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Cover photos (clockwise from main photo):
Moomin Creek floodplain, December 2004 (Peter Kellett, Department of Natural Resources)
Flow gauging downstream of Combadello Weir, December 2004 (Peter Kellett, Department of Natural Resources)
Moomin Creek in flood, December 2004 (Peter Kellett, Department of Natural Resources)
Gurley Creek – Jack Shea Swamp effluent, February 2001 (Andrew Falkenmire, DECCW)
Floodways and crop protection on lower Moomin Creek floodplain, February 2001 (Andrew Falkenmire, DECCW)

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Preface

Since the completion of Copeton Dam in 1976, regulation of the water flow has transformed the Moomin Creek Floodplain. The regular water supply has facilitated extensive irrigation development across the floodplain. The success of irrigated agriculture and the incidence of flood damage over the years triggered the construction of flood/crop protection works. The resulting modifications to the ground surface altered the natural flow of floodwater across the floodplain. A strategy was required to manage the present and potential impacts of current and future developments on flood flow patterns and flood-dependent ecosystems across the floodplain. This investigation addresses the flood flow requirements of the floodplain and land use changes, especially where steep land slopes or flow constrictions cause high flow velocities and potential erosion on the floodplain.

The Moomin Creek Floodplain Management Plan (FMP) replaces the document titled Guidelines for Moomin Creek Floodplain Development (known as the 'original' guidelines), printed in 1978. To date, these guidelines have served as the main reference for reviewing development applications for flood control works. However, the 1978 'original' guidelines needed to be replaced with a strategic plan that addressed the current and future developments and was consistent with the needs of sustainable natural resource management.

A draft FMP was exhibited by the former Department of Natural Resources (DNR) in 2003. The Department of Environment, Climate Change and Water (DECCW), on behalf of the Water Administration Ministerial Corporation (WAMC) under Part 8 of the Water Act 1912, has finalised the FMP in accordance with the New South Wales Government’s Floodplain Development Manual (2005) and following extensive consultation with floodplain landholders. Implementation, licensing and compliance functions under Part 8 of the Water Act 1912 are the responsibility of the NSW Office of Water (NOW), which has been established as a separate office within DECCW and administers NSW water legislation.

The FMP was prepared in consultation with the Moomin Creek Floodplain Management Committee (FMC), which comprised representatives of the community, various stakeholder groups and government agencies. Funding for this project was provided by the Natural Heritage Trust (NHT) and the New South Wales Government. Development of the FMP has progressed through three primary phases:

1 **Flood Study** – defines the nature and extent of flooding and flood-related issues (hydraulic, environmental and cultural) in technical terms.

2 **Floodplain Management Study (FMS)** – evaluates management options in consideration of social, environmental and economic factors, in order to address existing and future flood risk and flood management issues.

3 **Floodplain Management Plan** – outlines the strategies to manage flood risk and flood management issues and support the natural functions of the floodplain environment.

The Moomin Creek FMP was publicly exhibited during October–November 2003, and the submissions received during this process were taken into account in the preparation of the final plan.

The FMP allows for further floodplain management planning by providing a floodway network to allow the orderly passage of a 20- to 25-year event, as based on 1974 and 2001 flood data. The floodway network framework was necessary to improve the current drainage of the floodplain system and coordinate the required flows to flood-dependent ecosystems and the needs of landholders. The FMP, using the FMP floodway network, forms the basis for determining whether flood control works (earthworks, embankments or levees) on the floodplain will be granted approval under Part 8 of the Water Act 1912. The plan details the approval process and assessment criteria for proposed and existing works. Flood control
works located within floodways and outside delineated areas are assessed as non-complying works and are likely to be refused, modified or removed.

In line with sustainable natural resource management, care has been taken to ensure that flood-dependent ecosystems are located within the floodway limits. Flood-dependent ecosystems include areas of flood-dependent vegetation (e.g. coolibah, black box and river red gum), floodplain watercourses and seven identified wetlands. These ecosystems depend on flood flow to remain healthy and facilitate regeneration. All of the flood-dependent ecosystems are located within the floodway network (see Figures 8–10), thus ensuring their flood flow connectivity and maintaining productive capacity and the life-cycle processes that are supported by their periodic flooding.

As part of the finalisation of the adopted FMP floodway network, the identified floodplain management issues were investigated. Consultation with landholders highlighted issues that included both existing and proposed flood control works believed to obstruct and/or divert flood flow through the FMP area. The FMP outlines the modifications that will need to be made to identified problematic flood control works in order to comply with the FMP and ensure flood flow connectivity throughout the floodplain.

The performance of the FMP floodway network during floods will be assessed on information gathered during flood-monitoring activities. This information will be measured against the FMP’s objectives and the hydraulic, environmental, economic and social indicators that are outlined in the FMP.

The FMP will be assessed following major floods against three key performance indicators:

- Existing and proposed flood control works are constructed, maintained and modified in accordance with the FMP;
- The FMP floodway network allows for the orderly passage of floodwaters during a range of floods;
- The FMP floodway network allows for the delivery of floodwaters to support floodplain ecosystems.

The presence of dense vegetation cover within the FMP floodway network may increase hydraulic roughness and reduce floodway efficiency. There is a range of options under the *Native Vegetation Act 2003* and other relevant legislation to manage vegetation so that the FMP floodway network is maintained and operates as designed during floods.

It is expected that the FMP will be adopted as a Minister’s plan under the *Water Management Act 2000* in the future. The FMP is required to be reviewed at 5-yearly intervals in accordance with the *Water Management Act 2000*. Triggers for review include significant flood events, changes to land use, impediments to implementation and changes to factors that influence decisions. Climate change has the potential to result in many direct and indirect changes to floodplains, including to their hydrology and to the institutional framework in which floodplains are managed. Climate change has the potential to alter flood patterns as a result of changes in monthly average rainfall, rainfall distribution, rainfall intensity and flood frequency estimates. Changes to ground water and soil moisture could further influence the magnitude and duration of floods. Any direct or indirect impacts of climate change on agriculture will have a strong flow-on effect on floodplain management, as many rural floodplain landowners are primary producers. Early adaptive responses will decrease longer term vulnerability and economic costs. Therefore, as part of any plan review, particular attention will be given to exploring the adaptive capacity of rural FMPs to address climate change impacts on flood risk exposure, flood-dependent ecosystems (e.g. wetlands) and rural economies.
1 Introduction

1.1 Overview
The FMP was developed on the basis of a detailed technical analysis of flood flow and in accordance with the NSW Government’s Floodplain Development Manual (2005). The FMP is the outcome of a floodplain management process that included input from affected stakeholders. In formulating the FMP a detailed evaluation of factors that affect, and are affected by, the use of flood-prone land was undertaken. This included consideration of hydraulic, environmental, cultural and socio-economic factors.

The FMP has the following aims.

- Provide a floodway network that will improve the current drainage of the floodplain system and allow for the orderly passage of flood flows.
- Balance the expressed requirements of landholders with the requirement to minimise the impact of floodplain development on natural flood flow patterns and ecological functions.

The FMP incorporates the key points and main outcomes of the Moomin Creek Flood Study (2003) and the Moomin Creek Floodplain Management Study (2003) (FMS). The FMS deals with many issues, including legislative and policy matters and the floodplain environment, in substantial detail. The reader should refer to the FMS where background and/or greater detail are sought.

Once adopted under the provisions of Part 8 of the Water Act 1912, the FMP must be considered by NOW when it reviews and determines approval applications for flood control works under the Water Act 1912 (or the Water Management Act 2000 when it is applied).

1.2 Vision statement
Implementation of the Moomin Creek FMP will improve the community’s security against flood risk and allow for the sustainable management of agricultural lands and flood-dependent ecosystems.

1.3 Objectives
The primary objectives of the Moomin Creek FMP are as follows.

1 Coordinate floodplain development in order to minimise adverse changes to surface flow patterns.
2 Develop and adopt floodplain management principles and development assessment criteria.
3 Increase the sustainable social, economic and ecological benefits of using the floodplain.
4 Maintain and improve the diversity and health of native riverine and floodplain ecosystems that depend on regular flood inundation.
1.4 The FMP Area

1.4.1 Overview

This FMP is concerned with the floodplain of Moomin Creek. As identified in Figure 1, the Moomin Creek FMP is located within a floodplain as designated under Section 166 of Water Act 1912. It stretches approximately 80 km along Moomin Creek from upstream of the Gurley Creek – Moomin Creek confluence to upstream of the Mallowa Creek – Moomin Creek confluence. It covers an area of approximately 1200 km², with the centre of the area approximately 70 km south-west of Moree.

The FMP area lies primarily within the Local Government Area (hereafter LGA) of Moree Plains Shire, with small areas in the southern reaches within Narrabri Shire and Walgett Shire. The majority of landholders in the Moomin Creek area currently practice cropping, with the dominant system being cotton and wheat rotation. Although grazing still occurs, it is becoming less common.

For a more detailed description of the floodplain environment refer to the Moomin Creek FMS – Tamworth Office

1.4.2 Flooding

The Moomin Creek FMP area has floodwater contributions from several major drainage lines, including Moomin Creek, Mehi River, Tycannah Creek, Wolongimba Creek, Gurley Creek, Millebee Creek, Millie Creek and Thalaba Creek. Flooding of the area can originate from the following sources:

- runoff from the upper Gwydir River catchment
- runoff from the catchments of Tycannah, Gurley and Millie creeks
- a combination of the above.

In general terms, the flooding patterns within the Moomin Creek FMP area are as follows:

1. Upper Gwydir catchment floodwaters entering the Moomin Creek system predominantly affect the northern floodplain first, then gradually cross to the southern floodplain in the lower reaches towards Baroona Bridge (the western extent of the FMP area) and the confluence of Moomin and Wolongimba Creeks. Tycannah Creek flows combine with Moomin Creek flows at the upstream end.

2. Floodwaters from Gurley Creek and Millie Creek directly enter the southern floodplain of Moomin Creek, often contributing very large flood flows.

3. Flows in the Thalaba Creek system can spread onto the floodplain and interact with Moomin Creek floodwaters.

In many of the large historical flood events, Gurley Creek and Tycannah Creek contributed significant flows. When the two creek flows have similar timing, the flows converge to provide one large flow, increasing the size of the flood event.

Throughout the Moomin Creek system, depths of inundation on the floodplain are generally about 0.5 m, except in the defined depressions and swamps. On the floodplain flow velocities are generally low and below scour velocity, although they may be raised by localised obstructions or flow concentrations. At some locations in the FMP area velocities are higher due to steeper land slopes.
1.4.3 Environmental summary

Flooding is a vital natural process driving ecological productivity across the floodplain. Floodplains have a key ecological role in providing organic matter and nutrients that are cycled during floods, supporting an extensive food base for fish and waterbirds. Within the floodplain there is a mosaic of environments ranging from terrestrial (seldom flooded) to aquatic (permanently wet) environments. The development of agriculture and associated flood control works has modified the floodplain environment by removing floodplain vegetation and altering river-to-floodplain connectivity. Despite these impacts, the floodplain retains important ecological values, including tracts of wooded riverine terrain and ecologically productive wetlands that support a range of floodplain fauna.

Vegetation officers (former DNR Vegetation Officers) assessed floodplain vegetation within the FMP area to assess the extent and conservation value of stands of vegetation. Where locations of vegetation stands were identified to require flood access and to be of conservation value, the floodway network was extended to include these stands and ensure long exposure to flooding. (Refer to FMS Section 9.3.2.)

Seven wetlands were identified within the FMP area (Figures 8 to 10 in Appendix B): three large wetlands (Mongyer Lagoon, Collytootela Lagoon and Lower Water Wetlands) and four minor wetlands (A to D), which are classed as small lagoons and depressions adjacent to waterways inundated by large flood events.

Naturally functioning and healthy wetlands are adapted to a regime of wetting and drying. Nutrient cycling, invertebrate life cycles and aquatic plant life cycles are also linked to this regime. Major alterations to the regime reduce the ecological productivity and biodiversity of wetlands. The identified wetlands have exhibited signs of stress (including degradation of surrounding vegetation health and structure, deterioration of water quality and reduced wetland biodiversity) in recent years owing to the combined effects of river regulation and drought (see Section 7).

The Moomin Creek floodplain is also culturally significant to the Kamilaroi people. Aboriginal people traditionally occupied the well-watered parts of the landscape where resources were plentiful. Aboriginal sites of particular relevance to the FMP include scarred and carved trees that are flood dependent (river red gum, black box and coolibah) and wetlands and watercourses that may have spiritual significance.
2 Development of the FMP

2.1 Legislative and policy framework

The Moomin Creek floodplain must be managed within the current legislative and policy framework. A brief summary of the relevant primary pieces of legislation and policy is presented below.

2.2 Water Act 1912 and Water Management Act 2000

Development on floodplains in the western rural areas of NSW is managed through Part 8 of the Water Act 1912. Part 8 was gazetted in 1984 and makes provisions concerning ‘controlled works’ that affect, or are likely to affect, flooding and/or floodplain functions. Part 8 was amended in 1999 to allow for more strategic control of such works (hereafter known as flood control works) through the preparation of rural floodplain management plans, giving a streamlined and resource-efficient approval process. The amended Water Act provides for a broader consideration of issues in the approval of existing and proposed flood control works and strengthens NOW’s ability to deal with unauthorised works.

At the time of preparing this FMP the State Government had initiated wide-ranging reform of water legislation, with the outcome being the Water Management Act 2000. The Water Management Act 2000 consolidates most of the Acts previously covering water management in NSW and is being phased in gradually as water-sharing plans are developed and commenced for particular water sources. The floodplain management provisions of that Act will eventually replace Part 8 of the Water Act 1912. Under current transitional arrangements of the Act, existing FMPs under Part 8 of the Water Act 1912 may be deemed Minister's plans under the Water Management Act 2000.

As the regulation of flood control works will ultimately fall under the Water Management Act 2000, it is relevant to consider the objects and principles of that Act in the preparation of plans under Part 8. The objects of the Water Management Act 2000 are to provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations and, in particular:

(a) to apply the principles of ecologically sustainable development, and

(b) to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality, and

(c) to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:

(i) benefits to the environment
(ii) benefits to urban communities, agriculture, fisheries, industry and recreation
(iii) benefits to culture and heritage and
(iv) benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water.

(d) to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,

(e) to provide for the orderly, efficient and equitable sharing of water from water sources,
(f) to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,

(g) to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,

(h) to encourage best practice in the management and use of water.

In relation to floodplain management, the water management principles of the Water Management Act 2000 are as follows:

(a) floodplain management must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, water logging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and

(b) the impacts of flood works on other water users should be avoided or minimised, and

(c) the existing and future risk to human life and property arising from occupation of floodplains must be minimised.

The repealed Rivers and Foreshores Improvement Act 1948, which allowed for the carrying out of works to remove obstructions and to improve rivers and foreshores, has been replaced by provisions in the Water Management Act 2000 for controlled activities. Under the Water Management Act 2000, NOW requires approval for controlled activities, which include the removal or deposition of material in the bed of a watercourse or wetland and on adjacent land and other activities that affect the flow of water in a watercourse. Approval under the Water Management Act 2000 would be required where earthworks are proposed in the bed of a watercourse or wetland or where material is being sourced from a watercourse to construct a flood control work.

2.2.1 Core provisions – Water Management Act 2000

The Water Management Act 2000 specifies core provisions that must be dealt with in a floodplain management plan made for a water management area and additional provisions that may be dealt with. These provisions have guided the preparation of the FMP. The following section lists these provisions and outlines how they have been addressed in the FMP.

(a) Identification of the existing and natural flooding regimes in the area, in terms of the frequency, duration, nature and extent of flooding. A range of available flood data was analysed as part of the FMS in order to calibrate the computer model and develop design floods. Section 5 of this FMP describes the selection of the design flood and hydraulic modelling that supported the design of the floodway network.

(b) Identification of the ecological benefits of flooding in the area, with particular regard to wetlands and other floodplain ecosystems and groundwater recharge. The ecological benefits of flooding in the area are outlined in Section 7 of this FMP. Further detailed information on the environmental assessment is presented in Section 9 of the FMS.

(c) 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. Identification of existing flood works was undertaken in detail in the FMS, and the impact of these works on flood behaviour was assessed in relation to flood risk and the flood connectivity of flood-dependent
ecosystems. On the basis of this assessment, the FMP (Section 6) specifies modifications required to existing works to address identified hydraulic and environmental issues.

(d) Identification of the risk to life and property from the effects of flooding. The FMS undertook detailed risk analysis under different scenarios to investigate and finally adopt the design flood to be used for the hydraulic design of the FMP floodway network (FMP, Section 5). The FMP is a strategic plan that identifies a network of coordinated floodways that need to be kept open for floods up to, and including, the design flood, irrespective of whether there are flood protection works or not.

2.2.2 Additional provisions – Water Management Act

(a) Proposals for the construction of new flood works. Section 4.3 of this FMP outlines the approval and determination process for new flood works. The FMP floodway network (Figures 5 to 7 in Appendix B) will be used as the basis for determining applications for flood works.

(b) The modification or removal of existing flood works. This is dealt with in Section 6 of this FMP.

(c) Restoration or rehabilitation of land, water sources or their dependent ecosystems, in particular in relation to the following:
   (i) the passage, flow and distribution of floodwater,
   (ii) existing dominant floodways and exits from floodways,
   (iii) rates of flow, floodwater levels and duration of inundation,
   (iv) downstream water flows,
   (v) natural flood regimes, including spatial and temporal variability.

   These provisions are reflected in the floodplain management principles (Section 3) that informed decision-making in the design of the FMP floodway network (Section 5) and in the hydraulic and environmental improvement measures in Section 6.

(d) The control of activities that may affect, or be affected by, the frequency, duration, nature or extent of flooding within the water management area. The FMP provides guidance on how to control activities associated with flood works (Section 6 and Section 7.5).

(e) The preservation and enhancement of the quality of water in the water sources in the area during and after flooding. Impacts of the FMP on water quality are assessed at a strategic level in Table 5.

(f) Other measures to give effect to the water management principles and the objects of the Act. The performance indicators, monitoring and review measures described in Section 9 are designed to assess the performance of the FMP in achieving its objectives.

(g) Such other matters as are prescribed by the regulations. Currently no matters have been prescribed by the regulations.
2.3 The Flood Prone Land Policy

The primary objective of the NSW Government’s Flood Prone Land Policy (Section 1, *Floodplain Development Manual*, 2005) is to reduce the impacts of flooding on individual owners and occupiers of flood prone land, and to reduce private and public losses caused by flooding. A central tenet of the policy is that land use proposals for flood prone land be treated within the framework of a strategically generated floodplain risk management plan prepared by using a merit approach. The *Floodplain Development Manual* (NSW Government 2005) supports the policy and outlines a merit approach to floodplain management. The assessment criteria adopted in this FMP (Section 8) support the merit approach.

2.4 Other floodplain management controls

There are several other legislative acts and policies that are relevant to floodplain management and the approval process for flood control works. The majority of these relate to floodplain environmental matters such as flora and fauna, wetlands, threatened species and fish habitat.

- **The Environmental Planning and Assessment Act 1979** – This Act is of particular importance in determining applications for flood control works, NOW is required to assess the environmental impact of the works under Part 5 of this Act. Consideration of proposed works under Part 4 of the Act is not required.

- **The Commonwealth Environment Protection and Biodiversity Conservation Act 1999** – In certain circumstances, where a flood control work is likely to affect a matter or species of national environmental significance, such as a nationally listed threatened species or a listed migratory species, an approval may also be required under this Act. These approvals are assessed by the Commonwealth Department of the Environment, Water, Heritage and the Arts.

Other relevant pieces of legislation include:

- *Native Vegetation Act 2003*
- *Fisheries Management Act 1994*
- *Threatened Species Conservation Act 1995*
- *National Parks and Wildlife Act 1974*
- *Forestry Act 1916*.

Natural resource-management policies that supported decision-making in the FMP include:

- the NSW Wetlands Policy 2010
- the State Groundwater Dependent Ecosystems Policy 2002.
On 3 July 2008, the NSW Government announced the Floodplain Harvesting Policy, which aims to bring floodplain harvesting activities into the statutory framework for water management for the first time. It is proposed that entitlements for floodplain harvesting that are within existing Water Sharing Plan limits and the Murray Darling Basin Cap be established in each valley in NSW. Eligible works will be assessed to determine whether they can be authorised to take floodplain water; if they are approved, a share of the total allowable floodplain harvesting volume will be issued under licence. Once the policy is finalised (following public consultation), it is intended that the data contained in this FMP, the FMS and the Flood Study will support the implementation of the policy in the Moomin Creek floodplain.

### 2.5 Relevant management plans

The *NSW State Plan – Investing in a Better Future* (2009) outlines the goals, priorities and targets for the NSW Government to deliver better services and improved outcomes for the communities of NSW.

The State Plan priorities for the protection of the natural environment include the provision of better outcomes for native vegetation, biodiversity, land, rivers, and coastal waterways. Paramount to realising such outcomes is the need to meet the NSW Government’s state-wide targets for natural resource management. The Moomin Creek FMP will assist in meeting these targets by maintaining flood connectivity to support riverine ecosystems and wetlands. The Moomin Creek FMP aims to reduce the impacts of flooding on rural communities and supports ecologically sustainable development using practical environmental solutions within a strategic planning framework. The State Plan also identifies a number of current activities that contribute to the improvement of the health of catchments, rivers and wetlands including the implementation of catchment action plans that consolidate existing natural resource management plans and provide long-term direction for investment in natural resources.

The Border Rivers–Gwydir Catchment Management Authority (CMA) worked with local communities to prepare the Border Rivers–Gwydir Catchment Action Plan which was adopted by the NSW Government in January 2007. The Catchment Action Plan outlines a number of natural resource management targets, several of which are directly relevant to outcomes in the FMP. The Moomin Creek FMP should be viewed as one component of an integrated planning process, with other linked components including:

- Water Sharing Plan for the Gwydir Regulated River Water Source (*Gwydir Regulated River Management Committee 2002*)

### 2.6 Community consultation

An essential part of ensuring the successful progress and implementation of floodplain studies is to provide an effective communication system to encourage community involvement and develop an FMP with local knowledge and ownership. Community consultation has been a key component in the preparation of this FMP.
2.6.1 Moomin Creek Floodplain Management Committee

The Moomin Creek FMC was formed in May 1999 to oversee the development and implementation of the FMP, with technical assistance from DNR (now DECCW).

The role of the FMC was to scope strategies and outcomes sought in the floodplain management process. The Moomin Creek FMC consisted of a balance of representatives from the community (landholders), government department and rural farm groups, agencies, Moree Shire Council and community groups. Seven meetings were held throughout the duration of the study to discuss and review options and develop criteria for the FMP. In addition to this, landholder interviews (stakeholder meetings) were also undertaken, to ensure the views and concerns of the landholders were being taken into consideration.

For further details on the consultation process refer to FMS Section 3.

2.6.2 Public exhibition

The FMP was put on public exhibition during October–November 2003 and 15 responses were received. DNR, in consultation with the FMC, considered the submissions in October 2005. Where relevant, amendments were made to the FMP.
3 Floodplain management principles

An FMP is designed to cater for flood flows, provide flood mitigation, encourage sustainability and maintain flooding to flood-dependent ecosystems. In consultation with the Moomin Creek FMC, a set of floodplain management principles consistent with these objectives was adopted for this plan.

The adopted principles were used as a guide for the purpose of making decisions when assessing management strategies and options for the FMP. The adopted floodplain management principles conform with the general matters for consideration with respect to flood control work approvals, set out in Section 166C(1) of Part 8 of the Water Act 1912.

The principles adopted for the Moomin Creek FMP are listed below:

- Defined floodways must possess adequate hydraulic capacity and continuity to enable the orderly passage of floodwaters through the floodplain.
- Any system of defined floodways should conform as closely as is reasonable to the natural drainage pattern after taking into account the existing floodplain development.
- Floodway areas should be equitably allocated (between adjacent landholders) consistently with natural/historical flowpaths.
- Environmental issues related to the floodplain management plan need to be identified and investigated, including developing strategies for flood-dependent ecosystems such as wetlands, riparian vegetation, and any other environmentally sensitive areas.
- The exit of floodwaters from defined floodways should be at rates and depths similar to those that would have been experienced under natural/historical conditions and should discharge as close as practicable to the location of natural/historical floodways.
- Sufficient pondage must be retained on the developed floodplain so that the flood peak travel time is not unduly accelerated to downstream users or its height increased.
- Velocities of flood flow in defined floodways should be minimised and be of an order that would not cause erosion or increased siltation under various land uses.
- There should be no significant impact from floodplain development on any individual landholder or community infrastructure, including increases in peak flood levels and increased drainage times.
- Floodplain development should not cause significant redistribution of floodwater.
- Should the community agree, there may be scope to depart from the natural/historical drainage pattern, provided it is hydraulically and environmentally feasible.
- Socio-economic issues relating to floodplain management need to be identified and investigated. This includes considering both tangible damage (can be readily measured in monetary terms) and intangible damage (includes increased levels of emotional stress, physical illness and disruption to daily life).

These principles are adhered to and reflected within the FMP through adopted assessment criteria and will be applied by NOW when considering Part 8 applications under the Water Act 1912.
4 Plan implementation

4.1 Roles and responsibilities

Implementation of the FMP will be regulated under Part 8 of the Water Act 1912. NOW is currently responsible for the implementation of FMPs within rural NSW west of the Great Dividing Range. DECCW provides a technical advisory role in regards to implementation.

Successful implementation of the FMP depends largely on community ownership. Landholders should encourage one another to undertake appropriate land use management practices and undertake the required modifications to existing flood control works, (see Section 6). The roles of the relevant stakeholder in relation to the FMP implementation are listed in Table 1.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role / responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMC</td>
<td>• Oversee the preparation of the FMP</td>
</tr>
<tr>
<td></td>
<td>• Provide advice on FMP implementation</td>
</tr>
<tr>
<td>NOW (DECCW providing technical advisory role)</td>
<td>• Arrange for implementation of FMP measures, including those recommendations for changes to existing flood control works and restoration of floodwater access to the recommended flood-dependent ecosystems.</td>
</tr>
<tr>
<td></td>
<td>• Provide technical advice and support to landholders, where appropriate</td>
</tr>
<tr>
<td></td>
<td>• Assess applications for flood control works and perform ongoing licensing of existing flood control works</td>
</tr>
<tr>
<td></td>
<td>• Perform ongoing monitoring of floodway performance and floodway conditions and collect flood data</td>
</tr>
<tr>
<td>Landholders</td>
<td>• Undertake the required modifications to existing flood control works, with the direction of NOW</td>
</tr>
<tr>
<td></td>
<td>• Seek approval from NOW for any unlicensed and future proposed flood control works and construct works in accordance with licence consent conditions</td>
</tr>
<tr>
<td></td>
<td>• Undertake sustainable land use management practices</td>
</tr>
<tr>
<td></td>
<td>• Perform ongoing monitoring of floodway performance and floodway conditions and collect flood data</td>
</tr>
<tr>
<td>Local government</td>
<td>• Maintain hydraulic capacity at waterway structures (e.g. bridges, culverts, causeways)</td>
</tr>
<tr>
<td></td>
<td>• Arrange for implementation of FMP recommendations relating to council assets (e.g. new waterway structures or modifications to existing structures)</td>
</tr>
</tbody>
</table>
4.2 Performance assessment

To measure the success of the Moomin Creek FMP, DECCW will refer to the detailed performance indicators (Section 9.1) that will be developed as part of a State floodplain management policy. These indicators will be closely linked with the FMP objectives and will largely be based on monitoring and assessment information as outlined above and detailed in the FMS.

There are a number of data sources that can be used to report on the performance indicators, such as flood monitoring data, audits of complying flood control works, and the results from fauna and flora surveys. Although scrutiny of these data sources will yield detailed indicators, the following broad indicators are provided to give the reader an understanding:

- minimal disruption to the passage of flood waters within the defined FMP area
- maintenance of natural flooding regimes to identified wetlands and other flood-dependent ecosystems
- increased security against flood risk.

4.3 Part 8 Approval process for flood control works

4.3.1 General

All proposed and existing flood control works within the FMP floodplain require approval under Part 8 of the Water Act 1912.

All flood control works situated, or proposed to be constructed, on land within the designated floodplain will be determined in accordance with FMP and Part 8 of the Act.

4.3.2 Works that require approval

Any work requiring approval under Part 8 of the Water Act is defined as a ‘controlled work’. The following works are defined as controlled works requiring a Part 8 approval:

- an earthwork, embankment or levee:
  - situated or proposed to be constructed on land that is or forms part of the bank of a river or lake, or, is within a designated floodplain, or
  - wherever situated or proposed to be constructed that affects or is reasonably likely to affect the flow of water to or from a river or lake and is used or is to be used for, or has the effect or likely effect of, preventing land from being flooded

- any work:
  - that is situated, or proposed to be constructed, on land that is, or forms part of, the bank of a river or lake, or is within a designated floodplain, and is declared to be a ‘controlled work’
  - wherever situated or proposed to be constructed that affects or is reasonably likely to affect the flow of water to or from a river or lake, and is used or is to be used for, or has the effect or likely effect of, preventing land from being flooded, and is declared to be a ‘controlled work’.
However, a ‘controlled work’ does not include any works declared not to be a controlled work, or a work in respect of which a licence or approval is in force under Part 2, 5 or 9 of the Water Act.

In the FMP, a ‘controlled work’ within the meaning of Part 8 is referred to as a ‘flood control work’.

### 4.3.3 Applying for approval

To lodge an application for approval of flood control works, a Part 8 application form (Appendix C) must be completed and submitted to NOW.

The following must accompany the application form:

- application fee
- a detailed locality plan showing the location of the works and providing full details of the proposal, including specifications of the dimensions and design of the works, and the construction materials
- a detailed survey plan adopting Australian Height Datum (AHD) showing survey levels relevant to established and or proposed works
- supporting information that may help in the determination process (the applicant should get in touch with the nearest NOW office for details)
- for non-complying works, a report on the hydraulic and environmental impacts.

It is important that all information requested by NOW be provided to allow proper consideration of the application. If the requested information is not provided, NOW can refuse to deal with the application.

### 4.3.4 Determination process

All applications under Part 8 of the Water Act 1912, including works considered to be complying with the FMP, must proceed through a set process before NOW (on behalf of WAMC) makes a determination on the application under Section 171 of the Act. This process includes (but is not limited to) the following:

**Section 166C of the Water Act 1912.** NOW must have regard to the matters for general consideration outlined in Section 166C, including (but not limited to):

- the contents of any relevant FMP or any other relevant Government policy;
- 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;
- the effect or likely effect on water flows in downstream river sections;
- any geographical features, or other matters of Aboriginal interest that may be affected by a controlled work;
- the effect or likely effect of a controlled work on the passage, flow and distribution of flood waters;
- the effect or likely effect of a controlled work on existing dominant floodways or exits from floodways, rates of flow, flood water levels and the duration of inundation;
- the protection of the environment; and
- any other matters relating to the desirability or otherwise of a controlled work.
Part 5 of the Environmental Planning and Assessment Act 1979. All proposals must undergo assessment under Part 5. The factors to be considered include (but are not limited to):

- any environmental impact on a community;
- any environmental impact on the ecosystem of a locality;
- any reduction of aesthetic, recreational, scientific or other environmental quality or value of a locality;
- any impact on the habitat of protected fauna;
- any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air;
- any degradation of the quality of the environment;
- any reduction in the range of beneficial uses of the environment; and
- any cumulative environmental effect with other existing or likely future activities.

Floodplain Management Plan. NOW must consider the FMP and information contained within the FMP, including principles, assessment criteria, and any recommendations.

Other management plan. NOW must have regard to the contents of any other management plan or policy, including those dealing with the delivery of environmental water as specified under Section 8 of the Water Management Act 2000.

Aboriginal heritage assessment. NOW will liaise with the Culture and Heritage Division of DECCW to assess Aboriginal heritage issues associated with individual applications. Applications will be assessed in accordance with the National Parks and Wildlife Act 1974.

Additional information. NOW must consider any relevant supporting information that has been provided by the applicant.

4.3.5 Possible determinations

NOW must inform the applicant as soon as practicable of the determination of an application for a flood control work. The general terms of approval should be comprehensive enough to cover all of the constraints (terms and conditions) that may be applied to the relevant Part 8 licence. Under the Water Act 1912, there are three (3) possible determinations:

- approval of the application
- approval of the application subject to conditions
- refusal of the application.

In certain circumstances there may be a right of appeal to the Land and Environment Court in respect of a determination under the Water Act. Before making a determination in respect of an application for flood control works, NOW is required to decide whether the works do or do not comply with the FMP.

4.3.6 Typical approval conditions

The following is a list of typical conditions that can be attached to an approval. Please note that this list is not exhaustive, and conditions more specific to the property and proposal are likely.
works may be constructed on property ‘X’ in accordance with the location, nature, heights, floodway width and boundary corridors as specified in the plan.

the works shall be constructed and maintained in a manner that will minimise the possibility of damage being occasioned by them, or resulting from them, to any public or private interest.

if during the currency of this approval a floodplain investigation by NOW reveals that the work(s) should be modified in the public interest so as to permit a more satisfactory flow of water within the floodplain, the landholder shall, upon receipt of notice by NOW, modify the work(s) in accordance with such notice.

the height of the controlled work(s) between the points marked ‘A’ and ‘B’ on the plan shall not exceed ‘X’ metres above the natural surface level.

the controlled works between the points marked ‘B’ and ‘C’ on the plan shall be set back not less than ‘X’ metres from the nearest boundary of the property.

4.3.7 Unauthorised flood control works

The amended Water Act 1912 strengthened NOW's ability to deal with unauthorised works. Unauthorised controlled works include the following:

- works where there is no approval in force
- works that have been constructed otherwise than in accordance with an approval that is in force
- works that have not been constructed in accordance with the conditions of an approval.

It is an offence to construct a controlled work otherwise than in accordance with an approval that is in force, or to fail to comply with the conditions of an approval.

Where unauthorised works are identified, NOW may direct that one or more of the following types of work be carried out by issuing a notice under Section 180D of the Water Act 1912:

(a) work to remove, modify, repair or restore the controlled work or to render the work ineffectual.

(b) work to repair any damage caused by the controlled work (including any damage caused to any specified land, river, lake, structure or vegetation, or to the environment).

(c) work to ensure that any specified land, structure, river, lake or vegetation, or the environment, will not be damaged or adversely affected, or further damaged or further adversely affected, by the controlled work.

Without limiting (a) to (c) above, work to correct or restore any alteration caused by the controlled work to the flow of water into or from, or the quantity of water contained in, any specified river or lake.

- It is an offence to fail to comply with a direction.

- In the event of the occupier not complying with the served notice, NOW can carry out the work and recover the costs incurred in doing such work. NOW is not required to give any prior notice of its decision to exercise these powers. The occupier can appeal such action to the Land and Environment Court.
4.3.8 Complying works

Under Section 168B(2) of the Water Act 1912, a flood control work is to be assessed as a complying work if NOW is satisfied that the work complies with the FMP for the area in which the work is situated or proposed to be constructed. Within the Moomin Creek FMP area, complying flood control works are defined as:

- existing (unapproved) and proposed works that are located outside the draft FMP floodway network, as illustrated in Figures 5–7 (Appendix B);
- existing (unapproved) or proposed works to be modified in accordance with the required modifications, as specified in Table 3 and Table 4 or
- work that does not trigger any issues in regard to the adopted assessment criteria, described in Section 8.

A landholder will be required to provide the necessary supporting information to demonstrate that the application is a complying work. If an existing (unapproved) or proposed flood control work is complying, the application for approval will be determined by NOW without the need for advertising to canvass third-party objections. Although the majority of approvals for complying works are likely to be straightforward and expeditious, they will not be automatically approved and will be subject to the determination process outlined in Section 4.3.5, including assessment against the matters raised in Section 166C of the Water Act 1912 and Part 5 of the Environmental Planning and Assessment Act 1979 (see Section 2.4.1).

4.3.9 Non-complying works

Under Section 168B (3) of the Water Act 1912, a flood control work is to be assessed as a non-complying work if NOW is not satisfied that the work complies with the FMP for the area in which the work is situated or proposed to be constructed, or if the flood control work is situated or proposed to be constructed in an area that is not the subject of a floodplain management plan. For the Moomin Creek FMP area, non-complying flood control works are defined as:

- existing (unapproved) and proposed works located within the FMP floodway network, as illustrated in Figures 5–7 (Appendix B); and/or
- existing (unapproved) or proposed works that are not modified in accordance with the required modifications, as specified in Table 3 and Table 4; or
- works that trigger one or more issues when considering the adopted assessment criteria described in Section 8.

Non-complying works may be approved after a detailed investigation of the hydraulic, environmental, social and economic impacts of the proposal. The cumulative impact of the proposal on flooding characteristics will need to be comprehensively addressed in the application. It is important to understand that it is the applicant’s responsibility to provide the necessary technical details to support an application. Where the requested supporting information is not furnished, NOW can refuse to deal with the application.

Applications for non-complying works must be advertised and third-party objections sought before the determination of the application. If an objection is received that cannot be resolved, compulsory mediation will be required. NOW may request additional supporting information from the party who lodged the objection, with failure to do so possibly resulting in the objection being rejected. If NOW grants an approval for an application and an objection has been made, NOW must notify the objector of its determination. The occupier may appeal against the determination in the Land and Environment Court.
4.3.10 Floodplain harvesting works

Floodwaters play a vital role in replenishing the floodplain and wetland environment and are an important water source for many NSW irrigators.

The NSW Government is developing the Floodplain Harvesting Policy to ensure that floodplain harvesting is appropriately licensed, is sustainable for the long-term and to meet requirements under the Murray–Darling Basin Ministerial Council Cap and the National Water Initiative. The National Water Initiative requires NSW to establish a framework for managing activities that have the potential to intercept significant volumes of water.

4.3.11 Roads and railways

Roads and railways (and associated bridges, culverts and road works) vested in local government or State government transport agencies are declared by order as non-controlled works under Section 165(2)(a) of the Water Act 1912. However, the agencies constructing these works are required to assess the works’ environmental impact under the Environmental Planning and Assessment Act 1979.

4.3.12 Flood protection for high-value infrastructure

It should be recognised that landholders can protect from flooding those parts of their property that contain high value infrastructure such as houses, workshops and sheds. If such works are constructed solely for the protection of high-value infrastructure, Part 8 approval will not be required.

However, if such works are integrated into a much larger area of protection incorporating earthworks or levee banks that also protect arable land, then the infrastructure protection works will need to be assessed as a Part 8 determination process for flood control works on a property.
5 The FMP floodway network

5.1 General

The central element of the FMP is the floodway network. The floodway network represents the area reserved for flood discharge of the adopted design flood flow. Delineation of the floodway network areas provides the basis by which authorities limit future development to ensure that the primary function of the floodway network (to convey and store floodwaters) is not compromised.

The FMP floodway network was designed to maintain natural flooding patterns and enable the passage of flood water across the FMP area. The FMP floodway network is displayed in Figures 5–7 (Appendix B). The floodway network was designed strategically across the floodplain and is less accurate at the property level.

The FMP floodway network was designed to maintain natural flooding patterns and enable the passage of flood water across the FMP area. The FMP floodway network is displayed in Figures 5–7 (Appendix B). The floodway network was designed strategically across the floodplain and is less accurate at the property level.

The areas of native vegetation identified in Figures 8–10 (Appendix B) include flood-dependent ecosystems that require periodic flooding. These areas need to be kept within floodway areas, so they are subject to normal flooding patterns. (A possible alternative in some cases may be to place pipes through the bank to allow periodic flooding.) Environmental assessment of all proposed works and Part 8 approvals will identify the requirements for flooding of these areas. Figures 8–10 (Appendix B) show vegetation mapping undertaken in 1998–2001 and demonstrate the proximity of vegetation to the floodway areas.

All flood control works, including levees, channels and other works on the floodplain that alter the behaviour of floodwaters require approval from NOW under Part 8 of the Water Act 1912. The location of proposed flood control works relative to the floodway network is a key factor in the approval process. Proposed flood control works located outside the floodway network are assessed as complying works, and approval is relatively straightforward. Proposed flood control works located inside the floodway network are assessed as non-complying works and require a detailed investigation. In general, non-complying works are unlikely to be approved (further detail on the approval process is provided in Section 4.3).

Decisions relating to the delineation of floodway areas were guided largely by the adopted floodplain management principles. The hydraulic, environmental, social and economic, and legislative principles are all relevant to the delineation of the floodway areas.

In many cases, there is a trade-off between hydraulic and environmental concerns and maximising the area that can be protected for agricultural purposes. Decisions ultimately have been made on the basis of all of the relevant issues under consideration.

5.2 Hydraulic assessment overview

Implementation of floodplain management measures requires a detailed understanding and knowledge of flooding behaviour within the FMP area. To supplement available information on historical flood events, computer-based hydraulic models can be used to simulate flooding behaviour. Information derived from hydraulic modelling includes flood flow distribution, flood levels, and flood flow velocities within the floodplain.

Hydraulic models are used to assess the impact on flood behaviour of structural management options and any proposed flood control works.

The Moomin Creek system was hydraulically modelled using a fully dynamic, networked one-dimensional hydraulic model known as the Danish Hydraulic Institute’s MIKE 11 model.
MIKE 11 is a commercially available engineering package specifically designed for unsteady flow computation, particularly in river and floodplain systems. The program has built in functions for handling hydraulic structures such as culverts and weirs.

For more detailed information regarding the hydraulic modelling of the Moomin Creek floodplain system, including input data and calibration methods, refer to **FS Section 6.6**.

### 5.3 Design flood event

The design flood is the event to be used for the hydraulic design of the floodway network. It is applied to determine the magnitude of the event and the dispersion of water across the floodplain. Failure to adopt the design flood can lead to inequitable distribution of floodwater and an increase in the flood risk to neighbouring and downstream properties.

The 1974 flood event was used as the design flood for hydraulic modelling, planning and floodway network design purposes. The 1974 event was similar in size to the 1955 and 2001 flood events and provided the most comprehensive and available hydrologic and hydraulic data.

An annual recurrence interval (hereafter ARI) could not be accurately determined for the 1974 event. However, according to anecdotal historical flood information and the results of flood frequency analysis, the ARI of the 1974 flood is estimated to be in the range of a 20- to 25-year event. This is equivalent to an annual exceedance probability (AEP) of 4–5 per cent (refer to **Appendix A** for the definition of ARI and AEP).

### 5.4 Modelling procedure

The MIKE 11 modelling for the Moomin Creek FMP involved three distinct phases:

- **‘Pre-development-conditions’ modelling.** Modelling of the floodplain system before the changes in land use from grazing to intensive cropping and development. The modelling was undertaken to obtain information on the natural flooding behaviour within the FMP area.

- **‘Existing conditions’ modelling.** Modelling of the floodplain system after the area had experienced significant irrigation development. The modelling was undertaken to quantify any changes to the natural flooding characteristics within the FMP area.

- **‘Proposed conditions’ modelling.** Modelling of the floodplain system with various structural management options to determine an optimised solution. The issues were treated collectively to determine the impact on surrounding areas and the cumulative impact.

The models are suited to predicting the changes in flood behaviour due to existing or proposed floodplain development and served as an aid in the decision-making process.
6 Flood control works: proposals and required modifications

6.1 General

To finalise the adopted FMP floodway network, identified floodplain management issues needed to be investigated and resolved. These issues included existing flood control works that were identified during the consultation phase as areas of hydraulic concern, and proposed new flood control works. To address the identified issues, computer hydraulic modelling was undertaken and the adopted assessment criteria were applied in order to determine the best possible options. The identified issues are described in Table 3 and Table 4 and illustrated in Figures 2–4 (Appendix B).

It is important to remember that all proposed and existing flood control works within the FMP area require approval under Part 8 of the Water Act 1912. Where no approval exists, NOW may take compliance action(s) in accordance with the Act. A Part 8 approval, however, does not confer the right to undertake floodplain harvesting, which is subject to a separate approval and the Floodplain Harvesting Policy.

With regard to the issues outlined in Table 3 and Table 4, please note the following:

1 Specific structural requirements for proposed works and specific structural modifications to existing works will be administered under the relevant sections of Part 8.

2 Landholders proposing the new works outlined in Table 3 are required to lodge a Part 8 application for approval before any construction activities. The identified structural requirements should be incorporated into the engineering design of the work(s) and, where necessary, will be included as approval conditions under Section 176A of the Water Act 1912.

3 Minor modifications to existing approved works identified in Table 4 to be necessary will be administered through modifying the Part 8 approval conditions under Section 176A of the Water Act 1912.

4 With regard to unapproved works, occupiers who have not already lodged an application for approval will need to do so. An application that is for a non-complying controlled work will require advertising. Objections to the granting of an approval for a non-complying work may be made. Applications for complying flood control works do not require advertising.

5 Directions for remedial work(s) may be used to direct the occupier to perform specified work in a specified manner and within a specified time. The types of work that may be directed include work to remove, modify, repair or restore the controlled work or to render the work ineffectual (Section 4.4).

Please refer to Section 4.3 for further details regarding approval of flood control works and administration of the FMP under the Water Act 1912.

6.2 Staging of plan outcomes

The plan identifies broad implementation stages assigned to the works described in Table 3 and Table 4. Within this framework, priorities for permanent works, modifications and other measures are listed in Table 2.
Table 2: FMP priority actions

<table>
<thead>
<tr>
<th>Priority</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>The recommended actions are vital to ensure adequate performance of the floodway system. The responsible party will initiate consultation and action within 6 months of gazettal of this plan and have the works completed within 18 months.</td>
</tr>
<tr>
<td>Medium</td>
<td>These measures are important for hydraulic and/or environmental reasons. The responsible party will initiate consultation and action within 12 months of gazettal of this plan and have the works completed within 3 years.</td>
</tr>
<tr>
<td>Landholder discretion</td>
<td>It has been determined that these proposed works will not have a significant impact on surrounding properties and landholders can therefore lodge a Part 8 application to construct works at their discretion. Construction should not be undertaken until the Part 8 application is approved.</td>
</tr>
<tr>
<td>Ongoing</td>
<td>These issues or measures may require further investigation or need to be monitored by DECCW and relevant stakeholders during flood events.</td>
</tr>
<tr>
<td>Property</td>
<td>Map ref.</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------</td>
</tr>
</tbody>
</table>
| ‘Bloomvale’       | Figure 2 | Proposed development of the southern extent of ‘Bloomvale’: • causes floodwaters to spread farther onto the adjacent (Downes) property • could cause a tendency for floodwater velocities to increase at the southern corner of the development, possibly leading to scour and erosion in this area. | Landholder discretion | • Lodge a Part 8 application. • Control works will need to comply with height specification:  - A–B Below ground  - B–C Head ditch less than 400 mm  - C–D Tailwater return less than 300 mm (see Figure 2).  
• The southern corner of the development (C on Figure 2) needs to be rounded off to prevent scouring and erosion; and  
• At the southern corner of the development (shaded area Figure 2) there should be no fence line obstructions (fence line should be designed, constructed and managed to limit debris build-up and allow free passage of flood flow) in the area. This is to prevent flow redistribution caused by debris during flood events. In addition, this area should be excluded from the development and future farming/cropping and maintained in a vegetated state.  
• Refer to ‘Land use around Gurley Creek and Jack Shea Swamp’ (Table 4) regarding land use requirements for this area. | Landholder |

* Time period from gazettal of the FMP
<table>
<thead>
<tr>
<th>Property</th>
<th>Map ref.</th>
<th>Concerns</th>
<th>Timetable*</th>
<th>Recommendations</th>
<th>Responsibility</th>
</tr>
</thead>
</table>
| ‘Orlando’ | Figure 2 | Proposed developments:  
• could result in increased water levels in floodways north and south of the developments  
• could result in increased water levels upstream, causing an increase in flow to cross Bulyeroi–Millie Road  
• could result in quite high flow velocities through the southern floodway (Floodway B) (0.5–0.7 m/s)  
• may obstruct causeway on the Bulyeroi–Millie Road. | Landholder discretion |  
• Lodge a Part 8 application for the western development (Dev A – Figure 2). It is recommended that the southern floodway (Floodway B – Figure 2) not be farmed owing to high flow velocities and erosion potential. In addition, grazing should be undertaken with care to maintain ground cover.  
• Lodge a Part 8 application for the eastern development (Dev B – Figure 2) and incorporate a below-ground supply channel between the two developments.  
• It is recommended that the northern floodway (Floodway A – Figure 2) depressions and adjacent flood runners are not farmed owing to high flow velocities and erosion potential.  
• If obstruction of the Bulyeroi–Millie Road causeway occurs, establish a new causeway at an appropriate location.  
• Existing development in this area may be acceptable with limited-height works and setback subject to monitoring in future flow events. | Landholder  
Landholder should work with council to establish new causeway location. |
| ‘Iluka’ | Figure 2  
Figure 3 | Proposed development :  
• would cause narrowing of the floodway that runs through the north of ‘Iluka’.  
• could increase the volume and height of floodwaters crossing the Combadello–Poison Gate Road and onto ‘Elenera’. | Landholder discretion |  
• Lodge a Part 8 application according to the area defined as ‘Allowed Development’ on Figure 2, increasing the width of the northern floodway. | Landholder |

* Time period from gazettal of the FMP
### Table 4: Required modifications to existing flood control works and recommendations

<table>
<thead>
<tr>
<th>Issue</th>
<th>Map ref.</th>
<th>Concerns</th>
<th>Timetable*</th>
<th>Required modification and recommendations</th>
<th>Responsibility</th>
</tr>
</thead>
</table>
| Supply channels | Figure 2, Figure 3, Figure 4 | Supply channels that encroach onto the floodway network area and are above ground level have the potential to redistribute flood flow. Such channels can act as weirs, restricting the passage of flow and increasing upstream water levels during flood events. | High | • Unless otherwise approved by NOW, all existing and proposed supply channels that encroach into the floodway network must be lowed to below ground level, with the spoil removed.  
• Where necessary, this requirement will be attached to new and renewal applications as an approval condition under Part 8 of the *Water Act 1912*. | Landholders |
| Land use around Gurley Creek and Jack Shea Swamp | Figure 2 | Because of an increase in the sediment load of Gurley Creek, reducing its capacity, increased floodwaters are breaking out of the Creek over the floodplain. Steeper land slopes in this area and susceptible soils result in an increased potential for scour erosion. | High | • In the interest of sustainable land management it is recommended that the 'Bloomvale' floodway areas be used only for grazing.  
• These floodplain areas are potentially highly susceptible to erosion. These areas should be cropped using conservation farming practices (maximum ground cover) to limit potential erosion.  
• DECCW, Landcare, CMA and other support groups should work with landholders in an attempt to minimise the erosion of properties upstream in the Gurley Creek catchment. | Landholder |
| ‘Mirriadool’ | Figure 2 | Current development on this property is within the flood flow paths, with the potential to divert flows. | Medium | • Unless otherwise approved by NOW, all existing and proposed works within this area are to be at limited heights. If alternative height is required further investigation is required.  
• Maintain the supply channel at a limited height of approximately 0.5 m to maintain flow distribution.  
• Incorporate small openings (30 m wide) into the supply channel at the lowest points and low flow paths in order to help with the drainage and maintain the natural distribution for smaller flood events. | Landholder |

* Time period from gazettal of the FMP
<table>
<thead>
<tr>
<th>Issue</th>
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<th>Concerns</th>
<th>Timetable*</th>
<th>Required modification and recommendations</th>
<th>Responsibility</th>
</tr>
</thead>
</table>
| North ‘Krui’ | Figure 2 \ Figure 3 | Floodwater redistribution through ‘Krui’ and neighbouring properties:  
- Upstream development has resulted in more floodwater from Gurley Creek travelling north of Moomin Creek and through ‘Krui’, ‘Iluka’ and ‘Retreat’.  
- A reduction in Moomin Creek capacity between Millie–Telleraga Road and the ‘Krui’/‘Retreat’ boundary has resulted in floodwater breaking through the northern extent of ‘Krui’ in several locations. | Landholder discretion | - Construct a causeway on Retreat Road approximately 500–600 m downstream of the Millie–Telleraga Road and Retreat Road intersection.  
- Within the non-defined floodway area (hatched area – Figure 2) on North ‘Krui’, proposed works located in this area would be recommended as being beneficial to improving flow distribution along Moomin Creek and returning floodwaters to the southern side of the creek via two floodways (one that breaks from Moomin Creek through ‘Krui’ and one that breaks from Moomin Creek through ‘Aberfeldie’). A Part 8 application is required for any development on the northern side of Moomin Creek. | Landholder |
| ‘South Retreat’/‘Chesney’ floodway | Figure 3 | Narrowing of the floodway running along the southern boundary of ‘South Retreat’ and ‘Chesney’ resulted in an increase in floodwaters travelling over Millie Creek and through ‘Milton Downs’ and ‘Hazel Park’.  
This water may travel southwards, with the redistribution having the potential to affect Thalaba Creek water users.  
Re-opening of the ‘South Retreat’/‘Chesney’ floodway along the northern boundary (according to the ‘original’ guidelines). Landholders believe the northern floodway is located on high ground, providing inadequate distribution. | High | - Re-open the floodway, at ground level, running along the southern boundary of ‘South Retreat’ and ‘Chesney’, and construct a training bank extending along Millie Creek 300 m into the ‘Chesney’ boundary at 1m higher than the Millie Creek bank height.  
- No cropping in this floodway – Refer to comments on ‘Specific limited land use areas’ in Section 7.5.3 and Figure 3 (Land Use Area 3 – No Cropping). | Landholder |

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<th>Required modification and recommendations</th>
<th>Responsibility</th>
</tr>
</thead>
</table>
| ‘Retreat’ floodway | Figure 3 | Northern levee of ‘Retreat’ floodway:  
• failed in the 1984 and 2001 flood events, causing flood flow to redistribute northwards  
• has not been repaired; the function of the floodway is restricted and floodwaters are redirected north. | High | • Rebuild the levee with the following provisions:  
  – Include the angle at the western end to prevent ponding of floodwater.  
  – Rebuild to the levels specified in the ‘Retreat’ Floodway Proposal Plan – 1 m at the eastern extent and 1.3 m at the western extent.  
  – Maintain flood flow during large events north of the levee and through ‘Minna Minane’.  
• It is recommended that the narrow bend in the floodway not be farmed during summer owing to erosive velocities and increased pressure on the levee.  
• The floodway is identified under Land use Area 2 (See ‘Specific limited land use areas’ in Section 7.5.3) and should be maintained as such.  
• Supply channel in floodway should be below ground. | ‘Iluka’ landholder to rebuild levee with the three affected landholders sharing the cost (agreed to after landholder discussion on 8 June 1999) |
| Roly-poly on ‘Clarendon’ | Figure 3 | Roly-poly (*Salsola kali*) partly blocks the ‘Clarendon’ floodway and possibly redistributes flows south. | Landholder discretion | • Although not deemed necessary on hydraulic grounds, thinning of the roly-poly (or use of other management techniques), subject to allowance under vegetation legislation, would limit any flow redistribution.  
• Any vegetation clearing or thinning activities must be performed in accordance with the *Native Vegetation Act 2005* and the *Native Vegetation Regulation 2005*. | Landholder |

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<th>Responsibility</th>
</tr>
</thead>
</table>
| Vegetation in Moomin Creek | Figure 3 | Lignum (*Muehlenbeckia florulenta*) growth in the section of Moomin Creek bordered by 'Clarendon' and 'Aberfeldie':  
  - Is reducing the creek’s effective cross-sectional area  
  - May be causing floodwaters to break out of the creek at lower levels than previously. | On-going    | - Further investigation is required to determine the cause of the earlier breakout of floodwaters, as hydraulic assessment indicates that the impact of the lignum is minimal. Landholder may address this through grazing or selective regrowth management in accordance with Native Vegetation legislation/approval. | DECCW in conjunction with landholders |
| 'Kamilaroi'/ 'Bellevue' floodway | Figure 3 | Development of 'Kamilaroi' and 'Bellevue':  
  - Is causing significant redistribution of floodwater, with a significant increase in the flow travelling south of Moomin Creek. | High        | - Partly restore the natural flow distribution by increasing the width of the 'Kamilaroi'/‘Bellevue’ floodway to a minimum of 900 m.  
  - It is recommended that the 'Kamilaroi'/‘Bellevue’ floodway not be farmed during summer and that winter stubble is retained.  
  - Maintain the existing channel on ‘Bellevue’ at a maximum height of 0.3 m.  
  - Consider constructing causeways (in addition to existing culverts) along the Derra–Rowena Road in order to cope with the floodwaters crossing the road south of Moomin Creek. | Landholders  
  - Landholders to equitably share the floodway width increase  
  - Council to construct causeways |
Figure 4

'Hemingford' development:
- Development is causing drainage problems at the southern end of 'Hemingford'.
- Supply channel and narrowing of the 'Hemingford' floodway may increase flood levels through the southern corner of 'Alma' and 'New Haven' and may contribute to the southern section of the 'Alma' levee breaching.
- There is no guarantee that the supply channel will remain at an acceptable height.

<table>
<thead>
<tr>
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<th>Timetable*</th>
<th>Required Modification and Recommendations</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Hemingford' floodway</td>
<td>Figure 4</td>
<td>'Hemingford' development:</td>
<td>High</td>
<td>- Construct a floodway through Hemingford, a minimum of 100 m wide and located approximately 1300 m south of the Alma–Baroona Road.</td>
<td>Landholder</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Construct a drainage channel to provide effective drainage of upstream areas.</td>
<td></td>
<td>- Widen the 'Hemingford' floodway along the Alma–Baroona road to 700 m.</td>
<td>Markers to be installed by landholder under NOW supervision</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Maintain supply channels with the following provisions:</td>
<td></td>
<td>- Lower and maintain channel banks north of the Alma–Baroona Road at 161.2 m AHD (0.3 m above the natural surface) or lower – earthworks completed January 2002.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Lower and maintain channel banks south of the Alma–Baroona Road at 161.4 m AHD (0.4 m above natural surface) or lower.</td>
<td></td>
<td>- Install bore casings or equivalent (as markers) in the channel to enable assessment of channel height.</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
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<tr>
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<th>Responsibility</th>
</tr>
</thead>
</table>
| ‘Moomin’ floodway     | Figure 4 | ‘Moomin’ supply channel:  
• Backing up floodwater on ‘Alma’ and causing drainage and flooding problems.                                                                                                                                 | High       | • Maintain ‘Alma’ levees at a height greater than 1m to provide a sufficient safety factor.  
• Lower the supply channel section that crosses Moomin floodway and maintain at 161.3 m AHD (0.35 m above natural surface) or lower. Install bore casings or equivalent (as markers) in the channel to enable assessment of channel height.  
• Install a 20-m wide break in the supply channel with flow channelled below ground to improve drainage. Break should be at the lowest point in the floodway cross-section and should be below ground level and maintained to avoid scour. | Landholders  
Markers to be installed by landholder under NOW supervision |
| ‘Moomin Plains’        | Figure 4 | ‘Moomin Plains’ floodway:  
• Closure of the ‘Moomin Plains’ floodway may cause significant redistribution of flood flows. Such redistribution would result in increased floodwaters remaining on the northern side of Moomin Creek.  
• The ‘Moomin Plains’ supply channel may cause drainage and flooding problems.  
• The ‘Moomin Plains’ levees at a height greater than 1m to provide a sufficient safety factor.  
• Lower the supply channel section that crosses Moomin floodway and maintain at 161.3 m AHD (0.35 m above natural surface) or lower. Install bore casings or equivalent (as markers) in the channel to enable assessment of channel height.  
• Install a 20-m wide break in the supply channel with flow channelled below ground to improve drainage. Break should be at the lowest point in the floodway cross-section and should be below ground level and maintained to avoid scour. | Medium (may be provision for longer time) | • Re-open floodway to a minimum width of 1000 m.  
• Consider options to use existing floodways and large channels. Landholder to provide supporting information. | Issue to be resolved between NOW and landholder |

* Time period from gazettal of the FMP
7 Environmental and management assessment

7.1 Overview

The FMP will influence the floodplain environment through defining a floodway network that conforms as closely as is reasonable to the natural drainage pattern of the floodplain. This allows for the orderly passage of flood flow through the system, inundation of the floodplain, and improved flood access to flood-dependent ecosystems.

In the assessment of the environmental impacts of the FMP, current floodplain conditions were used as the benchmark. The impacts of the FMP were assessed at a strategic level (as opposed to property level) by considering the potential impacts on components of the floodplain environment. Refer to the FMS Section 9 for a more detailed environmental assessment.

7.2 Environmental assessment

The anticipated impacts of the FMP on components of the floodplain environment are summarised in Table 5.

Table 5: Environmental assessment: anticipated impacts of the Moomin Creek FMP

<table>
<thead>
<tr>
<th>Feature</th>
<th>Anticipated impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soils</td>
<td>Flooding benefits floodplain soils by contributing moisture, sediment and nutrients. These soils regain their porosity and structure through a wetting and drying cycle. The FMP is expected to improve floodplain inundation, resulting in improved soil condition and soil stability within the FMP floodway network.</td>
</tr>
<tr>
<td>Vegetation</td>
<td>Vegetation stands containing coolibah, black box and river red gum are adapted to periodic wetting and drying cycles and depend (to varying degrees) on periodic flooding for their longevity. Figures 8–10 (Appendix B) show floodplain vegetation within the FMP area in relation to the FMP floodway network. A high proportion of flood-dependent vegetation is located within the floodway limits, ensuring that floodwater access to this vegetation will be maintained and that regeneration and ongoing health of the vegetation is facilitated. There are several small stands containing coolibah and/or black box that lie outside the floodway network. These areas are largely surrounded by developed agricultural land and have been assessed by DECCW vegetation officers as being of low viability and conservation value. Because of the nature of the existing surrounding land use, inclusion of these stands in the floodway network was not considered a practical option.</td>
</tr>
</tbody>
</table>
### Table 5 continued

<table>
<thead>
<tr>
<th>Feature</th>
<th>Anticipated impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetlands</td>
<td>Naturally functioning and healthy wetlands are adapted to a regime of wetting and drying. Nutrient cycling, invertebrate life cycles and aquatic plant life cycles are also linked to this regime. Seven wetlands (including three named large lagoons and four minor lagoons/depressions) have been identified within the FMP area. <strong>Figures 8–10</strong> (Appendix B) illustrate these wetlands in relation to the FMP floodway network. As is evident, all of these wetlands are within the floodway limits. This ensures that flood flow connectivity to these wetlands is maintained and that the productive capacity and life-cycle processes supported by periodic flooding of the wetlands are maintained.</td>
</tr>
<tr>
<td>Fauna</td>
<td>Although no fauna surveys have been performed, the Moomin Creek floodplain is expected to support a range of species, including up to 42 threatened species and four migratory waterbird species that potentially inhabit the area. Wetlands and floodplain vegetation provides key habitat for these species. The FMP will ensure that flood flow connectivity to identified wetlands and floodplain vegetation is maintained, thereby improving habitat quality and availability for fauna species.</td>
</tr>
<tr>
<td>Fish</td>
<td>Eleven native fish species, including the threatened silver perch and endangered populations of olive perchlet and purple-spotted gudgeon, are known or expected to inhabit the Moomin Creek floodplain. The inundated floodplain provides important food resources for these species, as well as nursery habitat for golden perch and silver perch that spawn in response to flooding. The FMP will ensure that flood connectivity between the river and the floodplain is maintained. This will help maintain fish passage and access to spawning and feeding locations.</td>
</tr>
<tr>
<td>Water quality</td>
<td>The FMP will allow the orderly passage of flood flow through the system, reducing the potential for scour and erosion and subsequently improving surface water quality by minimising sedimentation and turbidity.</td>
</tr>
<tr>
<td>Groundwater</td>
<td>The FMP will help to maintain and improve natural groundwater recharge by aiming to achieve a more natural flood flow distribution and improving floodplain inundation. This will increase the likelihood (and duration) of natural groundwater recharge areas being subjected to flood flow inundation. If further information on natural recharge areas becomes available the FMP may need to be altered to ensure that these areas are exposed to natural flooding.</td>
</tr>
<tr>
<td>Cultural Significance</td>
<td>Four Aboriginal sites have been recorded on the Aboriginal Heritage Information Management System within the FMP area. These include a scarred tree, artefacts and an earth mound. It is likely that additional sites of significance exist (undiscovered) within the FMP area. Scarred trees may be species adapted to cycles of wetting and drying that depend on periodic flooding for their long-term health. The FMP includes the known scarred trees and all floodplain vegetation within the floodway network. As a result, the FMP ensures that flood connectivity to Aboriginal sites that may rely on flooding is maintained.</td>
</tr>
</tbody>
</table>
7.3 Instream works

There are a number of low-level instream works within the FMP area that may restrict flood flow and the free passage of fish. Under the Water Management Act 2000, these works are classified as ‘controlled activities’ for which approval is required. The scope of the FMP has not included these works, and it is recommended a field review be undertaken to identify, assess and evaluate the effects the works have on flood water flow (and fish passage) onto the floodplain.

7.4 Downstream floodplains

The FMP will have a positive influence on downstream floodplain environments, because it:

- attempts to provide a floodway network that conforms as closely as is reasonable to the natural flood pattern of the floodplain
- improves the connectivity between the FMP area and downstream floodplains by ensuring that there are no works affecting flood flow patterns.

These features indicate that the FMP will better control flow velocity and concentration and will improve flood flow distribution. Implementation of the FMP should have a positive influence on the hydrological regime and flooding characteristics of the downstream floodplains.

7.5 Land use management

7.5.1 General

To maintain and enhance the natural attributes of the floodplain environment, the following management activities should be considered:

- Establish and maintain a minimum riparian vegetation buffer zone along all waterways. This should be undertaken in accordance with the Border Rivers–Gwydir Catchment Action Plan and the Native Vegetation Regulation 2005, which specifies recommended buffer zone widths for different streams along the Moomin Creek system (see Section 7.7).
- Increase permanent vegetation cover with locally occurring native species, especially around environmentally sensitive and erosion risk areas.
- Preserve all remnant vegetation (including dead trees and fallen timber) and remove competitive weeds.
- Exclude or limit stock from remnant vegetation and wetland areas to maintain and protect vegetation structure and diversity of habitat, as well as reduce soil compaction.
- Minimise chemical use in the vicinity of wetlands and undertake chemical activities (storing, loading and mixing) within controlled or bounded areas.
- Undertake nutrient balance calculations so as to apply only as much fertiliser as the crop requires, and limit or avoid the use of residual chemicals when cropping floodways.
- Use best management practices.
7.5.2 Best management practices

It is the responsibility of all landholders to cooperate in minimising the negative impacts of soil erosion and degraded water quality. Practices that can be implemented for land and stream management include:

- Use conservation farming practices for cultivated areas, including reduced or zero tillage, stubble retention and well-designed erosion-control works.
- Use opportunity cropping for efficient utilisation of soil profiles (avoid a long fallow period and utilise seasonal conditions).
- Retain tailwater and stormwater on irrigation farms (see Australian Cotton Industry Best Management Practices, Cotton Research and Development Corporation 2000). By maximising storm water use and retaining tailwater on farm helps avoid contamination downstream or on neighbouring properties.
- Avoid farming and grazing of gullies and depressions.
- Improve stream management practices to reduce bed lowering, bank erosion and siltation; see Riverwise: Guidelines for Stream Management (Department of Water Resources 1993).

7.5.3 Specific limited land use areas

On the basis of the hydraulic characteristics of the 1974 design flood event, some of the floodways within the FMP floodway network have been identified to have significant erosion potential. To minimise erosion, scour and sedimentation within the FMP area, it is necessary to recommend limited land use practices within these floodways. Where necessary, land use and/or environmental conditions can be attached to applications for flood control works as approval conditions under Part 8 of the Water Act 1912.

1. Land Use Area 1 – Potential Erosion. Floodways identified under Land Use Area 1 on Figures 2–4 (Appendix B) are located where flood flows typically travel at high velocities and have the potential to cause erosion. The high velocities are usually the result of land slope and narrowing of the floodway.

Floodways associated with levees, where flows are constricted, are not to be cropped, but are to be maintained under pasture to limit erosion potential.

Other areas (not constricted by levees) where landholders do not adopt grazing, should be cropped carefully with conservation farming practices implemented to maintain maximum ground cover.

2. Land Use Area 2 – No Summer Cropping. The floodway identified under Land Use Area 2 on Figures 2–4 (Appendix B) has been narrowed, reducing its capacity to convey floodwaters. The growth of dense vegetation or crops can further reduce the floodway capacity, resulting in unacceptable flow redistribution. As such, it is necessary to keep the floodway clear to maintain flow capacity.

It is highly recommended that the Land Use Area 2 floodway be farmed only during winter, when the likelihood of a significant flood event is less probable. Stubble should be retained to give the floodway vegetative cover and erosion control during the summer.

3. Land Use Area 3 – No Cropping. Floodways identified under Land Use Area 3 on Figures 2–4 (Appendix B) are similar to the Land Use Area 2 floodways. However, they are located where flooding is more common and likely to occur anytime throughout the year. Because of the concentrated nature of flood flow, erosion is a significant problem...
and it is important to keep these floodways clear of objects that may reduce their capacity.

It is highly recommended that Land Use Area 3 floodways not be farmed or cropped at all. If farming were undertaken two undesirable situations could occur:

- a flood event may occur at a time when the crop is mature, causing reduced floodway capacity and subsequently flow redistribution; or
- a flood event may occur at a time when the crop is immature and the soil extremely vulnerable to erosion.

While grazing can assist with keeping the floodway clear of dense vegetation, it should be undertaken with care in order to avoid erosion problems.

### 7.6 Maintenance of floodways

To ensure the integrity of flow distribution, floodways, waterways and buffer zones require ongoing maintenance. Siltation and growth of dense vegetation will reduce the operational efficiency and channel capacity of floodways and waterways, and this in turn will increase flood flow breakouts.

It is important to remember that the design of the FMP floodway network is based on hydraulic and environmental requirements. To maintain the balance between hydraulic and ecological function, selective regrowth control of vegetation will be required. To achieve this, regrowth control should be undertaken in the floodway areas discussed in ‘Specific limited land use areas’ in Section 7.5.3 and identified in Figures 2–4 (Appendix B) as areas where land use should be limited in order to maintain flow capacity. In the remaining parts of the floodway network, regeneration should proceed and control performed only if flood monitoring analysis indicates that it is necessary or a preferred option.

There is a range of measures available under the Native Vegetation Act 2003 and certain provisions of the Native Vegetation Conservation Act 1997 that may allow thinning of vegetation in the FMP floodway network. Those proposing to undertake regrowth control as a form of floodway maintenance should contact the Border Rivers–Gwydir Catchment Management Authority (CMA) in the first instance. The method of thinning should be one that minimises soil disturbance and reduces damage to non-target species. It is equally important that floodways be maintained and regularly inspected for damage, with identified problems promptly fixed. Such maintenance should include slashing and desilting.

### 7.7 Riparian buffer zones

Riparian vegetation provides multiple benefits for improving water quality, land degradation (soil), salinity and terrestrial and aquatic biodiversity. It is known to support a greater diversity of plants and animals than does non-riparian vegetation. This is a result of its wide range of habitats and food types, its proximity to water, its microclimate, and its ability to provide refuge. Many native plants and animals are found only, or mainly, in riparian lands; these areas are therefore essential to these animals for all or part of their life cycles (DNR 2005).

Careful management and protection of riparian land is essential. Under the Native Vegetation Regulation 2005 the following buffer zones (Table 6) apply to the FMP area.

See Section 3.3 of the Native Vegetation Regulation 2005, Environmental Outcomes Assessment Methodology for size of stream and wetlands definitions and DECCW’s Major River Database for river and creek identification.
For streams, riparian buffer distances are measured on both sides of the stream from the top of the bank if this is defined, otherwise from the centre of the stream. If a stream has more than one bank on either side, the bank closest to the main channel should be used, to protect vegetation on and within the stream banks. For wetlands, riparian buffer distances are measured on all sides from the wetland limit. If a wetland has more than one bank, the bank closest to the wetland area should be used.

<table>
<thead>
<tr>
<th>Location</th>
<th>Size of stream or wetland</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minor watercourses, flood runners and effluents</td>
</tr>
<tr>
<td>Western Slopes and Plains</td>
<td>20 m</td>
</tr>
</tbody>
</table>

*Source: Native Vegetation Regulation 2005, Environmental Outcomes Assessment Methodology*

If a clearing or offset site is adjacent to a wetland, the distances for both streams and wetlands should be measured and the greater riparian buffer distance should be adopted (NSW DNR 2005).

Landholders will benefit from maintaining adequate riparian buffer zones in terms of improving water quality and minimising land degradation and restoration expenses. For more information on riparian buffer zones contact the Border Rivers–Gwydir CMA Office.

### 7.8 Road raising

For works undertaken on regional roads and State and national highways, roads authorities should follow the procedure set out in Section 29 of the *Roads Act 1993*. Under the Act, roads authorities are required to go through a public consultation process before undertaking the proposal. Landholders may make submissions with respect to the proposed road levels. After considering any submissions, the roads authority may decide to proceed with the proposal, with or without alteration, or to abandon the proposal.

For work undertaken on shire roads, a simplified informal procedure is usually adopted. Within Moree Plains Shire a formal design is usually not prepared. The new construction is typically based on the existing road levels and the final levels determined on site. At the construction phase, the council’s superintendent approaches landholders to discuss matters that may affect their interests, and their suggestions and objections are considered as appropriate.

Before doing any work on public roads, the local council should consider the aim of achieving and maintaining natural flood flow distribution. Council needs to consider potential impacts of road works for the full range of floods, for the entire floodplain system. Local council should consult DECCW and consider the FMP for the area in which any road works are proposed.
8 Assessing non-complying works

8.1 Overview

In order to apply the floodplain management principles, the Moomin Creek FMC developed and adopted specific hydraulic, environmental and socio-economic criteria. The developed criteria were developed as a tool to assess proposals and support the decision-making process by balancing flood risk and socio-economic and environmental factors, ensuring that all relevant issues will be considered.

The criteria are applied when evaluating proposed modifications or new flood control works under Part 8 of the Water Act 1912. They provide a consistent approach by ensuring all issues are considered and can help in formulating approval conditions.

The adopted assessment criteria were based on the 1974 flood event (design event; see Section 5.3); however, larger events may need to be considered.

8.2 Historical assessment criteria (for existing flood control works only)

- **Old guidelines.** Works that comply with the Guidelines for Moomin Creek Floodplain Development (WRC 1978) will typically be accepted, unless additional information and/or flood observations illustrate that the works have a significant adverse impact on flood flows.
- **Concerns and objections.** Any ongoing concerns and/or objections from neighbouring landholders must be taken into consideration during the assessment process.

8.3 Socio-economic assessment criteria

- **Disruption to daily life.** Unless previously agreed among all affected landholders, flood control works should not result in significant disruption to the daily life of surrounding landholders (e.g. property access).
- **Health impact.** Flood control works should not impose potential negative health impacts or stress on surrounding landholders.
- **Cost of the works.** The associated cost and benefit of undertaking the works should be warranted. In some cases it may be necessary to undertake a cost–benefit analysis (preliminary assessment may be adequate) in order to weigh up the hydraulic and/or environmental benefits of undertaking the works against the required expenditure. This must be determined through consultation with the affected stakeholders and NOW.
- **Infrastructure damage.** Flood control works should not have detrimental impacts, including increases in peak flood levels and drainage times, on any individual landholder or on community infrastructure.
- **Equity.** A landholder’s development proposal should not limit the future potential of other landholders to develop.
  - All current landholders should be allowed a reasonable area of protection, depending on the flood pattern across their property. (This does not mean that all holdings will get an equal share of flood protection.)
New landholders should be aware of previous agreements held between property holders regarding floodways, as these agreements should hold with changes in property ownership. The onus is on the new proprietor to understand the inter-property arrangements of mutual floodways (this is the ‘buyers beware’ principle). This is a legal issue and not one that the FMP attempts to cover. However, it is recommended that written proof regarding these agreements should be kept in case a legal issue arises.

- **Land use and restrictions.** Past and current land uses are to be considered. This FMP does not control or limit land use, except where it is an important factor associated with ‘flood control works’ approvals.

### 8.4 Ecological assessment criteria

- **Wetland connectivity.** Flood control works should not block or restrict natural flowpaths or floodways that supply wetland areas, nor alter the flooding regime to these areas.
- **Floodplain flora and fauna.** Flood control works should not isolate flood-dependent ecosystems from flood flow. The potential impact on habitat availability and threatened species may need to be assessed.
- **Soil condition and structure.** Flood control works should not impose negative impacts on soil structure or condition. For example, works should not increase the potential for scour and erosion and should not block flow to significant areas of floodplain soils.
- **Fish passage.** Flood control works should not significantly block or restrict the free passage and migration of fish within the floodplain environment.
- **Cultural sites.** Unless an agreement has been reached with DECCW and the local Aboriginal Land Council, flood control works should not destroy or damage any Aboriginal site or relic and should not block or restrict the delivery of flood flows to historically scarred and carved trees that rely on flooding regimes.
- **Groundwater recharge.** Flood control works should not block or restrict flood flow to identified groundwater recharge areas.

### 8.5 Flooding assessment criteria

- **Natural flooding characteristics.** Flood control works should not result in a significant departure from the natural flooding pattern of the floodplain (after taking into account existing floodplain development).
- **Hydraulic capacity.** Flood control works should not reduce the hydraulic capacity and continuity of floodway areas, but should enable the orderly passage of floodwaters through the floodplain).
- **Pondage and flow duration.** Flood control works should not significantly affect pondage duration on the developed floodplain or cause flood peak travel time to unduly accelerate to downstream users.
- **Redistribution.** Acceptable increases in peak flood levels and percentage peak flow redistribution, as a result of flood control works, should be assessed against the following guideline values:
  - Increase in peak levels on a neighbour’s boundary to be a maximum of 0.2 m above pre-development levels.
- No significant redistribution of peak discharge (less than 5 per cent of the pre-development distribution).

Each case should be assessed individually against the above guideline values; a more satisfactory outcome may be achieved by holding discussions with all affected landholders. Applications for works that exceed the above redistribution guidelines will be considered as non-complying works and must be subject to the Part 8 approval application process. Such works will generally not be approved unless an agreement has been reached between the applicant, NOW and downstream landholders and the relevant environmental criteria have been met.

- **Flow velocities.** Flood control works should not significantly increase velocities of flood flow within floodways. Velocities should be of an order that does not significantly increase erosion and siltation under various land uses. As a general rule, and using the figures in Table 7 as the maximum/limiting flow velocities, velocities should not increase by more than 50% from the pre-development flow velocities.

**Table 7: Assessment criteria – maximum permissible velocities**

<table>
<thead>
<tr>
<th>Ground condition</th>
<th>Maximum permissible velocity (m/s)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare soil</td>
<td>0.4</td>
</tr>
<tr>
<td>Crop</td>
<td>0.6</td>
</tr>
<tr>
<td>Native tussocky grass</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Values based on soil classification of medium to heavy clay, highly pedal with moderate dispensability; NSW Soil Conservation Service (1982).
9  Monitoring and review

9.1  Performance indicators

Following major floods, the performance of the FMP will be assessed against three sets of performance indicators:

1  Existing and proposed flood control works are constructed, modified and maintained according to the FMP.

2  The FMP floodway network allows for the orderly passage of flood waters during a range of floods.

3  The floodway network allows for the delivery of floodwaters to support floodplain ecosystems.

The performance of the FMP floodway network during floods will be assessed from information gathered during flood monitoring activities. This information will be measured against the FMP’s objectives and the following indicators:

- hydraulic:
  - improved passage of flood waters through the FMP floodplain
  - flood control works performing to the agreed hydraulic criteria

- environmental:
  - improved fish passage
  - improved habitat for plants and animals that utilise floodplains
  - increased flood connectivity to wetlands
  - flood control works performing to the agreed environmental criteria.

- economic:
  - reduced flood mitigation

- social:
  - reduced inundation period
  - less disruption to community infrastructure (roads, railways and essential services)
  - increase in flood awareness within the community.

In order to assess the performance of the FMP against these indicators, a monitoring program, as outlined below, is proposed.

9.2  Flood monitoring

Any surface water management scheme will require monitoring in mainstream and local catchment flow events to assess floodway efficiency and identify problem areas and whether any modifications or upgrades are required. An effective monitoring program will require input from both DECCW and landholders. Depending on the size of the flood, monitoring will range from simple observation to measuring of flows and levels, followed by additional
hydraulic analyses. The larger floods, nearing the design flood levels, should be monitored in more detail. In particular, as the hydraulic modelling has a significant degree of reliance upon flow estimates especially peak flows it will be important to collect data to verify these estimates.

DECCW will lead the planning and implementation of monitoring programs and will seek input from NOW, Moree Plains Shire Council and landholders. The following activities are recommended:

- DECCW/NOW to undertake aerial photography, collection of satellite imagery and survey.
- NOW to undertake stream gaugings and flow measurements.
- Where safe to do so, DECCW, NOW, Moree Plains Shire Council and landholders to observe the performance of their part of the floodway network, including marking high flood levels, estimating flow velocities and taking photographs. Landholders should also collate environmental data such as the extent of floodplain vegetation regeneration, and waterbird and fish observations.

(Refer to *Moomin Creek Floodplain Management Study* (DIPNR 2003), Appendix G for detailed advisory notes on flood monitoring.)

Following floods, landholders should the estimate flood damage, including crop and fencing losses and damage to private roads. Council should provide an estimate of flood damage to public roads and infrastructure.

### 9.3 Environmental monitoring

Environmental monitoring during and after floods would determine whether floodways are working as proposed to meet the requirements of flood dependent ecosystems in the area. Environmental data would consist mainly of observations, with supporting photography wherever possible. The scale of flooding would influence the extent of data collected.

DECCW should collate environmental data from Moree Plains Shire Council, landholders and other agencies. Council and landholders would observe their areas of the floodplain, noting:

- flooding patterns, including low- to medium-flood flows
- wetland inundation
- the presence of waterbirds and fish
- regeneration of floodplain vegetation.

### 9.4 FMP review

FMPs adopted as Minister’s plans under the *Water Management Act 2000* are required to be reviewed at 5-yearly intervals in order to determine whether their provisions adequately implement the water management principles of the Act. In addition to this requirement, it is recommended that the FMP be reviewed after the occurrence of a 1:20 year flood event through the system. This process would include reconvening the FMC in order to obtain the opinions of the various interest groups on the flood event and the performance efficiency of the FMP floodway network.
producers. Some landholders may respond to the impacts of climate change by undertaking reafforestation activities and creating carbon sinks. Early adaptive responses will decrease longer term vulnerability and economic costs. Therefore, as part of any plan review, particular attention will be given to exploring the adaptive capacity of rural FMPs to address the impact of climate change on flood risk exposure, floodplain ecosystems (e.g. wetlands) and rural economies.
References and further reading


DIPNR 2003, *Moomin Creek Flood Study*, Department of Infrastructure, Planning and Natural Resources, Sydney.


Hawes W 2000, 2002, Personal communication (Regional Ecologist, Department of Land and Water Conservation, Barwon Region).

Mawhinney W 2002, Personal communication (Surface Water Quality Office, Department of Land and Water Conservation, Tamworth).


NSW Fisheries 1999, Policy and Guidelines for Bridges, Roads, Causeways, Culverts and Similar Structures, NSW Fisheries, Sydney.


Savage L 2002, Personal communication (Vegetation Management Officer, Department of Land and Water Conservation).


Ward D 2002, Personal communication (Conservation Manager, NSW Fisheries)


## Appendix A: Glossary and abbreviations

### Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual exceedance probability (AEP)</td>
<td>The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage (%). For example, if a flood has an AEP of 5% there is a 5% chance that a flood of the same size, or larger, will occur in any one year.</td>
</tr>
<tr>
<td>Annual recurrence interval (ARI)</td>
<td>The long-term average number of years between the occurrence of a flood as big as, or larger than, the selected event. For example, floods with a discharge as great as, or greater than, the 20-year ARI flood event will occur on average once every 20 years.</td>
</tr>
<tr>
<td>Calibration</td>
<td>The process by which a hydrologic or hydraulic model is adjusted so that it best represents the real-world situation that the model is intended to simulate.</td>
</tr>
<tr>
<td>Cross-section</td>
<td>A section survey that describes/illustrates the shape of a section of land or waterway.</td>
</tr>
<tr>
<td>Discharge</td>
<td>The rate of flow of water, measured in terms of volume per unit time.</td>
</tr>
<tr>
<td>Flood</td>
<td>Relatively high stream flow when water overtops the natural or artificial banks or a stream and spreads over adjoining land.</td>
</tr>
<tr>
<td>Flood control works</td>
<td>Any controlled works referred to under Part 8 legislation of the <em>Water Act 1912</em>.</td>
</tr>
<tr>
<td>Flood-dependent ecosystem</td>
<td>Areas supporting plant and animal communities that are adapted to wetting (flooding) and drying and depend on flooding to remain healthy.</td>
</tr>
<tr>
<td>Flood hazard/risk</td>
<td>Potential for damage to property or persons due to flooding.</td>
</tr>
<tr>
<td>Floodplain</td>
<td>The portion of a river valley, adjacent to the river channel, which is covered with water when the river floods. It includes the area inundated by all floods up to the probable maximum flood.</td>
</tr>
<tr>
<td>Floodways</td>
<td>Those areas where a significant volume of water flows during floods. They are often aligned with obvious naturally defined channels. Floodways are areas which, even if they were partly blocked, would cause a significant redistribution of flood flow. They are often areas of deep flow or high velocities.</td>
</tr>
<tr>
<td>Hydraulics</td>
<td>Term given to the study of water flow in waterways and on the land surface.</td>
</tr>
<tr>
<td>Management plan</td>
<td>A document including, as appropriate, both written and diagrammatic information describing how a particular area of land is to be used and managed to achieve defined objectives.</td>
</tr>
<tr>
<td>Peak discharge</td>
<td>The maximum discharge occurring during a flood event.</td>
</tr>
<tr>
<td>Runoff</td>
<td>The amount of precipitation that ends up as streamflow.</td>
</tr>
<tr>
<td>Unsteady flow</td>
<td>Flow type that occurs when discharge and depth vary with time.</td>
</tr>
</tbody>
</table>
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEP</td>
<td>Annual exceedance probability</td>
</tr>
<tr>
<td>AHD</td>
<td>Australian Height Datum</td>
</tr>
<tr>
<td>ARI</td>
<td>Annual Recurrence Interval</td>
</tr>
<tr>
<td>CMA</td>
<td>Catchment Management Authority</td>
</tr>
<tr>
<td>DECC</td>
<td>Department of Environment and Climate Change</td>
</tr>
<tr>
<td>DECCW</td>
<td>Department of Environment, Climate Change and Water</td>
</tr>
<tr>
<td>DNR</td>
<td>Department of Natural Resources</td>
</tr>
<tr>
<td>DWE</td>
<td>Department of Water and Energy</td>
</tr>
<tr>
<td>FMC</td>
<td>(Moomin Creek) Floodplain Management Committee</td>
</tr>
<tr>
<td>FMP</td>
<td>(Moomin Creek) Floodplain Management Plan</td>
</tr>
<tr>
<td>FMS</td>
<td>(Moomin Creek) Floodplain Management Study</td>
</tr>
<tr>
<td>LGA</td>
<td>Local Government Area</td>
</tr>
<tr>
<td>NHT</td>
<td>Natural Heritage Trust</td>
</tr>
<tr>
<td>NOW</td>
<td>NSW Office of Water</td>
</tr>
<tr>
<td>WAMC</td>
<td>Water Administration Ministerial Corporation</td>
</tr>
</tbody>
</table>
# Appendix B: Part 8 application form

**APPLICATION UNDER SECTION 167 (1) (a) OF PART 8 OF THE WATER ACT FOR APPROVAL OF A CONTROLLED WORK**

When completing please read notes on the reverse side

<table>
<thead>
<tr>
<th>NAME(S) OF APPLICANT(S) <em>(See Note 1)</em></th>
<th>SURNAME</th>
<th>GIVEN NAME(S)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ADDRESS FOR SERVICE OF NOTICES</th>
<th>Postcode</th>
<th>Telephone</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>PROPERTY ADDRESS</th>
<th>Postcode</th>
<th>Telephone</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>LOCATION OF WORK <em>(See Note 2)</em></th>
<th>LOT/PLAN/PORTION NUMBER(S)</th>
<th>PARISH</th>
<th>COUNTY</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>RIVER/LAKE/ FLOODPLAIN <em>(See Note 3)</em></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>DESCRIPTION OF NATURE AND PURPOSE OF THE WORK <em>(See Note 4)</em></th>
</tr>
</thead>
</table>

(right) (please ✓) Existing ☐ Proposed ☐

<table>
<thead>
<tr>
<th>RIGHT OF OCCUPANCY OF THE LAND ON WHICH THE WORK IS LOCATED <em>(See Note 5)</em></th>
</tr>
</thead>
</table>

FREEHOLD ☐ LEASEHOLD ☐ PERMISSIVE ☐ OCCUPANCY ☐ OTHER (please describe) ☐

Delete whichever is inapplicable

Signature(s) of Applicant(s) .................................................. Date : / /

-----------------------------------

**DEPARTMENTAL USE ONLY**

☐ FEE ☐ PLAN ☐ DETAILS LICENCE NUMBER

-----------------------------------

**NOTES:**
NOTES

Note 1 :  APPLICANT’S NAME(S)

The application must show the FULL NAMES of ALL persons who are, or propose to be for the purpose of constructing the work, in occupation of ALL the lands and properties on which the work is, or proposed to be located.

Note 2 :  LOCATION OF WORK

The location of the work should be described by reference to the County / Parish / Portion(s) in which the work is situated or, if these details are not known or are inapplicable, in some other manner sufficient to identify its location, this information may be available from your local Council. If this information cannot be obtained please provide any other plan or title references to the land and ensure that the PLAN TO ACCOMPANY THIS APPLICATION clearly depicts property boundaries and the location of the work thereon.

Note 3 :  RIVER / LAKE / FLOODPLAIN

If the work is to be located near, on, or within the banks of a named lake, river or watercourse, please provide its name. If the work is on a flood plain of a particular river valley please provide the name of that river valley.

Note 4 :  DESCRIPTION OF WORK

Describe the nature, materials to be used, and purpose of the work, for example:

- an earthen levee, for preventing inundation of land ...
- an earthen access road; with concrete piped culverts; from residence to main road ...
- an earthen block dam; with wing walls for conservation of water ...
- earth fill building pad ...
- irrigation supply channel; with inverted siphons ...

If separate structures are proposed the Department may require that separate applications be lodged.

A controlled work, for which Approval is required is any structure which may affect the passage, distribution or height of flood water.

Note 5 :  OCCUPATION

Indicate the nature of the right of occupancy at present held over the land on which the work is or proposed to be located. If the right of occupancy is yet to be obtained describe the type of occupancy right being sought.

Note 6 :  FEE

This application MUST be accompanied by the prescribed fee. If you withdraw this application, prior to it having been determined (Approved or Refused) by the Department, the Department may retain part of the fee, as is deemed appropriate, to partly or wholly offset the expenses incurred dealing with the application.
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