Department of Climate Change, Energy, the Environment and Water

dcceew.nsw.gov.au

Draft Murray Valley Floodplain Management Plan

Report to assist Stage 1 public consultation

May 2024

Acknowledgement of Country

The Department of Climate Change, Energy, the Environment and Water acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and we show our respect for Elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

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Summary

The Water Group in the NSW Department of Climate Change, Energy, the Environment and Water (the department) is developing a whole-of-valley floodplain management plan (FMP) under the *Water Management Act 2000* (WM Act) for the Murray Valley. This will replace the five historical FMPs that were originally developed throughout the central Murray Valley under the *Water Act 1912.*

We are seeking feedback on the following key elements that will inform the development of the draft Floodplain Management Plan for the Murray Valley Floodplain (the draft FMP) through Stage 1 public consultation, including a formal public submission process from 20 May until 30 June 2024:

1. proposed **floodplain boundary**
2. proposed flood events to be used in hydraulic flood modelling (**design floods**)
3. proposed **floodway network**, which includes the main floodways, and areas important for the temporary storage of floodwater during the passage of a flood
4. flood-dependent and flood-impacted **Aboriginal cultural assets and values** located within the floodplain
5. flood-dependent and flood-impacted **heritage sites** located within the floodplain
6. flood-dependent **ecological assets** that have been identified within the floodplain
7. **local variances from default rules** for flood work applications in different areas of the floodplain.

The department is seeking feedback on the proposed floodway network and flood-dependent assets to identify and confirm the areas of the floodplain that require protection. FMPs protect these areas by restricting the types of flood works that can be constructed and in doing so allow for floodwater to move freely to and from a river or to assets that rely on it.

FMPs are required under the WM Act to consider the risk to life and property from the effects of flooding. The identification and confirmation of the proposed floodway network informs this consideration. The construction of a flood work in an area which has fast-flowing floodwater (floodways) can significantly increase the risk to life and property; both on the landholding where the flood work is constructed and on neighbouring properties. The draft FMP will limit the types and size of flood works constructed in floodways to minimise the risk to life and property.

Introduction

This report has been prepared to assist stakeholders in providing informed feedback during Stage 1 public consultation for the draft FMP. Stage 1 public consultation is intended to provide an early

opportunity for community feedback on key elements that will inform the development of the draft FMP prior to formal public exhibition of the draft FMP in late 2024.

The draft FMP will consolidate and update the existing floodplain management arrangements to:

- meet the requirements of the WM Act
- establish consistent rules for flood works across the floodplain
- improve the coordinated regulation of flood works across the southern Murray–Darling Basin.

Flood works are structures that alter the flow of water to/from a river or alter the movement of floodwater during a flood. Examples of flood works are levees, earthworks used to protect houses or infrastructure and roads.

In NSW all flood works require a flood work approval as per section 91D of the WM Act. Some activities considered low-risk or covered by other legislation may be exempt from an approval. Please see Exemptions to flood work approvals fact sheet on WaterNSW's website for further information.

The draft FMP will set the rules for flood work approvals and the criteria that will be used to assess applications. For further information on WaterNSW and flood work approval processes, please see the WaterNSW approvals webpage.

More information on FMPs, including the replacement of the historical FMPs in the southern Murray–Darling Basin, is available on our website.

Floodplain management plans cannot provide a comprehensive response to flooding

The roles and responsibilities of local government and NSW Government agencies in floodplain management and flood risk management are outlined in the NSW Flood Prone Land Policy and Flood Risk Management Manual (2023).

Improvements to flood risk mitigation were considered through the 2022 NSW Flood Inquiry. Read the inquiry report and the NSW Government response.

As part of developing the draft FMP, the department will provide all modelling information to the relevant Commonwealth, state and interstate emergency management agencies so that it may assist in their future flood predictions. The draft FMP will set rules for flood works on the Murray Valley Floodplain. It will not deal with flood mitigation or flood response.

Background

Murray catchment

The Murray catchment stretches over southern New South Wales, northern Victoria and south-eastern South Australia. The main drainage feature is the Murray River, which begins in the mountains of the Southern Alps of NSW and Victoria and flows in a westerly direction for over 2,500 kilometres to its outlet on the South Australian coast near Goolwa. The Murray catchment represents one-fifth of the total area of the Murray–Darling Basin and is one of the most significant agricultural areas in Australia.

The majority of the central Murray is used for agricultural purposes, with grazing being the dominant land use. The flat riverine plains make the region suitable for a variety of dryland and irrigated cropping enterprises. The Murray Irrigation Area also resides within the Central Murray (Murray Riverina catchment) and is the largest irrigation scheme in NSW.

Existing floodplain management arrangements

Existing floodplain management arrangements within the rural areas of the central Murray catchment consist of the following in-force FMPs prepared under the *Water Act 1912* (existing localised FMPs) with associated declared floodplains under the *Water Act 1912*:

- Tuppal and Bullatale Creeks Floodplain Management Plan (2006)
- Stage 1: Edward and Wakool Rivers (Deniliquin to Moama-Moulamein Railway) Floodplain Management Plan (2011)
- Stage 2: Edward and Wakool Rivers (Moama-Moulamein Railway to Gee Gee Bridge) Floodplain Management Plan (2011)
- Stage 3: Edward and Niemur Rivers (Moama-Moulamein Railway to Liewah and Mallan) Floodplain Management Plan (2011)
- Lower Edward-Wakool (Stage 4) Noorong Road to Wakool Murray Junction floodplain Management Strategy (2000).

The central Murray catchment also includes the existing Murray/Edward/Wakool River Systems Floodplain which was designated as a floodplain under the *Water Act 1912* in 1984.

Consideration will be given to the planning arrangements in the above FMPs when developing the draft FMP. Further, the boundaries of all the declared floodplains associated with the existing localised FMPs listed above have been incorporated into the proposed floodplain boundary.

The existing localised FMPs are published on our website.

Key elements for development of the floodplain management plan

The information and maps presented in this report have been prepared using the best available information for the Murray Valley Floodplain. The information and maps are subject to change following Stage 1 public consultation.

1. Proposed floodplain boundary

The boundary of the proposed Murray Valley Floodplain, shown in Figure 1, has been mapped to capture the areas that are inundated during large flood events while considering flood works that may influence the way floodwater moves across the landscape.

The proposed floodplain boundary extends downstream from the existing localised Tuppal-Bullatale FMP area in the east to the junction of the Murray and Murrumbidgee rivers in the west and includes areas currently within existing localised FMPs. To the south the proposed floodplain boundary aligns with the Murray River, and to the north is generally bound by public roads. The proposed floodplain boundary is 8,062 km^2 in area, and 91% of this area is already captured in an existing localised FMP.

The proposed floodplain boundary will connect with the floodplain boundaries for the FMPs currently being developed for the Murrumbidgee and Billabong Creek valleys, improving the assessment of cumulative impacts from individual flood works across the southern Murray–Darling Basin.

A combination of hydraulic and administrative factors, where appropriate, have been used to develop the proposed floodplain boundary including:

- inundation data within the Murray catchment
- hydraulic model development
- existing localised FMPs
- water source boundaries, as established in water sharing plans
- local government areas
- major roads and railways which act as barriers to large scale flood movement.

For a higher resolution version of the proposed floodplain boundary please see Stage 1 Interactive Spatial Map.

To assist with providing feedback on the proposed floodplain boundary as shown in Figure 1, we recommend you take a screenshot of the relevant area/s displayed on the interactive spatial map and use a drawing tool to illustrate feedback or refer to the area shown in written feedback. The screenshot of the map can be saved as an image file and attached to your submission.

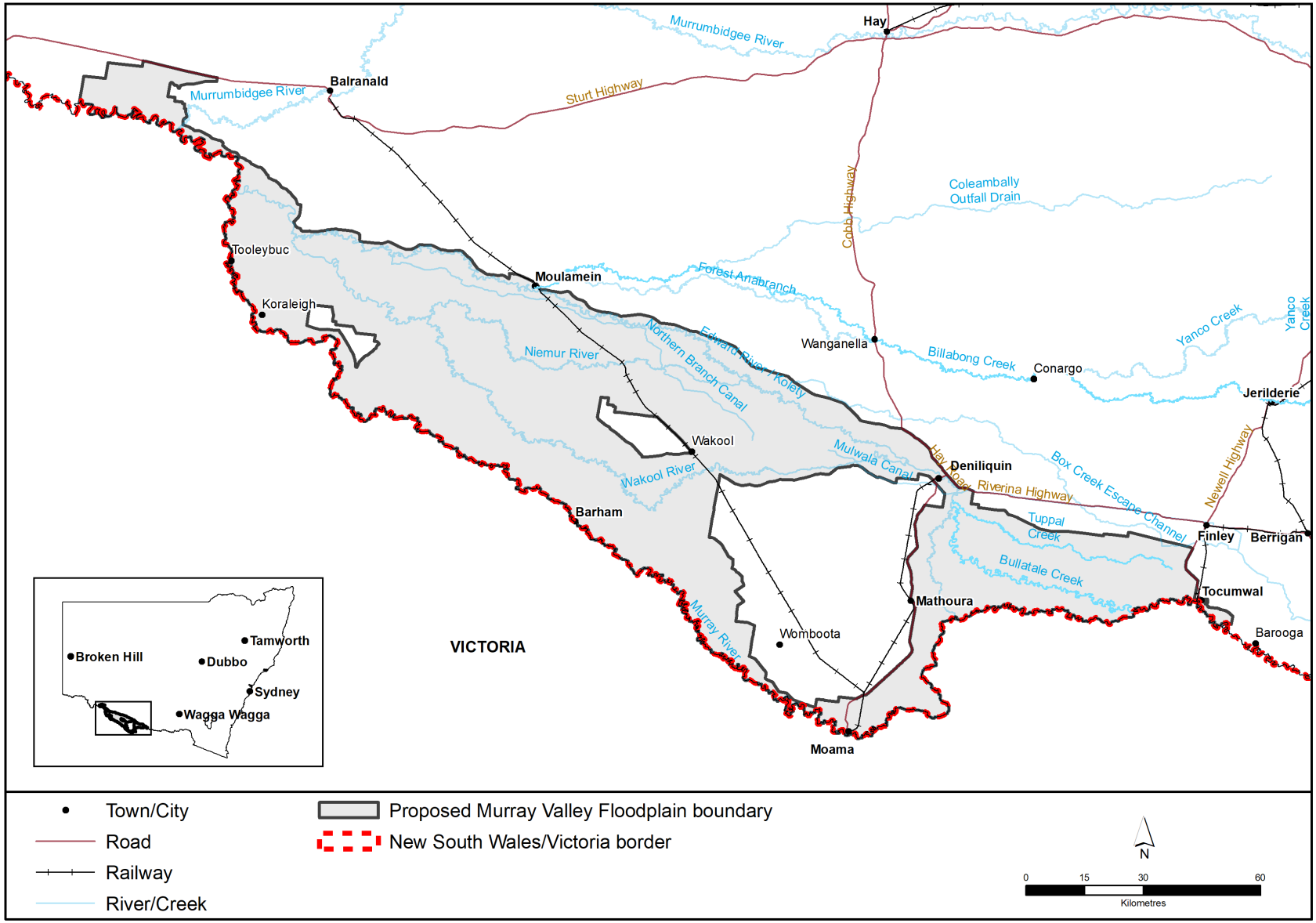
Prompts for feedback

Do you support the proposed boundary of the Murray Valley Floodplain?

Are there areas of the floodplain that should be included or omitted?

Is the proposed boundary correct at a property scale?

Figure 1. Proposed Murray Valley Floodplain



2. Proposed design floods

A design flood is a flood of known magnitude that can be modelled and used for planning or engineering purposes. They are usually based on recorded historical events that are preferably within the living memory of a community.

Selection of a design flood is based on an understanding of flood behaviour and associated flood risk. Multiple design floods are often selected to account for the social, economic, ecological and cultural consequences associated with floods of different magnitudes.

Design flood events that are selected will be described through the following attributes:

- the flood event that it is based on (month, year)
- where the data is taken from, such as a section of river and associated gauge
- the probability of an equivalent (or larger) flood event occurring in any given year, known as the annual exceedance probability (AEP).

A large design flood is a large magnitude flood event that generally has a 5% or less probability of occurring in any given year (AEP) while a small design flood is a smaller magnitude flood event that has at least a 10% probability of occurring in any given year (AEP). There may be some slight variances in the AEP associated with a large or small design flood because of the nature of the flood event that the design flood is based on.

The existing localised FMPs in the Murray valley use several design floods (1975, 1956 and 1993), depending on the location.

The draft FMP is being developed using two design floods of different magnitudes. Five hydraulic models were created to simulate the movement of these proposed design floods through the river channels and floodplain.

The following proposed design floods were used to model the floodway network:

- **large design flood of June to December 2022:** 2.5% AEP at the Murray River at Barham gauge (409005)
- **small design flood of September to December 2016:** 16% AEP at the Murray River at Barham gauge (409005).

More information on how the proposed design floods were selected, and the associated hydraulic models is available in Appendix 1. Development of the floodway network.

Prompts for feedback

Do you agree with the choice of the proposed design floods?

Do the proposed design floods align with your experience of past flood events?

3. Proposed floodway network

An FMP will coordinate flood work development on a floodplain to ensure that floodwater can move freely to and from rivers and creeks. To do this, an understanding of how water moves across the landscape when it floods is required.

Five hydraulic models have been developed to simulate the movement of floodwater through river channels, wetlands and the wider floodplain during the proposed large and small design floods. This modelling process identifies areas of the floodplain that have the deepest and fastest flowing floodwater and pose the greatest risk to life and property. These areas are known as floodways, and together with areas of ponding (inundation extent), make up the **floodway network**.

The proposed floodway network for the Murray Valley Floodplain, shown in Figure 2, has been defined by:

- mapping the outputs of hydraulic modelling
- considering the floodway networks in existing localised FMPs and aligning with them where appropriate
- reviewing additional flood photography and satellite imagery.

The proposed floodway network is comprised of **floodways** (approximately 9% of the floodplain) and the **inundation extent** (approximately 56% of the floodplain).

More information about how the hydraulic models and the floodway network were developed and how they differ from the existing localised FMPs is available in Appendix 1. Development of the floodway network.

For a higher resolution version of the proposed floodway network please see Stage 1 Interactive Spatial Map.

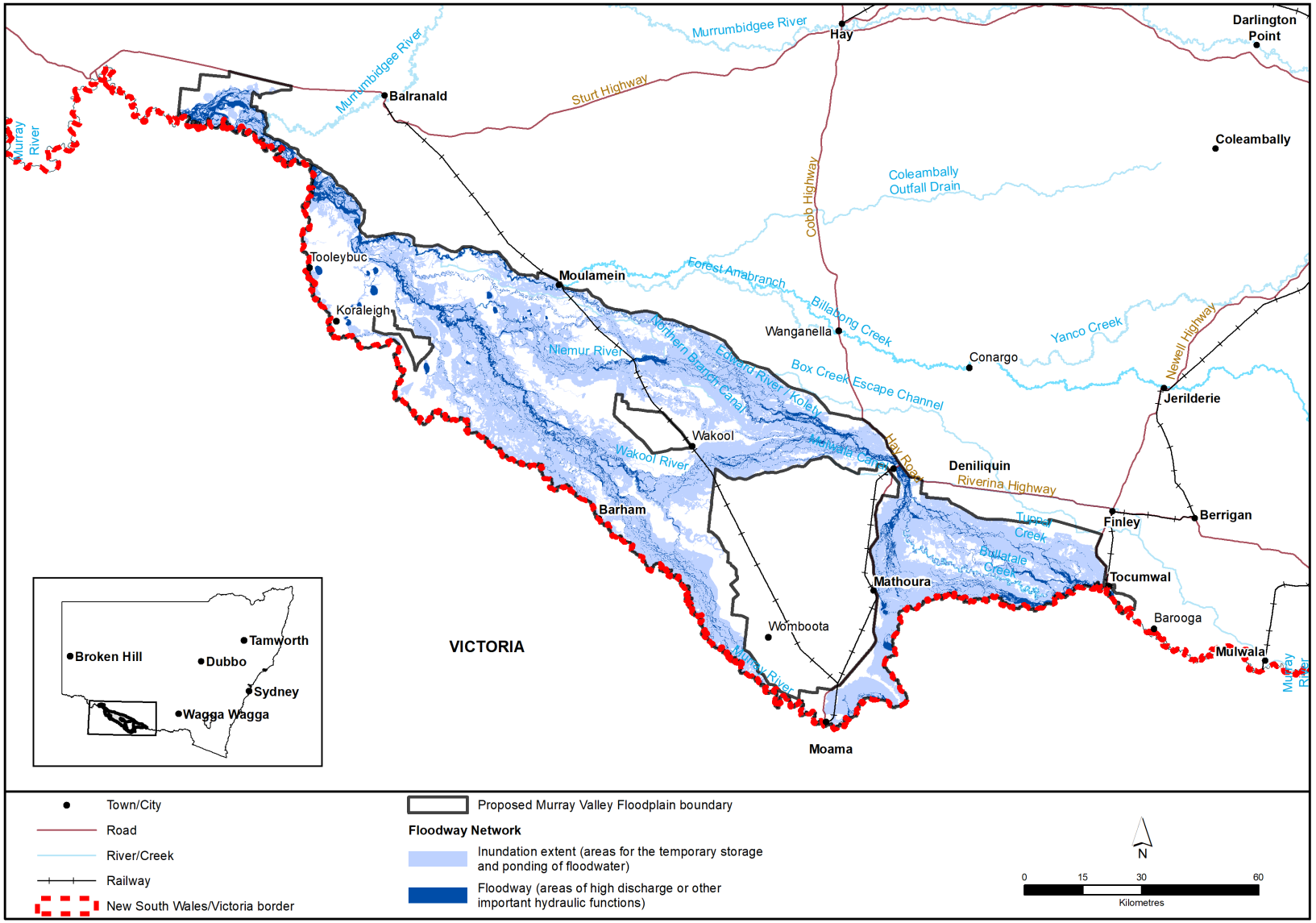
To assist with providing feedback on the proposed floodway network as shown in Figure 2 we recommend you take a screenshot of the relevant area/s displayed on the interactive spatial map and use a drawing tool to illustrate feedback or refer to the area shown in written feedback. The screenshot of the map can be saved as an image file and attached to your submission.

Prompts for feedback

Do the proposed floodways and inundation extent align with your experience of past flood events?

What changes should be made to the floodway network?

Figure 2. Proposed Floodway Network for the Murray Valley Floodplain



4. Identified flood-dependent and flood-impacted Aboriginal cultural assets and values

Aboriginal cultural assets and values on the floodplain can be:

- flood-dependent, such as waterholes, fish traps or scarred trees that require inundation
- flood-impacted, such as Aboriginal burial grounds or shell middens that can be damaged by scour and erosion caused by flooding or directly during the construction of a flood work.

We identify Aboriginal cultural floodplain assets in FMPs to support their protection and restoration, which in turn provides social and economic benefits to the community. Healthy waterways and floodplains are critical to the culture and wellbeing of Aboriginal people. Water provides food, kinship, connection, recreation, stories, songlines and healing.

The existing localised FMPs require flood works to be assessed against section 166 of the *Water Act 1912* (repealed) and Part 5 of the *Environmental Planning and Assessment Act 1979* to ensure connectivity and prevent ground disturbance to identified Aboriginal cultural sites and values.

The Aboriginal cultural assets and values currently registered on the Heritage Information Management Systems (AHIMS) are shown in Figure 3. This information is provided to demonstrate the abundance of Aboriginal cultural sites throughout the Murray Valley floodplain. Figure 3 is shown at a valley scale, does not show restricted sites and does not have an associated interactive map. First Nations communities in Deniliquin, Moama and Cummeragunja, as well as the NSW Heritage AHIMS team, were consulted on the use of Figure 3 and agreed to its inclusion in this report.

As part of assessing and determining an application for a flood work approval, a search of AHIMS must be conducted. To ensure that Aboriginal cultural assets and values are protected from impacts associated with flood works, the department has been explaining and promoting the use of AHIMS as part of consultation with First Nations communities.

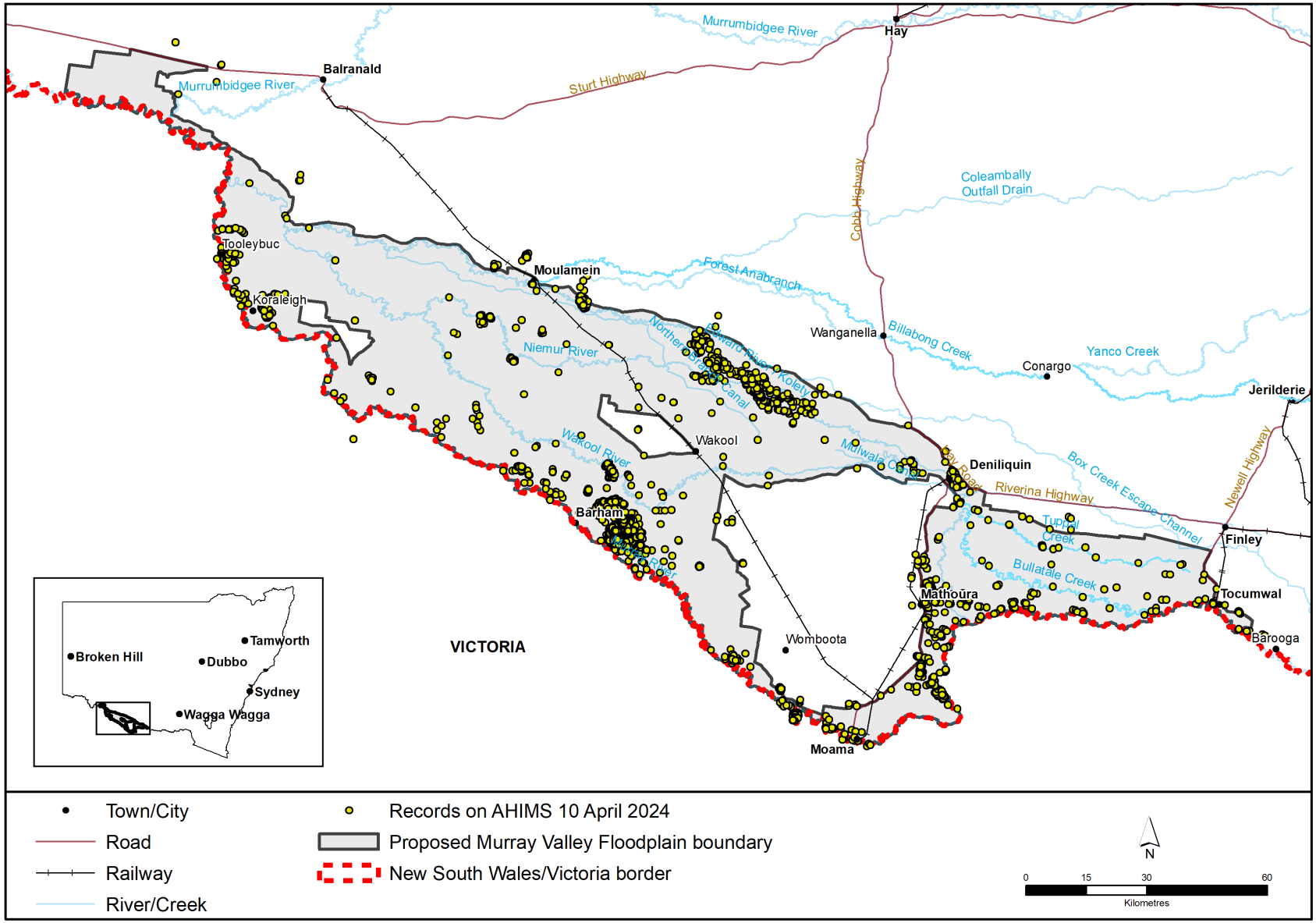
For more information on the First Nations consultation undertaken in the Murray valley floodplain, including the feedback received, please see Appendix 2. First Nations consultation.

Information on how FMPs can protect cultural assets is available on our website.

Prompts for feedback

Are there other Aboriginal cultural assets or values on the floodplain that should be considered?

Figure 3. Records on the Aboriginal Heritage Information Management System (as at April 2024) within the proposed Murray Valley Floodplain



5. Identified heritage sites

Heritage sites may be sensitive to changes in flood behaviour or disturbance from flood work construction. Heritage sites are cultural heritage objects and places as listed on the following Commonwealth, state and local government heritage registers:

- Australian Heritage Database
- NSW Aboriginal Heritage Information Management System
- NSW Historic Heritage Information Management System
- NSW State Heritage Register.

Some Aboriginal cultural assets and values may also be listed on heritage registers and are discussed in the previous section.

The heritage sites within the Murray Valley Floodplain that are recorded on the NSW State Heritage Inventory are shown in Figure 4. This information is provided to demonstrate the array of heritage sites throughout the Murray Valley Floodplain and does not have an associated interactive map. Some of these sites may be flood-impacted as they could be damaged by flooding or directly impacted during the construction of a flood work. Some sites, such as living River Red Gum trees with flood markers of historic value may be considered as flood-dependent heritage sites as the trees rely on periodic flooding to survive.

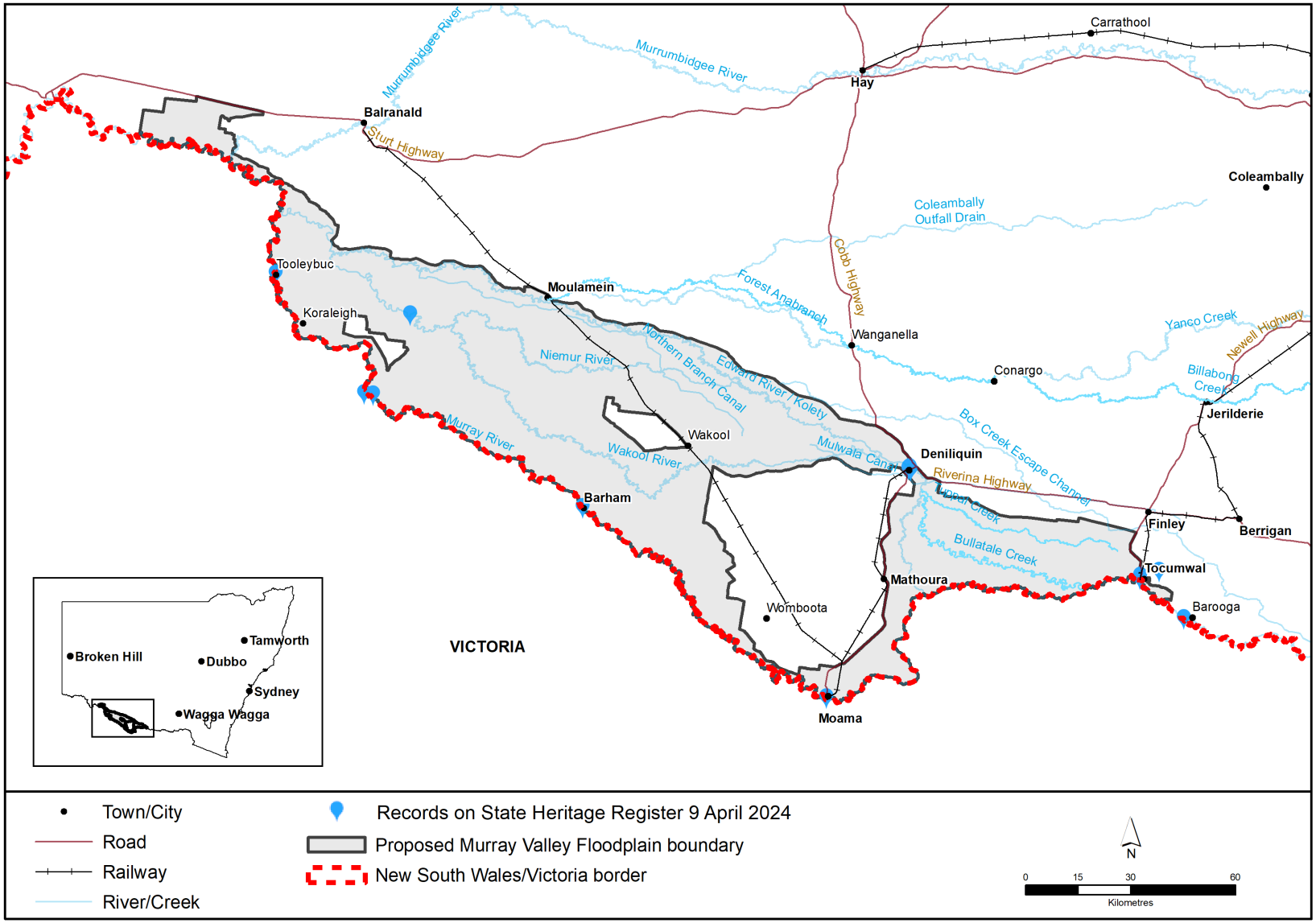
As part of assessing and determining an application for a flood work approval a search of the State Heritage Inventory must be conducted. This online search tool holds information about most statutory protected heritage items in NSW, including the State Heritage Register.

Find out more information about heritage listed items and significant sites in NSW by visiting the department's Heritage website.

Prompts for feedback

Are there other heritage sites on the floodplain that should be considered?

Figure 4. Records on the State Heritage Register from the NSW Heritage Inventory (as at April 2024) within the proposed Murray Valley Floodplain



6. Identified flood-dependent ecological assets

A key objective of an FMP is to maintain flood connectivity to flood-dependent ecological assets. This means that flood works should not block the floodways that connect them to floodwaters.

Flood-dependent ecological assets rely on flooding to maintain their ecological character and sustain essential processes. Flood-dependent ecological assets are identified in FMPs to support their protection and, which in turn provides social and economic benefits to the community.

A similar process is applied in the existing localised FMPs with the identification and inclusion of flood-dependent ecosystems and 'areas of possible wetland value', and the requirement for flood works to be assessed against section 166 of the *Water Act 1912* (repealed) and Part 5 of the *Environmental Planning and Assessment Act 1979* to ensure connectivity to identified ecological sites and to protect fish passage.

Within the proposed Murray Valley Floodplain, the following types of ecological assets shown in Figure 5, are being considered in the development of the draft FMP:

- **wetlands:** semi-permanent wetlands (non-woody) and floodplain wetlands (flood-dependent shrubland wetlands)
- **other floodplain ecosystems**: flood-dependent forest/woodland (wetlands) and flood-dependent woodland.

The ecological assets are categorised according to the flooding requirements of their vegetation communities, which correlates to the degree of connectivity required to the floodway network. For example, wetlands and their associated vegetation communities are highly flood-dependent and therefore will either be located within the floodway network or have a direct connection to the floodway network.

The ecosystems also provide important habitat for native fish, amphibians, reptiles, waterbirds, woodland birds and mammals, and invertebrate and microbial biota. Habitats for fish (and fish passage), waterbirds and other water-dependent fauna have been identified and will be considered in the development of the draft FMP.

The ecological assets are identified using the best available vegetation mapping and survey information, including the NSW State Vegetation Type Map[1] and wetland mapping. More information about how ecological assets have been identified and categorised is available in Appendix 3. Ecological asset identification and categorisation.

[1] Department of Planning and Environment (DPE) (2022) NSW State Vegetation Type Map. Current Release C1.1.M1.1 (December 2022)

For a higher resolution version of the proposed flood-dependent ecological assets please see Stage 1 Interactive Spatial Map.

To assist with providing feedback on the proposed floodplain boundary as shown in Figure 5, we recommend you take a screenshot of the relevant area/s displayed on the interactive spatial map and use a drawing tool to illustrate feedback or refer to the area shown in written feedback. The screenshot of the map can be saved as an image file and attached to your submission.

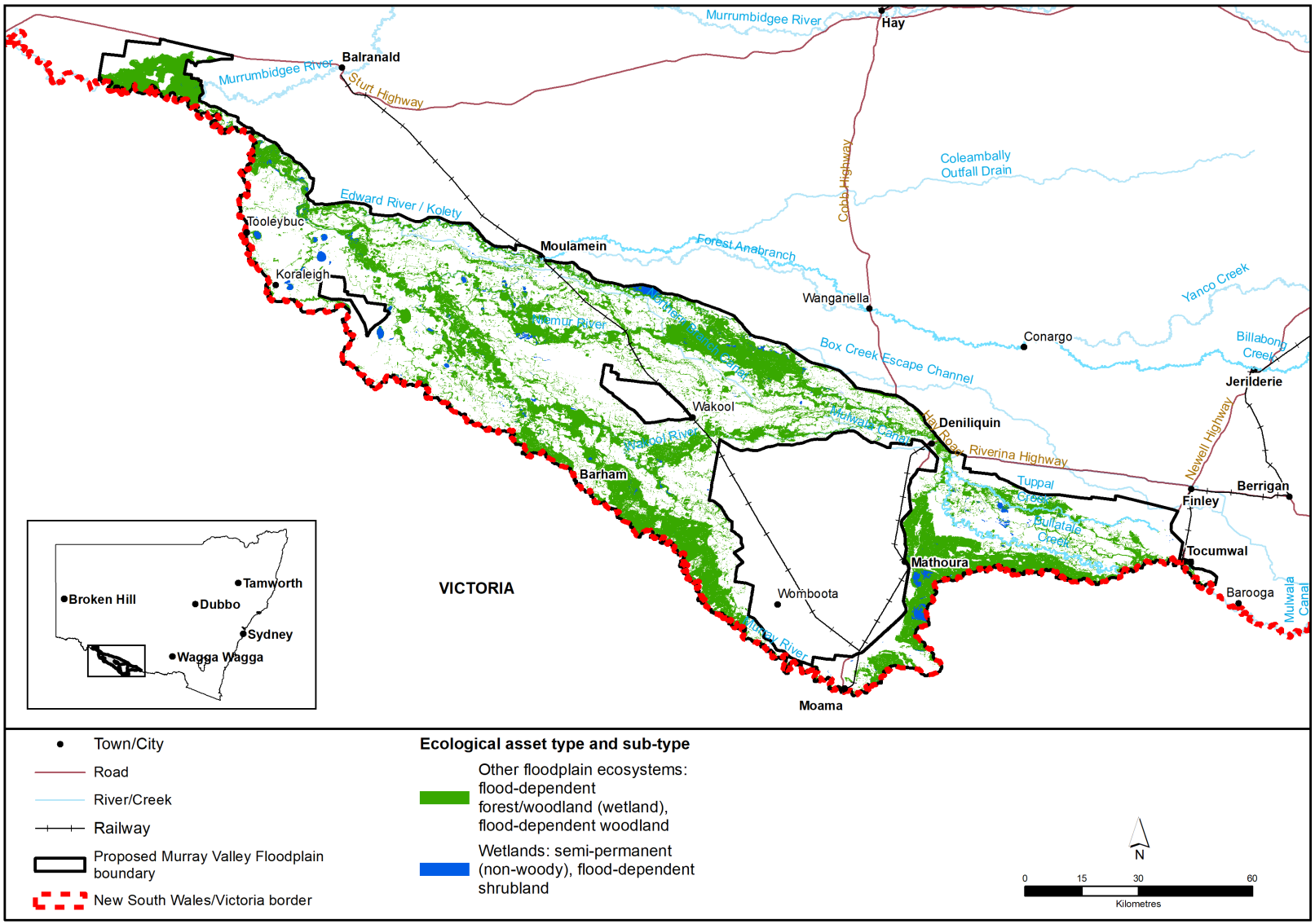
Prompts for feedback

Do you agree with the types of flood-dependent ecological assets that have been identified?

Are there other ecological assets on the floodplain that should be considered?

Are there any areas of ecological significance that are highly flood-dependent, which are not shown on Figure 5?

Figure 5. Identified flood-dependent ecological assets in the proposed Murray Valley Floodplain



7. Localised variances to some rules for flood work applications

FMPs follow a default rule set, which determines what can be assessed and approved as a flood work. These rule sets fall into two main categories depending on the location of the work:

- **Floodways and areas of ecological, heritage or Aboriginal cultural significance** – flood works in these areas will be restricted to specific types that are essential for the protection of life and property, or improvement of the floodplain
- **Inundation extent and flood fringe** – all types of flood works are permitted, subject to conditions and assessment criteria.

There are some specific aspects of the rule set that can be tailored to account for local conditions and needs. These aspects are detailed below and are subject to consultation outcomes.

For examples of existing FMP rules, please refer to the rule summary sheets for FMPs in the northern Murray–Darling Basin on the department's website.

Types of works permitted in floodways

The proposed floodways for the Murray Valley Floodplain are shown in Figure 2. The granting of flood work approvals in floodways will be limited to specific types of flood works.

This is a change from the current planning arrangements in the existing localised FMPs. Under existing planning arrangements any type of flood work within floodways may be applied for, subject to comprehensive assessment processes and advertising requirements for most types of flood works.

The difference in approaches between the existing localised FMPs and the draft FMP relates to the requirement under the WM Act for the draft FMP to consider the risk to life and property from the effects of flooding. The construction of a flood work in a floodway can significantly increase the risk to life and property; both on the landholding where the flood work is constructed and on neighbouring properties.

Hence, the default types of flood works permitted in floodways will be limited to those that are critical for domestic or farm operations, such as those designed to protect life, infrastructure or provide refuge for stock, and will be restricted to a specified size or enclosing a specified area. The assessment process will be streamlined and, in most circumstances, advertising will not be required.

Table 1 lists the default types of flood works and their purpose that are typically permitted in floodways. Landholders will be required to lodge an application for a flood work approval for these types of works.

Table 1. Flood work types typically permitted in floodways

Flood work type	Purpose
Access roads (roads within private property)	To ensure landholders have basic provisions to access property.
Primary access roads (private road leading directly to a permanently occupied fixed dwelling)	To further ensure landholders have basic provisions to access property or evacuate during a major flood event by permitting higher level roads that directly service homes.
Supply channels (below ground)	To ensure landholders can access water rights from water sources.
Stock refuges	To account for animal welfare and to minimise a landholder's potential to lose stock to floodwaters.
Infrastructure protection works	For protecting high value infrastructure such as homes and sheds. To minimise the risk to life and property from flooding.
Ecological enhancement works	To improve flood connectivity to a recognised flood-dependent ecological asset, such as a wetland or lagoon.
Aboriginal cultural value enhancement flood works	To improve flood connectivity to a recognised flood-dependent Aboriginal cultural asset or value, such as a waterhole or lagoon that holds significance to Aboriginal people.
Aboriginal cultural value protection work	For protecting flood-impacted cultural sites such as burial grounds and shell midden sites that may be damaged by scour and erosion.
Heritage site protection work	For protecting heritage listed sites such as cemeteries, buildings or other places that may be damaged by inundation or scour and erosion.

Prompts for feedback

Do you agree with the proposed types of flood works that may be considered for approval in floodways?

Are there any other essential work types that should also be considered for approval in floodways?

Maximum height of access roads

Access roads are an essential flood work that allows for the protection of life and property. When located in a floodway, they need to be constructed to allow for appropriate flood connectivity.

A key objective of the maximum height on an access road is to balance the impacts of the flood work with the need for adequate access during times of flood.

FMPs allow for both standard access roads (including farm tracks) and primary access roads (roads leading directly to a permanently occupied fixed dwelling) to be constructed within floodways. Primary access roads allow for a greater height to help protect lives during a flood.

The maximum height of an access road above the natural surface level may vary in response to local conditions and consultation outcomes.

We are seeking feedback on a maximum height value (above the natural surface level) for access roads in a floodway with 10 cm being the lower end of the threshold and 50 cm being the upper end of the threshold. All access roads will also be required to include causeways and to manage borrow pits related to construction and maintenance.

Prompts for feedback

What is an appropriate maximum height above the natural surface level for a standard access road located within a floodway?

What is an appropriate maximum height above the natural surface level for a primary access road located within a floodway?

Submission process

We are seeking feedback on key elements that will be used to prepare the draft FMP through a public submission process from **20 May until 30 June 2024.**

Have your say by:

Completing the online submission form OR

Downloading and completing a submission form and:

- Email us at floodplain.planning@dpie.nsw.gov.au, or
- Post the form to:

  Murray Valley FMP
  Water Group - NSW DCCEEW
  PO Box 189
  Queanbeyan, NSW 2620

A pre-recorded presentation has been developed on the department's website. It details an overview of the planning process and the feedback we are seeking.

During the Stage 1 consultation period, landholders and other stakeholders are invited to book individual appointments with departmental staff to ask questions about the key elements being proposed and how to make a submission. Table 2 lists the dates and locations are available. Register for an appointment here.

Table 2. Available dates and times for individual appointments

Date	Location	Time
Monday 3 June	Online	1pm – 5pm
Tuesday 4 June	Online	9am – 1pm
Wednesday 5 June	Moama Bowling Club 6 Shaw St, Moama	2pm – 6pm
Thursday 6 June	Deniliquin RSL 72 End St, Deniliquin	10am – 2pm
Tuesday 11 June	Online	9am – 1pm
Wednesday 12 June	Club Barham 6-8 Niemur Street, Barham	2pm – 6pm

Date	Location	Time
Thursday 13 June	Moulamein Bowling Club Endeavour Rd, Moulamein	10am – 2pm
Monday 17 June	Online	9am – 1pm

To assist with providing feedback on the maps shown in Figures 1, 2 and 5, we recommend taking a screenshot of the relevant area/s displayed on the interactive spatial map and either using a drawing function for illustrating feedback or referring to the area shown in your written feedback. The screenshot of the map can then be saved as an image file and attached to your submission.

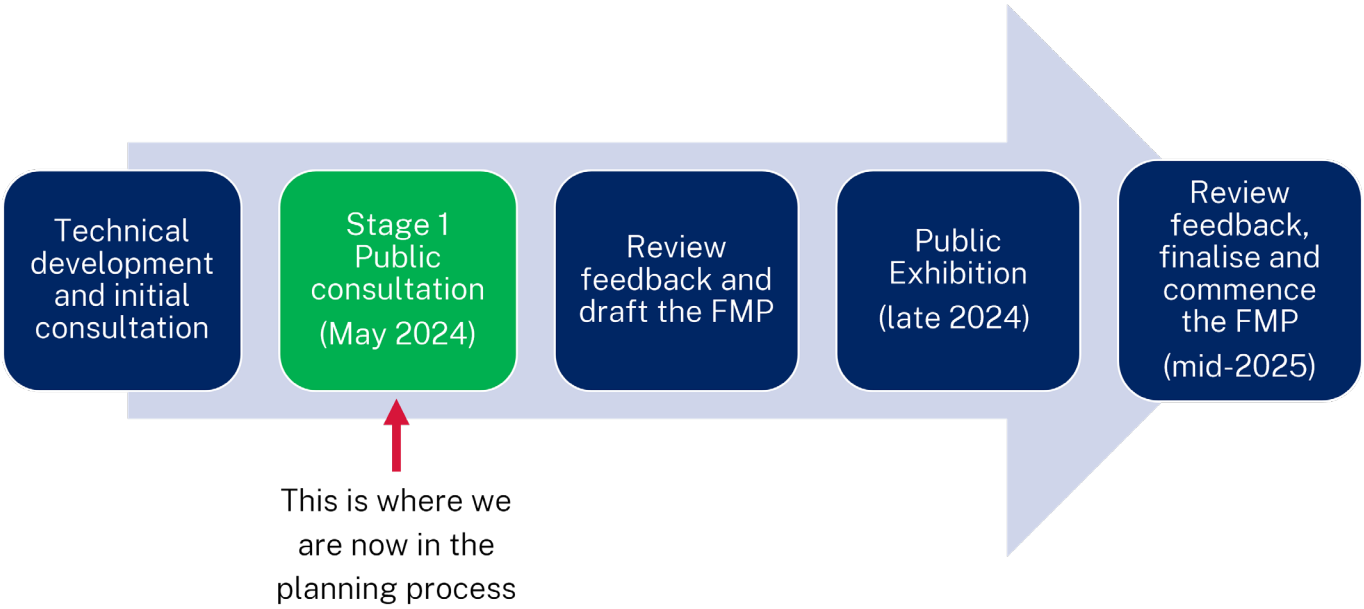
Next steps

All feedback is important and will be reviewed and considered when preparing the draft FMP for public exhibition (see Figure 6). Submissions will be published in line with the department's privacy policy, and a consultation outcomes report will be published summarising the feedback received.

The draft FMP will be released for formal public exhibition in late 2024, during which we will seek feedback on all elements of the draft FMP. This will include the draft management zones, rules and assessment criteria.

The final FMP is anticipated to commence 1 July 2025 following approval from the Minister for Water and concurrence from the Minister for Environment.

Figure 6. Status of the draft Murray Valley Floodplain Management Plan



Appendix 1. Development of the floodway network

What is the floodway network?

Floodways

Throughout a floodplain, there will be pathways of fast-flowing floodwater during times of flood. These areas are floodways and are part of the floodway network. They are often aligned with naturally defined channels. Floodways are high risk areas that, even if only partially blocked, would cause significant changes in the movement of floodwater across the floodplain. It is a critical area of the floodplain as it allows water to leave or return to a river or creek during times of flood or deliver floodwater to ecological assets and Aboriginal cultural values that depend on it.

Floodways also pose the greatest risk to life and property during times of flood.

Floodways in the proposed Murray Valley Floodplain compared to the existing localised FMPs

The proposed floodway network for the Murray Valley Floodplain, shown in Figure 2, differs conceptually from the previous planning arrangements. Floodways mapped in the existing localised FMPs were defined as the area "reserved for discharge", largely as a continuation of those areas identified in the 1970s/80s "guidelines for floodplain development". There were some exceptions where modelling indicated changes were required. The floodways in the existing localised FMPs generally accepted flood works that aligned with the previous guidelines. Proposed works within floodways were generally allowed so long as they met the assessment criteria in the FMP.

FMPs developed under the WM Act take a different approach to the delineation of floodways. Floodways in WM Act FMPs are typically narrower, and the surrounding areas are mapped as the inundation extent. The difference between these two approaches to floodways is shown in conceptual floodway cross-sections in Figure 7 and Figure 8 below.

More information about the types of flood works proposed to be permitted in floodways and how this differs from the existing localised FMPs is provided in section 7. Localised variances to some rules for flood work applications.

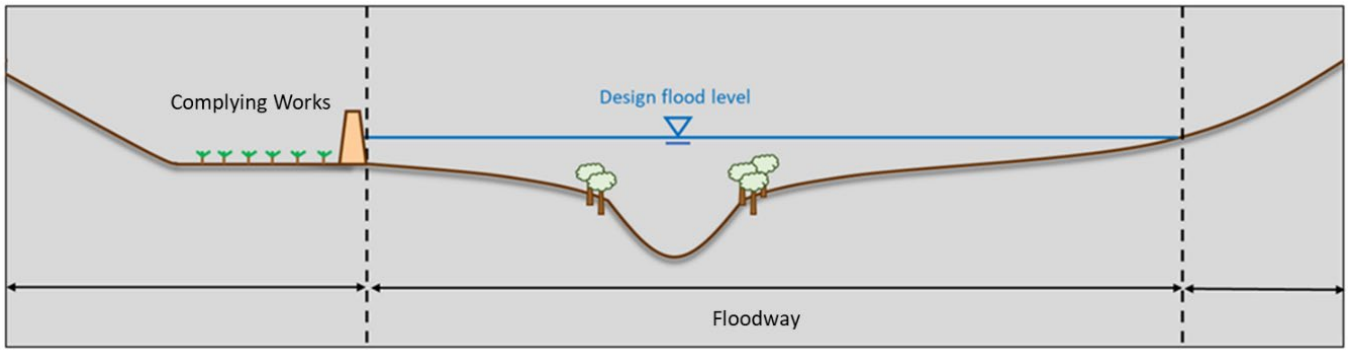


Figure 7. Conceptual floodway under the existing localised FMPs in the Murray Valley Floodplain (*Water Act 1912*)

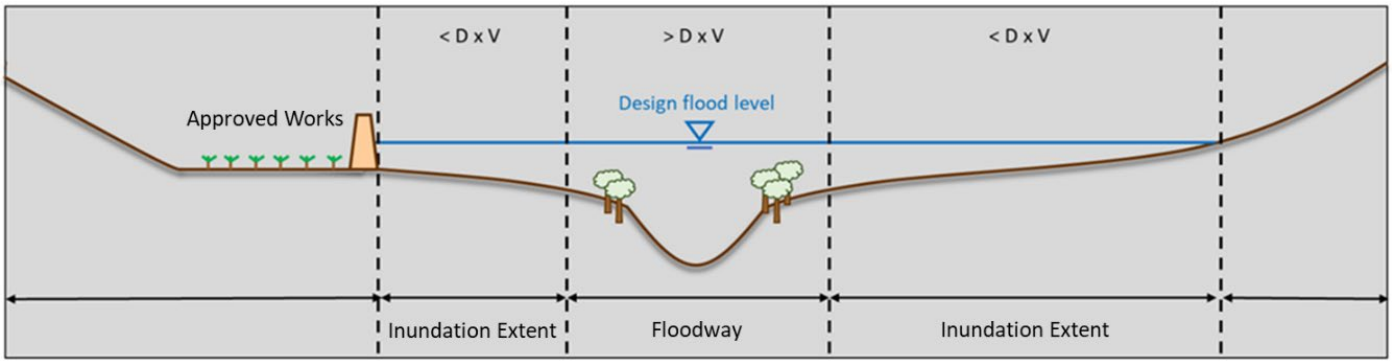


Figure 8. Conceptual floodway network under proposed Murray Valley FMP (*Water Management Act 2000*)

Inundation extent (ponding areas)

Along the floodways, there will be areas where floodwater breaks out (flood discharge) and forms ponds. As shown above in Figure 8, these areas are known as the inundation extent and are also part of the floodway network. The inundation extent is critical to storing floodwater during times of flood. Without these areas, the depth and speed of the floodwater in the floodway would dramatically increase. It is important that flood works constructed in these areas are coordinated so that they do not block inundation, particularly during large floods.

Other areas of the floodplain

The remaining area of the floodplain can be categorised as **flood fringe areas** or **flood protected areas**. These areas do not form part of the floodway network.

The flood fringe is an area which may be flooded but is not considered critical in the flow of water during times of flood. Flood-protected areas do not receive floodwater. This may be due to the area being high ground or the presence of existing structures prevents the passage of floodwater.

Consideration of unapproved flood works

The development of the floodway network includes consideration of existing flood works in the landscape, such as levees, embankments and roads. Each of these features can have a significant impact on the movement of floodwater and must be accounted for in the hydraulic models. Some of these flood works do not have a flood work approval. A process for determining how unapproved flood works are considered in the development of the floodway network is shown in Figure 10.

We acknowledge that unapproved flood works are a significant issue for many local landholders. To report concerns regarding unapproved works, please visit the NRAR website at www.nrar.nsw.gov.au/suspicious-activites. You can also contact NRAR on 1800 633 362 during business hours or via email nrar.enquiries@nrar.nsw.gov.au.

Developing the floodway network

Computer-based hydraulic models are used to simulate the movement of floodwater across the landscape for the large and small design floods. Modelling data, as well as additional information such as flood imagery and topographical information, is used to map the floodway network. This appendix describes the design floods and the hydrologic and hydraulic modelling that has been used to develop the proposed floodway network for the Murray valley floodplain.

Design floods

A design flood is a flood of known magnitude or annual exceedance probability (AEP) that can be modelled. A design flood forms the basis of the floodway network, and this information is used as the hydraulic basis when developing the management zones in an FMP. Selection of a design flood is based on an understanding of flood behaviour and associated flood risk. Multiple design floods may be selected to account for the social, economic and ecological consequences associated with floods of different magnitudes.

Two design floods were selected for the Murray valley floodplain:

- **large design flood – August to December 2022** (2.5% AEP at the Murray River at Barham gauge)
- **small design flood – July to December 2016** (16.9% AEP at the Murray River at Barham gauge).

AEP is the chance of a flood of a given or larger size occurring in any given year, usually expressed as a percentage (%) or a likelihood of 1 flood in x years. For example, a flood with an AEP of 5% means there is a 5% chance that a flood of the same size or larger will occur in any given year.

A flood frequency analysis was undertaken to assist with the selection of the design floods (Table 3). The flood frequency analysis was used to determine the relationship between peak flood discharge at a location of interest and the likelihood that a flood event of that size or greater would occur. Each of the gauges listed in Table 3 were selected as they have a long-term flow record and reliable flow estimates.

Table 3. AEP for historic flood events at selected locations in the proposed Murray Valley Floodplain

Location (gauge number)	2022 flood event AEP (%)	2016 flood event AEP (%)	1993 flood event AEP (%)	1992 flood event AEP (%)	1975 flood event AEP (%)
Edward River at Deniliquin	5.3	11.0	10.0	13.0	3.3
Edward River at Moulamein	2.5	9.1	13.0	14.6	6.0
Murray River at Tocumwal	3.3	3.2	4.0	11.0	0.5
Goulburn River at Shepparton	2.2	35.7	4.0	15.8	9.1
Campaspe River at Rochester	1.3	31.0	15	8.3	Not Available
Murray River at Barham	2.5	16.9	8.3	18.9	5.5
Murray River at Swan Hill	11.0	36.0	1.7	12.0	0.7

The large design flood (2022 flood event) was used to delineate floodways with significant discharge and to determine the extent of the floodway network. The large design flood was selected as:

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

Review of other historical events found that all other options for the large design event were limited either in the data available or their suitability in terms of their size (return period). While it is acknowledged that the 2022 floods had considerable local rainfall-runoff, the modelling (and plan) focus is on the riverine flooding.

The small design flood (2016 flood event) is a 16.9% AEP flood event at the Barham gauge. This smaller event was selected to ensure that critical flow paths were identified in the floodway network, where the modelled inundation extent of this event is compared to the identified floodways to ensure the accuracy of the network.

Hydraulic modelling

The Murray valley floodplain was divided into five reaches for hydraulic modelling purposes. These reaches are described in Table 4 and shown in Figure 9.

A suite of advanced one- and two-dimensional computer simulation software for hydraulic modelling of flood behaviour in rural and urban settings, known as TUFLOW, was used for each of the five reaches. The study area was modelled in the two-dimensional (2D) domain with key structures, such as culverts, incorporated as one-dimensional (1D) elements. Successful calibration and validation of the hydraulic models allowed historical flood events, including design flood events, to be replicated with an acceptable degree of accuracy.

For the purpose of defining acceptable degrees of accuracy, a hydraulic modelling standard specification was developed. It stipulates that all models need to be within 200 mm of inundation depths (based on gauge data and spot elevations) and 5% of the inundation width (based on aerial photography and satellite imagery).

Hydraulic model data and parameters

Hydraulic models have several parameters that need to be calibrated to correctly represent how floodwater behaves across the floodplain. The choice of values for these parameters can significantly affect the accuracy of the model outputs and lead to incorrect delineation of the floodway network. Some of these parameters include:

- Hydrometric and hydrologic model data: Recorded (gauged) hydrograph was used as boundary inflows for the hydraulic models.
- Boundary conditions: Each model identifies the inflow conditions at the upstream start of the project area and outflow conditions at the downstream finish of the project area.

  Representation of inflows is critical so that the model has the appropriate volumes and flow rates within the study area. Similarly, at the downstream boundary, water needs to be

removed from the model at the correct rates to avoid artificially increasing or decreasing flooding.

- **Topographic information:** a digital elevation model of the existing floodplain topography was developed using a range of topographic datasets acquired from available bathymetry, river cross sectional surveys and Light Detection and Ranging (LiDAR) laser surveying.
- **Grid size:** The model grid size, which is the spatial distance between calculation points, can have a significant impact on the accuracy of results. In particular, if areas with a high variation in topography are represented too coarsely, the flow distribution between different flow paths will be impacted. Grid sizes used in the hydraulic models for the proposed Murray Valley Floodplain are presented in Table 4.
- **Hydraulic structures:** All bridges, culverts, weirs, and regulators likely to impact flow along key watercourses and across adjoining floodplain areas were also included in the models as either 1D or 2D structures. In general, structures that were less than the model grid cell size wide (e.g., smaller floodplain culverts) were represented as 1D structures.

  All structures on the floodplain should be represented in the model with a high level of accuracy. If structures are not represented correctly, they will behave differently. For example, water may overtop a levee sooner in the model than it does in reality, or water may be constricted by a bridge to a greater degree in the model than in reality.

  Data for some of structures in the model area were captured by ground survey in previous studies (e.g. Sustainable Diversion Limit Adjustment Mechanism (SDLAM) projects, The Living Murray) and many remaining structures were measured during field inspections.
- **Existing hydraulic models:** Specific information such as surveyed topographical data and hydraulic structures information from previous developed hydraulic models within the study area were extracted and used in the hydraulic models developed for the Murray Valley Floodplain.
- **Land use / vegetation:** available land use and vegetation layers covering the study area were used to inform the “roughness" of the ground surface. Floodwater moves more slowly through dense vegetation compared to a cleared field. As part of the calibration process, flood observations, such as gauge data, satellite imagery, flood images, or footage, are compared to the model results, and the parameters like roughness are modified if the model is not aligning with the observed information.
- **Satellite imagery - Sentinel and Landsat:** Available satellite (Sentinel and Landsat 8) imagery of various dates during selected flood events were used for hydraulic model calibration and validation.
- **Data collected during previous flood events**: Flood information including local flood levels, flow directions, flood extents and inundation duration collected during previous community

consultation has been used for hydraulic model calibration and validation. Throughout June, July and August 2023 landholders and local councils, provided a range of data including ground and aerial flood level imagery and identification of areas where flood flow connectivity was compromised. To date, the department has collected an abundance of flood images, some drone footage and a significant number of verbal accounts of the 2022 flood event across all four valleys. The 2022 flood event was selected as the large design flood. There was also an abundance of historical flood information provided such as historical flood photos and descriptions of floodplain behaviour during past events from the 1950s to 2022.

- **Existing flood works:** A range of natural and constructed embankments extending across the floodplain, such as levees, rail, and road embankments, were included in the hydraulic models. Each of these features can have a significant impact on the movement of floodwater. Some of these flood works do not have a flood work approval.

A process for determining how unapproved flood works are considered in the development of the floodway network is shown in Figure 10. This process considers the potential flooding impacts of the unapproved work, whether the impact is contained within the landholding or if it impacts on other neighbouring properties and whether the impacted area is recognised as a floodway within the existing planning arrangements. Existing planning arrangements in the Murray Valley Floodplain are described in the Background section of this report.

Unapproved flood works are a significant issue for many local landholders. To report concerns regarding unapproved works, please visit the NRAR website at www.nrar.nsw.gov.au/suspicious-activites.

You can also contact NRAR on 1800 633 362 during business hours or via email nrar.enquiries@nrar.nsw.gov.au.

Table 4. Hydraulic models in each reach of the proposed Murray Valley Floodplain

Floodplain model reach	Model grid cell size	Model description
Murray Valley - Tuppal and Bullatale Creeks	40 m for dry and floodplain areas and 10 m for waterways and hydraulic controls	A TUFLOW 1D/2D grid model was built from upstream of the Newell Highway and railway bridge, at Tocumwal to downstream of the Barmah Road bridge at Barmah. The downstream extent of the model on the Edward River is located at Deniliquin. The other major features within this reach include Bullatale Creek, Tuppal Creek, Gulpa Creek, Native Dog Creek, Toupna Creek, Ulupna Creek, Aratula Creek, Warrick Creek, Broken Creek, Coolamon Creek, Four Post Creek, Barmah Creek and Tongalong Creek.
Murray River - from Barmah to Barham	40 m for dry and floodplain areas & 10 m for waterways and hydraulic controls	A TUFLOW 1D/2D grid model was built from Barmah Road Bridge at Barmah to downstream of the Thule Street bridge at Barham. The other major features within this reach are Gunbower Creek, Benarca Waterholes , Goulburn River, Crooked Creek, Burrumbury Creek, Barbers Creek, Broken Axle Creek, Belbins Creek, Upper Gunbower Creek, Deep Creek, Myloc Creek, Barbers Creek Backwater, Little Burrumbury Creek, Warrigal Creek, Bullock Head Creek, Campaspe River, Thule Creek and Backwater Creek.
Wakool River - from Deniliquin to Kyalite	40 m for dry and floodplain areas & 10 m for waterways and hydraulic controls	A TUFLOW 1D/2D grid model was built from upstream of Thule Street bridge on Murray River at Barham to the downstream of Swan Hill Road bridge at Swan Hill. The upstream extent of the model on the Edward River is located upstream of National Bridge at Deniliquin. The downstream extent of the model on the Wakool River is located downstream of Swan Hill Road. The other major features within this reach include Merran Creek, Little Murray River, Yallakool Creek, Wyam Creek, Barbers Creek, Yarrein Creek, Bullockhide Creek Eagle Creek, Coobool Creek, Colligen Creek, Mulligans Creek, Cockrans Creek, Back Creek, Porthole Creek, Bunna Creek, Merangatuk Creek, Merribit Creek, Mallan Mallan Creek, Cunninyeuk Creek and Waddy Creek
Edward River - from Deniliquin to Kyalite	40 m for dry and floodplain areas & 10 m for waterways and hydraulic controls	A TUFLOW 1D/2D grid model was built from upstream of Davidson Street bridge at Deniliquin to before Edward River convergence with the Wakool River. The downstream extent of the model on the Niemur River is at upstream of Cunninyeuk Road bridge before its convergence with the Wakool River. The other major features within this reach Include Yarrein Creek, Cockrans Creek, Colligen Creek, Murrain Yarrein Creek, Jimaringle Creek, Jawbone Creek, Gwynnes Creek, Swampy Creek, Booronong Creek, Middle Creek, Berambong Creek, Papanue Creek, Kangaroo Creek, Burragorrima Creek and Tumudgery Creek.

Floodplain model reach	Model grid cell size	Model description
Murray River – from Swan Hill to Boundary Bend	40 m for dry and floodplain areas & 10 m for waterways and hydraulic controls	A TUFLOW 1D/2D grid model was built along Murray River from downstream of Murray River Road Bridge at Swan Hill to downstream of Murray Valley Highway bridge at Robinvale. The upstream extent of the model on the Murrumbidgee River is located approximately 10 km downstream of Balranald, at Balranald Weir. The upstream extent of the model on the Wakool River is located at Kyalite. The other major features within this reach are Manie Creek, Burra Creek, Wee Wee Creek, Speewa Creek, Peacock Creek, Narcooyia Creek, Jack O'Brien's Creek, Taila Creek, Caringay Creek and Waldaira Creek.

Figure 9. The five reaches of the hydraulic models within the proposed Murray Valley Floodplain

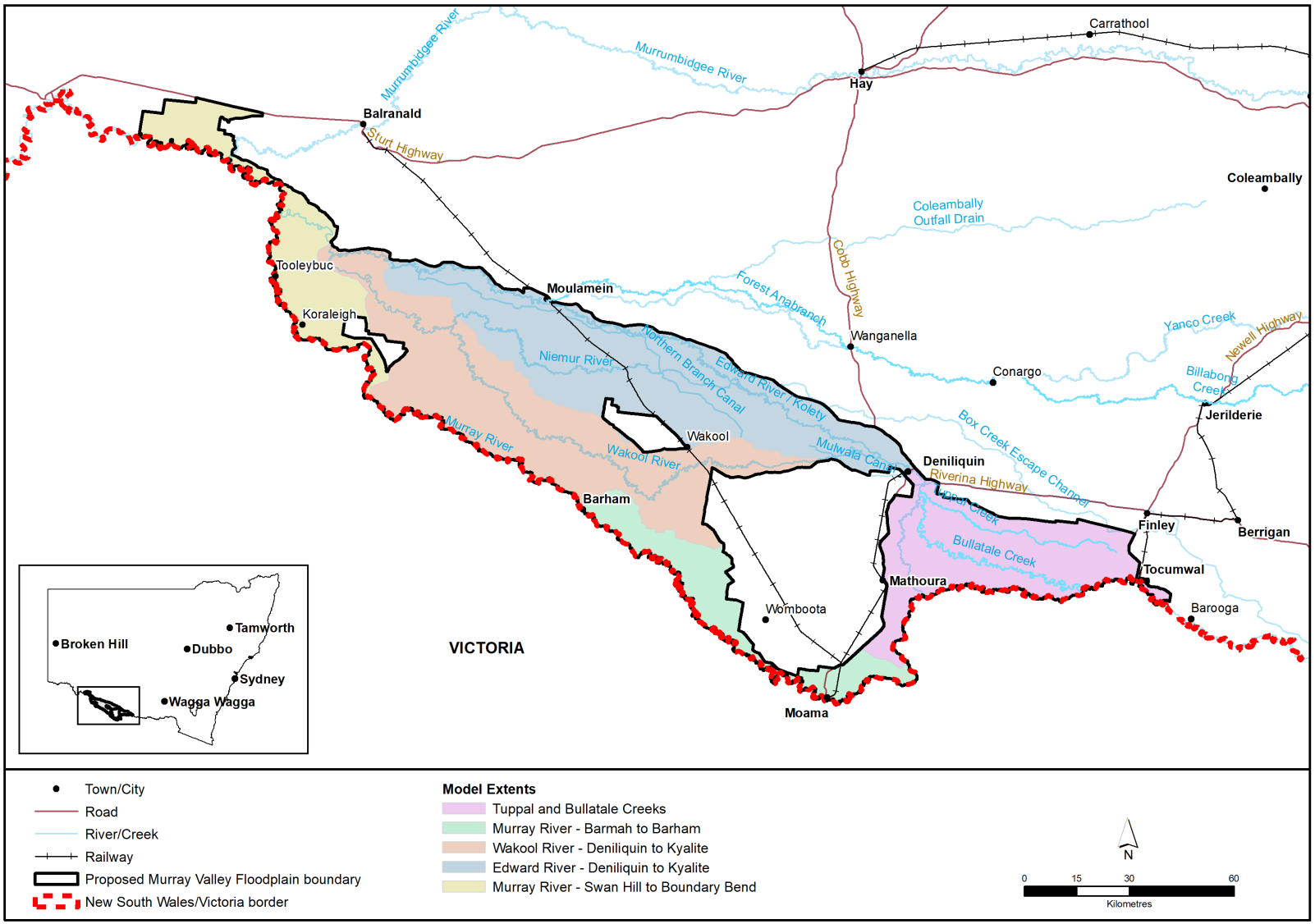
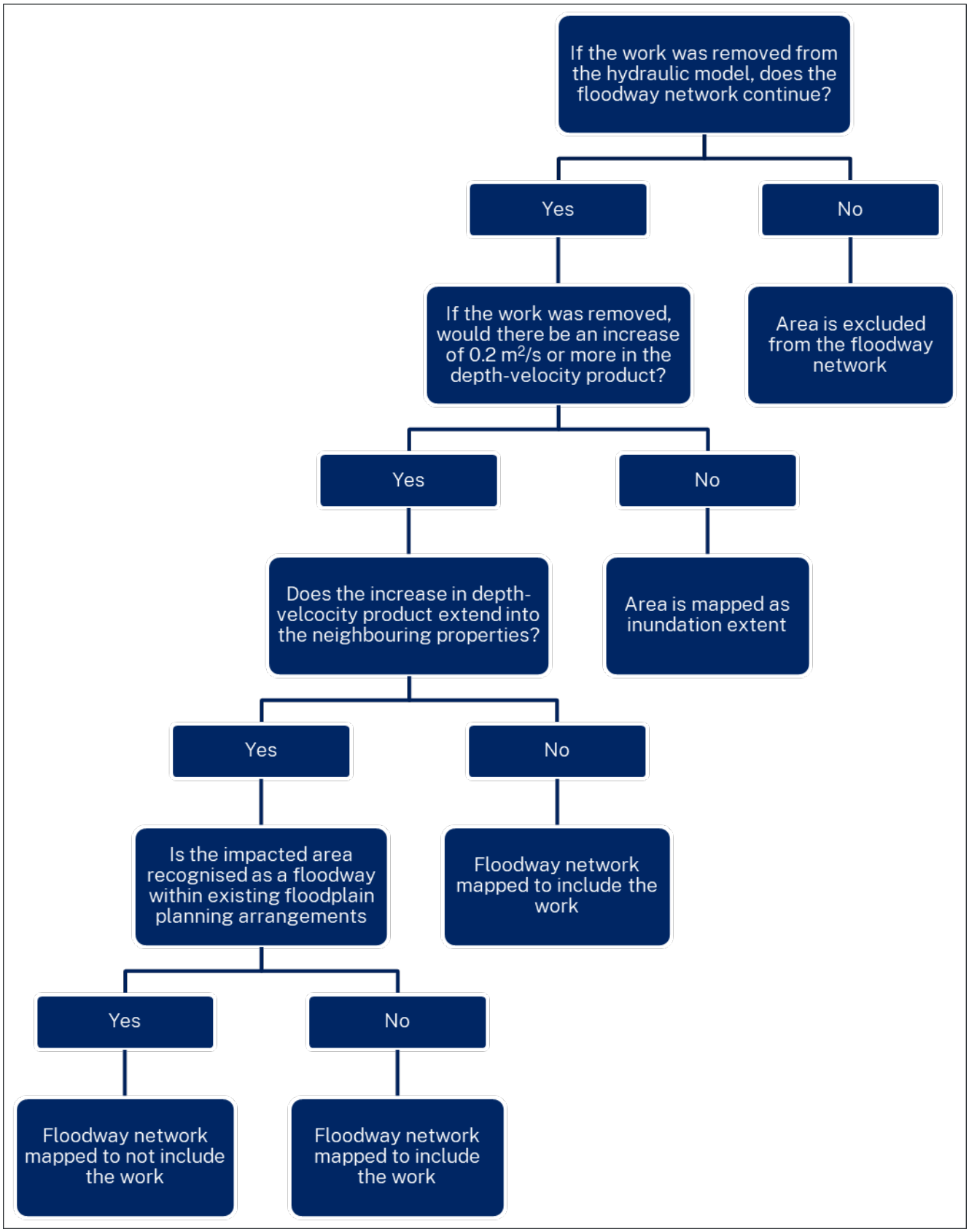


Figure 10. Process for determining how an unapproved work is considered in the development of the floodway network



Hydrology

Flood flow data at various points across the floodplain is a key input into the hydraulic models that are used to map the floodway network. Within the proposed Murray Valley Floodplain, flood flows were derived from mainstream and tributary streamflow gauges, while flows for ungauged tributaries were estimated using hydrologic information from adjacent catchments with an appropriate rate as determined by aerial imagery captured during each event.

Data from the following streamflow gauges (Table 5) was available for the development of the hydraulic models. More information about these streamflow gauges is available on the Water Insights website.

Table 5. Streamflow gauges used in the development of the hydraulic models for the Murray Valley Floodplain

Gauge number	Location
409202	Murray River at Tocumwal
409711	Murray Valley Drain 3 outfall at Sheepwash Creek
404210	Broken Creek at Rices Weir
409215	Murray River at Barmah
405277	Yambuna Drain Outfall
405232	Murray River at McCoys Bridge
406265	Campaspe River at Echuca
409056	Tuppal Creek at Aratula Road
405204	Goulburn River at Shepperton
406202	Campaspe River at Rochester
409005	Murray River at Barham
406263	Mullers Creek at Murray Valley Highway
409003	Edward River at Deniliquin
409013	Wakool River at Stoney Crossing
408213	Avoca River at Outfall (Tresco Pumphouse)
409058	Box Creek at Conargo Road
409204	Murray River at Swan Hill

Gauge number	Location
409109	Thule Creek at Lower Thule Road
409113	Barbers Creek at Barbers Pool
407202	Loddon River at Kerang
409086	Niemur River at Mallan School
409014	Edward River at Moulamein
410134	Billabong Creek at Darlot
409035	Edward River at Liewah
409013	Wakool River at Stoney Crossing
410130	Murrumbidgee River at D/S Balranald Weir
414200	Murray River at Below Wakool Junction
414203	Murray River at Euston

Model calibration and validation

The hydraulic models were calibrated and validated using selected historic flood events that are around the design flood magnitude and that likely activate all flood flow paths.

The flood events were used for calibration and validation are presented in Table 6.

Table 6. The selected flood events that were used to calibrate and validate the hydraulic models

Floodplain model reach	Large calibration Event	Small calibration Event	Validation Event
Murray Valley - Tuppal and Bullatale Creeks	August to December 2022 flood	September to December 1996 flood	September to November 2016 flood
Murray River - from Barmah to Barham	August to December 2022 flood	September to December 2016 flood	September to November 1993 flood
Wakool River - from Deniliquin to Kyalite	August to December 2022 flood	September to December 2016 flood	September to December 1993 flood
Edward River - from Deniliquin to Kyalite	August to December 2022 flood	September to December 2016 flood	September to December 1993 flood
Murray River - Swan Hill to Boundary Bend	August 2022 to January 2023 flood	July 2016 to January 2017 flood	July 1993 to January 1994 flood

The models were calibrated against a range of data sources, particularly:

- Peak flood heights at streamflow gauge locations
- Available flow distribution calculations for the existing non-statutory floodplain development guidelines
- the peak discharge magnitude and timing at streamflow gauge locations
- flood extents from satellite imagery and aerial photography.

A summary of the peak recorded flows and water levels during selected flood events for calibration and validation of the hydraulic models is presented in Table 7.

Table 7. Peak recorded flows and water levels during selected flood events for calibration and validation of hydraulic models

Gauge	2016 flood Water depth (m)	2016 flood Flow (ML/day)	2022 flood Water depth (m)	2022 flood Flow (ML/day)
Murray River at Tocumwal (409202)	6.85	165,000	7.32	165,600
Murray River at Barmah (409215)	6.85	Not available	7.32	Not available
KPF Offtake downstream Regulator (409114)	2.39	Not available	2.99	Not available
Murray River at Barham (409005)	6.08	31,100	6.21	36,406
Murray River at Swan Hill (409204)	4.30	27,203	4.60	30,075
Murray River at Below Wakool Junction (414200)	11.01	107,692	11.72	154,000
Tuppal Creek at Aratula Road (409056)	8.26	38,944	8.16	37,415
Wakool River at Coonamit Bridge (409061)	10.99	62,564	12.41	111,204
Wakool River at Stoney Crossing (409013)	9.30	66,944	10.86	133,592
Edward River at Deniliquin (409003)	8.62	76,416	9.19	102,958
Edward River downstream Stevens Weir (409023)	6.51	Not available	6.57	Not available
Edward River at Moulamein (409014)	5.76	17,169	6.23	26,253
Edward River at Liewah (409035)	7.12	16,490	F8.25	25,492

Hydraulic model outputs

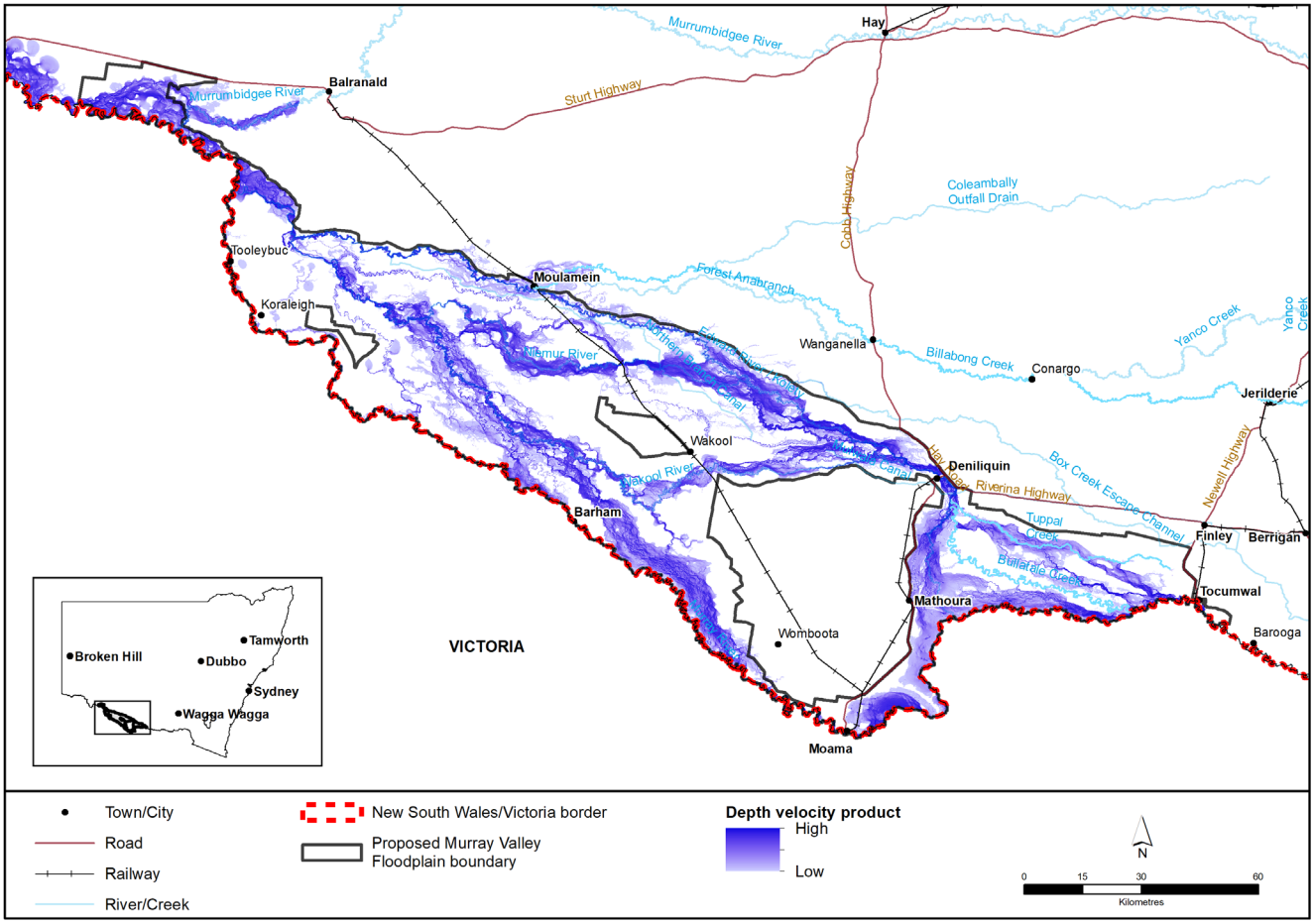
The hydraulic model outputs used to develop the floodway network included:

- depth-velocity product (DVP) maps for the large design flood (2022 flood, see Figure 11).

- inundation extents for the small design flood (2016 flood/1996 flood) and the large design flood (2022 flood).

These outputs were used to determine the appropriate size of each floodway and the overall floodway network. In areas where hydraulic data was not sufficient to accurately map the flood extents, the limits to the floodway networks determined by using aerial and satellite flood imagery captured for the design flood events.

Figure 11. Hydraulic modelling results (depth-velocity product) map from all five models for the large design flood event (2022 flood – 2.5% AEP at the Murray River at Barham gauge)



Mapping the floodway network

Hydraulic criteria

The small and large design floods provide the hydraulic basis for delineating the floodway network. The hydraulic criteria that were used to delineate the floodway network are described in Table 8.

Table 8. Summary of the criteria used to delineate the hydraulic categories in the floodway network

Hydraulic category	Criteria
Floodways	• Areas that have a depth-velocity product of greater than or equal to 0.2 m^2/s for the large design flood (August to December 2022) • Areas that support tributary flows and outer floodplain floodways that have a DVP of greater than or equal to 0.15 m2/s for the large design flood (August to December 2022) • Parts of the small design flood extent (July to December 2016/1996 flood) that ensure continuity of floodways
Inundation extent	• Flood extent of the small design flood (July to December 2016/1996 flood) and the large design flood (August to December 2022) • In areas outside the hydraulic model extent flood imagery from the 2022 flood event derived from Sentinel and Landsat imagery.
Areas outside of the floodway network	• Flood fringe areas outside the large design flood (August to December 2022) extent • Floodplain area enclosed by existing flood works that were not designed to be overtopped by floodwater.

Hydraulic modelling outputs may not always account for all of the important floodways. As such, additional data is used to ensure that the floodway network represents on-ground conditions. The following information was used to validate the floodway network:

- flood aerial photography and satellite imagery
- spatial watercourse layers
- rural floodplain development guidelines
- local knowledge from floodplain communities, and floodplain and environmental managers
- existing flood work development.

Floodways

Floodways in the Murray valley floodplain were mapped using the outputs of the hydraulic models, in particular the depth-velocity products from the large design flood (August to December 2022).

Floodways derived from the target depth-velocity threshold were compared with the inundation extent of the small design flood (July to December 2016/1996 flood). This comparison was undertaken to ensure that areas of the floodplain activated during small floods were identified as floodways, irrespective of whether they reached the selected depth-velocity threshold. Such areas

are also likely to be the first floodways activated during large flood events and may be important for connecting flood-dependent ecological and cultural assets to floodwater during smaller floods.

Inundation extent

The hydraulic modelling also produced the inundation extent of the large design flood (August to December 2022) across the floodplain. Where the flood extent was reliable, its outer limits were used to determine the extent of the floodway network.

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

Appendix 2. First Nations consultation

The department held multiple information sessions with First Nations communities across the proposed Murray valley floodplain between June and November 2023. An overview of the engagement activities completed to-date is provided in Table 9.

The purpose of this targeted engagement was to identify or confirm Aboriginal cultural assets and values on the floodplain, which is a key step in the development of the draft FMP, and to raise awareness about how FMPs can protect Aboriginal cultural assets and values. The Heritage NSW division also provided information on AHIMS that is used to support the development and implementation of an FMP.

The department will continue to liaise with First Nations communities in the Murray valley floodplain throughout the development of the draft FMP. This will include updates via the department's Southern Regional Aboriginal Water Committee.

Table 9. Overview of First Nation engagement sessions to-date

Date	Location	Who	Nation	Number of people
14 June 2023	Deniliquin	Deniliquin Land Council and Yarkuwa Indigenous Knowledge Centre members	Wamba Wamba and Perrepa Perrepa	10
15 June 2023	Moama	Moama Local Aboriginal Land Council	Yorta Yorta	1
24 August 2023	Barmah	Yorta Yorta Aboriginal Corporation staff member	Yorta Yorta	1
24 August 2023	Cummeragunja	Cummeragunja Local Aboriginal Land Council	Bangerang / Yorta Yorta	1
29 August 2023	Deniliquin	Deniliquin Local Aboriginal Land Council, Yarkuwa Indigenous Knowledge Centre members and community	Wampa Wampa and Perrapa Perrapa	10

Date	Location	Who	Nation	Number of people
28 November 2023	Deniliquin	Deniliquin Local Aboriginal Land Council, Yarkuwa Indigenous Knowledge Centre members and community	Wampa Wampa and Perrapa Perrapa	9
29 November 2023	Moama	Moama Local Aboriginal Land Council and Cummeragunja Local Aboriginal Land Council	Bangerang / Yorta Yorta	2
21 November 2023	Wagga Wagga	Southern Regional Aboriginal Water Committees (introduction)	Multiple	25

Feedback received

A summary of the feedback received from First Nations communities in the proposed Murray valley floodplain is provided in Table 10. First Nations communities in Deniliquin, Moama, Cummeragunja and Barmah, as well as the NSW Heritage AHIMS team, were consulted on the feedback summarised in Table 10 and agreed to its inclusion in this report.

Table 10. Summary of feedback received from First Nations communities in the Murray Valley Floodplain and the department's response.

Feedback received	Response from the department
There is a common desire to protect and care for Aboriginal cultural assets and values that are located on private properties. However, this cannot be done due to a lack of access.	While floodplain management plans do not deal with access, they can raise awareness of the value of Aboriginal cultural assets to First Nations people and the broader community. Healthy waterways and floodplains are critical to the culture and wellbeing of Aboriginal people. Water provides food, kinship, connection, recreation, stories, songlines and healing. The department encourages local landholders to build relationships with local First Nations communities to work together to care for cultural assets and values on the floodplain that, in turn, can provide social and economic benefits to the community.

Feedback received	Response from the department
Aboriginal cultural assets recorded in AHIMS are being damaged or destroyed during development processes.	The *National Parks and Wildlife Act 1974* protects Aboriginal cultural heritage in NSW. An Aboriginal Heritage Impact Permit is required for any activity or works where harm to an Aboriginal object or place cannot be avoided. This means that development proposals must consider impacts on Aboriginal cultural heritage. For further information about current development applications, please contact the local council in your area. To report damage or harm to an Aboriginal cultural asset contact the Environment Line: • By phone: 131 555 (24 hours a day, 7 days a week) • By email: info@epa.nsw.gov.au In relation to floodplain management, as part of assessing and determining an application for a flood work approval, a search of AHIMS must be conducted. In AHIMS, site information can be restricted so that culturally sensitive information is not shared publicly. Heritage NSW can provide assistance to facilitate communication between a landholder and the relevant knowledge holder/Elders in the event that a restricted Aboriginal cultural site is identified within or near a proposed flood work. Floodplain management plans provide an opportunity to improve public awareness of the value of Aboriginal cultural assets on the floodplain as it relates to the health and wellbeing of First Nations people, and in turn foster greater stewardship of these cultural assets.
Earth works such as levee banks in some locations are restricting flows during flood events preventing wetlands from receiving the water they need to thrive.	The Natural Resources Access Regulator (NRAR) is responsible for compliance and enforcement of flood works. As part of development of the new FMP all flood works are being identified and their approval status reviewed, this information will be provided to NRAR when complete. More information is available in the June 2023 consultation outcomes report that is published on the department's website.
A lot of First Nations people are aware of AHIMS but were unsure on how to use it, including how to use the mobile app.	Heritage NSW will continue to provide support to individual communities where required to add objects or places to AHIMS. For further information, please contact heritageinbox@environment.nsw.gov.au or phone (02) 9873 8500.
Poor mobile phone coverage when out on Country makes it difficult to record the location of Aboriginal cultural assets and values in AHIMS.	Heritage NSW will provide support to individual communities to supply a GPS unit to allow recording in areas with poor mobile phone coverage. For further information, please contact heritageinbox@environment.nsw.gov.au or phone (02) 9873 8500.

Feedback received	Response from the department
It is difficult for many First Nations people, including Elders, to attend information sessions and meetings that are held during regular business hours due to work commitments.	Where possible, the department will plan to host future events later in the afternoon or early evening to ensure that more people can attend information sessions and have their say.
On ground assessments are needed to identify Aboriginal cultural assets during both plan development and flood work applications	The department relies on a number of sources to identify Aboriginal cultural assets, of which AHIMS provides the most comprehensive database of community-driven information. Further, when assessing flood work applications it is a mandatory requirement for WaterNSW to review the area for sites registered in AHIMS.

Appendix 3. Ecological asset identification and categorisation

Identifying ecological assets

Two types of flood-dependent ecological assets have been identified in the proposed Murray Valley Floodplain: wetlands and other floodplain ecosystems.

Wetlands and other floodplain ecosystems include the flood-dependent vegetation communities that were identified and categorised into hydro-ecological functional groups according to the surface water requirements of the dominant or canopy species in the floodplain vegetation community, including:

- semi-permanent (non-woody) wetlands
- floodplain wetlands (flood-dependent shrubland wetlands)
- other floodplain ecosystems, including flood-dependent forest/woodland (wetlands) and flood-dependent woodlands.

Ecological asset type – wetlands

Vegetation mapping including the State Vegetation Type Map[2] of plant community types (PCTs) and several wetland studies was predominantly used to identify wetlands. PCTs identify recurring patterns of native plant species assemblages in relation to environmental conditions. More information about NSW plant community type classification is available on the department's website.

The following previous wetland studies and datasets have been identified:

- Directory of Important Wetlands in Australia[3]
- River Murray Wetlands Database[4]
- Wetlands of the River Murray[5]
- NSW Hydro Area dataset which contains delineations of named wetlands
- Mitchell Landscapes version 3.1 which identifies Murray Lakes, Swamps and Lunettes[6]

[2] NSW Department of Planning and Environment (DPE) (2022) NSW State Vegetation Type Map. Current Release C1.1.M1.1 (December 2022)

[3] Department of Climate Change, Energy, the Environment and Water (DCCEEW) (2016) Directory of Important Wetlands in Australia.

[4] NSW Murray Wetlands Working Group (2006) River Murray Wetland Database: NSW, Victoria, NSW Murray Wetlands Working Group, Albury

[5] Pressey RL (1986) Wetlands of the River Murray below Lake Hume, prepared for theRiver Murray Commission, Canberra

[6] Department of Environment and Climate Change (DECC) (2002) Descriptions for NSW (Mitchell) Landscapes Version 2 (2002)

The wetlands of the River Murray[5] and River Murray Wetlands Database[4] data informed the development of the existing Wakool River Stage 2 Moama–Moulamein Railway to Gee Gee Bridge FMP and the Edward and Niemur Rivers Stage 3 Moama–Moulamein Railway to Liewah and Mallan FMP. These existing localised FMPs were developed under the *Water Act 1912* and are published on the department's website.

The State Vegetation Type Map mapping of PCTs supersedes the vegetation mapping that was used to identify flood dependent ecosystems as a part of the design process for the floodway network for the existing localised FMPs. More information about the reliability and spatial precision of the State Vegetation Type Map is available on the department's website.

The department is committed to using the best available information in the development of the draft FMP. When newer ecological asset data becomes available in the short-term, this will be considered in the development of the draft FMP and further community feedback will be sought during Stage 2 public exhibition.

Wetlands of national and international importance

The following wetland areas are of international importance and are listed as Ramsar sites listed under the Ramsar Convention in 1999: NSW Central Murray Forests Ramsar site, specifically:

- Koondrook Forest Group
- Millewa Forest Group
- Werai Forest Group.

These sites are also listed in the Directory of Important Wetlands in Australia as follows:

- Koondrook and Perricoota Forests (NSW046)
- Millewa Forest (NSW053)
- Werai Forest (NSW056).

Wetland plant communities

Wetlands within the proposed Murray Valley Floodplain include semi-permanent (non-woody) wetlands and floodplain (flood-dependent shrubland) wetlands. The plant community types that make up these hydro-ecological functional groups and their watering requirements are shown in Table 11.

Lignum swamps are a priority for the NSW and Commonwealth Governments outlined in the Murray–Lower Darling Long Term Water Plan[7,8] and the Basin-wide environmental watering strategy[9].

Table 11. Wetlands – Plant community types in the Murray Valley Floodplain and their watering requirements

Wetlands by sub-type	Plant community type name (ID)	Ideal watering frequency (average recurrence interval)*
Semi-permanent (non-woody) wetlands	• Shallow marsh wetland of regularly flooded depressions on floodplains mainly in the semi-arid (warm) climatic zone (mainly Riverina Bioregion & Murray Darling Depression Bioregion; PCT 12) • Swamp grassland wetland of the Riverine Plain (PCT 47) • Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains (PCT 53) • Common Reed - Bushy Groundsel aquatic tall reedland grassland wetland of inland river systems (PCT 181) • Cumbungi rushland wetland of shallow semi-permanent water bodies & inland watercourses (PCT 182) • Permanent and semi-permanent freshwater lakes wetland of the inland slopes and plains (PCT 238)	1 in 1-2 years
Floodplain wetland (flood-dependent shrubland) wetland	Lignum shrubland wetland of the semi-arid (warm) plains (mainly Riverina Bioregion and Murray Darling Depression Bioregion; PCT 17)	1 in 1–3 years to 1 in 7–10 years
Floodplain wetland (flood-dependent shrubland) wetland	Canegrass swamp tall grassland wetland of drainage depressions, lakes and pans of the inland plains (PCT 24)	1 in 2-3 years to 1 in 5-7 years
Floodplain wetland (flood-dependent shrubland) wetland	Nitre Goosefoot shrubland wetland on clays of the inland floodplains (PCT 160)	1 in 1–2 years to 1 in 2–7 years

*Refers to the frequency at which a flow event is required to maintain the ecological character of the wetland, expressed as an average recurrence interval (the long-term average number of years between a flood event). Adapted from the Murray-Lower Darling Long Term Water Plan.

[7] Department of Planning, Industry and Environment (DPIE) (2020a) Murray–Lower Darling Long Term Water Plan. Part A: Murray–Lower Darling catchment. ISBN 978-1-922317-81-0 EES 2020/0080 September 2020

[8] Department of Planning, Industry and Environment (DPIE) (2020b) Murray–Lower Darling Long Term Water Plan. Part B: Murray–Lower Darling planning units. ISBN 978-1-922317-80-3 EES 2020/0081 September 2020

[9] Murray-Darling Basin Authority (MDBA) (2019) Basin-wide environmental watering strategy. Second Edition. 22 November 2019. Published by the Murray-Darling Basin Authority. MDBA publication no: 42/19. ISBN (online): 978-1-925762-47-1

Ecological asset type – other floodplain ecosystems

The State Vegetation Type Map mapping of plant community types (PCTs) and several wetland studies were predominantly used to identify other floodplain ecosystems.

Other floodplain ecosystems within the proposed Murray Valley Floodplain include flood-dependent forest/woodland (wetlands) and flood-dependent woodlands. The plant community types that make up these hydro-ecological functional groups and their watering requirements are shown in Table 12.

River Red Gum is a target ecological population and noted environmental objective of the *Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* and are a priority for the NSW and Commonwealth Governments outlined in the Murray–Lower Darling Long Term Water Plan[7,8] and the Basin-wide environmental watering strategy[9].

Table 12. Other floodplain ecosystems – Plant community types in the Murray Valley Floodplain and their watering requirements

Other floodplain ecosystems by sub-type	Plant community type name (ID)	Ideal watering frequency (average recurrence interval)*
Flood-dependent forest/woodland (wetland)	• River Red Gum-sedge dominated very tall open forest in frequently flooded forest wetland along major rivers and floodplains in south-western NSW (PCT 2) • River Red Gum herbaceous-grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion (PCT 5) • River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion (PCT 7) • River Red Gum - Lignum very tall open forest or woodland wetland on floodplains of semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion; PCT 11)	1 in 1–3 years

Other floodplain ecosystems by sub-type	Plant community type name (ID)	Ideal watering frequency (average recurrence interval)*
Flood-dependent forest/woodland (wetland)	• River Red Gum - Warrego Grass - Couch Grass riparian tall woodland wetland of the semi-arid (warm) climate zone (Riverina Bioregion and Murray Darling Depression Bioregion; PCT 8) • River Red Gum - wallaby grass tall woodland wetland on the outer River Red Gum zone mainly in the Riverina Bioregion (PCT 9) • River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion; PCT 10) • Yellow Box – River Red Gum tall grassy riverine woodland of NSW South Western Slopes Bioregion and Riverina Bioregion (PCT 74)	1 in 2–4 years
Flood-dependent woodlands	• Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion; PCT 13) • Black Box grassy open woodland wetland of rarely flooded depressions in south western NSW (mainly Riverina Bioregion and Murray Darling Depression Bioregion; PCT 16) • Black Box open woodland wetland with chenopod understorey mainly on the outer floodplains in south-western NSW (mainly Riverina Bioregion and Murray Darling Depression Bioregion; PCT 15) • Buloke - Moonah - Black Box open woodland on sandy rises of semi arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion; PCT 20)	1 in 3–7 years to 1 in 5–10 years

Consideration of water-dependent fauna and habitat in the identification of the flood-dependent ecological assets on the floodplain

The identification of the flood-dependent ecological assets within the proposed Murray Valley Floodplain includes consideration of key habitat features for water-dependent fauna including areas of native fish passage, observed waterbird breeding habitat sites and drought refugia. The proposed floodway network aims to provide for the adequate passage of floodwater to these areas to maintain their ecological value.