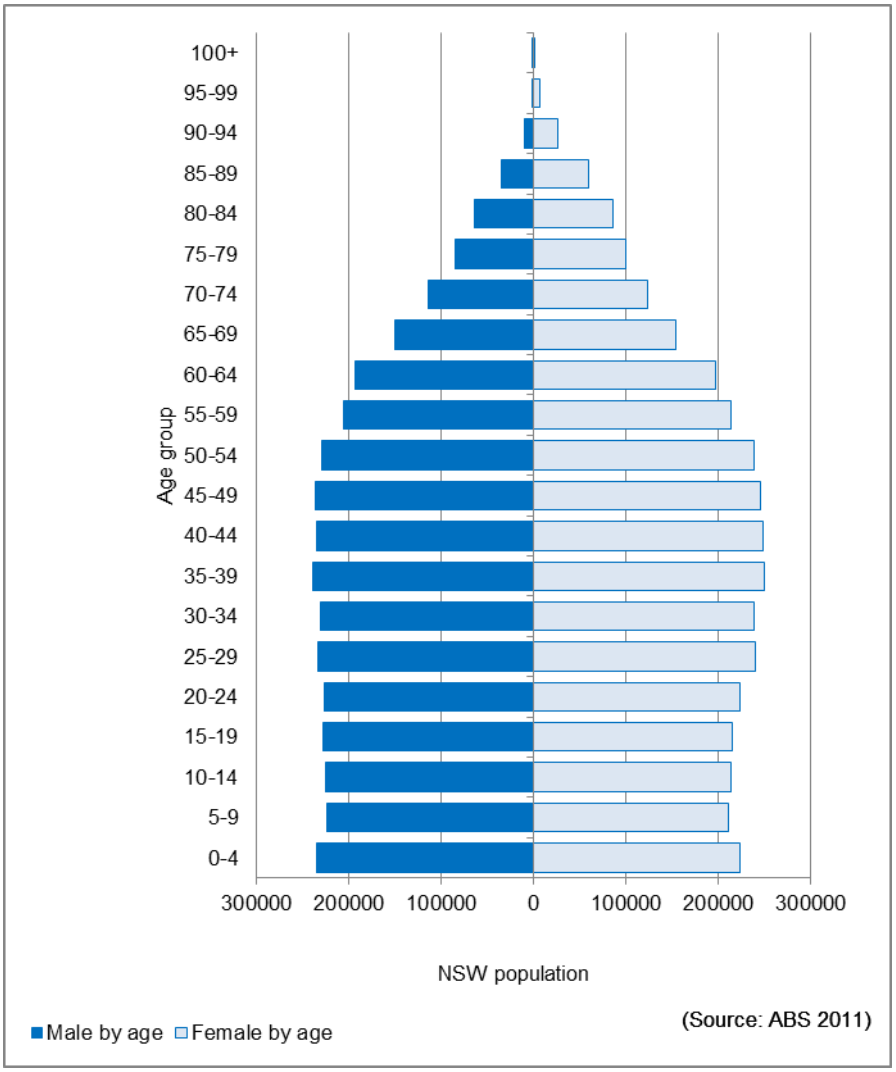


**Figure A12.5: NSW by age group and sex 2011.**

## The Border Rivers Rural Floodplain

The estimated population of the Border Rivers Rural Floodplain, calculated on the area of 7,280 square kilometres, is 1,100 people. This area is entirely in NSW. The population density of the Rural Floodplain is estimated to be 15 people per 100 square kilometres.

The Indigenous proportion of this community is 4.8%, which is almost twice that of the NSW community at 2.5%.

There are more males than females in this population, with the sex ratio of 119 considerably higher than the NSW state sex ratio of 97.

The dependency ratio of the Border Rivers Rural Floodplain is 45 although, as discussed regarding the dependency ratio calculated for the Border Rivers Floodplain Economy, a considerable number of farmers over the age of 64 years are working in the Agricultural sector.

The population pyramid (age by sex) indicates a lower than expected proportion of the population in the 15 to 45 age groups. This is likely to be related to the inaccessibility of secondary and tertiary education opportunities, and associated employment, in this area.

The age by sex distribution of the Border Rivers Rural Floodplain is presented in Figure A12.6.

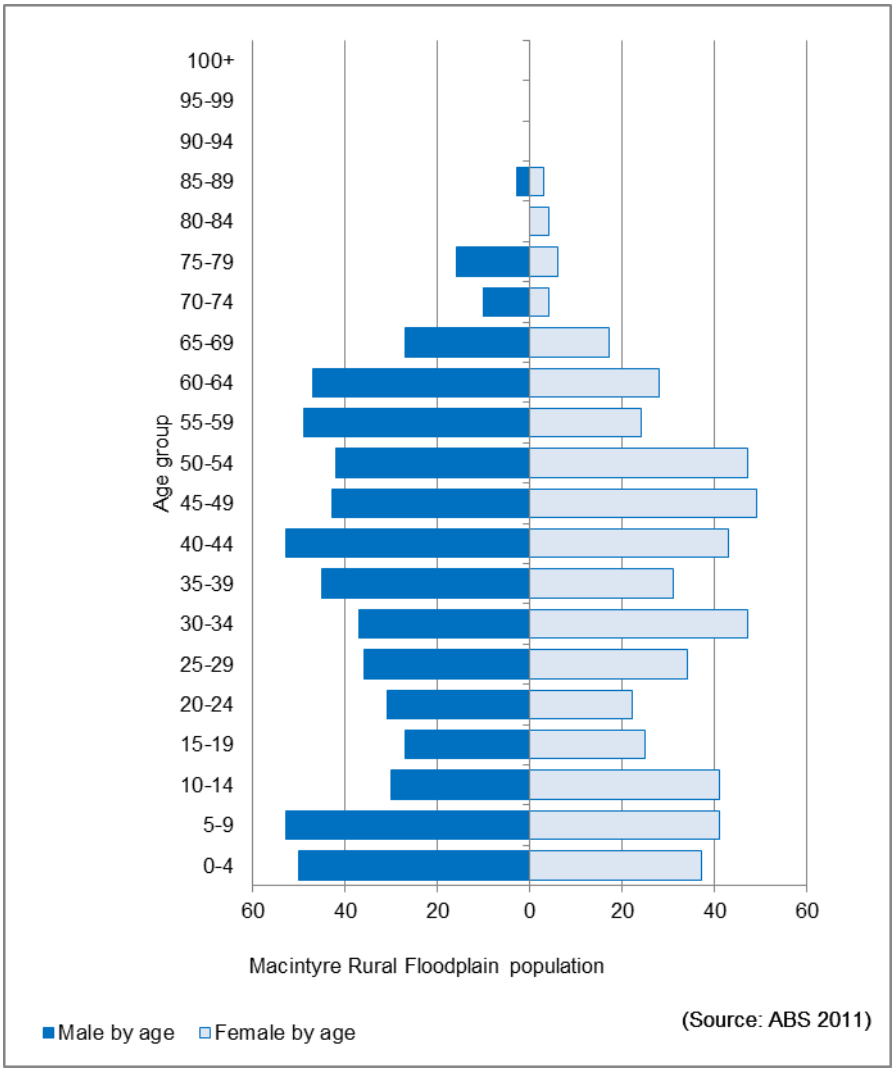


**Figure A12.6 Border Rivers Rural Floodplain population by age group and sex 2011.**

## The Border Rivers Urban Floodplain

The Border Rivers Urban Floodplain population of 7,130 people includes the urban centres of Goondiwindi (Qld) with a population of 5,800 and NSW towns of Boggabilla with 630, Mungindi with 480 and Toomelah with 230 people.

The Indigenous community constitutes 14.9% of the community which is substantially above the Rural Floodplains proportion of 4.8% and the NSW proportion of 2.5%.

The sex ratio of the Border Rivers Urban Floodplains is 94, which is lower than the Rural Floodplain and close to the NSW state sex ratio of 97.

The dependency ratio is 70, substantially higher than the adjacent Rural Floodplain community dependency ratio of 45 and the NSW state dependency ratio of 52.

The demographic statistics are presented in Table A12.2 and the age by sex distribution is presented in Figure A12.7. It is interesting to note that the urban community reflects the under representation in the 15 to 39 age groups, but to a lesser degree than, observed in the Rural Floodplain community.

**Table A12.2: NSW & Qld Border Rivers Urban Floodplain demographic statistics**

| | Area (Ha) | Total population | Indigenous population | Dependency ratio |
|---|---|---|---|---|
| Queensland: Goondiwindi | 24.7 | 5,800 | 340 | 60 |
| NSW: Boggabilla | 4.3 | 630 | 370 | 70 |
| NSW: Mungindi | 2.2 | 480 | 130 | 70 |
| NSW: Toomelah | 2.2 | 230 | 230 | 71 |
| Total Border Rivers Urban Floodplain | 33.4 | 7,130 | 1,070 | 70 |

Source: ABS 2011a

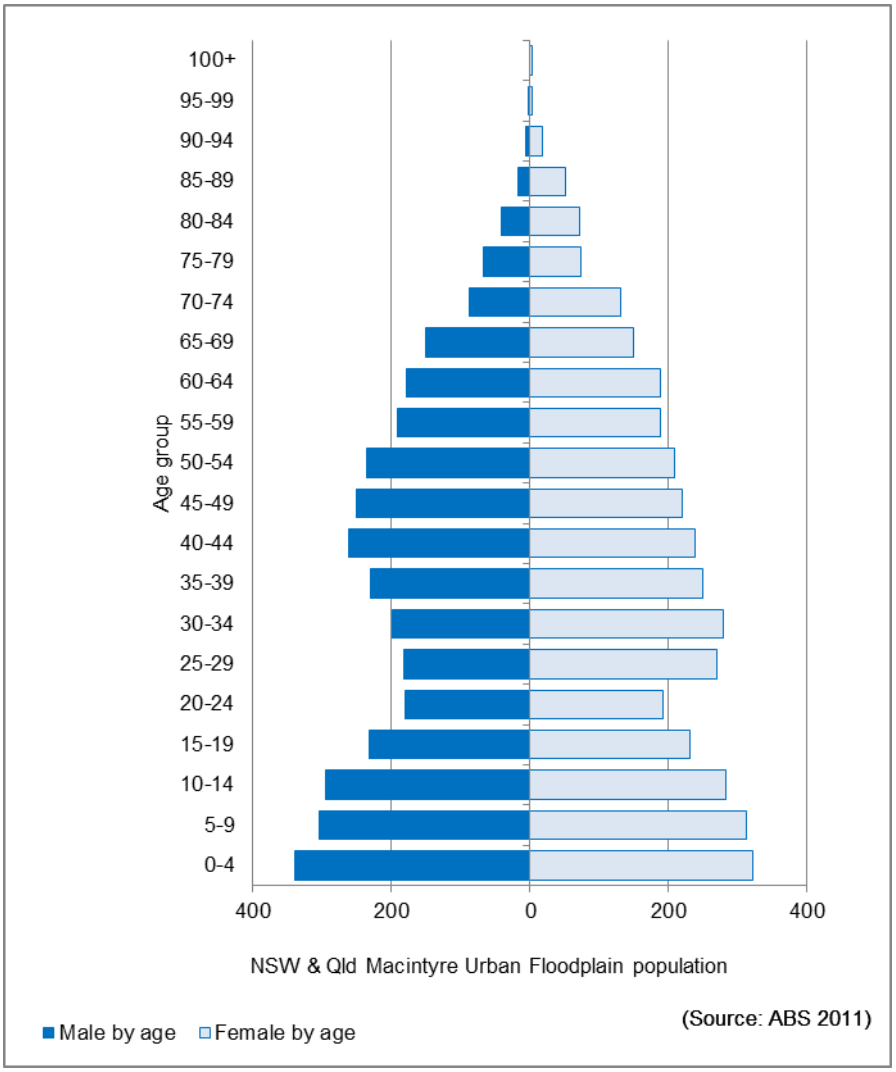


**Figure A12.7: NSW & Qld Border Rivers Urban Floodplain population by age group and sex 2011.**

# Household Income

## Border Rivers Floodplain Economy

The weekly household income in the Border Rivers Floodplain Economy closely correlates with that of the Border Rivers Urban Floodplain, with 64% of the population living in the townships. The proportion of Low income households (with weekly incomes of $599 or below) in the Border Rivers Floodplain Economy, at 22%, is close to the NSW state proportion of 23%. The proportion of Medium income households (with weekly incomes of $600 to $2,499 per week) in the Border Rivers Floodplain Economy, at 67%, is greater than the NSW proportion of 56%. Consequently, the High income household proportion of 11% is less than the NSW state proportion of 21%.

The weekly household income proportions for NSW, and for the Border Rivers Floodplain Economy, Rural Floodplain and Urban Floodplain, are presented in Figure A12.8.

## Border Rivers Rural Floodplain

The Border Rivers Rural Floodplain households in 2011 are slightly more prosperous relative to their NSW state counterparts, with a lower proportion of households in the Low income category. The proportion of households in the Low income category, at 17%, is less than the NSW state proportion of 23%. The proportion of households in the Medium income range, at 70%, is greater than the NSW state proportion of 56%. However, the High income proportion of 14% is less than the state proportion of 21%.

## Border Rivers Urban Floodplain

The Border Rivers Urban Floodplain community has the same proportion of Low income households as the NSW state, at 23%. The proportion of Medium income households at 66% is greater than the NSW state proportion of 56%, and the proportion of High income households at 11% is less than the NSW state proportion of 21%.

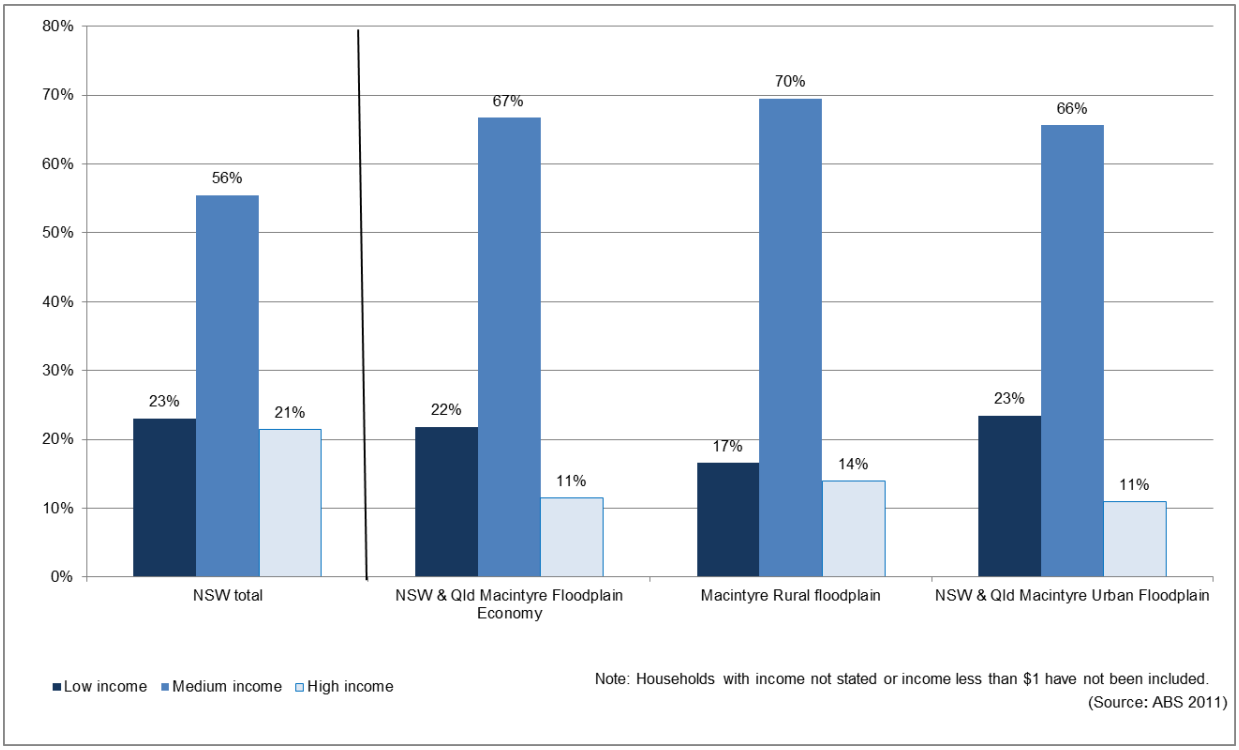


**Figure A12.8: Distribution of households in low, medium, and high income categories (%).**

# Employment

## Border Rivers Floodplain Economy

The labour force of the Border Rivers Floodplain Economy is 5,270 persons. The number of people 15 years and above is 8,250. The labour force participation rate that is the number of persons in the labour force as a percentage of persons aged 15 years and over, is 64% and is very close to the NSW participation rate of 60%.

Employment in the Border Rivers Floodplain Economy is predominantly within the Agricultural, forestry and fishing sector with 32% of employment (730 people, with this number including a large agricultural area not on the Rural Floodplain). In contrast, the NSW state Agriculture sector engages 2% of the workforce. The next most significant employment sectors are Retail trade,

Health care and social assistance, and Education and training with 10%, 8%, and 7% of employment respectively. There is a relatively even distribution of the remaining 43% of employment amongst the remaining sectors. Employment by sector for the top 10 sectors in the Border Rivers Floodplain Economy is presented in Figure A12.9, and for NSW State total in Figure A12.10.

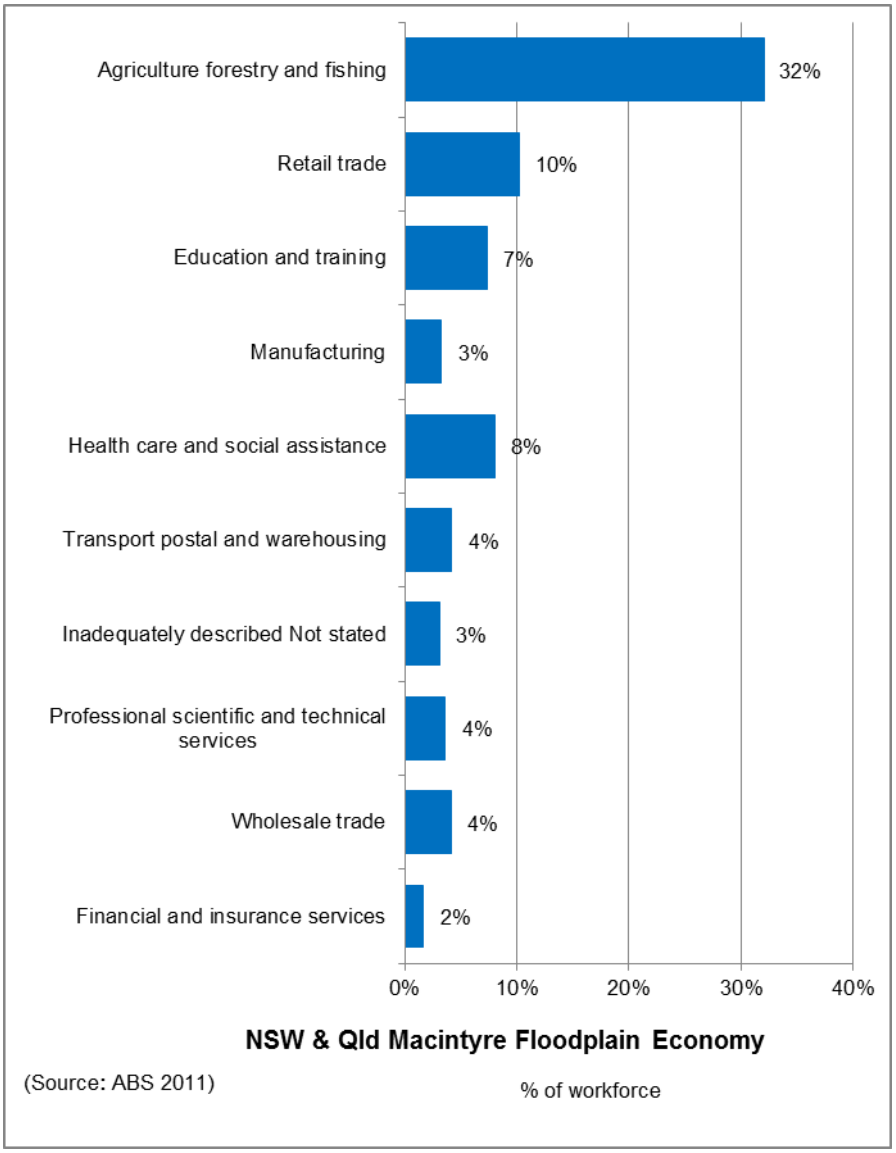


**Figure A12.9: NSW & Qld Border Rivers Floodplain Economy employment by industry sector.**

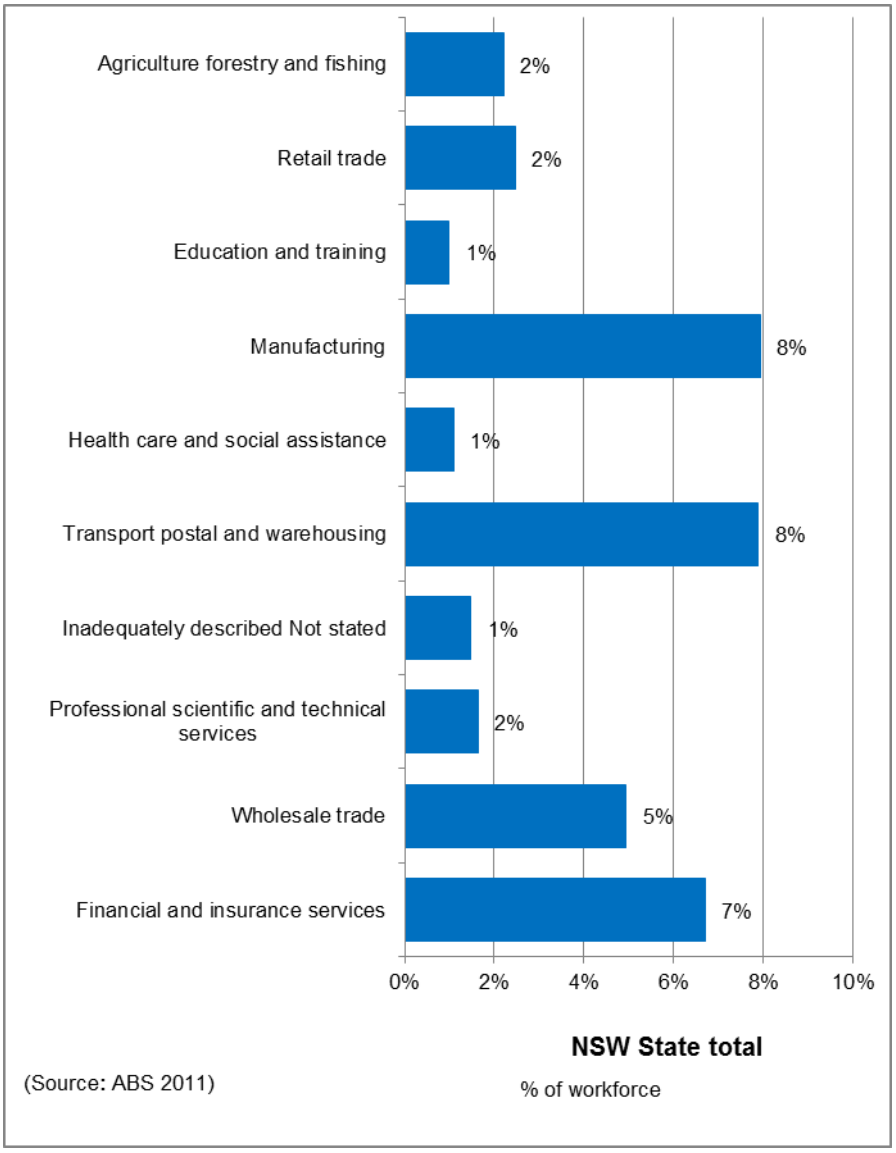


**Figure A12.10: NSW State economy employment by industry sector.**

## Border Rivers Rural Floodplain

The labour force of the Rural Floodplain is 620 persons. The population 15 years and above is 850 persons. The labour force participation rate is 73%, markedly higher than the NSW participation rate of 60%.

Employment in the Border Rivers Rural Floodplain is dominated by the Agriculture, forestry and fishing sector, with 68% of the workforce or 423 people, working in the agricultural industry. This is in sharp contrast to the NSW state agriculture sector which engages only 2% of the workforce. The next most significant employment sector of the Border Rivers Rural Floodplain is Retail trade, constituting 4% of the workforce. Employment by sector for the top 10 sectors in the Rural Floodplain is presented in Figure A12.11.

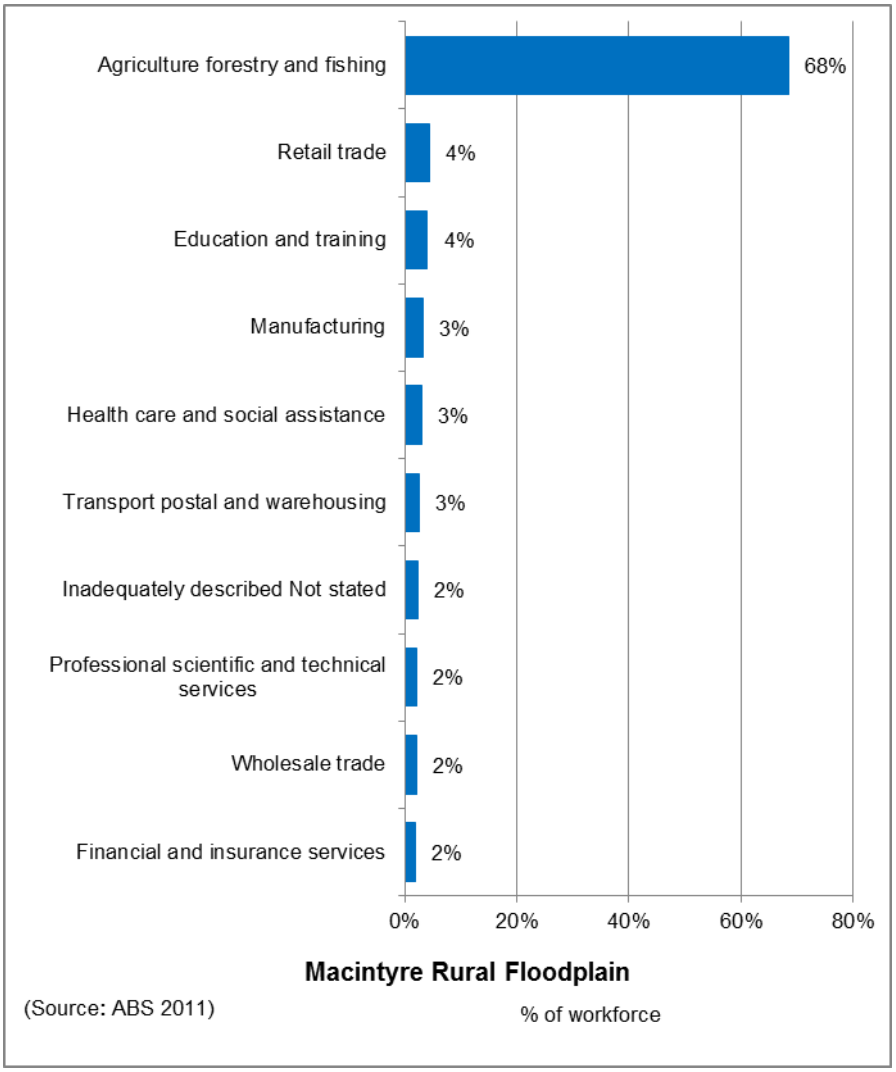


**Figure A12.11: Border Rivers Rural Floodplain employment by industry sector.**

## Border Rivers Urban Floodplain

The labour force of the Urban Floodplain is 3,160 persons. The population 15 years and above is 5,280 persons. The labour force participation rate is 60%, the same as the NSW average, but lower than both the participation rate in the Floodplain Economy and the Rural Floodplain.

In contrast with the surrounding rural community, employment in the Border Rivers Urban Floodplain is reasonably evenly distributed across sectors. A significant proportion of the workforce is employed in the service sectors. The Retail trade sector is the most significant employer with 14% of the workforce closely followed by Agriculture, forestry and fishing (12%, with 370 workers), and then by Health care and social assistance (10%). Employment by sector, for the top 10 sectors in the Urban Floodplain, is presented in Figure A12.12.

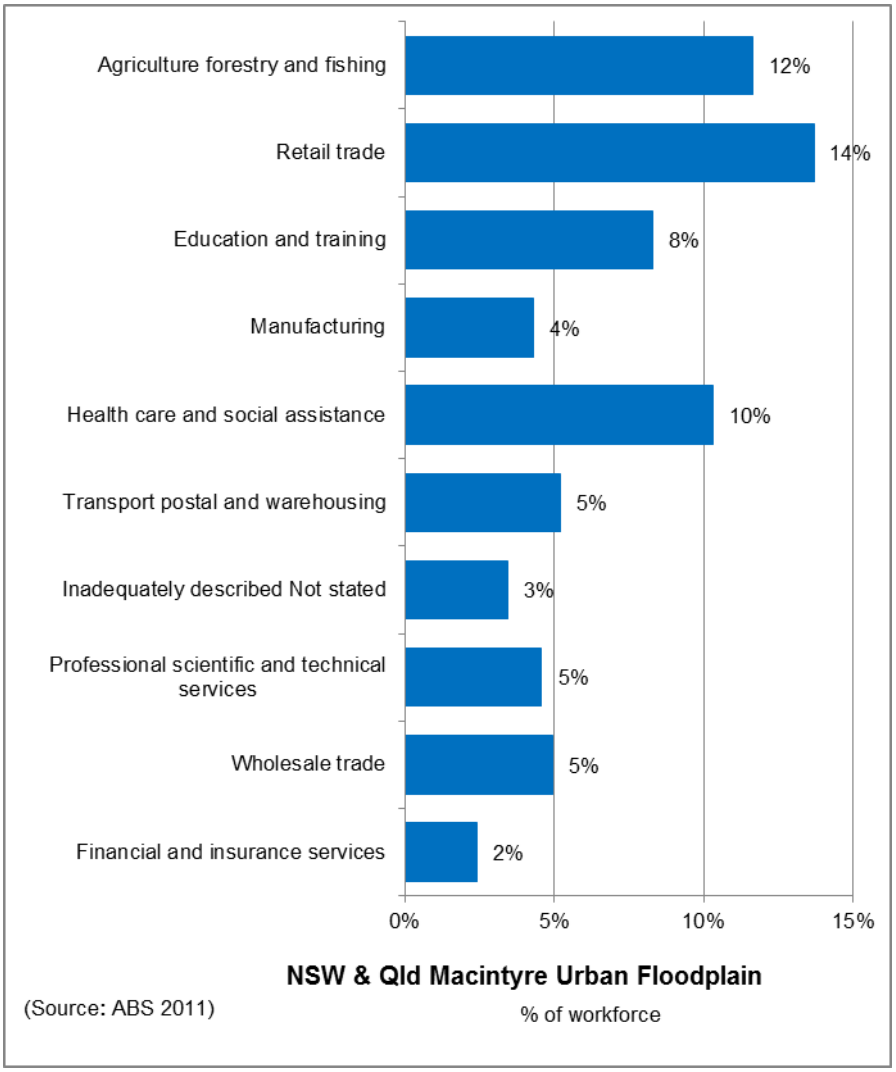


**Figure A12.12: NSW & Qld Border Rivers Urban Floodplain employment by industry sector.**

# Estimated employment of the Border Rivers Valley FMP 2020 area

Given the location of the townships, it is assumed that about one quarter of the 370 NSW & Qld Border Rivers Urban Floodplain residents employed in the Agriculture sector work in the Border Rivers Valley FMP 2020 area while the other three quarters would be working in the other adjacent areas of agriculture in NSW or Queensland.

The estimated total employment in the agricultural sector potentially impacted by the Border Rivers Valley FMP 2020 is 410 persons, counting the 318 Agriculture workers from the Rural Floodplain (423 adjusted to 318 as the area of the Rural Floodplain is larger than the Border Rivers Valley FMP 2020 area) and one quarter of the 370 (92) Agriculture workers from the Urban Floodplain.

# Wellbeing Indicators

Socio-Economic Indexes for Areas (SEIFA) is a product developed by the ABS that ranks areas in Australia according to relative socio-economic advantage and disadvantage (ABS 2011b). The indexes are based on information from the five-yearly Census. The index scores are on an arbitrary numerical scale; the scores do not represent some quantity of advantage or disadvantage. As measures of socio-economic level, the indexes are best interpreted as ordinal

measures. They can be used to rank (order) areas and illustrate the distribution of socio-economic conditions across different areas.

The Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) summarises 25 variables that indicate either relative advantage or disadvantage. This index ranks areas on a continuum from most disadvantaged to most advantaged. An area with a high score on this index has a relatively high incidence of advantage and a relatively low incidence of disadvantage.

The IRSAD scores for the whole of the Local Government Areas of Moree Plains (A) and Inverell (A) are in the 2nd decile of NSW, demonstrating distinct relative disadvantage.

At the SA1, level, the lowest area IRSAD score is 473 (ranked 3, decile 1 in the state), located in the township of Toomelah. The highest scoring area has a score of 1,097 (decile 10 in Queensland) which is the urban area on the western edge of Goondiwindi.

The range and distribution of the IRSAD scores for the floodplain area are presented in Figure A12.13. The dark green areas have a score that is amongst the lowest 10% of scores for the state, being the relatively more disadvantaged. The red areas are areas of advantage while the yellow areas are relatively neither advantaged nor disadvantaged. The IRSAD scores for the smaller SA1 areas representing the townships of Boggabilla and Mungindi (see insert in Figure A12.13) are shaded green indicating that they are relatively disadvantaged. The rural floodplain areas are generally shaded yellow to light orange (deciles 5, 6 and 7) indicating that they are relatively advantaged, excepting the upstream SA1 in decile 3 which is marginally disadvantaged.

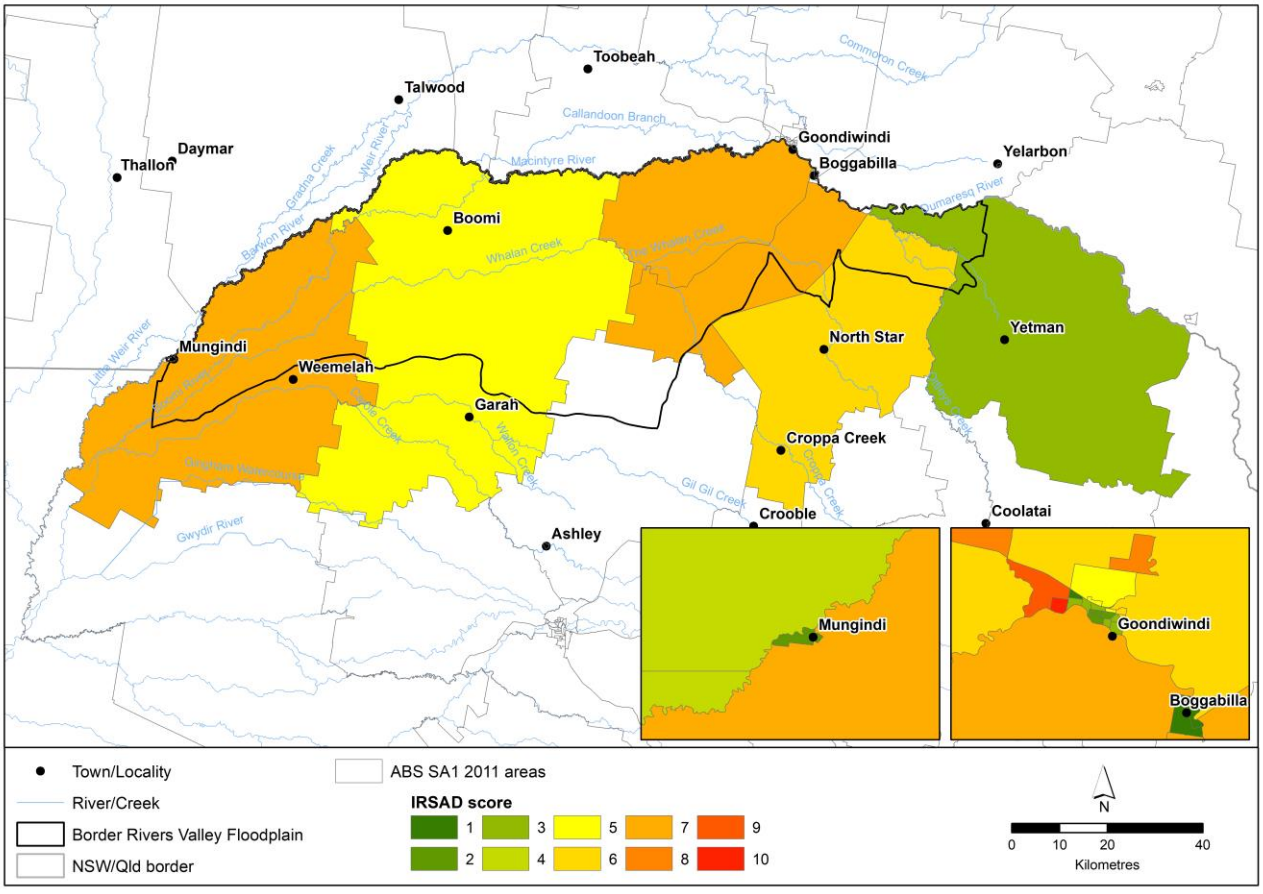


**Figure A12.13: Index of Relative Socio-economic Advantage and Disadvantage, State decile.**

# Agricultural Production

Agricultural production is the significant production activity of the region's economy, occupying 94% of the farm holding area in the Border Rivers Valley FMP 2020 area. Agricultural production is

predominantly cropping, which is dominated by cotton and to a lesser extent wheat. Irrigation on the Border Rivers Rural Floodplain is dominated by irrigated cotton production. The regional economy is structured to process the inputs and outputs of these industries and provide the services they require. The performance of the regional economy responds in large part to the fortunes of the cotton and wheat industries.

The ABS Agricultural Census 2011 provides agricultural production statistics for the Moree Region and Inverell Region-East SA2 areas that cover the majority of the Border Rivers Valley FMP 2020 and the Border Rivers Rural Floodplain (ABS 2011c). The combined area of these two regions is distinct from the FMP area, as the combined area includes a substantial area of non-floodplain to the east and south of the Border Rivers Rural Floodplain (Figure A12.2).

## Overall Agricultural Production

In the Border Rivers Valley FMP 2020 region, entirely in NSW, broad acre cropping and livestock production are the predominant agricultural products. The value and area of holding of these products in the Border Rivers Valley FMP 2020 area was estimated based on the following assumptions:

- cotton, wheat and livestock agricultural production and area of holding is evenly distributed throughout the regions;
- the estimated percentage of area of each ABS SA2 region within the Border Rivers Valley FMP 2020 area are Moree Region 27%, and Inverell Region-East 2%;
- for each region, the value and area of agricultural production of individual crops and products within the Border Rivers Valley FMP 2020 area as a percentage of total production within these region, are proportionate to the estimated percentage of area of the region within the Border Rivers Valley FMP 2020 area; and
- the value and area of agricultural production of individual crops and products for the Border Rivers Valley FMP 2020 area are the sum of the proportional estimates for the Moree Region and Inverell Region-East regions.

As agricultural production is not evenly distributed across the area of these regions, the values derived and presented below provide estimates (only) of the value of production and the area of holding in the Border Rivers Valley FMP 2020 area (Figure A12.14). Horticultural and pigs, goats and poultry production are not included in the estimated totals because their production is not conventionally undertaken in the floodplain area.

The Gross Value of Agricultural Production (GVAP) in 2010-2011 in the Border Rivers Valley FMP 2020 area, using a farm holding area of 438,100 hectares, is estimated to be $234 million or 2.0% of total NSW GVAP. Broadacre cropping estimated at $222 million constitutes 95% of the GVAP of production within the Border Rivers Valley FMP 2020, using 247,000 hectares or 56% of the area (Table A12.3). The highest value producing individual broadacre crops are Cotton yielding $118 million or 50%, and Wheat yielding $55 million or 24%, of the total Border Rivers Valley FMP 2020 area GVAP. Livestock and livestock products yield $12 million, accounting for 5% of GVAP while using 38% of the area. Data for GVAP and area of holding is presented in Table A12.3 and Table A12.4.

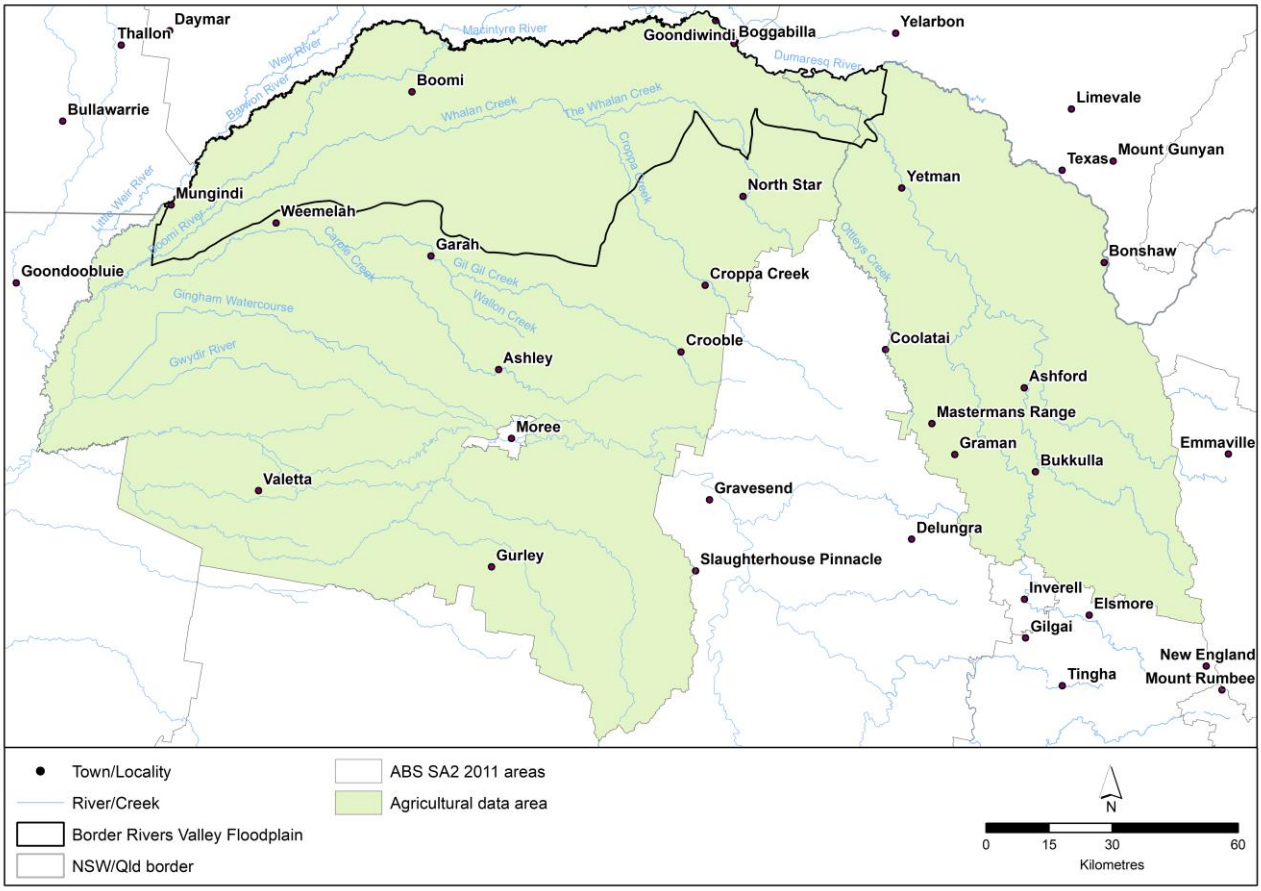


**Figure A12.14: Border Rivers Valley FMP 2020 and Agricultural data area.**

### Table A12.3: Overview of gross value of agricultural production 2011 by region and NSW total (Source: Based on ABS Agricultural Census 2011 data)

| Gross Value of Agricultural Production ($M) | Inverell Region-East ($M) | Moree Region ($M) | Estimated Border Rivers Rural Floodplain ($M) | NSW Total ($M) |
|---|---|---|---|---|
| Broadacre crops – Cereal crops for grain – Wheat for grain | 5 | 206 | 55 | 2,511 |
| Broadacre crops – Cereal crops for grain – excluding wheat | 9 | 117 | 31 | 998 |
| Legumes for grain | 1 | 52 | 14 | 237 |
| Oilseeds | 2 | 10 | 3 | 438 |
| Hay – Pasture and cereal and other crops cut for hay | 3 | 2 | 1 | 284 |
| Other crops – Cotton | 2 | 442 | 118 | 1,126 |
| Other crops – excluding cotton | 1 | 1 | 0 | 97 |
| **Total value of broadacre crops** | **22** | **829** | **222** | **5,690** |
| Horticulture – Fruit | - | na | na | 1,708 |
| Horticulture – Nurseries and cut flowers and cultivated turf | - | na | na | 312 |
| **Total Horticulture** | **-** | **na** | **na** | **2,020** |
| Livestock products – Whole milk | 0 | - | 0 | 505 |
| Livestock products – slaughtered and other disposals – Cattle and calves | 38 | 30 | 9 | 1,616 |
| Livestock products – Wool | 10 | 7 | 2 | 853 |
| Livestock products – slaughtered and other disposals – Sheep and lambs | 8 | 5 | 1 | 610 |
| Livestock products – slaughtered and other disposals – Pigs | - | na | na | 166 |
| Livestock products – slaughtered and other disposals – Goats | - | na | na | 6 |
| Livestock products – Eggs produced for human consumption | - | - | - | 194 |
| Livestock products – slaughtered and other disposals – Poultry | - | na | na | 686 |
| **Total Livestock and livestock products** | **56** | **41** | **12** | **4,635** |
| **Agriculture – Total Value ($M)** | **77** | **871** | **234** | **11,714** |

Note. 'NA' means that this crop is unlikely to occupy floodplain land. Source: Based on ABS Agricultural Census 2011 data. The ABS Agricultural Census 2011 identifies the area watered and the quantity of water used by irrigated agricultural production for the Inverell Region–East and Moree regions in 2010–11 (ABS 2011a). 2% of the irrigated agriculture in the Inverell Region–East and 27% of Moree Region were included in the Border Rivers Valley Floodplain.

### Table A12.4: Overview of land (ha) mainly used for agricultural production 2011 (Source: Based on ABS Agricultural Census 2011 data)

| Area | Inverell Region-East | Moree Region | Estimated Border Rivers Rural Floodplain | NSW Total |
|---|---|---|---|---|
| Broadacre crops – cereals Wheat for grain | 8,893 | 334,725 | 89,419 | 3,814,726 |
| Broadacre crops – cereals – other than Wheat for grain | 17,845 | 192,613 | 51,698 | 1,637,949 |
| Broadacre crops – non-cereal – Cotton | 767 | 133,447 | 35,596 | 329,665 |
| Broadacre crops – non cereal – other than Cotton | 6,700 | 185,742 | 49,653 | 1,262,087 |
| **Land mainly used for agriculture – Crops** | **62,662** | **921,706** | **246,956** | **9,209,190** |
| Horticulture – Orchard fruit and nut trees | - | - | - | 47,483 |
| Horticulture – Grapevines for wine production | - | - | - | 42,246 |

| Area | Inverell Region-East | Moree Region | Estimated Border Rivers Rural Floodplain | NSW Total |
|---|---|---|---|---|
| Horticulture – Nurseries cut flowers and cultivated turf | - | - | - | 4,529 |
| Hay and Silage – Hay | 3,969 | 4,092 | 1,167 | 312,513 |
| Pasture seed production – Clean pasture seed produced | 32 | - | 1 | 18,280 |
| Land mainly used for agriculture – Total grazing | 449,430 | 586,493 | 164,980 | 46,419,229 |
| Land mainly used for agriculture – Other agricultural purposes | 965 | 410 | 128 | 29,377 |
| Land mainly used for agriculture – Forestry plantation | 5,942 | 9 | 116 | 112,489 |
| **Area of holding – Total area of holding** | **572,082** | **1,602,128** | **438,129** | **58,326,346** |

Note. Source: Based on ABS Agricultural Census 2011 data. The ABS Agricultural Census 2011 identifies the area watered and the quantity of water used by irrigated agricultural production for the Inverell Region–East and Moree regions in 2010–11 (ABS 2011a). 2% of the irrigated agriculture in the Inverell Region–East and 27% of Moree Region were included in the Border Rivers Valley Floodplain.

## Irrigated Agricultural Production

The ABS Agricultural Census 2011 identifies the area watered and the quantity of water used by irrigated agricultural production for the Moree Region and Inverell Region-East regions in 2010-2011 (ABS 2011c).

The total area watered and the total quantity of water used by the two regions represent the total irrigated area and quantity of water used in the Border Rivers Valley FMP 2020 area, based on the assumption that irrigated agriculture in the Moree Region and Inverell Region-East regions is predominantly situated in the Border Rivers Valley FMP 2020 area.

Horticultural production is not included in the estimated totals because its production is not conventionally undertaken in the floodplain area.

There was a total of 19,300 hectares of irrigated land in the Border Rivers Valley FMP 2020 area in 2010-2011. This area of irrigated land constitutes approximately 4% of the Border Rivers Valley FMP 2020 farm holding area.

It is estimated that 110,900 megalitres of water was extracted for agricultural irrigation across the Moree Region and Inverell Region-East regions in 2010-2011. The majority of the irrigation water used in 2010-2011 was applied to cotton, using 107,500 megalitres or 97%, at an estimated average rate of 5.9 megalitres per hectare. Irrigation for cotton used an estimated 18,200 hectares or 94% of the estimated Border Rivers Rural Floodplain irrigated area. Data for irrigation activity is presented in Table A12.5 and Table A12.6.

**Table A12.5: Area (ha) of irrigated agricultural production 2011 (Source: Based on ABS Agricultural Census 2011 data)**

| Area watered (ha) | Inverell Region-East | Moree Region | Estimated Border Rivers Rural Floodplain | NSW Total |
|---|---|---|---|---|
| Cereal crops – for Grain or Seed (for example wheat / oats / maize) | 302 | 2,171 | 585 | 5,377,721 |
| Other crops – Broadacre other (for example canola / field beans / lupins / sunflowers/ poppies) | 121 | 269 | 74 | 1,261,888 |
| Other crops – Cotton | 304 | 68,378 | 18,237 | 329,665 |
| Cereal crops – Cut for Hay (inc. wheat / oats / forage sorghum) | 109 | 57 | 17 | 104,019 |
| Fruit or Nut trees/ Plantation or Berry fruits (exc Grapes) | na | na | na | 49,842 |
| Grapevines | na | na | na | 44,155 |

| Area watered (ha) | Inverell Region-East | Moree Region | Estimated Border Rivers Rural Floodplain | NSW Total |
|---|---|---|---|---|
| Nurseries/ Cut flowers/ Cultivated turf | - | - | - | 4,529 |
| Pasture – Cut for Hay | 185 | 44 | 15 | 165,217 |
| Pasture – for Grazing | 22 | 748 | 200 | 46,419,230 |
| Pasture – for Seed | 56 | 83 | 23 | 18,280 |
| **Total area watered and used – area watered** | **2,173** | **72,363** | **19,336** | **674,064** |

Note. 'NA' means that this crop is unlikely to occupy floodplain land. Source: Based on ABS Agricultural Census 2011 data. The ABS Agricultural Census 2011 identifies the area watered and the quantity of water used by irrigated agricultural production for the Inverell Region–East and Moree regions in 2010–11 (ABS 2011a). 2% of the irrigated agriculture in the Inverell Region–East and 27% of Moree Region were included in the Border Rivers Valley Floodplain

### Table A12.6: Water used (ML) for Irrigated Agricultural Production 2010-2011(ABS 2011c).

| Water for agricultural production (ML) | Inverell Region-East | Moree Region | Estimated Border Rivers Rural Floodplain | NSW Total |
|---|---|---|---|---|
| Cereal crops – Cut for Hay (inc. wheat / oats / forage sorghum) | 106 | 51 | 16 | 13,989 |
| Cereal crops – for Grain or Seed (for example wheat / oats / maize) | 333 | 3,027 | 814 | 203,841 |
| Other crops – Broadacre other | 188 | 1,001 | 271 | 809,078 |
| Other crops – Cotton -Volume applied | 1,020 | 403,198 | 107,525 | 1,073,849 |
| Fruit or Nut trees/ Plantation or Berry fruits (exc Grapes) | 66 | 8,134 | 2,170 | 94,237 |
| Grapevines | na | - | na | 106,594 |
| Nurseries/ Cut flowers/ Cultivated turf | - | - | - | 17,596 |
| Pasture – Cut for Hay | 1,140 | 277 | 96 | 78,406 |
| Pasture – for Grazing | 117 | 15 | 6 | 232,629 |
| Pasture – for Seed | 15 | 34 | 9 | 6,281 |
| Total area watered and used | **3,424** | **415,781** | **110,926** | **2,745,896** |

Note. 'NA' means that this crop is unlikely to occupy floodplain land. Source: Based on ABS Agricultural Census 2011 data. The ABS Agricultural Census 2011 identifies the area watered and the quantity of water used by irrigated agricultural production for the Inverell Region–East and Moree regions in 2010–11 (ABS 2011a). 2% of the irrigated agriculture in the Inverell Region–East and 27% of Moree Region were included in the Border Rivers Valley Floodplain

# Appendix 14: Quadrants of management zones

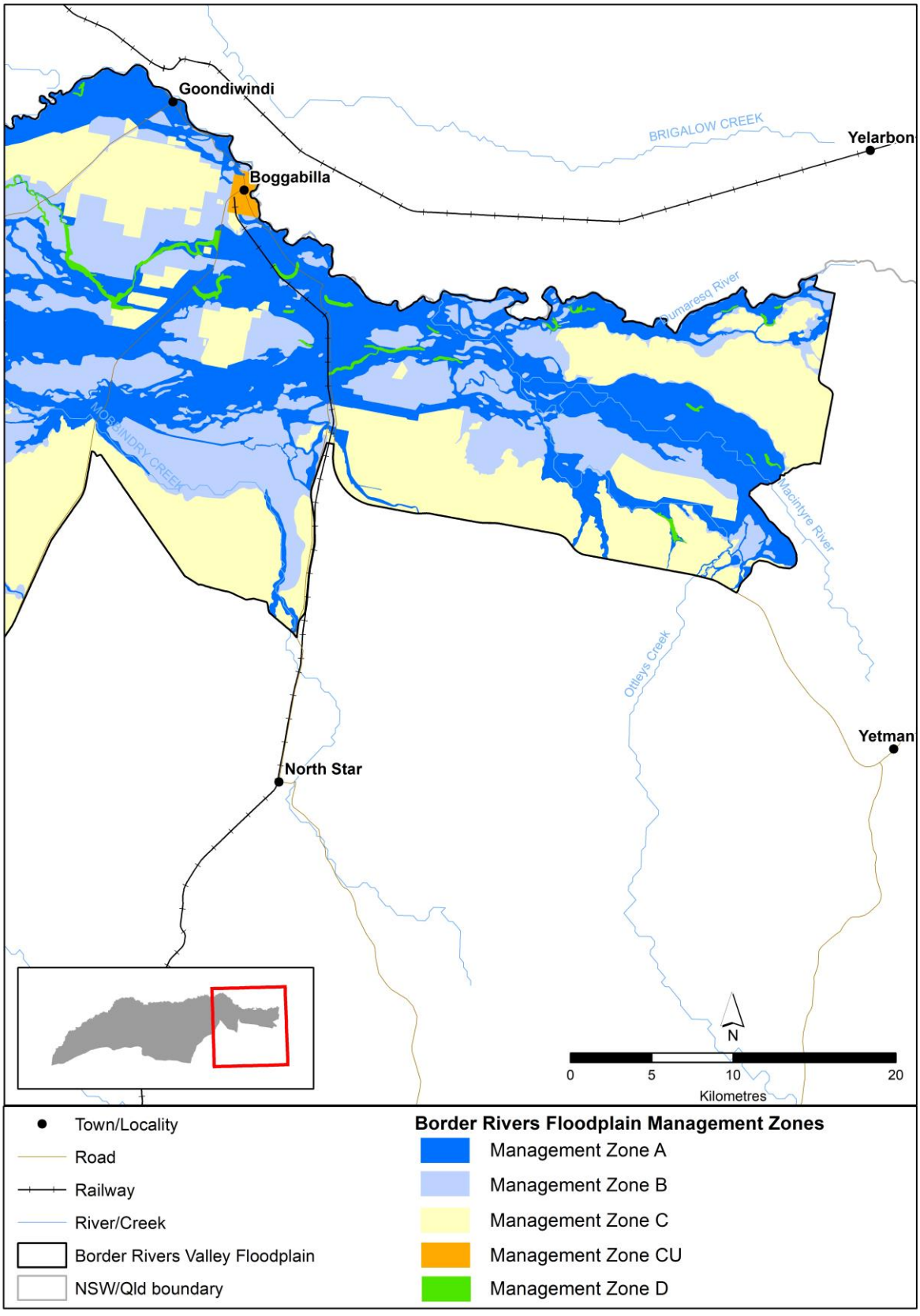


**Figure A13.1: Management zones in the Border Rivers Valley Floodplain – quadrant one of four**

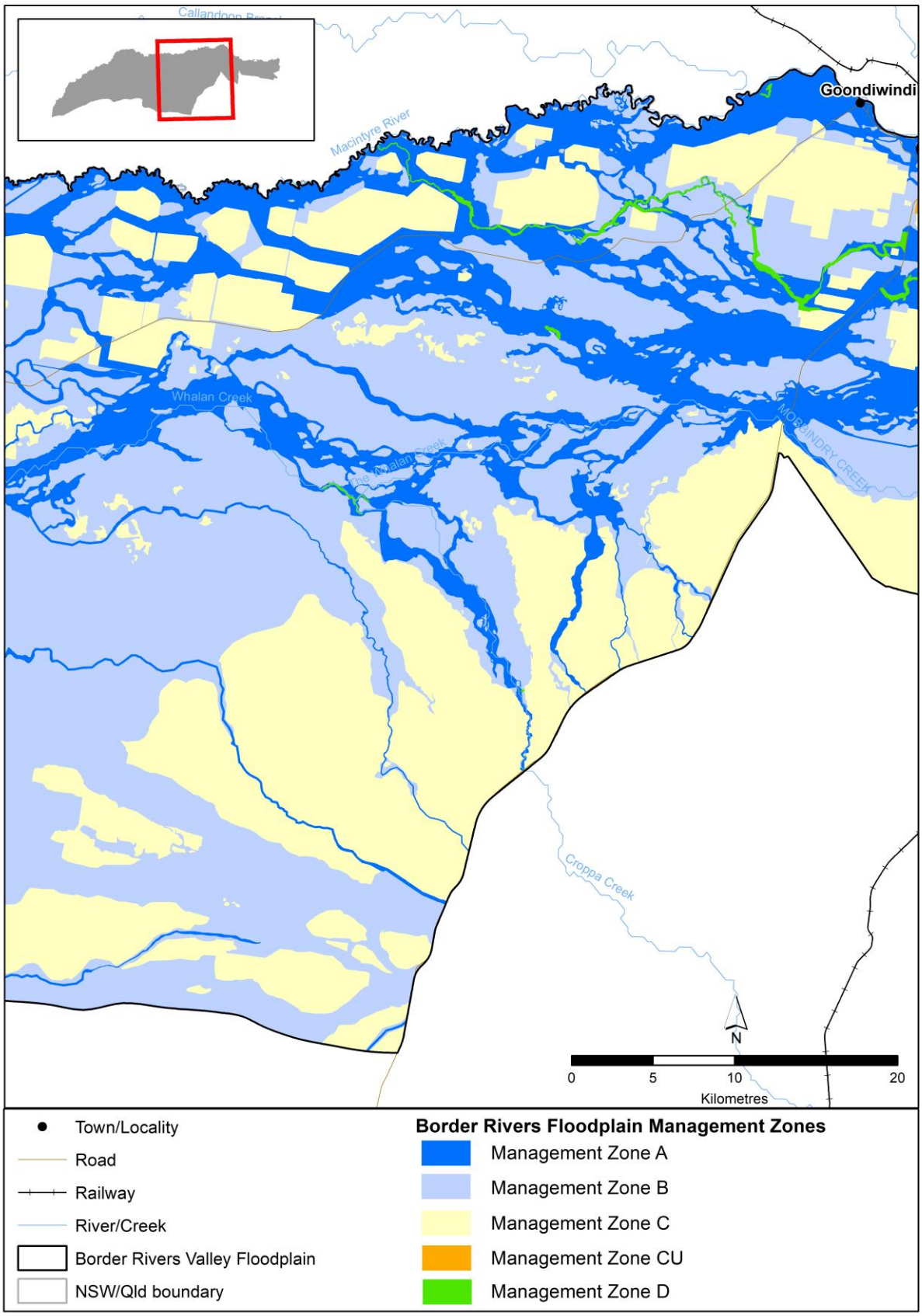


**Figure A13.2: Management zones in the Border Rivers Valley Floodplain – quadrant two of four**

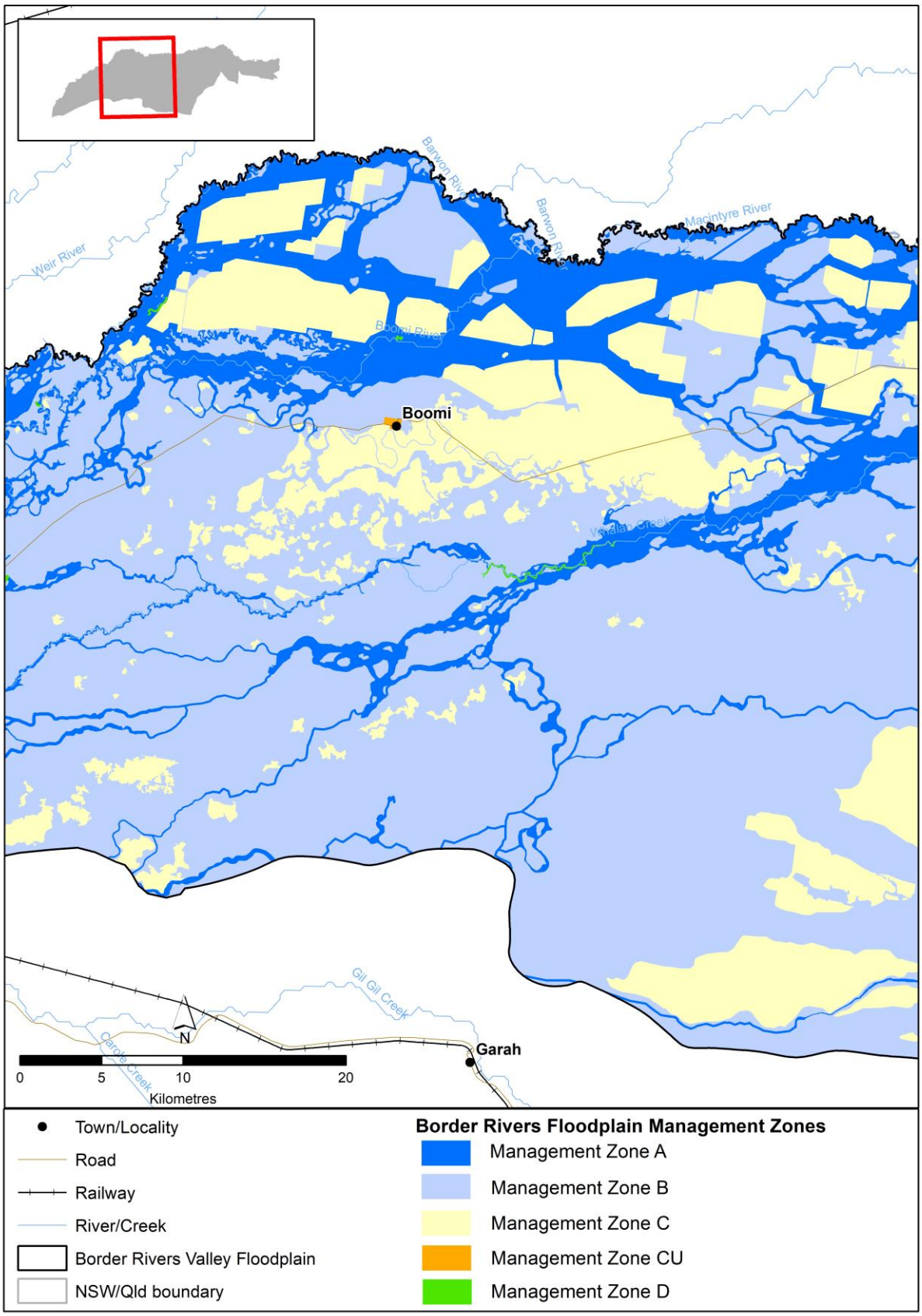


**Figure A13.3: Management zones in the Border Rivers Valley Floodplain – quadrant three of four**

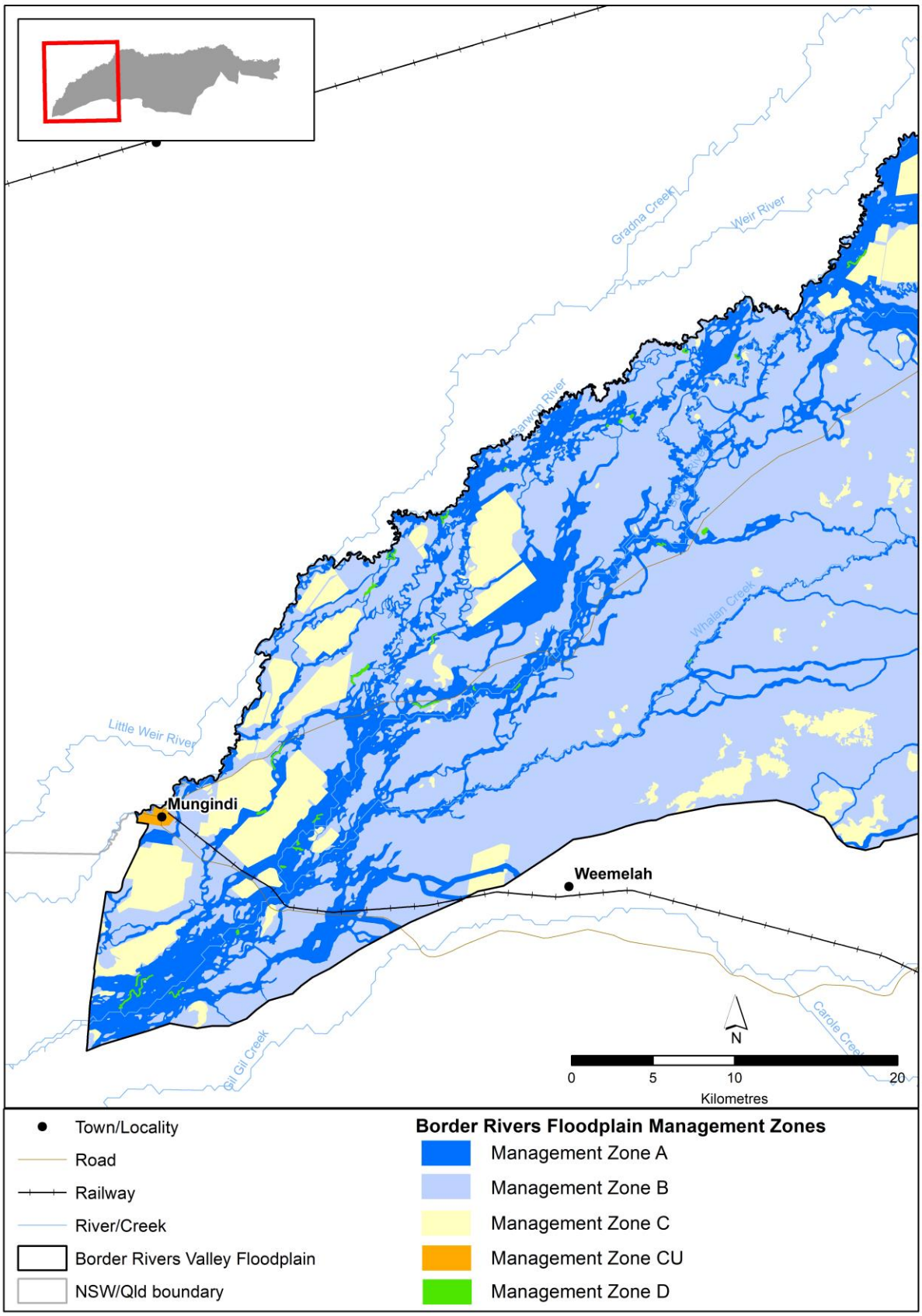


**Figure A13.4: Management zones in the Border Rivers Valley Floodplain – quadrant four of four**

# Appendix 15: Management Zone D Assets

Sixty-four floodplain assets were recommended to become MZ D (Table A14.1 and Figure A14.1). All 64 assets have high ecological value. The ecological significance of each asset is stated in the table and a description is provided below.

Note that some of the unnamed MZ D assets were named after the parish that they were in.

**Table A14.1: Floodplain assets classified as management zone D**

| ID number | Area of ecological significance | Ecological significance | Area (ha) | Zone | Easting | Northing |
|---|---|---|---|---|---|---|
| 1 | Barden Lagoon | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 25 | 56 | 274788 | 6817880 |
| 2 | Boobera Lagoon | Nationally significant wetland listed on The Directory of Important Wetlands of Australia. Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. | 164 | 56 | 213983 | 6829404 |
| 3 | Boobera Watercourse | Nationally significant wetland listed on The Directory of Important Wetlands of Australia. Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Boobera Watercourse key environmental asset in the Border Rivers region (MDBA 2010). Waterbird feeding and breeding habitat. Functional capacity to act as an aquatic drought refuge | 213 | 56 | 222723 | 6830676 |
| 4 | Mundine Waterhole | Nationally significant wetland listed on The Directory of Important Wetlands of Australia. Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. | 10 | 56 | 215341 | 6829516 |
| 5 | Boomi River Billabong | Functional capacity to act as an aquatic drought refuge | 10 | 55 | 644965 | 6650000 |
| 6 | Boomangera Waterhole | Functional capacity to act as an aquatic drought refuge | 14 | 55 | 711216 | 6803749 |
| 7 | Bora Waterhole | Functional capacity to act as an aquatic drought refuge | 35 | 55 | 763556 | 6811922 |
| 8 | Bora Wetland | Functional capacity to act as an aquatic drought refuge | 55 | 56 | 244568 | 6827738 |
| 9 | Bumble Waterhole | Functional capacity to act as an aquatic drought refuge | 31 | 55 | 761665 | 6811111 |
| 10 | Carwell Lagoon | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012Functional capacity to act as an aquatic drought refuge. Waterbird habitat. | 23 | 55 | 761665 | 6796590 |

| ID number | Area of ecological significance | Ecological significance | Area (ha) | Zone | Easting | Northing |
|---|---|---|---|---|---|---|
| 11 | Coolibah Lagoon | Functional capacity to act as an aquatic drought refuge | 30 | 56 | 701468 | 6823234 |
| 12 | Curraweena Waterhole | Functional capacity to act as an aquatic drought refuge | 4 | 55 | 727027 | 6802328 |
| 13 | Doondoona Waterhole | Functional capacity to act as an aquatic drought refuge | 44 | 55 | 693366 | 6782766 |
| 14 | Gobbooyallana Lagoon (Turkey Lagoon) | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012Functional capacity to act as an aquatic drought refuge | 13 | 56 | 244887 | 6825632 |
| 15 | Goony Waterhole | Functional capacity to act as an aquatic drought refuge | 11 | 55 | 700741 | 6793104 |
| 16 | La Mascotte Billabong | Functional capacity to act as an aquatic drought refuge | 7 | 56 | 274871 | 6827406 |
| 17 | Malgarai Lagoon | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge. Waterbird habitat. | 67 | 56 | 251365 | 6823522 |
| 18 | Malgarai Overflow | Functional capacity to act as an aquatic drought refuge. Waterbird habitat. | 60 | 56 | 248886 | 6822391 |
| 19 | Marakai Wetland | Functional capacity to act as an aquatic drought refuge | 9 | 55 | 693091 | 6782966 |
| 20 | Maynes (Yarrangooran) Lagoon | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge. Waterbird habitat. | 97 | 56 | 240376 | 6826521 |
| 21 | Morella Watercourse | Nationally significant wetland listed on The Directory of Important Wetlands of Australia. Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Waterbird feeding and breeding habitat.<br>Functional capacity to act as an aquatic drought refuge | 233 | 56 | 227826 | 6833123 |
| 22 | Pungbougal Lagoon | Nationally significant wetland listed on The Directory of Important Wetlands of Australia. Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Waterbird feeding and breeding habitat.<br>Functional capacity to act as an aquatic drought refuge | 119 | 56 | 233498 | 6826177 |

| ID number | Area of ecological significance | Ecological significance | Area (ha) | Zone | Easting | Northing |
|---|---|---|---|---|---|---|
| 23 | Morella Lagoon | Nationally significant wetland listed on The Directory of Important Wetlands of Australia. Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Waterbird feeding and breeding habitat.<br>Functional capacity to act as an aquatic drought refuge | 169 | 56 | 237655 | 6829298 |
| 24 | Poopoopirby Lagoon | Nationally significant wetland listed on The Directory of Important Wetlands of Australia. Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Waterbird feeding and breeding habitat.<br>Functional capacity to act as an aquatic drought refuge<br>Poopoopirby Lagoon is a key environmental assets in the Border Rivers region (MDBA 2010). | 9 | 56 | 234858 | 6826257 |
| 25 | Gooroo Lagoon | Nationally significant wetland listed on The Directory of Important Wetlands of Australia. Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Waterbird feeding and breeding habitat.<br>Functional capacity to act as an aquatic drought refuge<br>Gooroo lagoon is a key environmental assets in the Border Rivers region (MDBA 2010). | 68 | 56 | 231192 | 6828770 |
| 26 | Niggettes Creek Waterhole | Functional capacity to act as an aquatic drought refuge | 22 | 55 | 711185 | 6799783 |
| 27 | Polidoroi Lagoon | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 60 | 55 | 792542 | 6812784 |
| 28 | Telephone Lagoon | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 32 | 56 | 254828 | 6823242 |
| 29 | Thorndale Lake | Functional capacity to act as an aquatic drought refuge | 13 | 55 | 727902 | 6810328 |
| 30 | Unnamed Lagoon – Barden | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 10 | 56 | 273726 | 6818090 |
| 31 | Unnamed Lagoon - Bengalla A | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 4 | 56 | 270863 | 6826806 |

| ID number | Area of ecological significance | Ecological significance | Area (ha) | Zone | Easting | Northing |
|---|---|---|---|---|---|---|
| 32 | Unnamed Lagoon - Bengalla B | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 12 | 56 | 271990 | 6827143 |
| 33 | Unnamed Lagoon - Bengalla C | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 21 | 56 | 274137 | 6826614 |
| 34 | Unnamed Lagoon - Boroo | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 3 | 55 | 715686 | 6814174 |
| 35 | Unnamed Lagoon (Dindierna) | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 7 | 55 | 716514 | 6800850 |
| 36 | Unnamed Lagoon (Hamilton) | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 11 | 55 | 704218 | 6792706 |
| 37 | Unnamed Lagoon - Narrawal A | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 14 | 55 | 695565 | 6781918 |
| 38 | Unnamed Lagoon - Narrawal B | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 6 | 55 | 699265 | 6785766 |
| 39 | Unnamed Lagoon - Tulloona | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 3 | 56 | 218249 | 6801116 |
| 40 | Unnamed Lagoon - Turrawah A | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 5 | 55 | 702048 | 6789759 |
| 41 | Unnamed Lagoon - Turrawah B | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 10 | 55 | 702986 | 6790880 |

| ID number | Area of ecological significance | Ecological significance | Area (ha) | Zone | Easting | Northing |
|---|---|---|---|---|---|---|
| 42 | Unnamed Lagoon - Turrawah C | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 6 | 55 | 702955 | 6791246 |
| 43 | Unnamed Lagoon - Umbri A | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 17 | 55 | 708741 | 6808851 |
| 44 | Unnamed Lagoon - Umbri B | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 3 | 55 | 713756 | 6800672 |
| 45 | Unnamed Lagoon - Werrina A | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 3 | 55 | 721996 | 6816804 |
| 46 | Unnamed Lagoon - Werrina B | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 5 | 55 | 722808 | 6817048 |
| 47 | Unnamed Lagoon -Werrina C | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 6 | 55 | 723436 | 6817437 |
| 48 | Unnamed Lagoon - Werrina D | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 8 | 55 | 726656 | 6821333 |
| 49 | Unnamed Lagoon - Werrina E | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 7 | 55 | 729871 | 6821012 |
| 50 | Unnamed Lagoon – Winslow | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 8 | 55 | 725177 | 6809522 |
| 51 | Unnamed Lagoon - Boomangera Creek | Functional capacity to act as an aquatic drought refuge | 10 | 55 | 711985 | 6811264 |

| ID number | Area of ecological significance | Ecological significance | Area (ha) | Zone | Easting | Northing |
|---|---|---|---|---|---|---|
| 52 | Unnamed Lagoon - Gravelly Creek | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 33 | 55 | 706745 | 6801599 |
| 53 | Unnamed Lagoon - Myall Park | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 5 | 56 | 273027 | 6816032 |
| 54 | Toomelah Lagoon | Functional capacity to act as an aquatic drought refuge | 11 | 56 | 253769 | 6824960 |
| 55 | Unnamed Lagoon - Spring Creek | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 55 | 56 | 269087 | 6813616 |
| 56 | Unnamed Lagoon 1 | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 23 | 56 | 270025 | 6820938 |
| 57 | Unnamed Lagoon 2 | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 36 | 56 | 262402 | 6826482 |
| 58 | Unnamed Lagoon 3 | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 27 | 56 | 261300 | 6825425 |
| 59 | Unnamed Lagoon 4 | Functional capacity to act as an aquatic drought refuge | 46 | 56 | 247845 | 6826265 |
| 60 | Unnamed Lagoon 5 | Functional capacity to act as an aquatic drought refuge | 13 | 56 | 246011 | 6823688 |
| 61 | Unnamed Lagoon 6 | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 20 | 55 | 707378 | 6806812 |
| 62 | Unnamed Lagoon 7 | Significant lagoon/wetland listed on Schedule 5: Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012. Functional capacity to act as an aquatic drought refuge | 23 | 56 | 231507 | 6838456 |
| 63 | Wombyanna Lagoon | Functional capacity to act as an aquatic drought refuge | 23 | 55 | 737330 | 6826895 |
| 64 | Woolinna and Cobbanthanna Waterholes | Functional capacity to act as an aquatic drought refuge | 60 | 55 | 759111 | 6810462 |

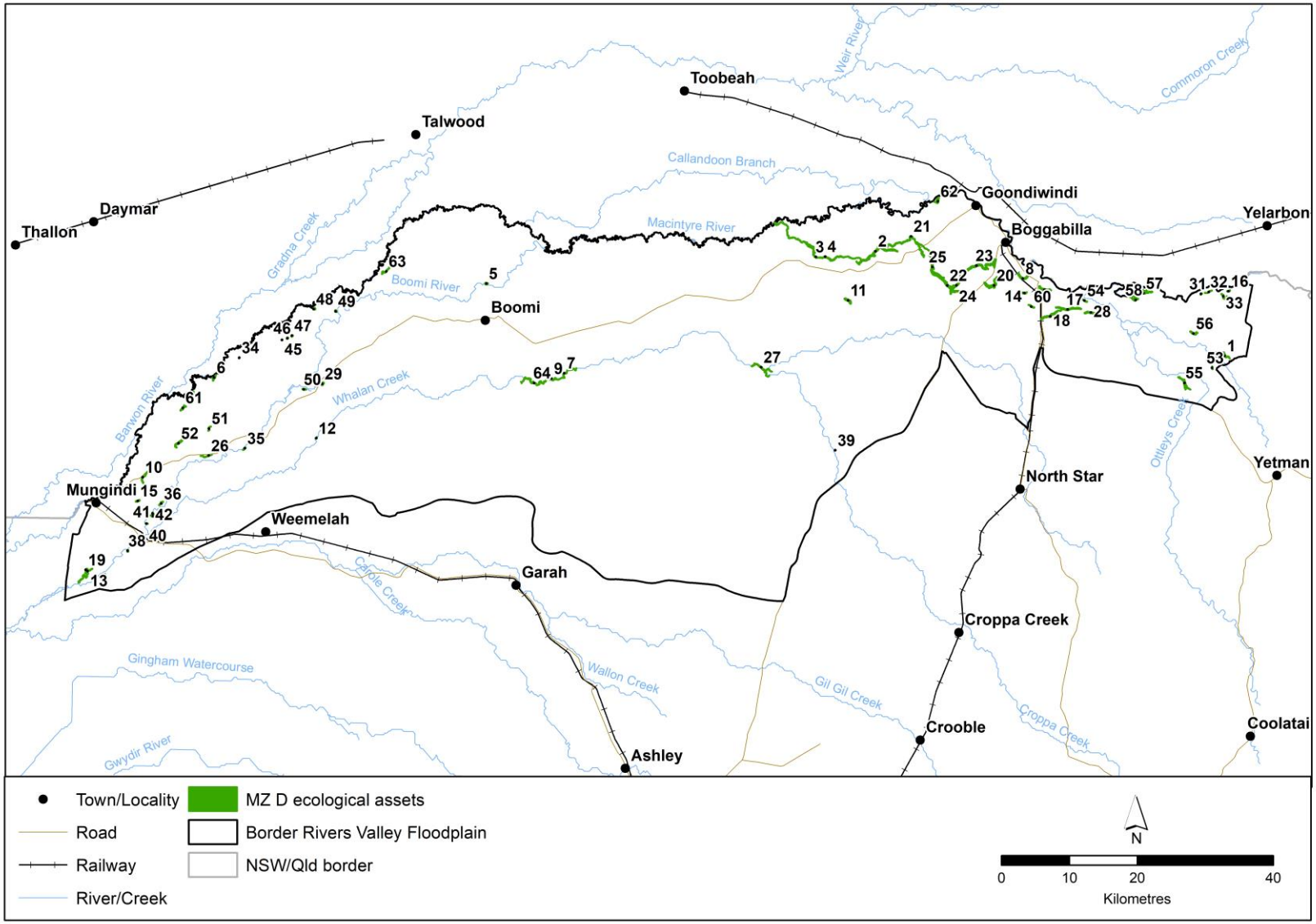


**Figure A14.1: MZ D Assets in the Border Rivers Valley Floodplain**

# Barden Lagoon

The Barden lagoon is a large open lagoon on 'Doonkami' property adjacent to the Macintyre River fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 and Poplar Box - Belah woodland - PCT 56 (OEH 2015). Barden lagoon provides the functional capacity to act as an aquatic drought refuge and the lagoon is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Boobera Watercourse, Boobera Lagoon and Mundine Waterhole

The Boobera Lagoon is a large and nationally significant wetland complex listed under *A Directory of Important Wetlands of Australia* (Environment Australia 2001). The Boobera Lagoon is a remnant feature of a previous course of the Macintyre River. It is one of the few permanent waterbodies in the arid environment of the Murray-Darling Basin. Boobera Lagoon is fringed with flood-dependent vegetation including River Coobah swamp wetland on the floodplains of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion - PCT 241, Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 and River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015). The Boobera Lagoon provides the functional capacity to act as an aquatic drought refuge for a variety of aquatic biota, including several freshwater turtle species such as Broad-shelled Turtle (*Macrochelodina expansa*) (University of Canberra Wildlife Tissue Collection), Eastern long-necked turtle (*Chelodina longicollis*) and the Macquarie Turtle (*Emydura macquarii*) (Bionet 2016: OEH Default Sightings).

Boobera Lagoon also provides habitat for a variety of frog species including the Salmon Striped Frog (*Limnodynastes salmini*), Spotted Grass Frog (*Limnodynastes tasmaniensis*), Broad-palmed Frog (*Litoria latopalmata*) and Desert Tree Frog (*Litoria rubella*) (Bionet 2016: OEH Default Sightings) and the Northern Banjo Frog (*Limnodynastes terraereginae*), Sudell's Frog (*Neobatrachus sudelli*) and the Wrinkled Toadlet (*Uperoleia rugose*) (Spark 2013).

The Boobera Lagoon is listed as a significant identified lagoon and wetland – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

Boobera Lagoon has significant Aboriginal cultural significance (Green et al. 2012).

The Mundine waterhole is a large open water lagoon on the Boobera Watercourse fringed with flood-dependent vegetation including Water Couch marsh grassland wetland of frequently flooded inland watercourses - PCT 204 and Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The Mundine waterhole provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

The Boobera Watercourse, Boobera lagoon and Mundine Waterhole provide feeding and breeding habitat for a variety of waterbird species. The Boobera Watercourse is listed as a key environmental asset in the Border Rivers region (MDBA 2010).

# Bora, Bumble, Cobbanthanna and Woolinna Waterholes

The Bora, Bumble, Cobbanthanna and Woolinna waterholes are four large waterholes on the Whalan Creek upstream of Euraba Bridge (Boonangar Road) fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded

floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The Bora, Bumble, Cobbanthanna and Woolinna waterholes provide the functional capacity to act as an aquatic drought refuge.

# Carwell Lagoon

The Carwell lagoon is a large lagoon on Gravelly Creek just south of Caloona Boomi Road. The lagoon is fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 and Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains - PCT 40 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge. The lagoon also provides habitat for a variety of waterbird species including Plumed Whistling-Duck (*Dendrocygna eytoni*) and the endangered Black-necked Stork (*Ephippiorhynchus asiaticus*) (Bionet 2016: OEH Default Sightings).

Carwell Lagoon is also listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Gobbooyallana Lagoon

The Gobbooyallana lagoon is a small oval shaped lagoon at Turkey Lagoon property which provides the functional capacity to act as an aquatic drought refuge. Gobbooyallana Lagoon is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Goony Waterhole

The Goony waterhole is a large waterhole on Gravelly Creek fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The Goony Waterhole provides the functional capacity to act as an aquatic drought refuge.

# Malgarai Lagoon and Malgarai Overflow

The Malgarai lagoon and Malgarai overflow are large open water lagoon's on 'Merawah' property adjacent to the Macintyre River fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015).

The Malgarai lagoon and Malgarai overflow provide the functional capacity to act as an aquatic drought refuge. The lagoon and overflow provide habitat for a variety of waterbird species including Grey Teal (*Anas gracilis*), Australasian Grebe (*Tachybaptus novaehollandiae*), Australian White Ibis (*Threskiornis Molucca*), Australian Wood Duck (*Chenonetta jubata*), Eastern Great Egret (*Ardea modesta*), Little Pied Cormorant (*Microcarbo melanoleucos*), Pacific Black Duck (*Anas superciliosa*), Pink-eared Duck (*Malacorhynchus membranaceus*), White-faced Heron (*Egretta novaehollandiae*), White-necked Heron (*Ardea pacifica*), Yellow-billed Spoonbill (*Platalea flavipes*) and the threatened Freckled Duck (*Stictonetta naevosa*) (Bionet 2016: Birds Australia Atlas of Australian Birds 2 observations).

# Maynes (Yarrangooran) Lagoon

The Maynes (Yarrangooran) lagoon is a large open water lagoon on the eastern side of the Newell Highway near the Macintyre River fringed with flood-dependent vegetation including Water Couch marsh grassland wetland of frequently flooded inland watercourses - PCT 204, Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine

Plains Bioregion - PCT 39 and River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge for freshwater fish and other aquatic biota (Reid et al. 2012, Medeiros and Arthington 2014, Medeiros and Arthington 2011, Medeiros and Arthington 2008, Medeiros 2004).

The lagoon provides habitat for frogs, such as the Spotted Grass Frog (*Limnodynastes tasmaniensis*) and a variety of waterbird species including Australian Pelican (*Pelecanus conspicillatus*), Australian White Ibis (*Threskiornis Molucca*), Australian Wood Duck (*Chenonetta jubata*), Eastern Great Egret (*Ardea modesta*), Grey Teal (*Anas gracilis*), Royal Spoonbill (*Platalea regia*), Straw-necked Ibis (*Threskiornis spinicollis*) and Yellow-billed Spoonbill (*Platalea flavipes*) (Bionet 2016). Maynes Lagoon is also listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Morella Watercourse including Gooroo, Morella, Pungbougal and Poopoopirby Lagoons

The Morella Watercourse is a large and nationally significant wetland complex listed under *A Directory of Important Wetlands of Australia* (Environment Australia 2001). The Morella Watercourse is a remnant feature of a previous course of the Macintyre River.

The Gooroo, Morella, Pungbougal and Poopoopirby lagoons are large lagoons on the Morella Watercourse near the Macintyre River fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 and River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015). The lagoons provide the functional capacity to act as an aquatic drought refuge for freshwater fish and other aquatic biota (Medeiros and Arthington 2011, Reid et al. 2012). Pungbougal Lagoon provides the functional capacity to act as an aquatic drought refuge for a variety of aquatic biota, including freshwater turtles such as Macquarie Turtle (*Emydura macquarii*) (University of Canberra Wildlife Tissue Collection) and Broad-shelled Turtle (*Chelodina expansa*) and for waterbirds including the endangered Black-necked Stork (*Ephippiorhynchus asiaticus*) (Bionet 2016: OEH Default Sightings). The Gooroo and Poopoopirby lagoons are listed as key environmental assets in the Border Rivers region (MDBA 2010).

# Polidoroi Lagoon

The Polidoroi lagoon is a large open water lagoon on ‘Wongalee’ and Adavale properties adjacent to Whalan Creek (Croppa Creek) fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The Polidoroi Lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Telephone Lagoon

The Telephone lagoon is an open water lagoon on ‘Boonal’ property adjacent to the Macintyre River fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015) and developed land. The Telephone lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Boomangera Creek

A long linear unnamed lagoon on the Boomangera Creek fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 and Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Gravelly Creek

An unnamed lagoon between the Barwon and Boomi Rivers fringed with native grasslands and developed land (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Myall Park

A narrow unnamed lagoon fringed with flood-dependent vegetation including Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains - PCT 53 (OEH 2015) on the floodplain between Ottleys Creek and the Macintyre River. The lagoon is just east of Myall Park property, and south of the Tucka Tucka Road. The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Toomelah Lagoon

The Toomelah lagoon is a large lagoon on the northern side of Tucka Tucka Road, just south of Toomelah township fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015). The lagoon is important for the local Toomelah Mission and provides the functional capacity to act as an aquatic drought refuge.

# Unnamed Lagoon - Spring Creek

A large unnamed open water lagoon on Spring Creek fringed with flood-dependent vegetation including Water Couch marsh grassland wetland of frequently flooded inland watercourses - PCT 204, Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains - PCT 53, and Poplar box-Belah woodland - PCT 56 (OEH 2015), candidate native grasslands and cleared land. The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon 1

An unnamed open water lagoon just north of the Macintyre River fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon 2

A large unnamed open water lagoon adjacent to the Dumaresq River fringed with flood-dependent vegetation including Water Couch marsh grassland wetland of frequently flooded inland watercourses - PCT 204 and Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains - PCT 53 (OEH 2015) and candidate native grasslands and cleared land. The lagoon is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon 3

A small unnamed open water lagoon on the northern side of Keetah Road adjacent to the Dumaresq River fringed with flood-dependent vegetation including Water Couch marsh grassland wetland of frequently flooded inland watercourses - PCT 204 and Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains - PCT 53 and candidate native grasslands (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon 4

A large unnamed open water lagoon adjacent to the Macintyre River at the junction of the Bruxner Highway and Tucka Tucka Road, fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 and Poplar box-Belah woodland - PCT 56 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge.

# Unnamed Lagoon 5

A large unnamed open water lagoon surrounded by developed land just west of Whalan Creek and the Bruxner Highway. The lagoon provides the functional capacity to act as an aquatic drought refuge.

# Unnamed Lagoon 6

A small unnamed open water lagoon on ‘Galtymore’ property adjacent to the Barwon River fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 and candidate native grasslands (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon 7

A narrow unnamed open water lagoon adjacent to the Macintyre River fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Barden

A small unnamed open water lagoon on the northern side of the Macintyre River fringed with flood-dependent River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Bengalla A

A small unnamed open water lagoon on the southern side of the Dumaresq River fringed with flood-dependent River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Bengalla B

A small unnamed open water lagoon on the southern side of the Dumaresq River fringed with flood-dependent River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Bengalla C

A small unnamed open water lagoon on the southern side of the Dumaresq River fringed with flood-dependent River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Boroo

A small unnamed open water lagoon on the southern side of Boomangera Creek fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36, Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 and Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains - PCT 40 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon (Dindierna)

A small unnamed open water lagoon adjacent to the Boomi River fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 and River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains

Bioregion - PCT 36 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon (Hamilton)

A small unnamed open water lagoon on the northern side of the Boomi River fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 and River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion – PCT 36 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Narrawal A

A small unnamed open water lagoon on the southern side of the Boomi River fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Narrawal B

A small unnamed open water lagoon on southern side of the Boomi River fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Tulloona

A small unnamed open water lagoon on the eastern side of the Croppa Creek fringed with Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions - PCT 55 (OEH 2015) on its western side. The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Turrawah A

A small unnamed open water lagoon on the eastern side of the Boomi River fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 and River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015) and native grasslands. The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Turrawah B

A small unnamed open water lagoon on the eastern side of the Boomi River fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36, Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Turrawah C

A small unnamed open water lagoon on the eastern side of the Boomi River fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015) and native grasslands. The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Umbri A

A small unnamed open water lagoon between the Macintyre River and Galtymore Road, fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36, Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 and Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains - PCT 40 and native grasslands (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Umbri B

A small unnamed open water lagoon between Carrigan Road and the Boomi River fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 and Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Werrina A

A small unnamed open water lagoon on the southern side of Boomangera Creek fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 and Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains - PCT 40 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Werrina B

A small unnamed open water lagoon on the southern side of Boomangera Creek fringed on its northern side with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 and Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains - PCT 40 (OEH 2015). Native grasslands fringe the lagoon on its southern side. The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Werrina C

A small unnamed open water lagoon on the southern side of Boomangera Creek fringed with flood-dependent vegetation including Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains - PCT 40 and River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Werrina D

A small unnamed open water lagoon at the confluence of the Boomangera Creek and the Macintyre River fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 and Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains - PCT 40 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Werrina E

A small unnamed open water lagoon on the northern side of the Boomi River fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36, Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 and Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains - PCT 40 (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Unnamed Lagoon - Winslow

A small unnamed open water lagoon on the southern side of the Boomi River fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36, 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 and native grasslands (OEH 2015). The lagoon provides the functional capacity to act as an aquatic drought refuge and is listed as a significant identified lagoon – Schedule 5 – Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources 2012.

# Wombyanna Lagoon

The Wombyanna Lagoon is an open water lagoon on 'Barra' property adjacent to the Macintyre River fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39, River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 (OEH 2015) and developed land on its eastern side. The Wombyanna Lagoon provides the functional capacity to act as an aquatic drought refuge.

# Boomi River Billabong

The Boomi River Billabong is a highly ephemeral billabong located on the northern bank of the Boomi River approximately 1 kilometre upstream of the Boonangar Road – Boomi River bridge. The billabong is fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 and Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The Boomi River Billabong provides the functional capacity to act as an aquatic drought refuge.

# Boomangera Waterhole

The Boomangera waterhole is a semi-permanent waterhole on Crooked Creek fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 and Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The Boomangera Waterhole provides the functional capacity to act as an aquatic drought refuge.

# Bora Wetland

The Bora wetland is an ephemeral billabong adjacent to the Tucka Tucka Road and the Macintyre River consisting of flood dependent Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 fringed with Poplar Box - Belah woodland on clay-loam soils on alluvial plains of north-central NSW - PCT 56 (OEH 2015). The Bora wetland provides the functional capacity to act as an aquatic drought refuge.

# Coolibah Lagoon

The Coolibah lagoon is an ephemeral billabong on Coolibah Watercourse on 'Myall Plain' property, a historic site of Cobb and Co coach corduroyed road/bridge. The billabong is fringed with Poplar Box - Belah woodland on clay-loam soils on alluvial plains of north-central NSW - PCT 56 (OEH 2015) and provides the functional capacity to act as an aquatic drought refuge.

# Curraweena Waterhole

The Curraweena Waterhole is a highly ephemeral chain of ponds on Whalan Creek at 'Kluang' property fringed with flood-dependent vegetation including Water Couch marsh grassland wetland of frequently flooded inland watercourses - PCT 204, Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 and Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains - PCT 40 (OEH 2015). The Curraweena Waterhole provides the functional capacity to act as an aquatic drought refuge.

# Doondoona Waterhole

The Doondoona Waterhole is an ephemeral waterhole on Doondoona Creek fringed with flood-dependent vegetation including River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion - PCT 36 and Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The Doondoona Waterhole provides the functional capacity to act as an aquatic drought refuge.

# La Mascotte Billabong

The La Mascotte billabong is a semi-permanent billabong which provides the functional capacity to act as an aquatic drought refuge located at ‘La Mascotte’ property fringed with native grasslands. The La Mascotte billabong provides the functional capacity to act as an aquatic drought refuge.

# Marakai Wetland

The Marakai wetland is an ephemeral billabong on ‘Marakai’ property fringed with Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 (OEH 2015). The Marakai wetland provides the functional capacity to act as an aquatic drought refuge.

# Niggettes Creek Waterhole

The Niggettes Creek waterhole is an ephemeral waterhole located on the Niggettes Creek on the southern side of the Caloona Boomi Road. The waterhole is fringed with flood-dependent vegetation including Coolibah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion - PCT 39 and Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains - PCT 40 (OEH 2015). The Niggettes Creek waterhole provides the functional capacity to act as an aquatic drought refuge.

# Thorndale Lake

Thorndale Lake is a highly ephemeral lake just east of the Carrigan Road adjacent to Thorndale Creek fringed with flood-dependent Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains - PCT 40 (OEH 2015) and native grasslands. The Thorndale Lake provides the functional capacity to act as an aquatic drought refuge and provides habitat for a variety of waterbird species.

# Appendix 16: Peak discharge calculation locations

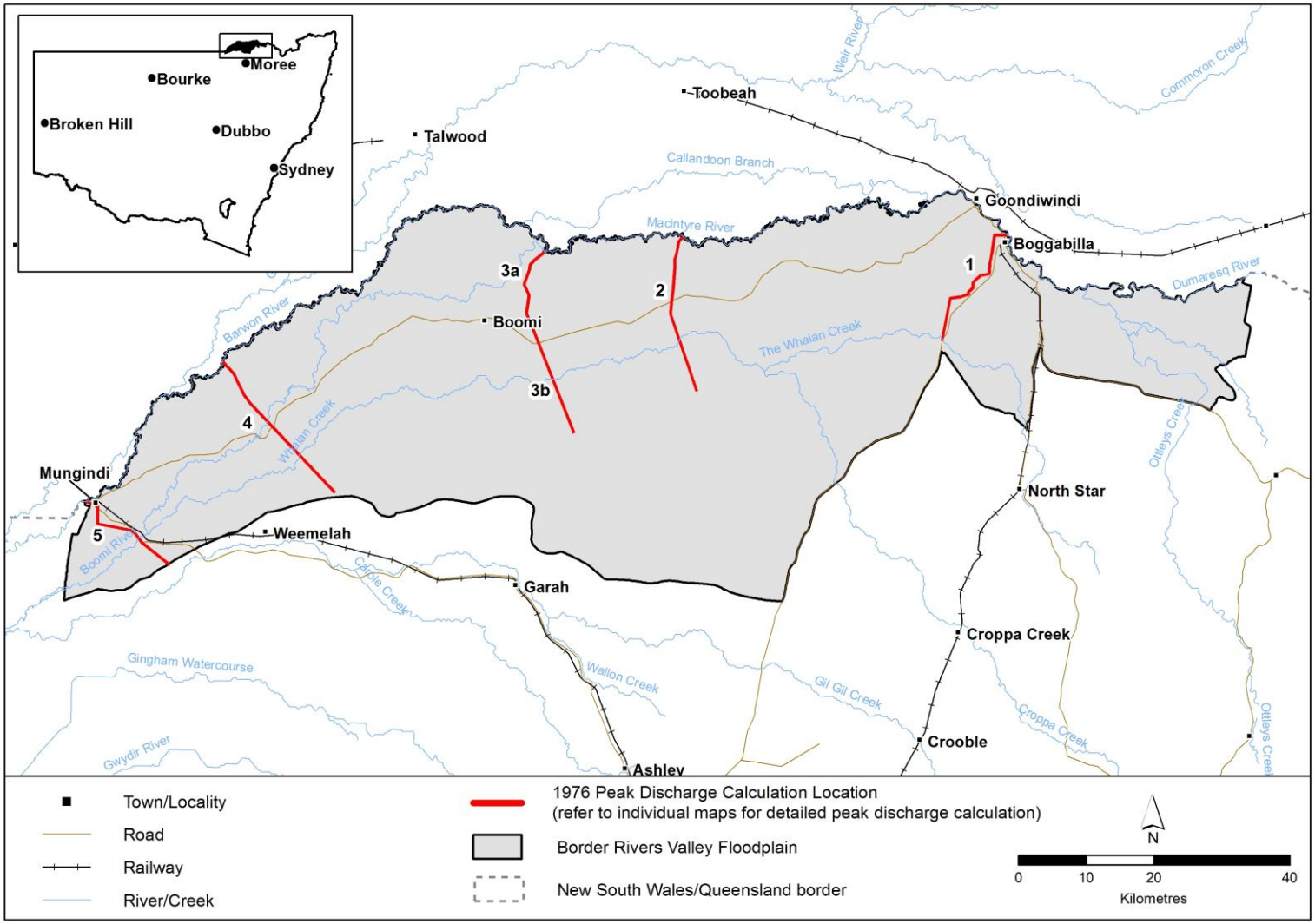


**Figure A15.1: 1976 Peak discharge calculation locations across the Border Rivers Valley Floodplain**

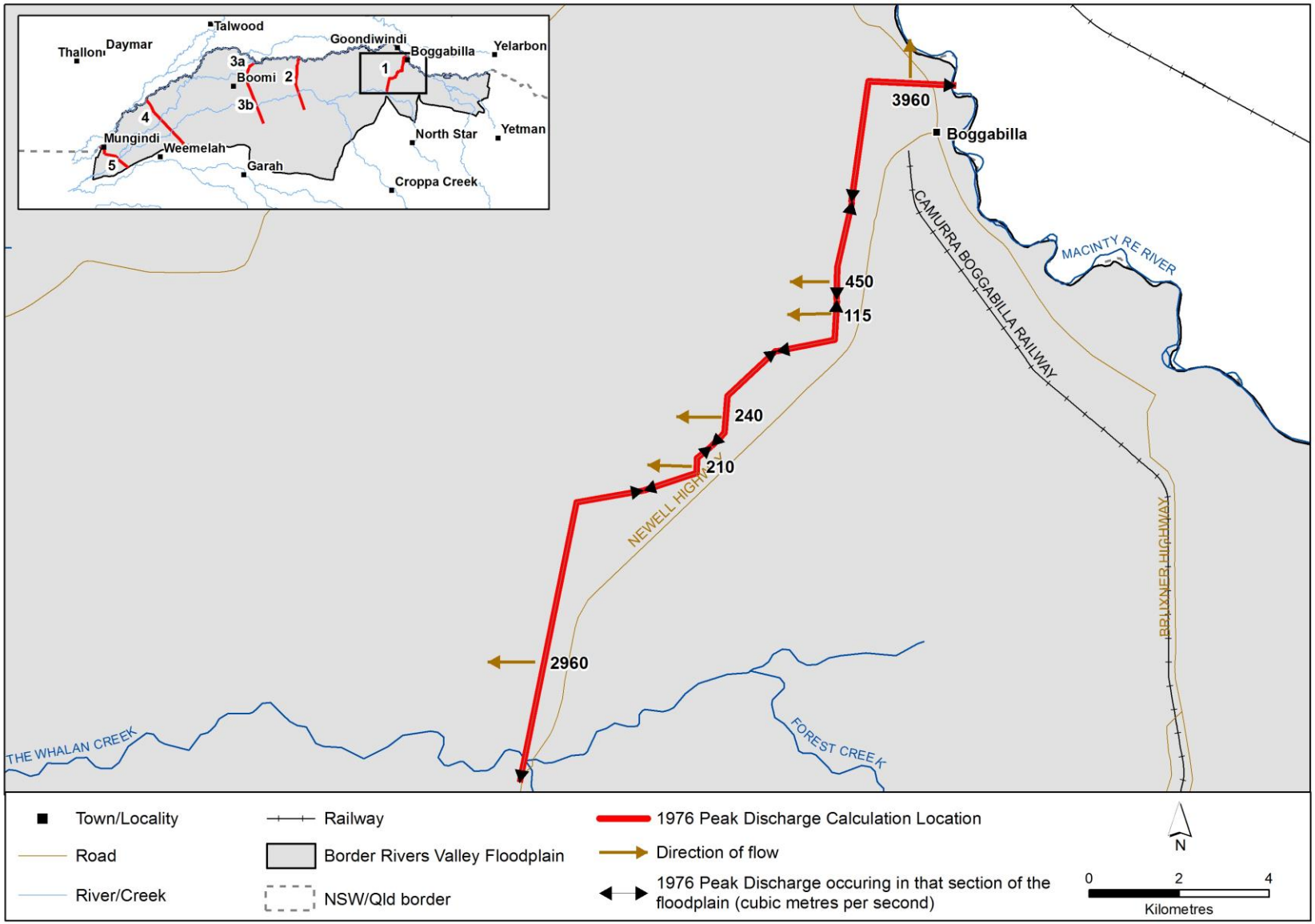


**Figure A15.2: 1976 Peak discharge calculation location 1 - near Boggabilla**

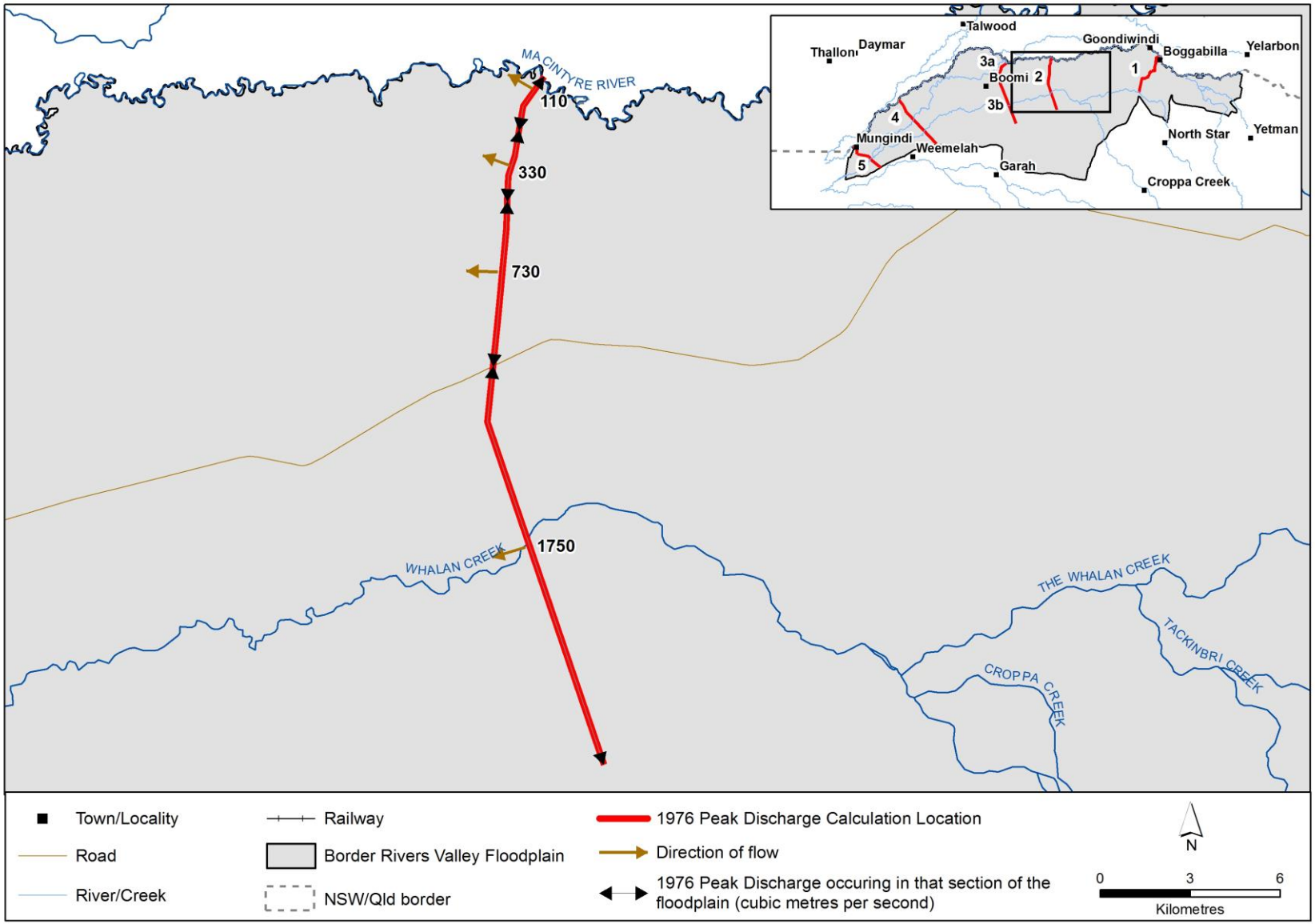


**Figure A15.3: 1976 Peak discharge calculation location 2 – between Boggabilla and Boomi**

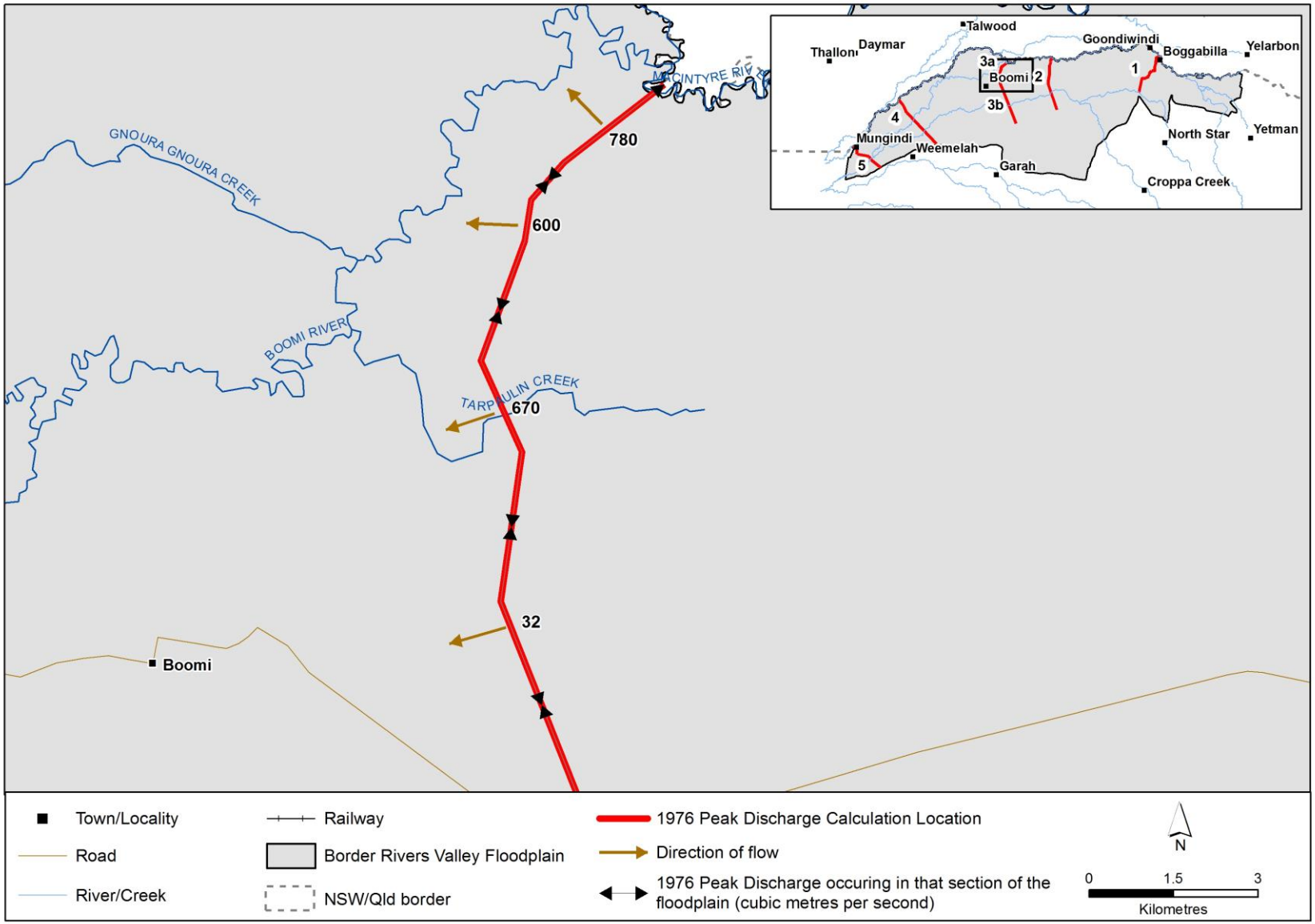


**Figure A15.4: 1976 Peak discharge calculation location 3 (North) – near Boomi**

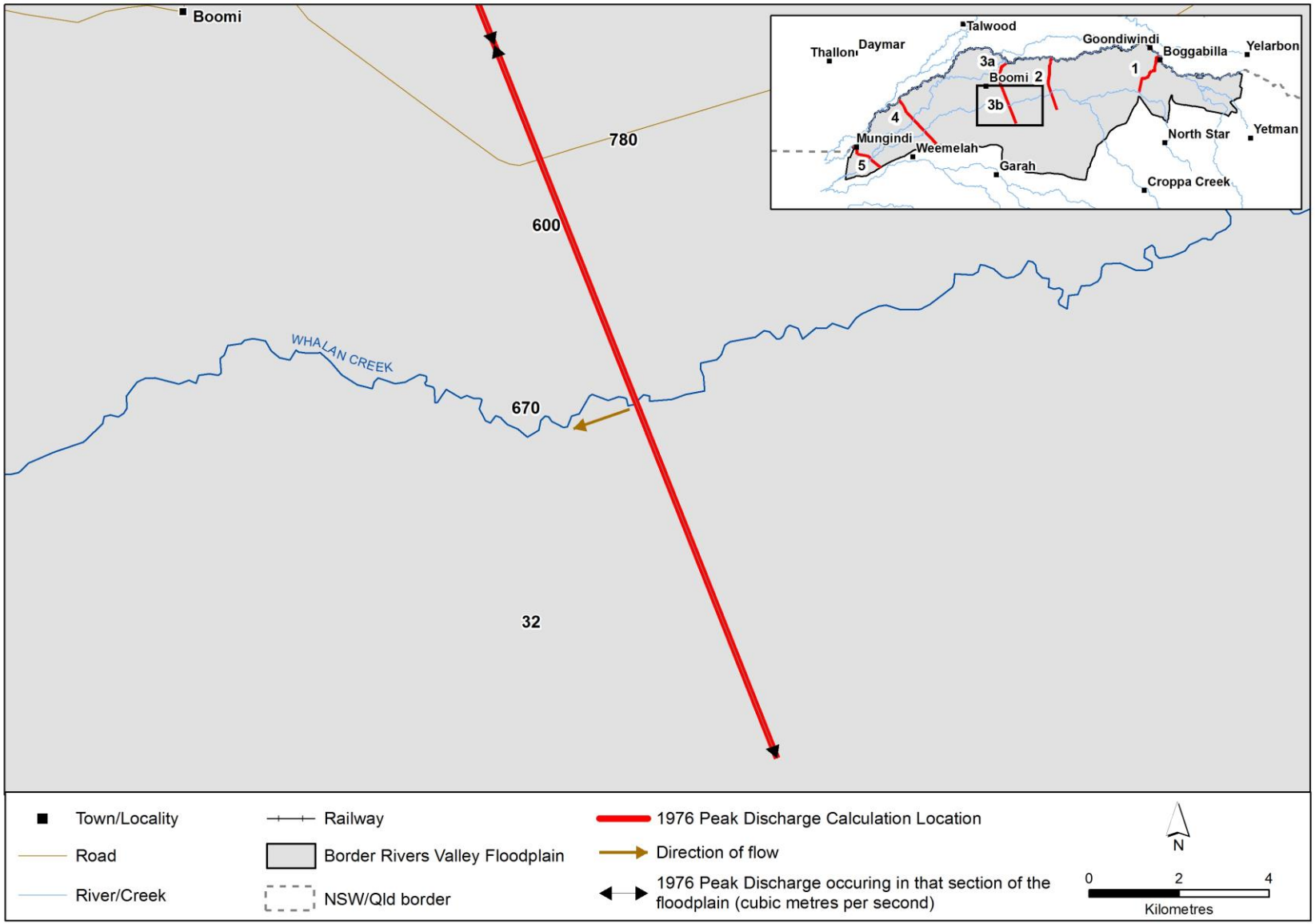


**Figure A15.5: 1976 Peak discharge calculation location 3 (South) – near Boomi**

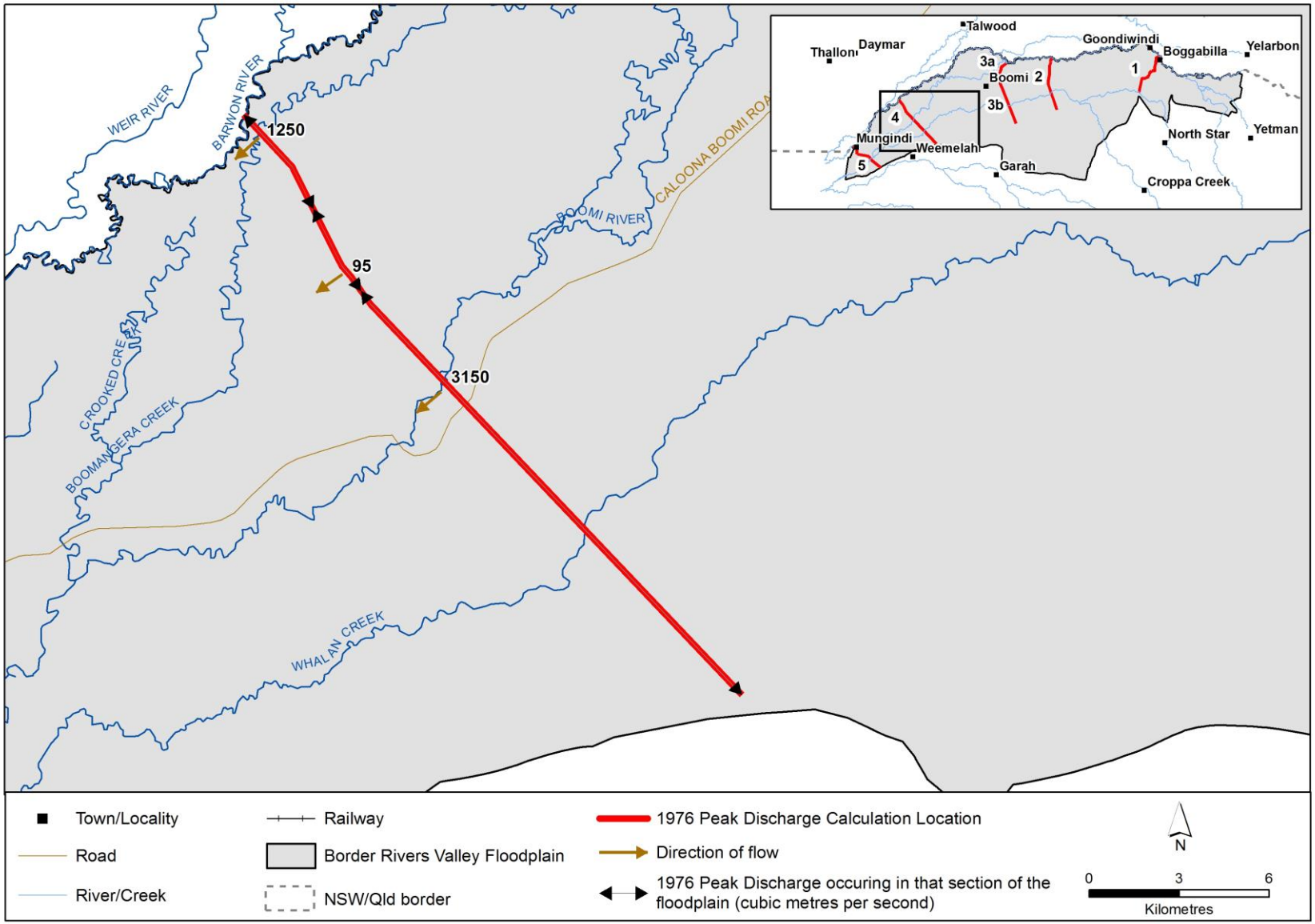


**Figure A15.6: 1976 Peak discharge calculation location 4 – between Boomi and Mungindi**

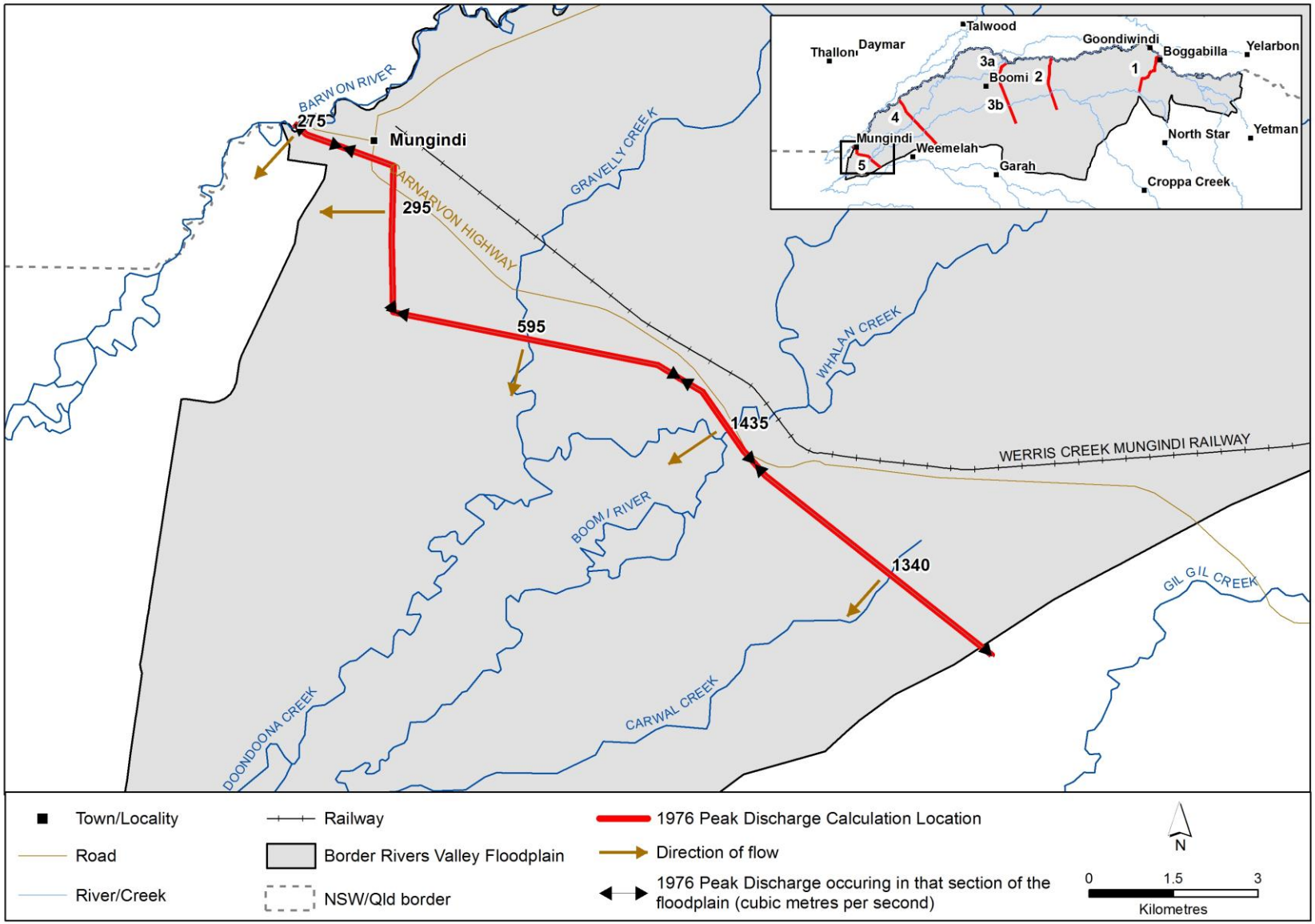


**Figure A15.7: 1976 Peak discharge calculation location 5 – near Mungindi**

# Appendix 17: Approach for consulting with Aboriginal stakeholders

As the first peoples of Australia, Aboriginal people have certain inherent rights, including the right to maintain culture, which requires the ability to maintain links with Country (including traditional lands and seas). Aboriginal stakeholders include individuals of Australian Aboriginal descent who have a cultural connection to the Border Rivers Valley Floodplain. Aboriginal stakeholders and interests may be represented by communities, formal or informal working groups or committees and Aboriginal Land Councils.

The department's Water Group works closely with the department's Environment, Energy and Science Group when consulting with Aboriginal stakeholders because the latter undertakes many environment protection, natural resource management and conservation activities that have direct relevance to and impacts on Aboriginal communities. As a result, the former OEH has produced principles and frameworks to guide the implementation of meaningful community engagement that ensures the needs of Aboriginal communities are met in relation to the conservation and continuation of their cultural heritage and values. These documents include:

- Aboriginal People, the Environment and Conservation (APEC) principles (Department of Environment and Conservation NSW 2006)
- An Aboriginal Community Engagement Framework for DECC (unpublished, 2007)
- Working to protect Aboriginal cultural heritage (OEH 2011b).

The APEC principles guide the inclusion of the rights and interests of Aboriginal people into OEH work by supporting DPI – EES and Aboriginal people to jointly and openly identify the level of involvement that Aboriginal communities would like in DPI-EES's environmental management and conservation activities. The five principles are:

1. Spirituality and connection
2. Cultural resource use
3. Wellbeing
4. Caring for country
5. Doing business with Aboriginal people.

Both the Aboriginal Community Engagement Framework for DECC and the Working to protect Aboriginal cultural heritage documents support the implementation of the APEC principles.

The Aboriginal cultural heritage and contemporary cultural values and connections of the Border Rivers Valley Floodplain are rich and vibrant. Many of the cultural values of Aboriginal peoples of the Border Rivers are linked to flooding and floodwater and the FMP has an objective to contribute to the protection of cultural, heritage and spiritual features of the floodplain that are significant to Aboriginal people and other stakeholders.

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