

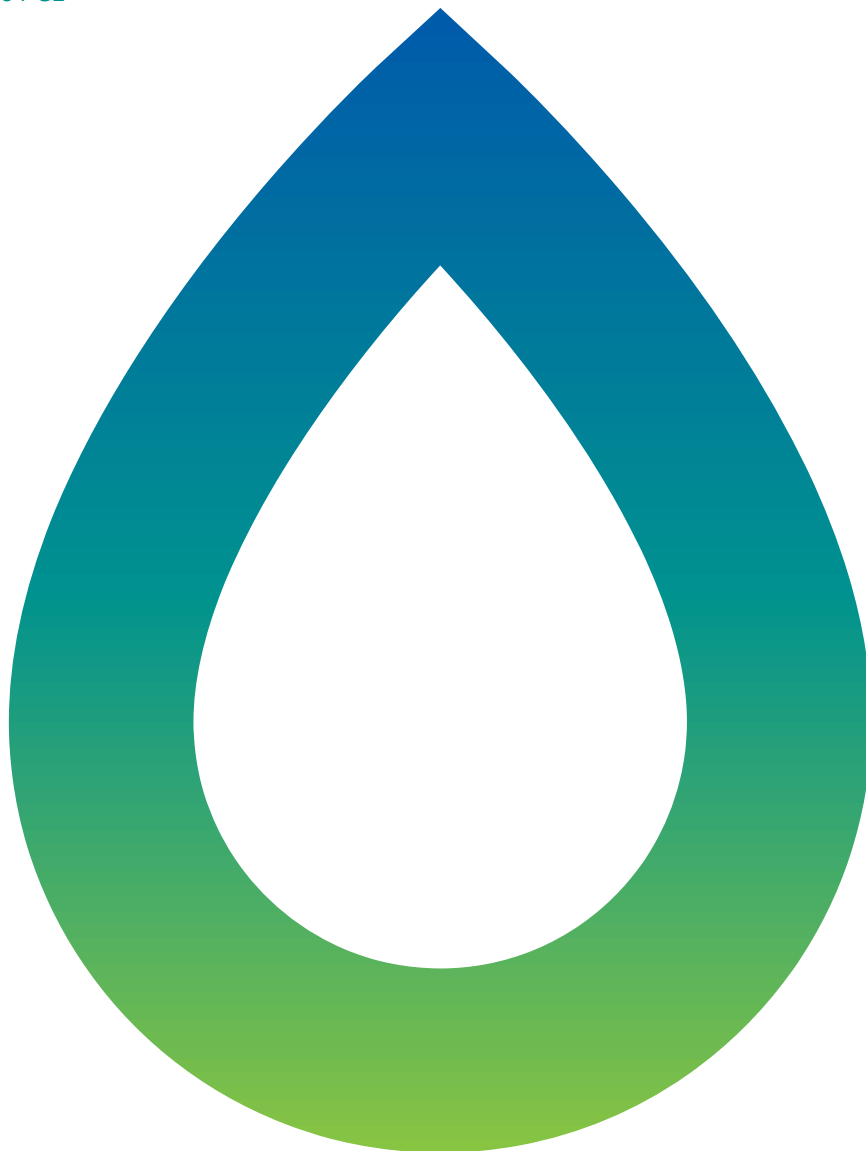


BOGGABRI FLOODPLAIN RISK MANAGEMENT STUDY AND DRAFT PLAN

Narrabri Shire Council

9 February 2024

1599-04-G2





DETAILS

Report Title Boggabri Floodplain Risk Management Study and Draft Plan
 Client Narrabri Shire Council

THIS REVISION

Report Number 1599-04-G2
 Date 9 February 2024
 Author Hayden Guse
 Reviewer Greg Roads

Version	Issued to	Date	Prepared by	Reviewed by
1599-04-G2	NSC	27/02/2024	MH	DA

Minute No	Meeting Date	Description
023/2024	27 February 2024	Adopted

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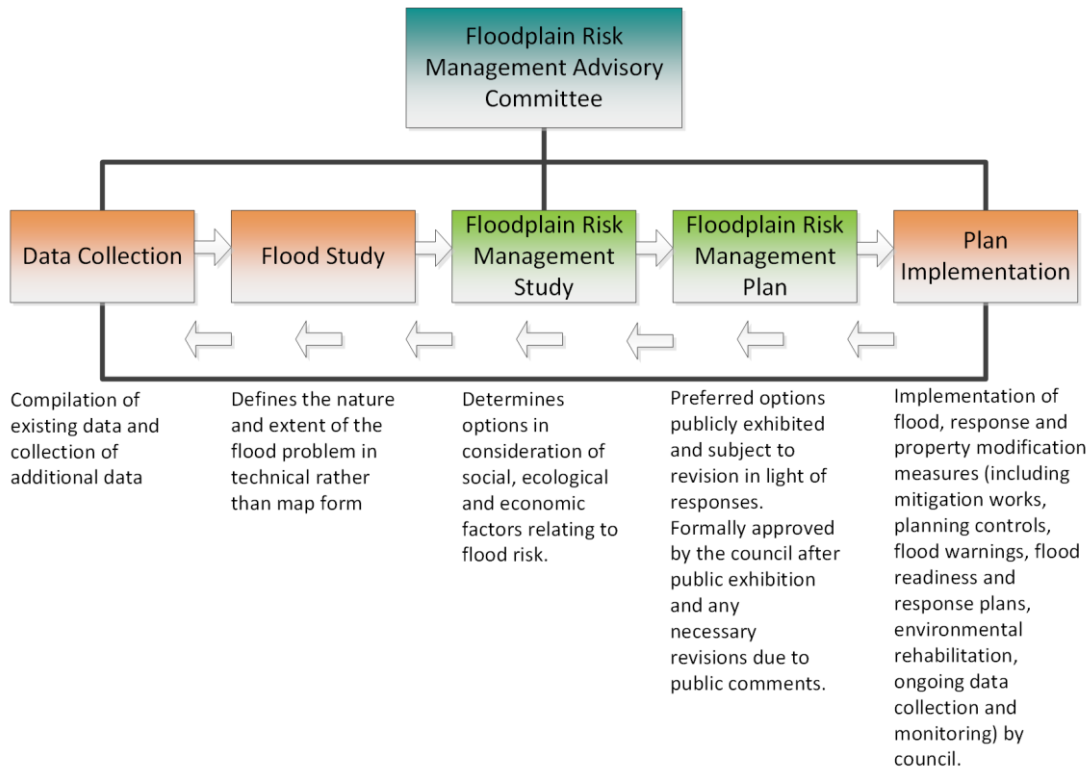


FOREWORD

The New South Wales (NSW) Government’s Flood Prone Land Policy provides a framework for managing development on the floodplain. The primary objective of the policy is to develop sustainable strategies for managing human occupation and use of the floodplain using risk management principles. Under the Policy, the management of flood liable land remains the responsibility of local government. The State Government subsidises flood mitigation works to alleviate existing problems and provides specialist technical advice to assist councils in the discharge of their floodplain management responsibilities.

The NSW Government’s Flood Risk Management Manual (2023) has been prepared to support the NSW Government’s Flood Prone Land Policy. The 2023 manual was not gazetted at the commencement of this study. This study was undertaken while the Floodplain Development Manual (2005) (the Manual) was gazetted.

The Manual provides councils with a framework for implementing the policy to achieve the policy’s primary objective. The framework is shown below.



The tasks outlined in this report are the floodplain risk management study and draft floodplain risk management plan components of the process. This report represents the first dedicated floodplain risk management study and draft plan undertaken exclusively for Boggabri.

This report should be read in conjunction with the Boggabri Flood Study (WRM, 2021).

This project was prepared with financial assistance from the NSW Government’s Floodplain Management Program. This document does not necessarily represent the opinions of the NSW Government or the Department of Planning and Environment.



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EXECUTIVE SUMMARY

STUDY OBJECTIVE

Narrabri Shire Council has received financial support from the New South Wales (NSW) State Floodplain Management Program to prepare a floodplain risk management study and plan (FRMSP) for Boggabri. The objective of the study, documented in this report, is to investigate a range of flood mitigation works and measures to address the existing, future and continuing flood problems in Boggabri, in accordance with the NSW Government's Flood Prone Land Policy.

EXISTING FLOOD PROBLEM

The Boggabri region is prone to flooding from the Namoi River and Coxs Creek. The urban area of Boggabri is infrequently inundated, with only rare events inundating the township. However the rural and semi-rural areas, particularly around the showgrounds, are frequently impacted by Namoi River and Coxs Creek overflows, which often causes interruption of transport routes, and infrequently directly impacts homes and businesses.

Two residential buildings within the study area are predicted to be inundated above floor level for the 5% annual exceedance probability (AEP) design flood, with up to one additional unsurveyed property also potentially inundated above floor level. At least 14 residential and seven non-residential buildings within the study area are predicted to be inundated above floor level for the 1% AEP design flood, with up to 15 additional unsurveyed properties also potentially inundated above floor level. Flood hazard vulnerability mapping identified 80 buildings in areas that would be unsafe for both people and vehicles in the 1% AEP design event.

The estimated flood damage costs for a 1% AEP design flood would be about \$3.9 million (excluding road, bridge and agricultural flood damages). Once flood levels exceed the 1% AEP event the potential damage to the community rapidly increase with the 0.5% AEP design flood predicted to inundate at least 84 properties above floor level (and potentially 18 additional unsurveyed properties), with damage costs estimated at \$11.4 million (excluding road, bridge and agricultural flood damages).

FLOOD RISK MANAGEMENT OPTIONS

A range of emergency response, structural and non-structural (planning) measures were investigated to address the existing flood problem in Boggabri. The measures investigated were guided by community feedback gathered throughout the project.

Emergency response measures

The SES Narrabri Shire Flood Emergency Sub Plan (2023) covers issues such as flood warning, resupply, evacuations and flood recovery. This FRMSP and the preceding flood study contains additional and up-to-date flooding information that can be incorporated into this Flood Emergency Sub Plan. For example, to help assist prioritisation of evacuation and/or resupply, volumes 2 and 3 of the Flood Emergency Sub Plan can incorporate the road and building inundation information contained in this study.

The existing flood evacuation centres in Boggabri were found to provide refuge up to the most extreme flood events. Boggabri can however be cut-off by road for extended periods, so recommendations have been made to further investigate additional resupply options. Recommendations have been made to update flood warning services to include moderate and major flood levels to help inform the community of the potential consequences of oncoming floods, to



lower the defined minor flood level to allow actions to be taken prior to key roads being cut, and to expand warning services into the Coxs Creek catchment.

Structural measures

It was identified during community consultation that there was little appetite for large scale structural flood mitigation around Boggabri. Investigations into structural measures therefore focussed on road safety initiatives and house raising/voluntary purchase schemes to reduce damage, hazard and disruption from Namoi River and Coxs Creek flooding. This FRMSP found that low-cost non-static signage was the preferred option to discourage drivers entering floodwaters when trying to get commute to Boggabri from the east. This FRMSP found that voluntary purchase of the most flood-prone property in the study area has a benefit cost ratio of greater than 1. The benefit cost ratio of other properties that are potentially eligible for voluntary purchase, and any voluntary house raising scheme, is unlikely to exceed 0.5 and hence Council would be unlikely to secure funding for these structural mitigation measures. Further assessment and consultation with the local community is recommended for all proposed structural mitigation measures.

Non-structural (planning) measures

Boggabri's flood risk zones were defined based on an assessment of the hazard, consequence and frequency of flooding. To manage the future flood problem, changes to existing land use mapping and building and development controls have been recommended based on the flood risk defined in this FRMSP. These risk based recommendations are consistent with recommendations made for other communities (Narrabri) in Narrabri Shire

- For low flood risk areas (which covers most of the residential areas of Boggabri), new development would need to ensure that residential building floor levels are above the flood planning level (defined as the 0.5% AEP flood level) and commercial building floor levels are above the 1% AEP flood level. Flood impact assessments would be required for significant filling. Minor extensions to dwellings could not be lower than the existing dwelling floor level.
- For medium flood risk areas, a range of measures are proposed including the prohibition of land-use intensification and development that requires assisted evacuation. All new habitable residential buildings, and extensions of existing habitable residential buildings would be required to prepare a flood evacuation plan.
- For high flood risk (floodway) areas, any new development or extensions would be prohibited.

FLOODPLAIN RISK MANAGEMENT PLAN OUTCOMES

The proposed outcomes of this floodplain risk management study (i.e., the draft Boggabri Floodplain Risk Management Plan) are documented in the following table.

Measure	Recommendation	Priority	Responsibility	Costing
Flood education plan	<ul style="list-style-type: none"> • Develop and implement an ongoing flood education plan. • Display the flood study and floodplain risk management study and draft plan on Council's website and in hardcopy in Boggabri library. 	High	Council/SES	Low



Measure	Recommendation	Priority	Responsibility	Costing
Road safety upgrades	<ul style="list-style-type: none"> Investigate locations and options for additional signage on commonly flooded road sections. 	High	Council	Low-Medium
Voluntary purchase scheme	<ul style="list-style-type: none"> Consult with properties currently identified for voluntary purchase. 	High	Council	Medium-High
Flood warning	<ul style="list-style-type: none"> Converse with BOM about establishing moderate and major flood levels and altering the minor flood level for Boggabri as part of their Namoi and Peel River Valley flood warning system. Converse with BOM about establishing flood forecasting and warning services for Coxs Creek. 	High	Council/SES/BOM	Low
Building floor levels and flood levels	<ul style="list-style-type: none"> Enable access to building floor level information (where available) and flood level information upon request. 	High	Council	Low
Building and development controls	<ul style="list-style-type: none"> Incorporate flood risk map into the Development Control Plans (DCP). Consider proposed flood risk measures in DCP updates. 	Medium	Council	Low
Narrabri Shire Flood Emergency Sub Plan	<ul style="list-style-type: none"> Review and update the Narrabri Shire Flood Emergency Sub Plan to incorporate the latest information on flood risks to properties and include additional information on road inundation and flood warning. Update references to evacuation centres and update suitable helicopter landing points to include at least one location that will be available in a very rare or extreme flood event. Communicate the updates and content of the plan to the community. 	Medium	SES	Low
Boggabri helipad	<ul style="list-style-type: none"> Consider potential locations for construction of a helipad. Investigate funding sources for construction/upgrade of a helipad. 	Medium	LEMC	Medium-High
Land use zoning	<ul style="list-style-type: none"> Consider rezoning parts of vacant lots zoned RE1 or RE2 that are partly covered by proposed floodways. 	Low	Council	Low
Voluntary house raising scheme	<ul style="list-style-type: none"> Benefit cost ratio unlikely sufficient to access funding. Do not progress. 	Do not progress	N/A	N/A



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1 INTRODUCTION

1.1 OVERVIEW

WRM Water & Environment Pty Ltd (WRM) was commissioned by Narrabri Shire Council (NSC) to undertake the Boggabri Floodplain Risk Management Study and Plan (FRMSP). The FRMSP has been prepared following modelling conducted for the Boggabri Flood Study (WRM, 2021) and is the first FRMSP dedicated to Boggabri and surrounds.

Figure 1.1 shows the extent of the study area covering the township of Boggabri and surrounds. The key drainage features within the study area are also shown. The main drainage features are the Namoi River, which drains east of the urban area of Boggabri, and Coxs Creek, a tributary of the Namoi River, which drains south of the urban area of Boggabri.

Historically, the urban areas of Boggabri have rarely experienced above floor flooding, with the largest floods occurring in 1955 and 1908. The most recent floods in November 2021 and October 2022 were moderate events that had little impact on urban areas of Boggabri.

1.2 STUDY PROCESS

The floodplain risk management study and plan has been undertaken in two reports:

- **the Boggabri Flood Study** collected flood related data for the study area and developed computer based hydrological and hydraulic models to define the flood flows, levels, depths and extents across the floodplain for a range of small and large events. The potential impact on peak flood levels due to climate change was also assessed.
- **the Boggabri Floodplain Risk Management Study and Draft Plan** (this report) reviews the existing flood risks confronting the study area and re-evaluates the potential floodplain risk management and mitigation options that are available to reduce the future flood risk. The mitigation and management measures consider the environmental, social, economic, planning and emergency management issues and constraints within the study area. Recommendations are also made to reduce the flood hazard and risk to people and property in the existing community and to ensure future development is controlled in a manner consistent with the flood hazard and risk.

This study has been undertaken in accordance with the New South Wales (NSW) Government's Floodplain Development Manual (the Manual), which supports the NSW Government's Flood Prone Land Policy. The Manual recognises three separate flood problems: the existing problem, the future problem and the continuing problem:

- The **existing problem** refers to existing properties that are liable to flooding and flood damage.
- The **future problem** refers to those properties, which upon development or redevelopment, become flood-labile and susceptible to significantly higher levels of flood damage.
- The **continuing problem** refers to the risk of flooding and flood damage that remains when all adopted floodplain management measures have been implemented. The continuing flood risk and associated damage can only be eliminated by designing for the probable maximum flood (PMF) event. In general, design for the PMF event is either economically or practically infeasible.

Different flood management options were assessed in this study for each flood problem.

- **Structural measures**, such as house raising were investigated to reduce damage, hazard and disruption associated with the existing problem.



- **Planning measures**, such as zoning and building controls (e.g., minimum floor levels) were reviewed to reduce damage, hazard and disruption associated with the future problem.
- **Community response measures**, such as flood warning, community education, evacuation and recovery, were reviewed to reduce damage, hazard and disruption associated with the residual problem.

1.3 REPORT STRUCTURE

The report is structured as follows:

- Section 2 provides background information on the existing land use and the environmental and social characteristics of the study area. A description of the previous floodplain management studies that have been undertaken in Boggabri is also provided;
- Section 3 describes the flood behaviour across the study area and provides flood hazard, flood function and flood risk mapping;
- Section 4 describes the community consultation undertaken throughout the project;
- Section 5 presents the emergency response planning community classifications and provides additional information on flood warnings and evacuation routes to manage the residual flood risk in Boggabri;
- Section 6 outlines and assesses a range of structural flood management options to mitigate the existing flood risk in Boggabri;
- Section 7 outlines and assesses a range of non-structural flood management options to mitigate the future flood risk and manage the residual flood risk in Boggabri;
- Section 8 presents the conclusions and summarises the recommendations of the study;
- Section 9 is a list of references;
- Section 10 is a glossary of technical terms used in this report;
- Appendix A shows property inundation mapping for the 20% annual exceedance probability (AEP), 10% AEP, 5% AEP, 2% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and probable maximum flood design flood events; and
- Appendix B shows emergency response planning community mapping.

Attachment 1: confidential attachment for NSC only, not for public release.

- Appendix C lists and maps the properties identified for voluntary purchase under a potential voluntary purchase policy; and
- Appendix D lists and maps the properties identified for house raising under a potential house raising policy.

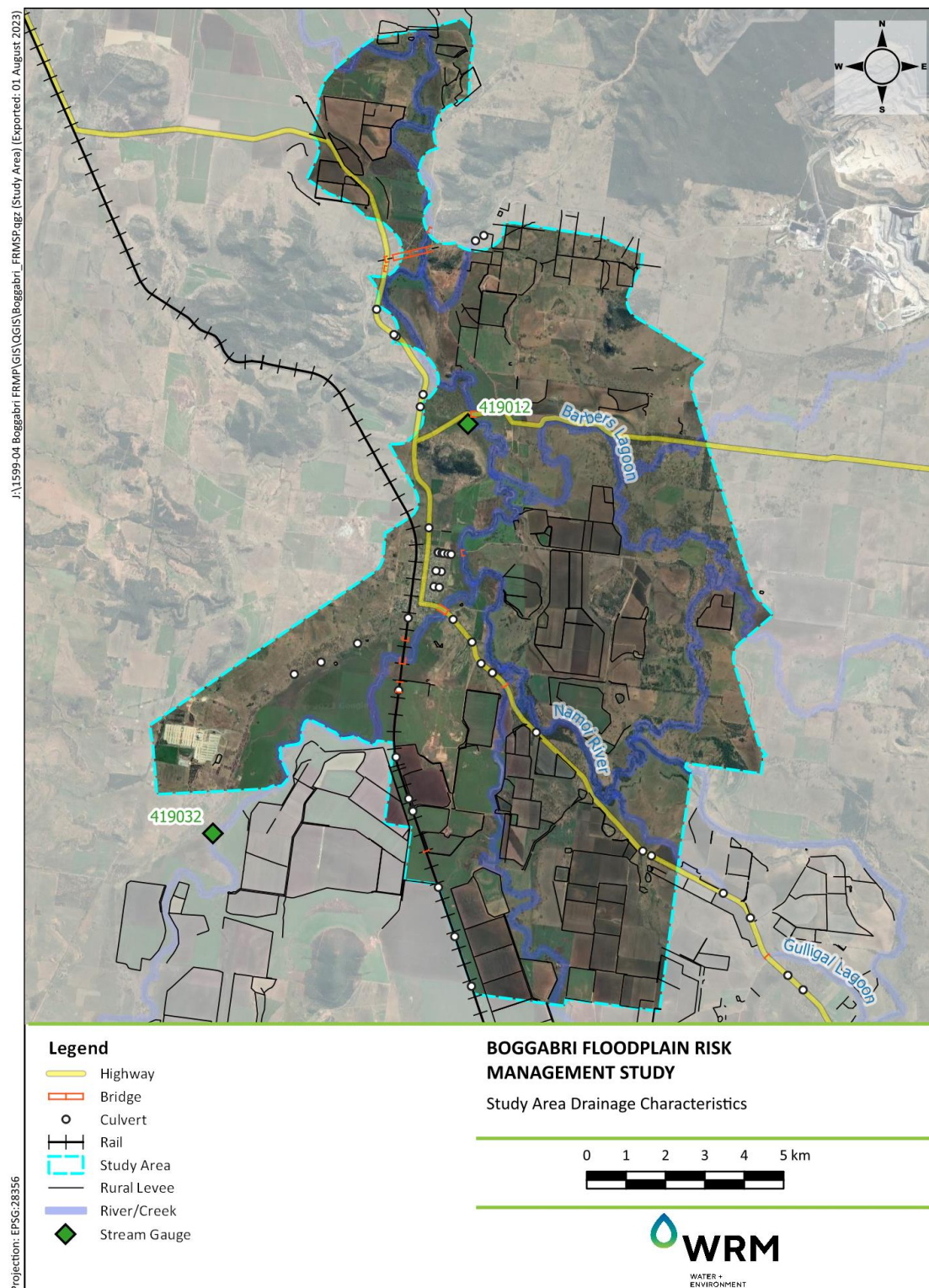


Figure 1.1 Study area



2 BACKGROUND

2.1 STUDY AREA DRAINAGE

The Boggabri floodplain risk management study area (shown in Figure 1.1) is based on the Boggabri hydraulic model extent from the Boggabri Flood Study (WRM, 2021), but excludes:

- any area outside (south) of Narrabri Shire Council boundary;
- any area within 500 m of the edge of the hydraulic model; and
- a section of upper Coxs Creek where topographic data accuracy is not to sufficient standard (refer WRM, 2021).

The main drainage features in the study area are the Namoi River and Coxs Creek, a tributary of the Namoi River, both of which drain past Boggabri (see Figure 1.1).

The Namoi River has a catchment area of 18,500 km² upstream of Boggabri (excluding Coxs Creek). Major tributaries of the Namoi River upstream of Boggabri include the Macdonald River, Manilla River, Peel River, Mooki River and Coxs Creek. There are three major reservoirs upstream of Boggabri, Chaffey Dam on the Peel River, Split Rock Dam on the Manilla River and Keepit Dam on the Namoi River.

The Namoi River overflows into several flood channels between Gunnedah and Boggabri. Deadmans Gully breaks out of the Namoi River channel about 10 km downstream of Gunnedah and drains back into the Namoi River about 3 km upstream of Boggabri. The Namoi River overflows into Gulligal Lagoon about 16 km upstream of Boggabri and drains back into the Namoi River about 6 km upstream of Boggabri. Barbers Lagoon breaks out of the Namoi River channel about 6 km upstream of Boggabri and drains back into the Namoi River between 3 km and 7 km downstream of Boggabri.

The Coxs Creek catchment to Boggabri covers approximately 3,878 km². The lower Coxs Creek catchment from Mullaley to Boggabri is very flat with slopes of around 0.1% along the extensively cropped floodplain.

Past Boggabri, the Namoi River channel is approximately 6 m to 8 m deep and about 50 m to 70 m wide, while Coxs Creek at Boggabri is approximately 4 m to 6 m deep and about 80 m to 120 m wide. Coxs Creek and the Namoi River join immediately east of Brent Street in Boggabri.

2.2 LAND USE

Figure 2.1 shows the land use zones within the study area identified in the local environment plan (LEP) (note Figure 2.1 does not show the entire study area, however the land use over the remainder of the study area is entirely zoned RU1, RU4 or R5). The existing urban areas of Boggabri are generally zoned for general residential (R1), local centre (B2), mixed use (B4), light industrial (IN2), infrastructure (SP2), public recreation (RE1) or private recreation (RE2). On the fringe of the urban areas are areas of large lot residential (R5) and general industrial (IN1). The bulk of the remaining land around Boggabri is zoned for primary production (RU1) or rural small holdings (RU4).

2.3 ENVIRONMENT

The Boggabri region partially overlies the Great Artesian Basin (Molino Stewart, 2016). Seasonal and semi-permanent wetlands occur along the Namoi watercourse, though little wetland storage is present immediately around Boggabri.

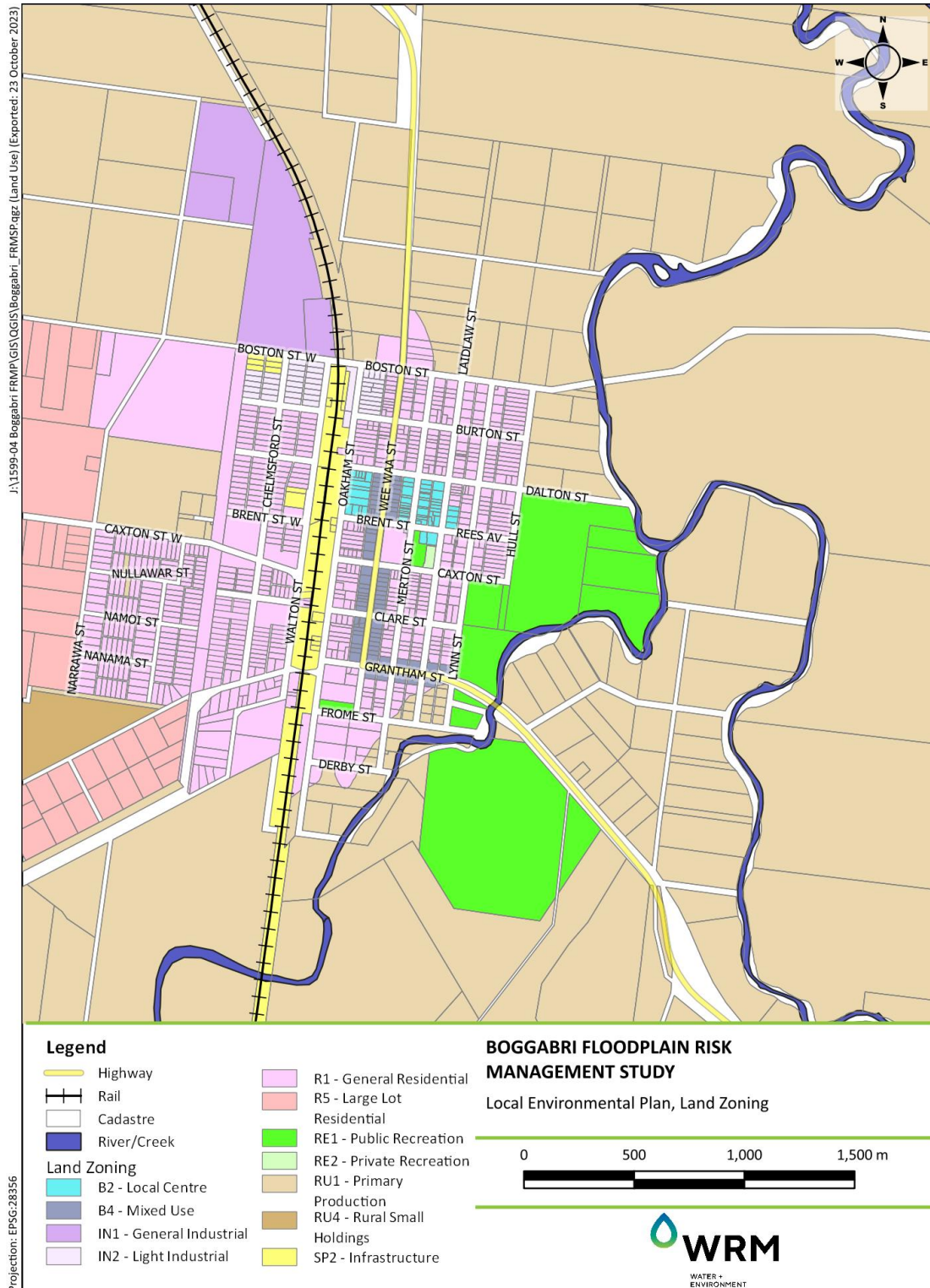


Figure 2.1 Boggabri local environment plan land use zones



There are 154 listed threatened species, endangered ecological communities and endangered populations within NSC boundaries (Molino Stewart, 2016). There are several threatened woodland species that have been identified as endangered and may be located within the study area including the White Box, Yellow Box, Blakely's Red Gum Grassy Woodland, Fuzzy Box Woodland, Myall Woodland, Brigalow and Inland Grey Box Woodland (NSW DPE, 2023).

2.4 SOCIAL CHARACTERISTICS

The population of the Narrabri local government area (LGA) (in which Boggabri is located) has remained steady since 2001, varying only slightly between the 2001 census (13,800) and the 2021 census (12,703) (ABS, 2021). The 2021 census records a population of 885 in the township of Boggabri, living in 488 private dwellings. There were 67 unoccupied private dwellings. Approximately 25% of the population were aged over 65 (which is significantly higher than the state and national averages), while 18% of the population are children below 14. This suggests that the community may be more vulnerable to the impacts of flooding and may require additional assistance during flood evacuations. The population overwhelmingly speak English.

The region's economy is based on traditional agricultural industries such as cereal grains, cotton, livestock and oilseeds (Namoi CMA, 2013). Mining and extractive industries as well as supermarket, health and cotton ginning workers are also strongly represented (ABS, 2021).

2.5 PREVIOUS FOOD MITIGATION AND FLOODPLAIN RISK MANAGEMENT STUDIES AND PLANS

2.5.1 Namoi Valley Flood Mitigation Study (Laurie, Montgomerie & Pettit, 1980)

The study by Laurie, Montgomerie and Pettit described wide scale flooding along the Namoi River. Gauges and roads around Boggabri are mentioned in the study (in the context of how they provide warning to/transport to Narrabri), however flooding at Boggabri is not explicitly discussed.

2.5.2 New South Wales Inland Rivers Floodplain Management Studies: Summary Report – Namoi Valley (Laurie, Montgomerie & Pettit, 1982)

The Namoi Valley Floodplain Management Study summarised proposed flood mitigation options at several locations throughout inland New South Wales, including Boggabri. For Boggabri this study noted that there was “only minor flood problems in the town” and “by directing future growth towards higher ground away from the river should ensure that the flood problem remains minor”. The study also noted “Council’s planning scheme, when developed, should desirably provide zonings which negate, or severely limit building in areas within the 1955 flood limit, or within such other limits as the WRC’s current study might indicate as desirable”.

2.5.3 Upper Coxs Creek Floodplain Management Plan (NSW DNR, 2005)

This report was prepared to assess the community-owned strategies to manage flood risk and flood management issues and support the natural function of the floodplain environment. It is concerned with the floodplain of Coxs Creek between Bundella and Mullaley and provides a framework for improving the drainage of the floodplain system, as well as resolving land use management issues. This FMP has since been superseded.



2.5.4 Carroll to Boggabri Floodplain Management Plan (NSW DNR, 2006)

The Carroll to Boggabri Floodplain Management Plan (FMP) was prepared to “mitigate flooding, manage development to ensure the functions of the floodplain are sustainable in all aspects” (NSW DNR, 2006). The Carroll to Boggabri FMP defined floodways, riparian zones and wetlands along the Namoi River floodplain. The FMP does not prohibit structural works within the defined floodways, however it does note that they are unlikely to be approved. The FMP set out the criteria under which earthworks on the floodplain are assessed, namely socio-economic, ecological and flooding behaviour criteria. For flooding behaviour, natural flooding characteristics, hydraulic capacity, pondage and flow duration, flow redistribution and velocities are all considered. Unacceptable impacts of non-complying works on the floodplain are:

- *More than 10% cumulative and 5% individual increase of flows onto other landholders property (for the design flood);*
- *An increase in flood level of more than 100 mm on other landholders property;*
- *More than a negligible (10 mm) increase in flood level on any house dwelling; and*
- *More than 50% increase for velocities up to 0.5 m/s.*

This FMP has since been superseded.

2.5.5 Lower Coxs Creek Floodplain Management Plan (NSW OEH, 2013)

This report was prepared to assess the community-owned strategies to manage flood risk and flood management issues and support the natural function of the floodplain environment. It is concerned with the floodplain of Coxs Creek between Mullaley and Boggabri and provides a framework for improving the drainage of the floodplain system, as well as resolving land use management issues. Unacceptable limits of non-complying works on the floodplain are listed as:

- *The redistribution of flow is limited to 2.5% increase for an individual property, and a total of 5% cumulative for flowpath.*
- *Velocities within flood flowpaths are limited to a 50% increase from pre-developed velocities.*
- *The change in water level at a neighbour’s boundary to be a maximum of 0.2 m compared to the pre-development flood level.*

This FMP has since been superseded.

2.5.6 Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019 (NSW Government, 2019)

This FMP is a legal instrument under the Water Management Act 2000. This FMP supersedes the FMPs documents in the preceding sections. The Upper Namoi Valley Floodplain FMP splits the floodplain into seven distinct zones, each with specific rules and assessment criteria. The FMP also maps existing flood works, many of which are situated upstream of Boggabri.



3 FLOOD BEHAVIOUR

3.1 OVERVIEW

The principal objective of the Boggabri Flood Study (WRM, 2021) was to define the existing flood behaviour across the study area. For these studies, a two-dimensional hydraulic model was developed to define the flood levels, depths, extents and flows across the study area for a range of frequent to extreme flood events. The model was calibrated to the 1955, 1971, 1997, 1998 and 2000 flood events.

This chapter describes the flood behaviour across the study area based on the results of these studies, including an assessment of:

- the probability of flooding;
- flow conveyance and storage functions of the floodplain; and
- the variation in, and the drivers and degree of, flood hazard and flood risk within the floodplain.

3.2 FLOOD DESCRIPTION

The results of the flood modelling presented in the flood study (WRM, 2021) are summarised below.

- **20% AEP design flood** - flooding around Boggabri would be mainly contained within the defined watercourse channels, with major flood runners activated. Some inundation would be expected around Derby Street and Frome Street, while one house on Grantham Street South would be surrounded by floodwater and a further three would have the road east and west of them inundated. The Kamilaroi Highway would be overtopped approximately 4 km southeast of Coxs Creek bridge, and Braymont Road would be overtopped immediately east of the bridge;
- **10% AEP design flood** – Derby Street, Frome Street and Caxton Street would experience some inundation. More flood runners between the Kamilaroi Highway and Grantham Street South would be inundated;
- **5% AEP design flood** - extensive out-of-bank areas would be inundated. Lynn Street would begin to experience inundation. The Kamilaroi Highway would be overtopped at many locations southeast of Boggabri. Almost the entire reach of Braymont Road through to the intersection with Barbers Lagoon Road would be overtopped;
- **2% AEP design flood** – overtopping of the Kamilaroi Highway would be almost continuous from the eastern side of the Coxs Creek bridge. All buildings between the Kamilaroi Highway and Grantham Street South would be surrounded by inundation. Inundation would be experienced over Lynn Street, Hull Street, Boston Street and the southernmost end of Oakham Street. Buildings in the southeastern and northeastern sections of Boggabri would begin to be surrounded by shallow inundation;
- **1% AEP design flood** – flood extents would exceed the 1955 flood, with the eastern part of Boggabri experiencing inundation;
- **0.5% and 0.2% AEP design floods** - the inundation would progressively extend west into the eastern and northeastern part of town; and
- **probable maximum flood** – this event represents the extent of Namoi Valley flood liable land with almost the entire extent of urban development in Boggabri east of the rail line experiencing inundation.



For most of the urban areas of Boggabri, flooding will only have a direct impact in a rare flood event. However, frequent flood events will impact on the road network and the area between the Kamilaroi Highway and Grantham Street South is particularly prone to inundation. Inundation around Boggabri can occur due to overtopping of the Namoi River, Coxs Creek, or both.

The results of the Boggabri Flood Study (WRM, 2021) were released to the community in December 2020. No community submissions were made in response to the flood study. NSC adopted the flood study (WRM, 2021) at its meeting on Tuesday, 23 February 2021.

3.3 ASSESSMENT OF CLIMATE CHANGE

3.3.1 Previous assessment

The assessment of the impact of climate change on flooding at Boggabri was documented in the Boggabri Flood Study (WRM, 2021). The former NSW Office of Environment and Heritage (2019) authored a guideline for incorporating the latest version of Australian Rainfall and Runoff (AR&R) into NSW floodplain risk management studies. For consideration of climate change the guideline specifies:

“Rather than simulating additional scenarios specifically to consider climate change, the scale of climate change impacts can generally be practically assessed using the 0.5% and 0.2% AEP floods as proxies for the 1% AEP flood, subject to long-term changes in flood-producing rainfall events related to climate change.”

In line with the above, the 0.5% AEP flood mapping was adopted to show the likely impact of climate change on the 1% AEP event.

3.3.2 Further assessment

The hydrologic model developed in the Boggabri Flood Study was used to further assess the potential impact of climate change at Boggabri. The 2090 planning horizon has representative concentration pathway (RCP) 4.5 (low), RCP6.0 (mid) and RCP8.5 (high) projected changes in rainfall intensity for the Central Slopes region of +10.8%, +13.1% and +22.8% respectively (Geoscience Australia, 2019). Increasing the 1% AEP rainfall intensity for the critical duration Coxs Creek storm by +13.1% (mid concentration) resulted in the peak flow at the Coxs Creek gauge increasing from 2,303 m³/s to 2,754 m³/s. For comparison the critical duration 0.2% AEP peak discharge at the Coxs Creek gauge was estimated at 3,480 m³/s. Hence the adoption of the 0.5% AEP flood mapping as being representative of the impact of climate change on the 1% AEP event appears to have been quite conservative.

3.4 HYDRAULIC HAZARD

The Boggabri Flood Study (WRM, 2021) defined provisional hydraulic hazard categories across the study area for the full range of design flood events. The provisional hydraulic hazard categories were calculated using the hydraulic model results, defined by the depth, depth-velocity product and the velocity of floodwaters, in accordance with Figure L2 of the Manual (NSW Government, 2005).

The Australian Disaster Resilience Guideline 7-3 Flood Hazard (AIDR, 2017) recommends grouping the floodplain into six hazard categories using flood depth, flood velocity and the depth-velocity product in accordance with Figure 3.1. This figure resembles Figure L1 in the Manual (NSW Government, 2005) but further delineates the floodplain based on recent research undertaken on the trafficability of vehicles and the safety of people during flood events.

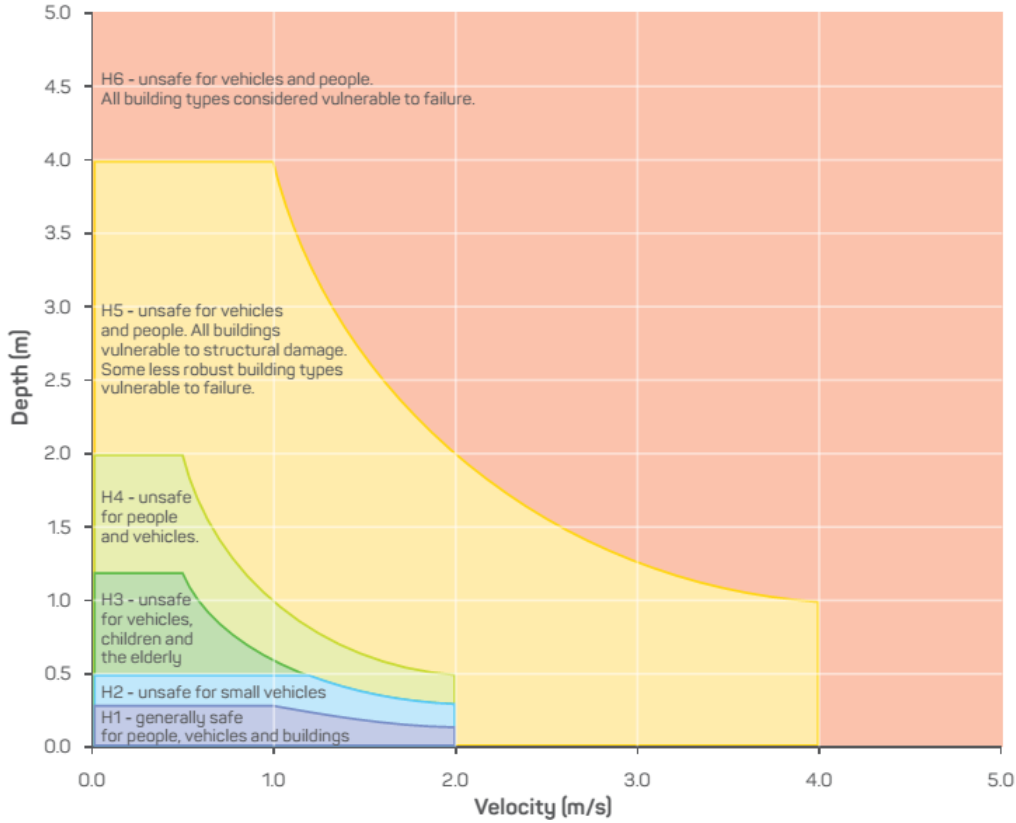


Figure 3.1 Flood hazard vulnerability curve (source: AIDR, 2017)

Figure 3.2 shows the hydraulic hazard in Boggabri for the 1% AEP design flood, using the flood hazard vulnerability curve shown above (AIDR, 2017).

For the 1% AEP design flood event, the H6 (most hazardous) areas are generally confined to the waterway corridors of Coxs Creek and the Namoi River. The H5 areas include many of the flood runner channels, as well as significant additional area along the H6 waterway corridors. According to the flood hazard vulnerability curve in Figure 3.1, H5 and H6 hazard categories define areas where structures become vulnerable to failure. Boggabri has four buildings within these hazard zones for the 1% AEP design flood.

The H4 and H3 hydraulic hazard areas for the 1% AEP design event cover the northeastern and southeastern fringe of urban Boggabri. According to the flood hazard vulnerability curve in Figure 3.1, hazards H3 and above are unsafe for children and the elderly, and H4 and above are unsafe for all people.

Small scale evacuation would be required for a 1% AEP design flood event in Boggabri, as 31 buildings in Boggabri are covered by hydraulic hazard areas H3 to H6. Hydraulic hazard mapping for other design flood events was provided in the Boggabri Flood Study (WRM, 2021). Table 3.1 details the number of existing buildings within each hydraulic hazard zone for each modelled design flood event.



Table 3.1 Existing building count in each hydraulic hazard zone

Flood event	Number of buildings per hydraulic hazard zone*					
	H1	H2	H3	H4	H5	H6
20% AEP	0	0	0	0	0	0
10% AEP	1	0	1	0	0	0
5% AEP	2	5	2	0	0	0
2% AEP	19	5	10	3	0	0
1% AEP	39	14	23	4	4	0
0.5% AEP	20	26	60	24	12	0
0.2% AEP	15	19	40	78	51	3
PMF	4	4	3	8	49	418

* number of buildings is the count of buildings in each zone, it does not indicate buildings subject to above floor level flooding (refer Section 3.8 for counts of flooded buildings)

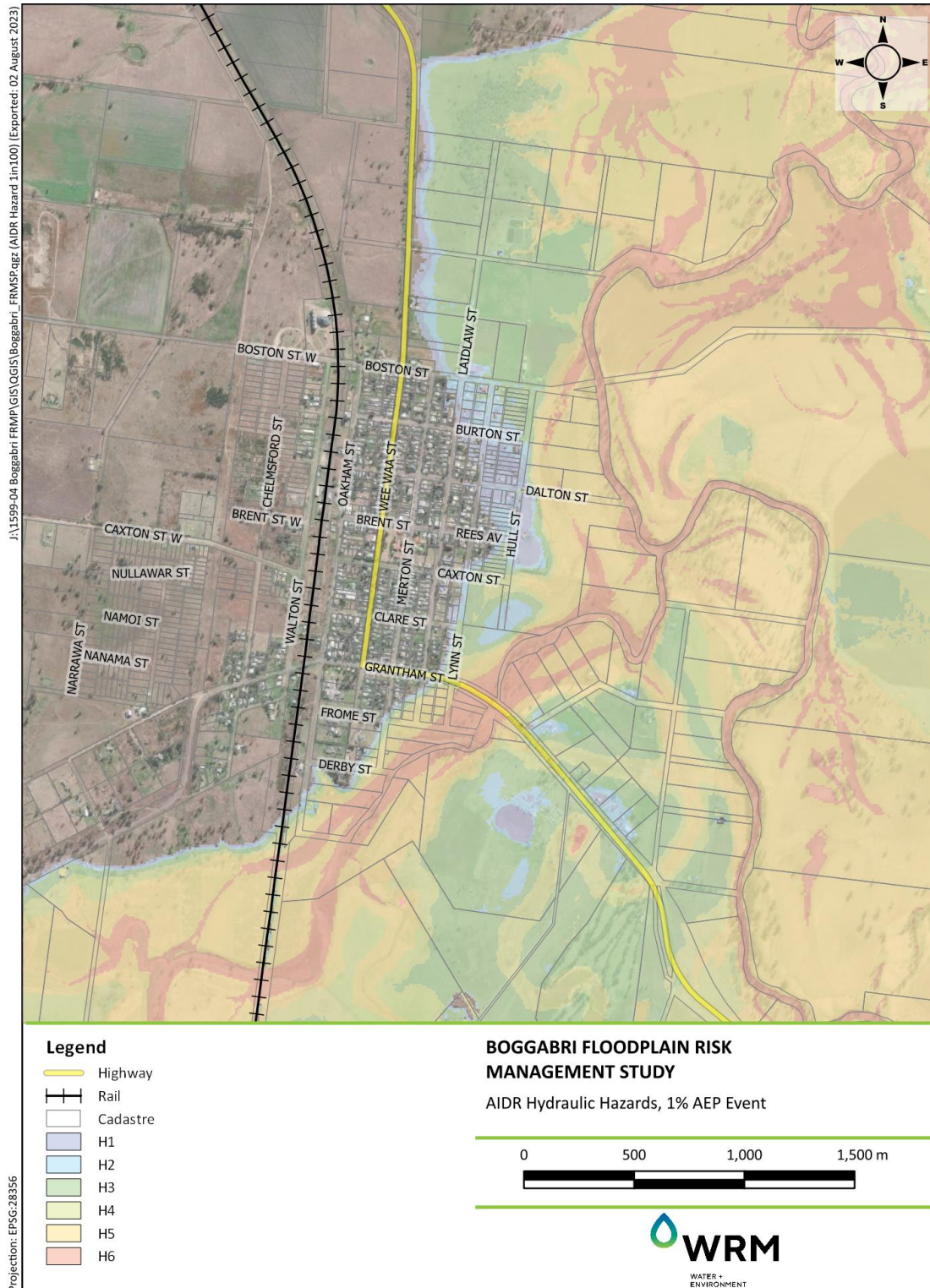


Figure 3.2 Australian Institute for Disaster Resilience hydraulic hazard (AIDR, 2017), 1% AEP design flood



3.5 FLOOD PLANNING AREA

Section 5.21 of the Narrabri LEP (NSC, 2012) outlines flood planning provisions for managing development on the floodplain within Narrabri Shire. The flood planning clauses in the LEP apply to land within the flood planning area, which in the LEP is taken to have the same meaning as defined in NSW Floodplain Development Manual (NSW Government, 2005).

Definitions in the Manual (NSW Government, 2005)

flood planning area – the area of land below the FPL and thus subject to flood related controls

flood planning levels (FPLs) – are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans

The 1% AEP event is the design event upon which flood planning levels are typically set, however there is some flexibility in the selection of flood size to reflect local flood circumstances. A freeboard is then added to this event to account for various uncertainties, such as (NSW Government, 2005):

- uncertainties in modelling;
- localised water level differences;
- wave action;
- climate change; and
- cumulative effects of future developments.

A freeboard of 0.3 m to 0.5 m is typical to account for the above uncertainties. As the 0.5% AEP design event is approximately 0.5 m higher than the 1% AEP design event throughout the Namoi River and Coxs Creek, the 0.5% AEP event was adopted as the flood planning level. The extent of land parcels at or below the 0.5% AEP event (i.e., the flood planning area) is shown in Figure 3.3.

The possible effect of climate change on flooding in Boggabri, considered in Section 3.3, showed that climate change will likely increase 1% AEP flood levels around Boggabri. The 2090 RCP6.0 (mid) rainfall intensity increase resulted in a 20% increase in peak flow at the Coxs Creek gauge. The 0.5% AEP event resulted in a 51% increase in peak flow at the Coxs Creek gauge. This validates the adoption of the 0.5% AEP event as the flood planning level as the possible impact of climate change is less than the increase from 1% AEP to 0.5% AEP leaving additional freeboard for the other uncertainties listed above.

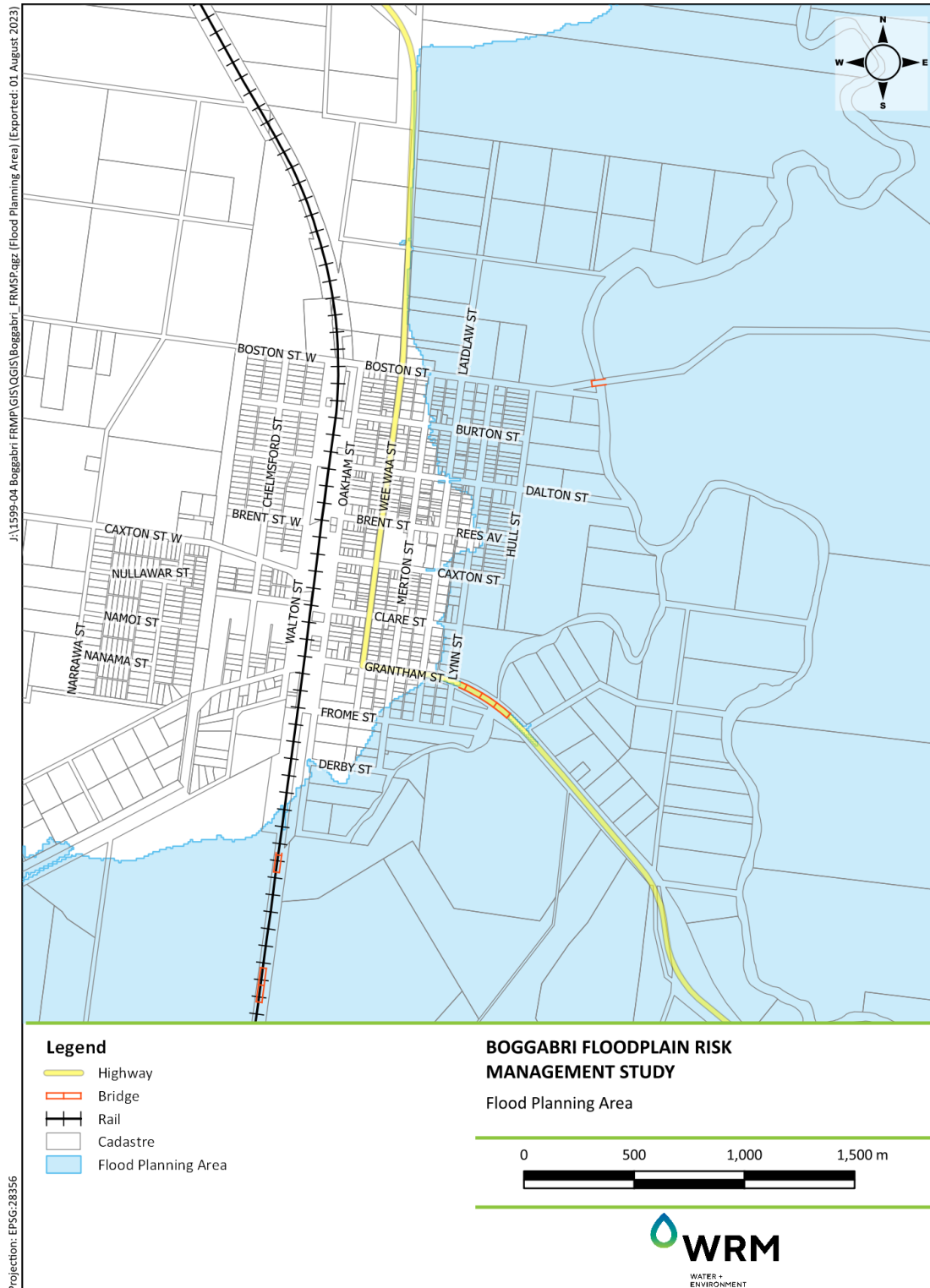


Figure 3.3 Flood planning area



3.6 HYDRAULIC CATEGORIES / FLOOD FUNCTION

3.6.1 Background

The Manual (NSW Government, 2005) defines three hydraulic categories (flood function) of flood prone land:

- **Floodways** are those areas where a significant volume of water flows during floods and are often aligned with obvious natural channels. They are areas that, even if only partially blocked, would cause a significant increase in flood levels and/or a significant redistribution of flood flow, which may in turn adversely affect other areas. They are often, but not necessarily, areas with deeper flow or areas where higher velocities occur.
- **Flood storage areas** are those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. If the capacity of a flood storage area is substantially reduced by, for example, the construction of levees or by landfill, flood levels in nearby areas may rise and the peak discharge downstream may be increased. Substantial reduction of the capacity of a flood storage area can also cause a significant redistribution of flood flows.
- **Flood fringe** is the remaining area of land affected by flooding, after floodway and flood storage areas have been defined. Development in flood fringe areas would not have any significant effect on the pattern of flood flows.

No previous definition of hydraulic categories (flood function) has been conducted explicitly for Boggabri. The Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019 (NSW Government, 2019) has however defined floodways for the Upper Namoi Valley, including the floodplain past Boggabri.

3.6.2 Floodways

Based on the floodway definition provided in the previous section, the following methodology was used to delineate floodways within the study area:

1. An indicator technique was used to determine indicative areas of conveyance. High flood risk areas (refer section 3.7) were delineated and then adopted as the potential floodway indicator as these areas experience significant flow depth or velocity (i.e., are areas where significant conveyance likely occurs).
2. Each flowpath within the study area was examined across a variety of design flood events and the conveyance method (NSW DPE, 2022) was used to determine the extent of the flowpath that encompasses approximately 80% of the total conveyance. This extent was then used to modify (clip or extend) the indicator areas delineated in step 1.
3. The provisional floodways from steps 1-2 were compared to floodways defined in the Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019 (NSW Government, 2019) and minor modifications were made to ensure some level of consistency between the studies.
4. Aerial imagery and topography was reviewed to ensure no channels had been missed in steps 1-3.
5. Small holes in the floodway polygon were filled, flowpaths were connected, isolated patches of high risk area were removed and other minor modifications were made to define a continuous floodway polygon.
6. Velocity mapping was reviewed and some trimming of low velocity areas was undertaken.



Figure 3.4 shows the resultant adopted floodways, compared to the floodways defined in the Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019 (NSW Government, 2019). The floodways defined in this study are generally wider, though this was not unexpected with the Upper Namoi Valley study relying on one-dimensional hydraulic modelling upstream of Boggabri (whereas this study utilised two-dimensional hydraulic modelling).

3.6.3 Flood storage areas

Based on the flood storage definition provided previously, the following methodology was used to delineate flood storage areas within the study area:

1. Flow hydrographs were reviewed. This review revealed attenuation as floods progress down the Namoi River valley (i.e. there is flood storage on the Namoi River floodplain).
2. Already defined floodway areas were not considered.
3. An indicator technique was used to determine indicative areas where a significant portion of flood volume may be stored. Flood storage volume is a function of flood depth, so depth was adopted as a potential flood storage indicator. Given that depth varies based on the event being analysed and the floodway areas often correspond to significant flow depths, the following depth indicators were adopted: any inundated non-floodway area for 20% AEP and 10% AEP events, depths greater than 0.3 m for the 5% AEP event, depths greater than 0.5 m for the 2% AEP and 1% AEP events, depths greater than 1.2 m for the 0.5% AEP event and depths greater than 2.0 m for the 0.2% AEP event.

Figure 3.5 shows the adopted flood storage areas.

3.6.4 Flood fringe areas

Flood fringe areas are the remainder of the floodplain extending from the edge of the flood storage area up to the PMF extent. Figure 3.5 shows the adopted flood fringe areas.

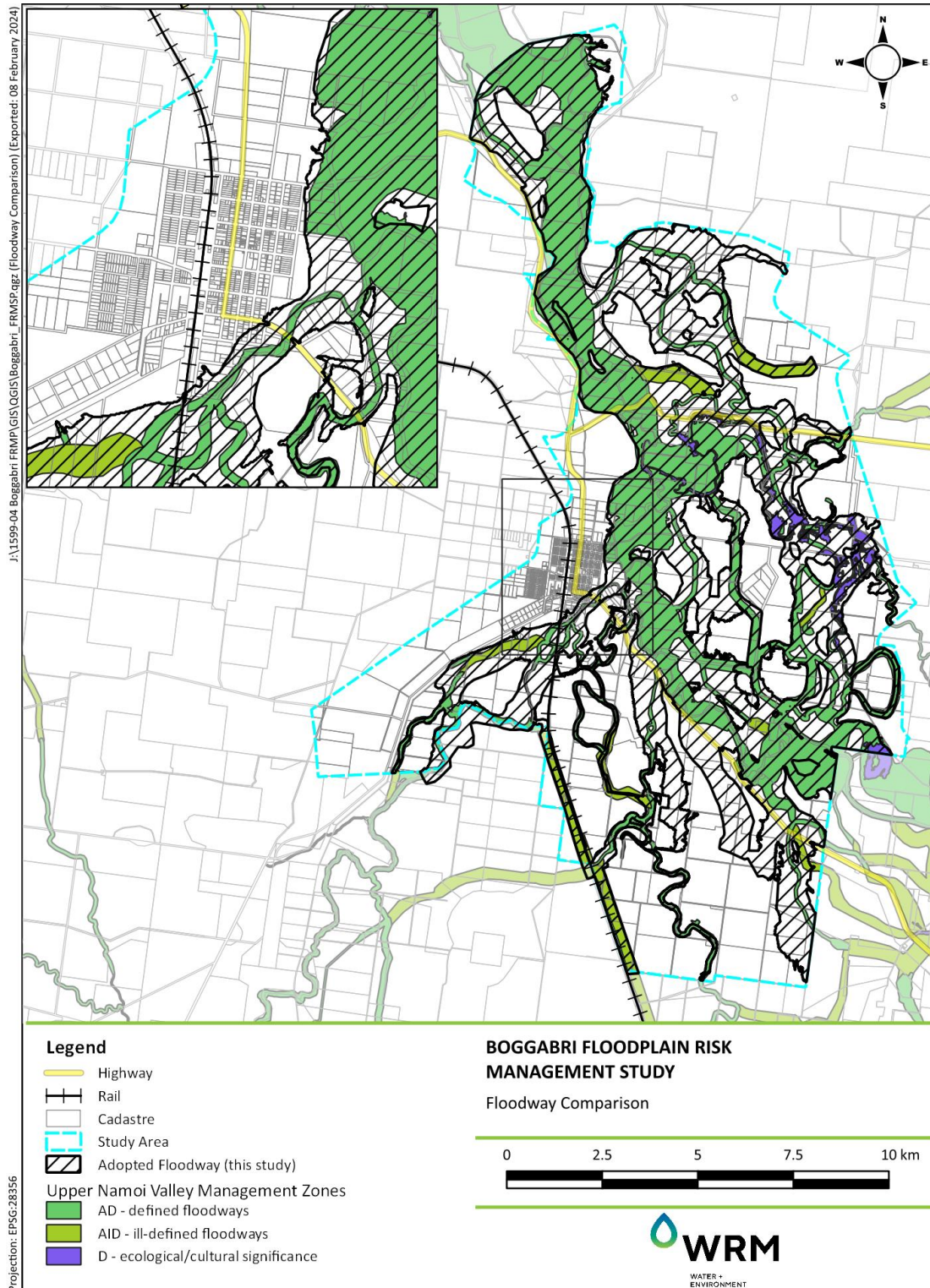


Figure 3.4 Floodway comparison map

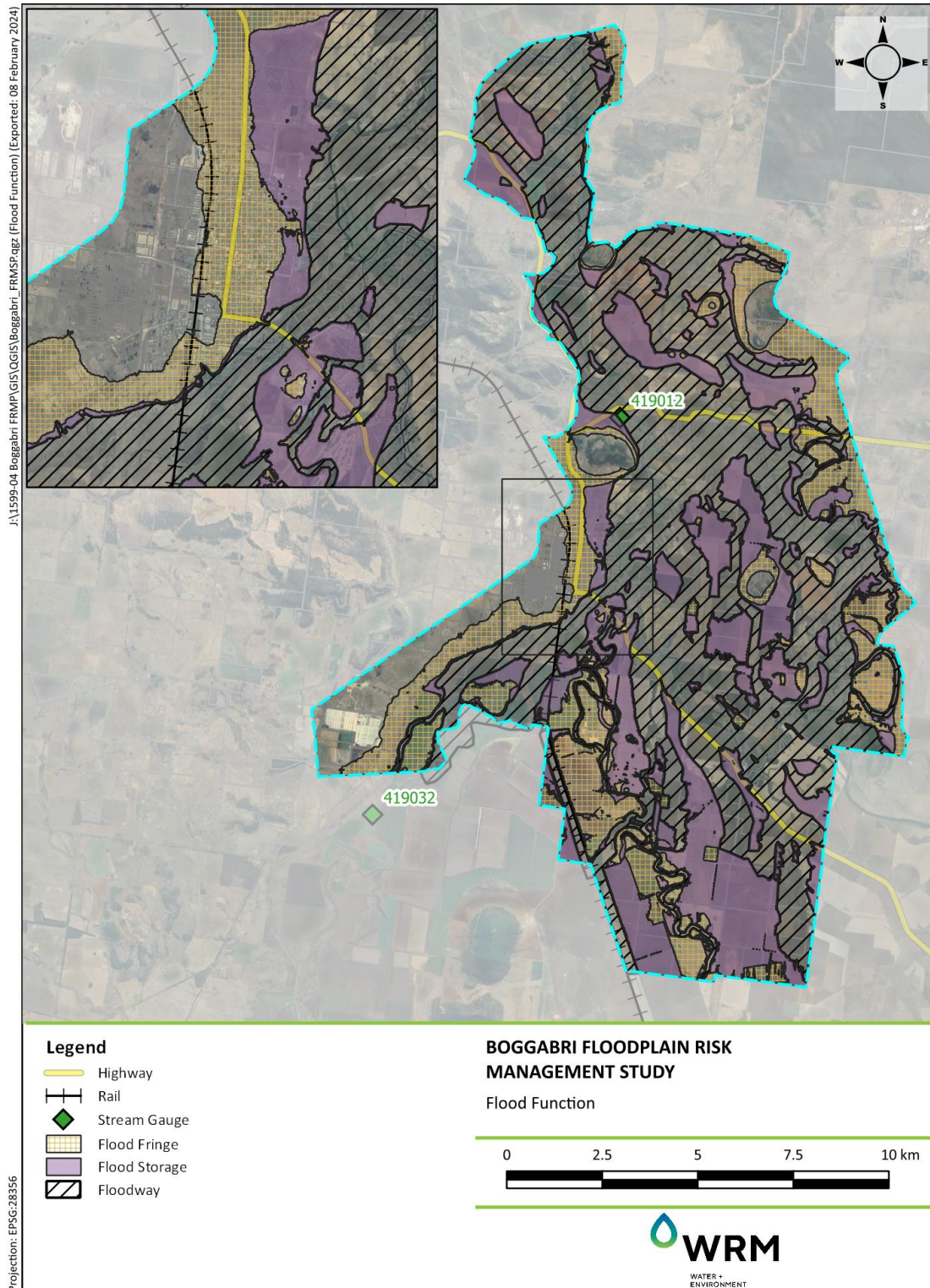


Figure 3.5 Flood function map



3.7 FLOOD RISK

3.7.1 Overview

The flood risk to a community is measured in terms of both the scale of consequence, and the likelihood of that consequence. Other factors that influence flood risk (i.e., factors that can influence the scale of consequence), includes:

- effective warning time;
- flood readiness;
- rate of rise of floodwaters;
- duration of flooding;
- evacuation problems;
- effective flood access;
- type of development; and
- demographic factors, including vulnerability and tolerability of the community.

Most areas across Boggabri (except for Boggabri West) have either a rising road access area or a low flood island emergency response classification (see Section 5.6). There is generally at least 24 hours flood warning available for the large, slow moving flood events from the Namoi River and the rate of rise of regional floodwaters is often relatively slow for all areas affected by Namoi River flooding. Coxs Creek flooding is from a smaller catchment area, hence there is less warning, however there are many gauges in the upper catchment to provide some warning of rising creek levels.

Long-term residents of Boggabri are generally 'flood aware' given the frequency of flooding throughout history, however the lack of a rare flood event in recent times may have led to a level of complacency in the community. The aforementioned factors do not necessarily alter the flood exposure, but do reduce the overall flood risk profile, by allowing time for the community to receive flood warnings and respond appropriately (e.g., through evacuation, moving house contents etc.).

3.7.2 Assessment of flood risk

The previous sections were concerned with the likelihood of flooding and the flood function. In this section the consequences of flooding have been assessed to produce a flood risk map that is independent of flood event magnitude (i.e., a single risk map rather than a hazard map for each design flood event). This map can then be used as a decision-making tool as it concisely demonstrates where flood risk management strategies are most needed.

The Australian Disaster Resilience Guideline 7-6 (AIDR, 2017) was used as a guide for assessing the flood risk across Boggabri. The guideline suggests the use of a qualitative risk matrix, an example of which is shown in Table 3.2, to define the level of flood consequence to the community and in particular people, economy, environment, public administration and social settings.

The AIDR hydraulic hazard classifications have been used to define the level of consequence to people, economy, public administration and social settings. The vulnerability of the community and assets in each hydraulic hazard zone is as follows (AIDR, 2017):

- Hydraulic hazard H1 – generally safe for people, vehicles and buildings;
- Hydraulic hazard H2 – unsafe for small vehicles;
- Hydraulic hazard H3 – unsafe for vehicles, children and the elderly;



- Hydraulic hazard H4 – unsafe for people and vehicles;
- Hydraulic hazard H5 – unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust building types vulnerable to failure; and
- Hydraulic hazard H6 – unsafe for vehicles and people. All building types considered vulnerable to failure.

Table 3.2 Example qualitative risk matrix (source: AIDR, 2017)

Likelihood of consequence	AEP range (%)	Level of consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likely	>10	Low	Medium	High	Extreme	Extreme
Unlikely	1 to 10	Low	Low	Medium	High	Extreme
Rare to very rare	0.01 to 1	Very low	Low	Medium	High	High
Extremely rare	<0.01	Very low	Very low	Low	Low	High

Risk: ■ Very low ■ Low ■ Medium ■ High ■ Extreme
 AEP = annual exceedance probability

The level of consequence to the environment cannot be assessed purely on hydraulic hazard but can be qualitatively assessed.

Table 3.3 provides an assessment of the consequences in each hydraulic hazard zone for each modelled design flood, including the number of existing buildings in each zone. Based on this information a risk rating has also been provided for each zone, which has then been used to define the flood risk matrix for Boggabri.

Table 3.3 Level of consequence in each hazard zone and adopted flood risk

Row No.	Design event	Hydraulic hazard	Number of buildings	Level of consequence	Adopted Risk
1	20% AEP	H1	0	Minor – hydraulic hazard is generally safe, but the frequent likelihood of inundation poses other threats (stress from repeated inundation etc.)	Medium
2		H2 & H3	0	Moderate – hydraulic hazard begins to become unsafe for certain people and the frequent likelihood of inundation poses other threats (stress from repeated inundation etc.)	High
3		H4 – H6	0	Major to Catastrophic – hydraulic hazard is unsafe for people and there is a frequent likelihood of inundation	Extreme
4	10% AEP	H1	1	Per row 1	Medium
5		H2 & H3	1	Per row 2	High



Row No.	Design event	Hydraulic hazard	Number of buildings	Level of consequence	Adopted Risk
6		H4 – H6	0	Per row 3	Extreme
7		H1	2	Minor – hydraulic hazard is generally safe	Low
8	5% AEP	H2 & H3	7	Moderate – hydraulic hazard begins to become unsafe for certain vehicles and people	Medium
9		H4	0	Major – hydraulic hazard is unsafe for people	High
10		H5 & H6	0	Major to Catastrophic – hydraulic hazard is unsafe for all vehicles and people	Extreme
11	2% AEP	H1 & H2	24	Minor to Moderate – hydraulic hazard begins to become unsafe for certain vehicles	Low
12		H3	10	Moderate – hydraulic hazard begins to become unsafe for certain people and all vehicles	Medium
13		H4 & H5	3	Major – hydraulic hazard is unsafe for people and structures	High
14		H6	0	Major to Catastrophic – hydraulic hazard is unsafe for all vehicles, people and buildings	Extreme
15	1% AEP	H1	39	Minor - hydraulic hazard is generally safe.	Very Low
16		H2	14	Moderate – hydraulic hazard begins to become unsafe for certain vehicles	Low
17		H3 & H4	27	Major – hydraulic hazard is unsafe for vehicles and either becoming unsafe or totally unsafe for people	Medium
18		H5	4	Major – hydraulic hazard is unsafe for people and vehicles and structures become vulnerable	High
19		H6	0	Per row 14	Extreme
20		H1 & H2	46	Minor - hydraulic hazard is generally safe. A significant proportion of the population is exposed	Very Low
21	0.5% AEP	H3	60	Moderate to Major – hydraulic hazard begins to become unsafe for vehicles and certain people. A significant proportion of the population is exposed	Low
22		H4	24	Major – hydraulic hazard is unsafe for people and vehicles	Medium
23		H5	12	Major – hydraulic hazard is unsafe for people and vehicles and structures become vulnerable	High
24		H6	0	Major to Catastrophic – hydraulic hazard is unsafe for all vehicles, people and buildings	Extreme
25	0.2% AEP	H1 – H3	74	Minor to Moderate - hydraulic hazard is beginning to become unsafe for some people. A significant proportion of the population is exposed	Very Low
26		H4	78	Moderate to Major – hydraulic hazard is unsafe for vehicles and people. A significant proportion of the population is exposed	Low



Row No.	Design event	Hydraulic hazard	Number of buildings	Level of consequence	Adopted Risk
27	PMF	H5	51	Major – hydraulic hazard is unsafe for people and vehicles and structures become vulnerable	Medium
28		H6	3	Major to Catastrophic – hydraulic hazard is unsafe for all vehicles, people and buildings	High
29		H1 – H3	11	Minor - hydraulic hazard is beginning to become unsafe for some population but for an extreme event	Very Low
30		H4	8	Moderate – hydraulic hazard is unsafe for vehicles and people but for an extreme event	Low
31		H5	49	Major – hydraulic hazard is unsafe for people and vehicles and structures become vulnerable but for an extreme event	Low*
32		H6	418	Catastrophic – hydraulic hazard is unsafe for all vehicles, people and buildings but for an extreme event	Low*

* While there are major or catastrophic consequences the available flood warning and the extreme rarity of the design event means the overall risk is low

3.7.3 Flood risk matrix

Table 3.4 provides the qualitative flood risk matrix for Boggabri, which in effect is a summary of the consequence assessment provided in Table 3.3. The matrix defines groups six zones of flood risk on the floodplain and simplifies this into three distinct regions:

- very low risk to low risk;
- medium risk; and
- high risk to extreme risk.

Table 3.4 Flood risk matrix

Design Flood	AIDR Hazard Category					
	H1	H2	H3	H4	H5	H6
20% AEP	Medium	High	High	Extreme	Extreme	Extreme
10% AEP	Medium	High	High	Extreme	Extreme	Extreme
5% AEP	Low	Medium	Medium	High	Extreme	Extreme
2% AEP	Low	Low	Medium	High	High	Extreme
1% AEP	Very Low	Low	Medium	Medium	High	Extreme
0.5% AEP	Very Low	Very Low	Low	Medium	High	Extreme
0.2% AEP	Very Low	Very Low	Very Low	Low	Medium	High
Extreme Event	Very Low	Very Low	Very Low	Low	Low	Low

3.7.4 Flood risk map

Figure 3.6 shows the flood risk map derived from the flood risk matrix. The model results were adjusted to remove isolated islands and to provide a perimeter around the high risk area.

The flood risk map shows that:

- High/extreme flood risk is limited to the Namoi River and Coxs Creek channels as well as significant floodplain breakouts and flood-runner channels;



- Medium flood risk covers the northeastern extent of urban Boggabri and much of the Namoi River floodplain;
- Very low/low flood risk covers much of urban Boggabri; and
- Flood free land around urban Boggabri is predominantly limited to the area west of the railway line (shown as unshaded area on Figure 3.6).

The approximate number of existing buildings located within each flood risk zone are provided below:

- extreme/high flood risk – 12 buildings;
- medium flood risk – 45 buildings;
- low/very low flood risk – 429 buildings; and
- flood free land – 73 (may be more as the property survey was limited to the PMF extent).

Figure 3.7 shows the flood risk mapping around urban Boggabri compared to the adopted flood planning area.

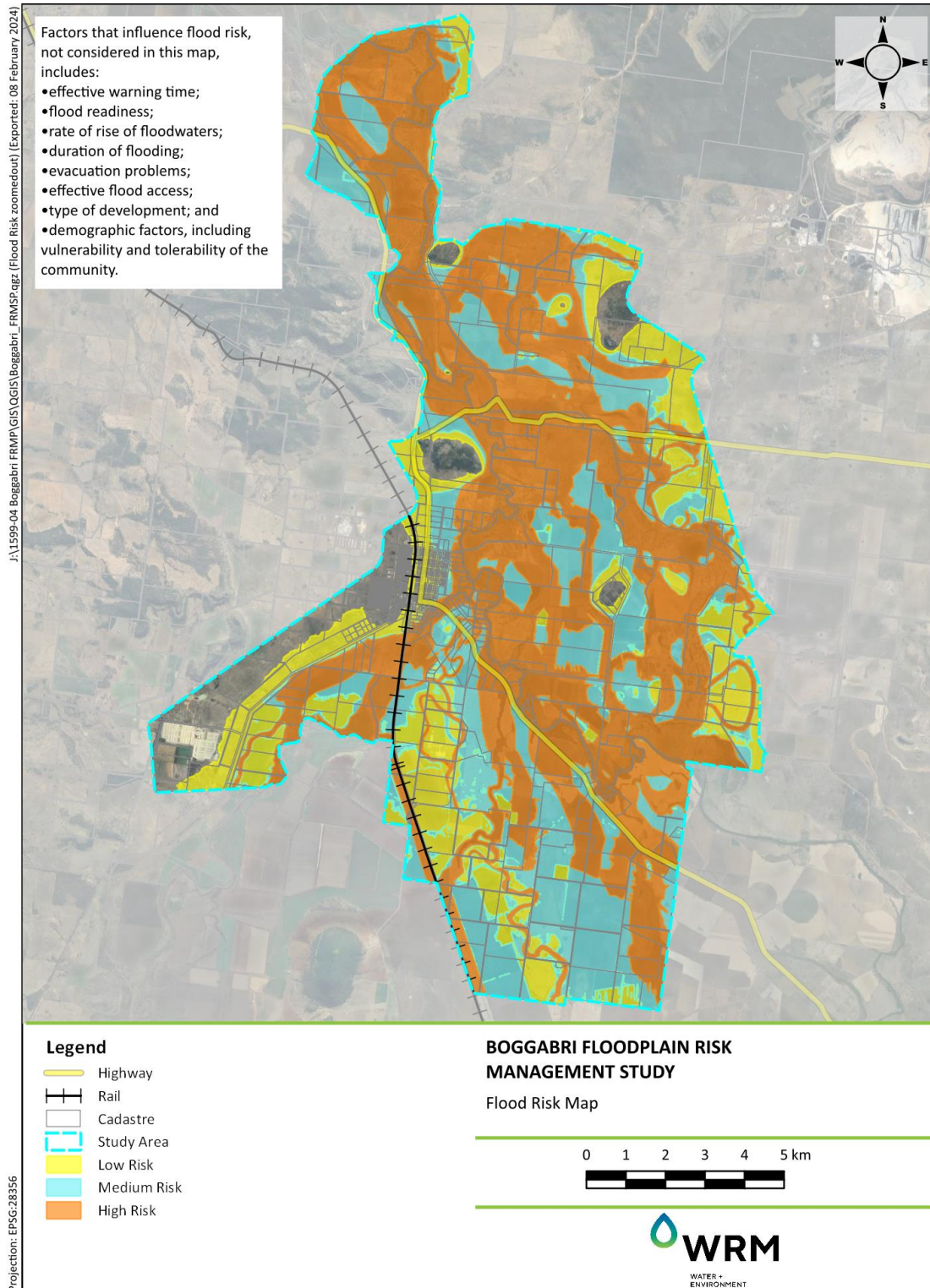


Figure 3.6 Flood risk map, study area

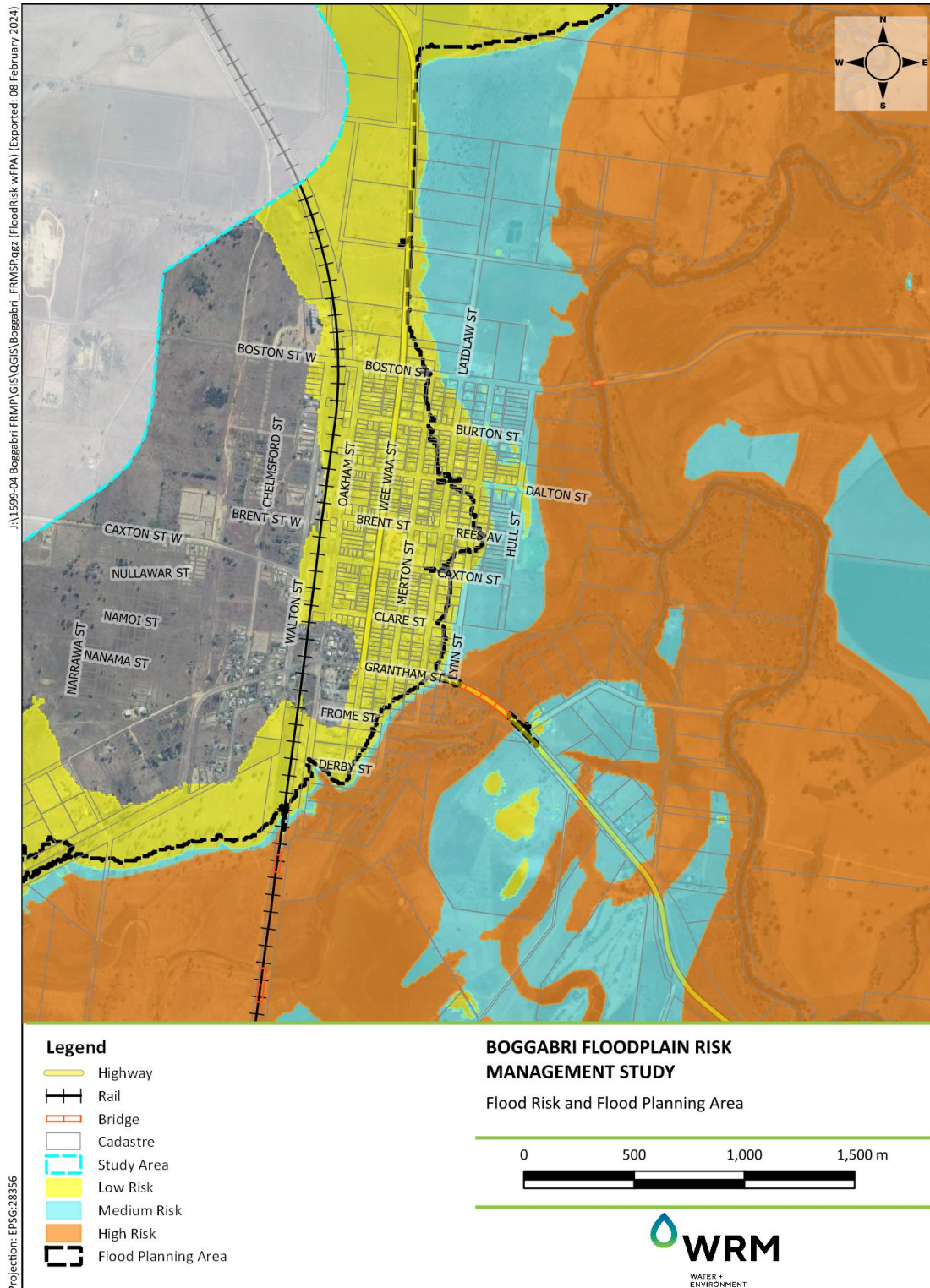


Figure 3.7 Flood risk map, urban Boggabri



3.8 TANGIBLE FLOOD DAMAGE ESTIMATE

The flood damage estimation methodology and results were represented in the Boggabri Flood Study (WRM, 2021). The tangible flood damage assessment was limited to the surveyed properties (those in and around urban Boggabri). An additional 67 buildings in the study area appear to be flood prone but do not have sufficient detail available to include in the flood damage estimate. Mapping of property inundation events is given in Appendix A.

The flood damage estimates have been updated to March 2023 dollars in Table 3.5.

Table 3.5 Estimated number of flood affected buildings and flood damage

Parameter	Event (AEP)							
	20%	10%	5%	2%	1%	0.5%	0.2%	PMF
No. residential buildings flooded AGL *	-	1	4	15	45	102	154	343
No. residential buildings flooded AFL *	-	1	2	5	14	75	135	343
Total residential damages (\$K)	\$0	\$135	\$341	\$1,236	\$3,882	\$11,159	\$23,058	\$97,988
No. non-residential buildings flooded AGL *	-	-	-	4	9	9	16	72
No. non-residential buildings flooded AFL *	-	-	-	-	7	9	16	72
Total non-residential damages (\$K)	\$0	\$0	\$0	\$0	\$44	\$240	\$981	\$11,413
Building average annual damage	\$292,560							

AGL – above ground level (count includes buildings flooded above both ground level and floor level), AFL – above floor level,
* buildings with a surveyed floor level.



4 COMMUNITY CONSULTATION

4.1 OVERVIEW

Community consultation commenced in early 2023 to seek feedback on recent (2021 and 2022) flood experience as well as gather the thoughts of Boggabri locals on flooding, flood risk and potential flood management options. This feedback was gathered during the preliminary stages of the FRMS to ensure that the FRMS was guided by community sentiment.

Following publication of a draft version of this document, the draft was released for public exhibition and a questionnaire used to collect feedback on the content of the draft, particularly on the recommended actions for flood mitigation in Boggabri (i.e., the draft Boggabri Floodplain Risk Management Plan). Based on feedback from the community consultation, minor revisions were made to the draft to produce this FRMSP.

4.2 METHODOLOGY

Upon commencement of this study a community newsletter and questionnaire was sent to landowners in the study area to keep residents informed of the upcoming study and to gather feedback on recent flood experience and opinions on potential flood mitigation options suitable for Boggabri. Social media, local media and Council's website were used to advertise the study and to remind residents to complete the questionnaire. A Boggabri community barbecue was also attended by members of the study team to discuss the study, encourage residents to fill out the questionnaire and gather other relevant information and feedback.

The feedback gathered at the commencement of the study was compiled and reviewed prior to commencing work on flood mitigation options. The emergency response planning measures, structural flood management options and non-structural (planning) flood management options assessed in this FRMSP was guided by the community feedback.

An initial draft of the FRMS was released for comment from NSC, the floodplain risk management advisory committee (FRMAC) and NSW government. Following receipt of comments and further updates to the FRMS a revised draft was released for public exhibition. Print-outs of the draft document were placed on exhibition at Council's office and at the Boggabri library. The draft document was placed on a project specific website (accessed through NSC's website) along with frequently asked questions and other relevant flood related content. Social media, local media and Council's website were utilised to advertise the public exhibition period and to remind residents to complete a questionnaire on the FRMS. Two community information sessions were facilitated by members of the study team to summarise the study, explain the recommendations in detail and to gather feedback from those in attendance. Additional one-on-one sessions were held with landowners of houses identified in high-risk flood areas (where the landowners could not attend the public information sessions).

At the conclusion of the public exhibition period all feedback was compiled and reviewed and minor amendments were made to the FRMS to produce the FRMSP (this document).

4.3 SUMMARY OF FEEDBACK

4.3.1 Feedback at study commencement

The questionnaire released at commencement of this study was completed by 29 community members:



- Six of the 29 respondents noted their property or workplace was inundated during either the 2021 or 2022 flood events, with no respondent experiencing above floor level flooding.
- None of the respondents evacuated their property in 2021 or 2022.
- Only 15 of 29 respondents commented on flood warning during the 2021 and 2022 flood events, seven of which believed warnings were inadequate.
- Feedback was sought on potential emergency response, structural and non-structural flood mitigation options to be considered for Boggabri. The responses to these questions have been summarised in Section 5.2, 6.2 and 7.2 respectively.
- Feedback was sought on flood evacuation options. The responses to these questions have been summarised in Section 5.2.
- Many respondents to the questionnaire made comment that Boggabri does not flood. This is contrary to six respondents noting their property or workplace was inundated in 2021 or 2022 (which were frequent flood events). This perception that Boggabri (particularly urban Boggabri) does not flood is common throughout town and reflective of the fact that a rare (major) flood has not been experienced in the Namoi basin for many decades, and the 1955 flood inundated few properties on the eastern edge of town.

Discussions with residents at the community barbecue revealed:

- Few community members were aware of floods larger than 1955 being recorded in the 19th and early 20th century.
- Feedback on the Boggabri Flood Study (WRM, 2021) was predominantly positive, with the mapping generally corresponding with community members expectations (i.e., the 10% AEP mapping closely resembled what was experienced in 2021 and 2022 – events that had gauge levels very similar to the 10% AEP design event).
 - There was some scepticism of the very rare flood event mapping (events larger than 1% AEP).
- There was widespread commentary on the impact that mining has had on flooding (much of this commentary corresponded to areas outside of the flood study hydraulic model area).
- Many community members specifically opposed the option of investigating levees as a structural mitigation option.
- Many community members raised concerns about road safety, with descriptions of previous incidents where vehicles had driven into floodwaters and required assistance a common discussion.
- Some community members were concerned about flood warning and monitoring infrastructure.
- Long-term Boggabri residents often had a sound knowledge of flooding characteristics around Boggabri and were aware of their flood risk. Newer and/or younger residents had a much lesser understanding of Boggabri's flood risk with some surprised to hear that the 2021 and 2022 events were representative of frequent flood events.

4.3.2 Draft FRMS public exhibition feedback

The questionnaire released during the public exhibition of the draft FRMS was completed by 22 community members. The questionnaire asked whether residents supported each of the recommendations contained in the draft FRMS and provided space for commentary on each recommendation. All ten recommendations in the draft FRMS received majority support, hence each



of these has remained as a proposed outcome in this study (i.e. the draft Boggabri Floodplain Risk Management Plan presented in the Executive Summary and Table 8.1). There was some minor revision to some of these recommendations based on the community feedback.

The level of support for each recommended action is listed below:

- Implementing a flood education plan: 21 in favour, 1 against
- Delivering road safety upgrades: 19 in favour, 2 against
- Providing a voluntary purchase scheme: 13 in favour, 8 against
- Altered and updated flood warning: 21 in favour, 1 against
- Providing access to building floor level and flood level information: 20 in favour, 2 against
- Modifying building and development controls: 16 in favour, 5 against
- Updating the Narrabri Shire Flood Emergency Sub Plan: 19 in favour, 3 against
- Investigating a Boggabri helipad: 20 in favour, 1 against
- Altering land use zoning: 17 in favour, 4 against
- Not progressing a voluntary house raising scheme: 17 in favour, 5 against

Specific feedback on the recommended emergency response, structural and non-structural flood mitigation options for Boggabri are summarised in Sections 5.2, 6.2 and 7.2 respectively.



5 EMERGENCY RESPONSE PLANNING

5.1 OVERVIEW

The principal residual flood risk management option for Boggabri is evacuation. The Narrabri Shire Flood Emergency Sub Plan covers “arrangements for prevention, preparation, response and initial recovery for flooding” (NSW SES, 2023). Issues such as flood warning, evacuations and flood recovery are discussed in the Flood Emergency Sub Plan.

For emergency response planning, the Boggabri region was split into the following communities based on their differing emergency response requirements:

- Boggabri Town;
- Boggabri West;
- Showgrounds;
- Coxs Creek North; and
- Rural.

Figure 5.1 shows the emergency response communities including locations of the various properties that are at risk within each community. Each community has been delineated using the Flood Emergency Response Planning Classification Of Communities flood risk management guideline (NSW Government, 2007) with the following classifications:

- Low flood island (Showgrounds, Coxs Creek North and Rural);
 - Low flood islands are characterised as areas that have evacuation routes cut prior to residential areas being inundated, but all residential areas will inundate if flood levels continue to rise (i.e., all habitable areas are below the PMF). Low flood islands require evacuation prior to roads being cut, otherwise rescue by air and/or boat will be required if water levels continue to rise.
- Area with rising road access (Boggabri Town); and
 - Rising road access areas are characterised as areas that are below the PMF but have roads that continually rise leading out of the floodplain. Rising roads access areas require progressive evacuation as water levels continue to rise.
- Not flood affected (Boggabri West).
 - Areas that aren’t flood affected are above the PMF level, hence roads and properties are not inundated.

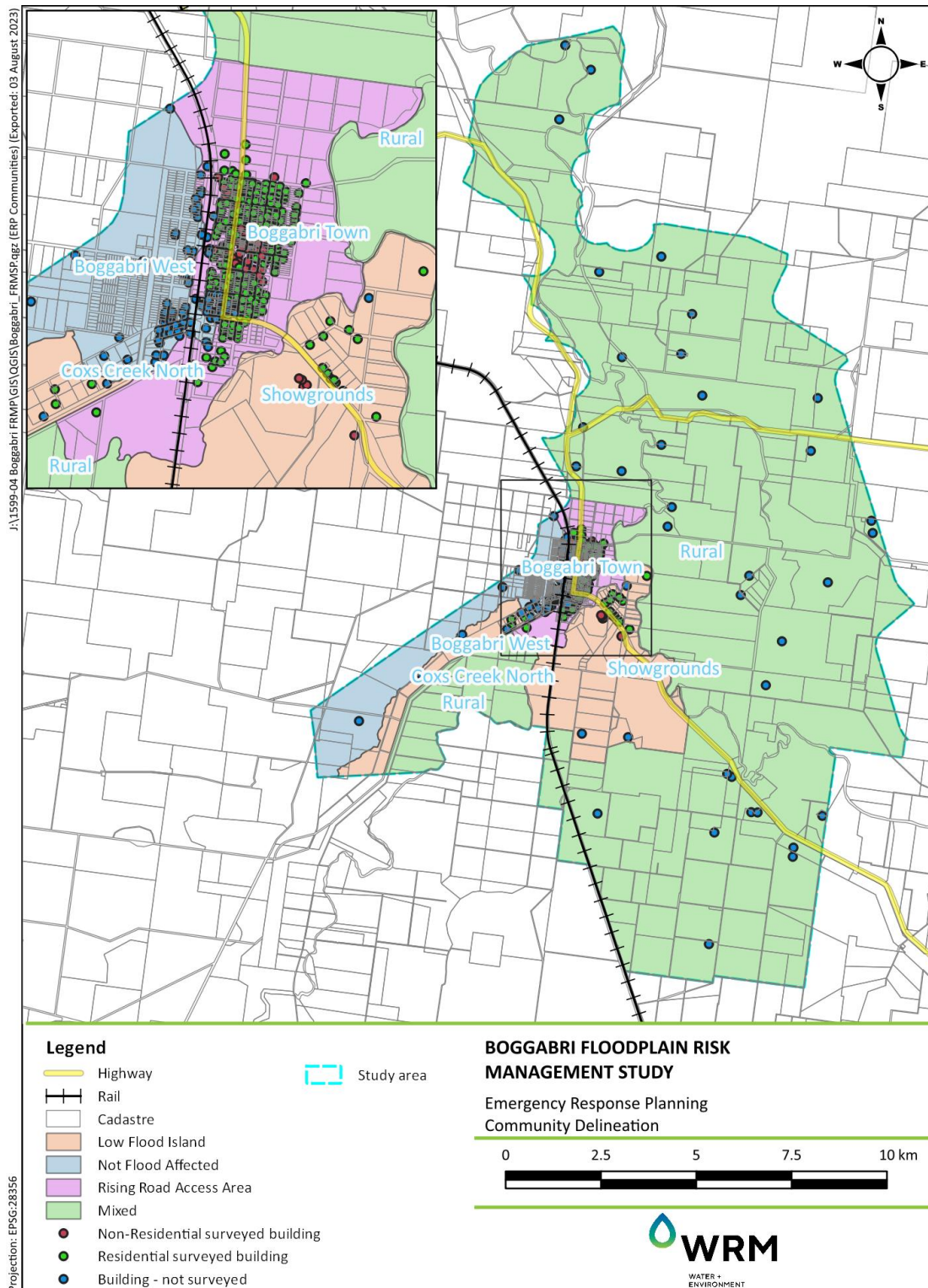


Figure 5.1 Flood emergency response planning communities



5.2 COMMUNITY FEEDBACK

5.2.1 Overview

The community consultation program for the FRMSP is described in Chapter 4. Specific feedback on emergency response planning measures is detailed below.

5.2.2 Feedback at study commencement

Community consultation undertaken in early 2023 sought feedback on potential flood management options (including emergency response planning options). Responses to a community questionnaire and discussions with community members about potential emergency response planning flood mitigation options revealed:

- Approximately 50% of respondents did not reply to the non-structural/emergency response flood mitigation question;
- Of the approximately 50% who did respond or discussed this with FRMSP team members at the community barbecue:
 - There were various concerns about flood warning and evacuation, including:
 - Lack of options for helicopter evacuation/resupply;
 - Not knowing where the evacuation centres were;
 - Alerts from stream gauges not being timely;
 - No alerts when dams in the catchment are spilling;
 - Lack of awareness of the danger of driving into floodwaters;
 - Not having advanced issue of road closure notices; and
 - The need for additional gauges in the catchment to aid flood warning.
 - There was support for flood education initiatives such as:
 - Education programs in local schools;
 - More SES involvement in the community; and
 - Display of historic and design flood levels at various points across town.
- There was general discontent with flood warnings in recent flood events (particularly with official warnings reportedly being based on outdated information) with many residents relying on discussion with neighbours and upstream landholders for flood warnings;
- Road closure information and enforcement was a common discussion point with many expressing frustration at the number of previous incidents where drivers had entered floodwater and then required assistance from emergency services (where available) or neighbouring landholders; and
- General confusion around evacuation, with many residents assuming that because widespread flooding hadn't been recorded in urban Boggabri before that it would not be experienced in the future (i.e., complacent that there would be no need for evacuation).

5.2.3 Draft FRMS public exhibition feedback

A draft version of this document was released for public exhibition in late 2023. Responses to a community questionnaire and discussions with community members about emergency response planning options revealed:

- There was majority support for all of the emergency response management options presented in the draft document for public exhibition (increased flood education, modified flood warning,



access to building floor level and flood level data and updates to the Narrabri Shire Emergency Sub Plan);

- There were suggestions for upgrades to existing stream gauges (to ensure real-time data is always available) and potential locations for additional stream gauges;
- There was much discussion about the classification of flood levels at Boggabri with strong support to reduce the minor flood level from 7.0 m to 6.0 m (at the Iron Bridge gauge) to allow flood warnings to be communicated prior to widespread road closure; and
- There was support for additional flood mapping and educational resources that would allow residents to easily relate predicted gauge levels at the Iron Bridge to predicted inundation extents and road closures.

With majority support for all recommendations in the draft document, all recommendations remain in this FRMSP. Based on the feedback gathered during public exhibition there were minor modifications made to this FRMSP, particularly the flood warning recommendations.

5.3 ACCESS ROAD INUNDATION

Figure 5.2 shows roads estimated to be inundated by more than 0.3 m in the 20%, 5% and 1% AEP design events respectively. It has been assumed that inundation of more than 0.3 m depth would result in road closure. It should be noted that local catchment runoff may inundate more roads than what is shown in Figure 5.2, hence Figure 5.2 should be used as a guide only.

The results show that:

- For the 20% AEP event –
 - 10-15 km of roads within the study area are inundated by more than 0.3 m depth;
 - Approximately 2.5 km of Braymont Road is inundated;
 - Approximately 0.2 km of Barbers Lagoon Road is inundated; and
 - Approximately 1.3 km of Rangari Road is inundated.
- For the 5% AEP event –
 - 47.5-52.5 km of roads within the study area are inundated by more than 0.3 m depth;
 - Approximately 6.1 km of Braymont Road is inundated;
 - Approximately 0.4 km of Barbers Lagoon Road is inundated;
 - Approximately 4.7 km of Rangari Road is inundated; and
 - Approximately 1.7 km of Kamilaroi Highway south of Boggabri is inundated.
- For the 1% AEP event –
 - 102.5-107.5 km of roads within the study area are inundated by more than 0.3 m depth; and
 - There is significant inundation along most roads around Boggabri, particularly on major roads into town.

Roads in urban Boggabri are likely to be trafficable up until the 1% AEP design flood (except for northeastern urban Boggabri, west of Braymont Road bridge). For events up to the 1% AEP event, evacuation of rural residents to evacuation centres in urban Boggabri needs to be achieved prior to the access roads being cut. Inundation to roads is likely to last longer than 24 hours at many locations, meaning that residents who do not evacuate risk being isolated for a prolonged period and / or becoming inundated if the flood becomes more serious.

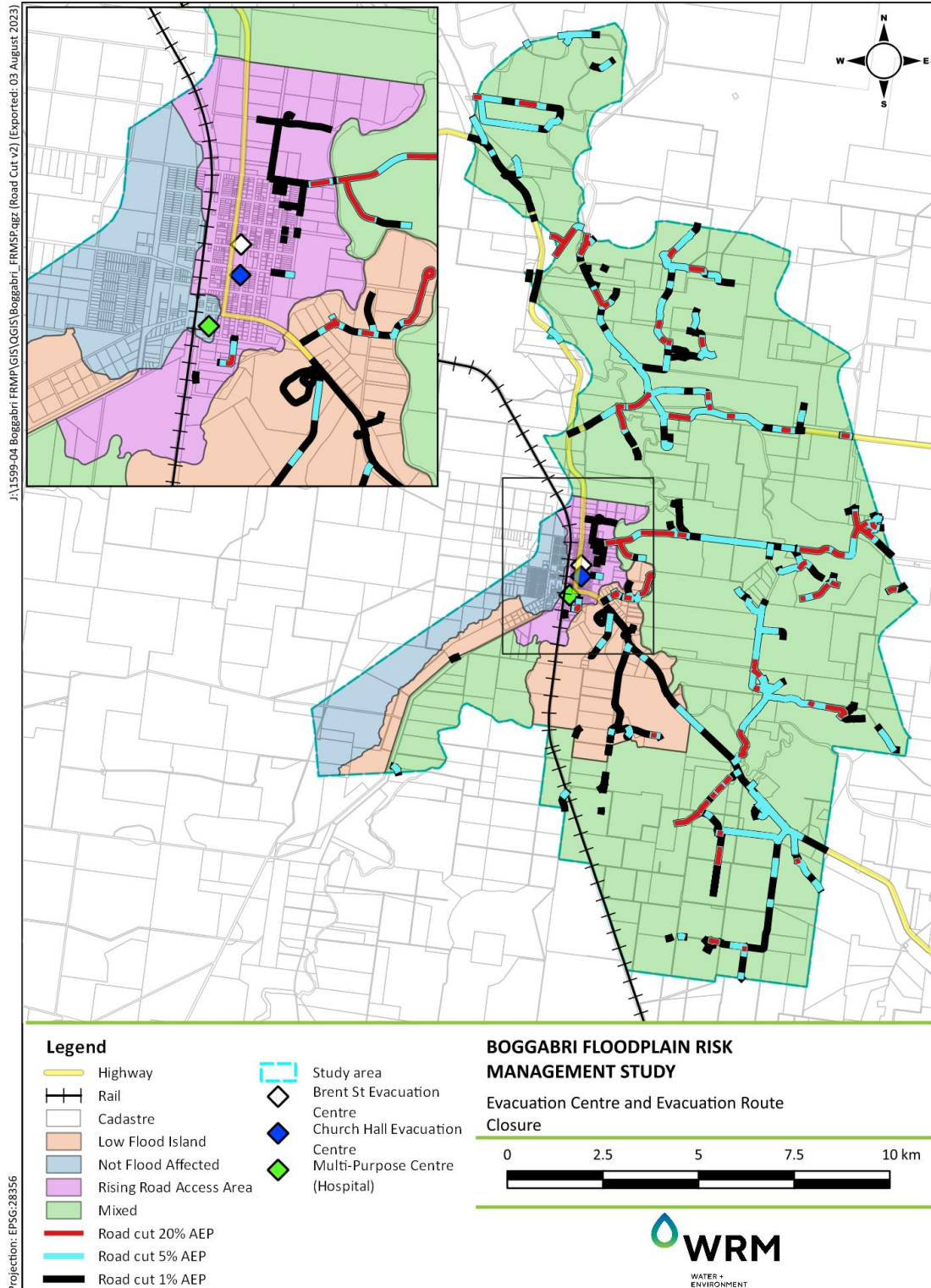


Figure 5.2 Roads inundated by 0.3 m or more, 20% AEP, 5% AEP and 1% AEP events



5.4 EVACUATION CENTRES

5.4.1 General

The Narrabri Shire Flood Emergency Sub Plan nominates the following locations as flood evacuation centres for Boggabri (refer Figure 5.2):

- CWA Rooms in Brent Street; and
- Uniting Church Hall in Norton Street.

The (former) CWA rooms in Brent Street are believed to be the Boggabri Home and Community Care (HACC) centre in Brent Street. The (former) Uniting Church Hall in Norton Street is believed to be the St Barnabas (Anglican Church) Community Op Shop and memorial Hall in Merton Street. The Flood Emergency Sub Plan requires revision to correct this naming so that new residents are familiar with evacuation centres.

Both nominated flood evacuation centres have ground levels more than 1 m (and floor levels more than 1.7 m) above the 0.2% AEP design flood event. Both nominated flood evacuation centres are predicted to be inundated by the PMF.

The nominated flood evacuation centres for Boggabri are therefore sufficiently flood resilient for all but the most extreme flood events. The roads in urban Boggabri rise from east to west meaning access to both evacuation centres would be available up until up until the time of both centres being inundated. In an extreme flood if both evacuation centres were predicted to be inundated then evacuees would need to be relocated to a venue further to the west.

5.4.2 Services

The Boggabri Sewage Treatment Plant is predicted to become surrounded by flood water for events between the 5% AEP and 2% AEP design floods. It is unlikely that any tanks or ponds would be overtopped until rarer events are experienced, however sewage services are likely to be disrupted prior to evacuation centres becoming flood affected.

Boggabri's electricity substation is on the western side of the railway line and is outside the predicted PMF flood extent.

The Boggabri Police Station is not predicted to be inundated by the 0.2% AEP event but would be inundated for the PMF. The Boggabri Fire Station is on the edge of the predicted 0.2% AEP extent, hence would be inundated prior to the evacuation centres being inundated. The Boggabri SES facility is not predicted to be inundated by the 0.2% AEP event but would be inundated for the PMF. The Boggabri SES facility has greater flood immunity than both nominated evacuation centres.

The Boggabri Multi-Purpose Service (hospital, ambulance station and residential aged care) is not predicted to be inundated by the PMF. Access to the Boggabri Multi-Purpose Service would be available from the evacuation centres up until the time that the evacuation centres were inundated.

5.5 FLOOD WARNING

5.5.1 Overview

Consultation with the Boggabri community revealed that formal and informal flood warning has historically been received through several channels. Formal flood warning provided by the Commonwealth Bureau of Meteorology (BOM) is often shared through television news broadcasts,



council social media, as well as being accessed directly from the BOM website. Some residents also rely on informal flood warnings from property owners on the floodplain upstream of Boggabri.

5.5.2 Water level monitoring

There are two stream gauges in the vicinity of Boggabri:

- Namoi River at Boggabri (419012), known locally as the Iron Bridge; and
- Coxs Creek at Boggabri (419032), located about 1 km upstream of the Namoi Cotton Gin.

Current and historic water levels at both stream gauges are available online through the WaterNSW website. Recorded stream gauge levels from recent and significant Namoi River flood events and the modelled design flood events are provided in Table 5.1.

Table 5.1 Stream gauge water levels

Flood event	Gauge level at 419012 (the Iron Bridge)	Gauge level at 419032 (Coxs Creek at Boggabri)	Relevant Boggabri flood map
20% AEP	7.76	6.76 *	Figure C.1 ^a
2022	8.39	6.93	N/A
2021	8.50	8.32	N/A
10% AEP	8.51	7.65 *	Figure C.2 ^a
5% AEP	9.28	8.31 *	Figure C.3 ^a
2% AEP	10.16	8.96 *	Figure C.4 ^a
1955	10.52	8.80 *	Figure B.1 ^a
1910	10.66	N/A	N/A
1% AEP	10.79	9.33 *	Figure C.5 ^a
0.5% AEP	11.52	9.63 *	Figure C.6 ^a
0.2% AEP	12.69	9.94 *	Figure C.7 ^a
PMF	21.15	N/A	Figure C.8 ^a

* Estimated level from 419032 rating curve

^a Boggabri Flood Study (WRM, 2021)

5.5.3 Formal flood warning service

Historically, flood emergency response planning at Boggabri has been based on flood level predictions provided by BOM for the Namoi River at Boggabri gauge (419012) – known locally as the Iron Bridge. Key gauges upstream of Boggabri include Tamworth (419009), Manilla (419022) and Gunnedah (419001) gauges (BOM, 2013). The BOM predictions at Boggabri are determined using computer based hydrologic models of the catchment using real time recorded water levels at the upper catchment stream gauges (mentioned above) and predictions of future stream flows based on rainfall that has fallen (and potentially could fall) in the catchment. The minor flood level used by BOM for the Namoi River at Boggabri is 7.0 m. There is currently no defined moderate or major flood levels. The predicted flood level for Boggabri can be cross-referenced to Table 5.1 which specifies the relevant flood map to show flood extents and depths for various Namoi River flood levels at the Iron Bridge.



Due to the large catchment area upstream of Boggabri there is typically hours to days difference between flood peaks occurring at upstream gauges and the flood peak arriving at Boggabri. The travel time of the flood peak from Gunnedah to Boggabri is in the order of 24-30 hours (NSW SES, 2023).

There are no flood level predictions or formal warnings provided for Coxs Creek. Coxs Creek flows are accounted for by BOM when issuing warnings for Namoi River flooding, but no specific predictions are made for levels in Coxs Creek.

5.6 EMERGENCY RESPONSE PLANNING COMMUNITIES

5.6.1 Overview

Figure 5.1 shows the five communities adopted for emergency response planning (ERP). Appendix B contains mapping of each individual ERP community. Approximately 93% of the study area is inundated by the PMF by greater than 0.3 m depth. The land inundated by more than 0.3 m depth reduces to approximately 76% of the study area in the 1% AEP design flood, 47% of the study area in the 5% AEP design flood and 24% in the 20% AEP design flood. Local roads often inundate to great depth prior to primary escape routes inundating, hence early evacuation during flooding can be critical.

Both Boggabri flood evacuation centres are confined to a single ERP community. Hence inundation of this community (Boggabri Town) would be critical to not only the population of that community, but also to the population of all Boggabri ERP communities.

Though there are five distinct ERP communities, there are three distinct regions of Boggabri:

- the area north of Coxs Creek and west of the Namoi River;
- the area east of the Namoi River; and
- the area between Coxs Creek and the Namoi River.

There are three key bridges across Coxs Creek and the Namoi River open to vehicle access (as well as an additional crossing for the Maules Creek Coal Mine). The Kamilaroi Highway (Grantham Street) bridge over Coxs Creek is not predicted to be overtopped until events exceed the 0.2% AEP design flood, though the Kamilaroi Highway east of the bridge is overtopped in the 1% AEP design flood. The Braymont Road bridge over the Namoi River was being replaced at the time of this report being published. Regardless of the new bridge structure immunity, Braymont Road east and west of the bridge is overtopped and untrafficable prior to flood levels reaching the 20% AEP design event. The Rangari Road bridge (the Iron Bridge) over the Namoi River is predicted to be overtopped between the 5% AEP and 2% AEP design flood, though Rangari Road east and west of the bridge is overtopped and untrafficable prior to reaching the 20% AEP design event. Hence prior to the Iron Bridge stream gauge reaching the 20% AEP level (7.76 m) the only trafficable crossing of the Namoi River or Coxs Creek is the Kamilaroi Highway (information sourced from ex-SES volunteers suggests that the Kamilaroi Highway is the only trafficable watercourse crossing from an Iron Bridge gauge level of 6.3 m).

5.6.2 Boggabri Town

The Boggabri Town ERP community is the area north of Coxs Creek, west of the Namoi River, east of Grain Valley Road, south of Finchs Lane and extending west to the edge of the floodplain (the extent of the PMF). This community encompasses most Boggabri residential and non-residential structures. This community contains both of Boggabri's nominated evacuation centres.



Flood levels in the Boggabri Town ERP community are dictated by levels in Coxs Creek and the Namoi River. In frequent flood events the Boggabri Town ERP community is largely flood-free, however as flood events get more severe, overflows from Coxs Creek and the Namoi River extend further west into this community. This community is a rising road access area.

Table 5.2 details design flood behaviour in the Boggabri Town community, including the flood depths over the key evacuation routes and the number of buildings flooded for design flood events. The Boggabri Town community consists of approximately 423 buildings, approximately 84% of which are residential. The Boggabri Town community is not highly flood prone with most of the community only impacted by rare to extreme floods.

The first buildings in this ERP community inundated above floor level are situated in the northeastern section of the Boggabri Town ERP community (between Boston Street and Burton Street). The options for evacuation routes are plentiful with the nearest east-west road to be taken until evacuees are far enough west to reach the evacuation centres.

The Boggabri Town community is a rising road access area, hence staged evacuation is key to avoid being cut-off from evacuation centres. With both designated evacuation centres being within this community the entire population of Boggabri and surrounds will need to transit through this community if a flood event is sufficiently large to warrant evacuation.

Table 5.2 Predicted flood behaviour, Boggabri Town ERP community

Design event (AEP)	Predicted Namoi Rv (419012) and Coxs Ck (419032) gauge heights	Approx. flood depth over road crown (m)		No. buildings flooded	
		Burton St @ Lynn St	Caxton St @ Lynn St	Above ground level	Above floor level
20%	7.76 & 6.76	N/A	N/A	0	0
10%	8.51 & 7.65	N/A	N/A	0	0
5%	9.28 & 8.31	N/A	N/A	1	0
2%	10.16 & 8.96	N/A	N/A	6	1
1%	10.79 & 9.33	0.1	N/A	35	8
0.5%	11.52 & 9.63	0.7	0.4	91	64
0.2%	12.69 & 9.94	1.7	1.2	150	131
PMF	21.15 & N/A	>5	>5	421	421

5.6.3 Boggabri West

The Boggabri West ERP community is the area west of the floodplain (the predicted PMF extent). There are 71 buildings in the Boggabri West ERP community (to the edge of the study extent), including the Boggabri Multi-Purpose Service (hospital, ambulance station and residential aged care)). The Boggabri West ERP community is not flood affected however flooding would still affect this community in the following ways;

- Loss of flood affected services based in other communities (i.e., sewage treatment);



- Servicing the community members requiring access to the Multi-Purpose Service; and
- An influx of population should an extreme flood event occur and the designated evacuation centres need to retreat outside the floodplain.

5.6.4 Showgrounds

The Showgrounds ERP community is the area between Coxs Creek and the Namoi River. This community is a low flood island that contains 23 buildings (16 residential). The Showgrounds ERP community is split by multiple flood runners as river and creek levels increase, with roads starting to be overtopped for events more frequent than 20% AEP.

Flood levels in the Showgrounds ERP community are dictated by levels in Coxs Creek and the Namoi River. In frequent flood events the Showgrounds ERP community has areas of significant flood depth, and as flood events get more severe, overflows from Coxs Creek and the Namoi River affect more of the community.

Table 5.3 details design flood behaviour in the Showgrounds community, including the flood depths over the key evacuation routes and the number of buildings flooded for design flood events. The Showgrounds community is highly flood prone with most of the community impacted by rare floods and the entire community directly impacted by extreme floods.

The first buildings inundated above floor level are situated on the northern side of the Kamilaroi Highway. The evacuation option for the Showgrounds community is taking the Kamilaroi Highway northwest over the Coxs Creek bridge then turning north to access the evacuation centres. The Kamilaroi Highway generally has better immunity than the surrounding local roads, hence evacuation needs to occur prior to local roads becoming untrafficable. Table 5.3 shows that Grantham Street South has poor flood immunity and will be cut during frequent flood events.

The Showgrounds community is a low flood island, hence early evacuation is key to avoid being cut-off from evacuation centres. Some properties in the community will become isolated when flood levels exceed 20% AEP, though the Kamilaroi Highway has much greater immunity than the local roads. If flood levels reach the 1% AEP level then over 86% of land in this community will be inundated by more than 0.3 m and over half of the properties in this community will have been flooded above floor level. With both designated evacuation centres being within the neighbouring Boggabri Town ERP community on the other side of Coxs Creek, evacuation via the Kamilaroi Highway is critical for this community.

**Table 5.3 Predicted flood behaviour, Showgrounds ERP community**

Design event (AEP)	Predicted Namoi Rv (419012) and Coxs Ck (419032) gauge heights	Approx. flood depth over road crown (m)			No. buildings flooded	
		Grantham St South @ 0.4 km N of Kamilaroi Hwy	Binalong Rd @ Kamilaroi Hwy	Kamilaroi Hwy @ Golf Club	Above ground level	Above floor level
20%	7.76 & 6.76	0.2	N/A	N/A	0	0
10%	8.51 & 7.65	1.0	N/A	N/A	1	1
5%	9.28 & 8.31	1.4	<0.1	N/A	3	2
2%	10.16 & 8.96	1.7	0.5	0.1	14	5
1%	10.79 & 9.33	2.1	0.9	0.5	21	15
0.5%	11.52 & 9.63	2.6	1.4	1.0	22	22
0.2%	12.69 & 9.94	3.5	2.1	1.8	23	23
PMF	21.15 & N/A	>5	>5	>5	23	23

5.6.5 Coxs Creek North

The Coxs Creek North ERP community is the area west of Grain Valley Road to the edge of the floodplain (the predicted PMF extent). This area is a low flood island that contains eight buildings (all residential). This small rural residential community south of urban Boggabri has flood levels predominantly dictated by levels in Coxs Creek.

In frequent and rare flood events the Coxs Creek North ERP community is largely flood-free, however as flood events get more severe, overflows from Coxs Creek affect Grain Valley Road, blocking access to the evacuation centres. Roads begin to get cut when flood levels rise above the 0.5% AEP level, though less than 5% of land in this community will be inundated for this design event.

Table 5.4 details design flood behaviour in the Coxs Creek North community, including the flood depths over the key evacuation routes and the number of buildings flooded for design flood events. By the time that residential buildings begin to be flooded in the Coxs Creek North ERP community it is likely that the designated evacuation centres would also be flood affected. Hence any evacuees from this community would travel northeast along Grain Valley Road prior to this road being cut and they would then head towards the evacuation centres if they were still in service.



Table 5.4 Predicted flood behaviour, Coxs Creek North ERP community

Design event (AEP)	Predicted Namoi Rv (419012) and Coxs Ck (419032) gauge heights	Approx. flood depth over road crown (m)		No. buildings flooded	
		Grain Valley Rd @ 1.9 km W of Mt View Rd	Grain Valley Rd @ Mt View Rd	Above ground level	Above floor level
20%	7.76 & 6.76	N/A	N/A	0	0
10%	8.51 & 7.65	N/A	N/A	0	0
5%	9.28 & 8.31	N/A	N/A	0	0
2%	10.16 & 8.96	N/A	N/A	0	0
1%	10.79 & 9.33	N/A	N/A	0	0
0.5%	11.52 & 9.63	0.2	N/A	0	0
0.2%	12.69 & 9.94	0.6	0.2	0	0
PMF	21.15 & N/A	>5	>5	8	8

5.6.6 Rural

The rural area has been defined by the remainder of the Boggabri study area. This area consists of many low flood islands with local roads and major roads subject to inundation for frequent flood events. There are approximately 34 buildings in the study area in the Rural ERP community. These buildings were not surveyed hence the immunity of each building is not known.

31 of the 34 buildings in the Rural ERP community need to cross either the Namoi River or Coxs Creek to access evacuation centres in urban Boggabri. With Boggabri's evacuation centres within urban Boggabri this means that evacuation of the rural area east and north of Boggabri needs to happen prior to the Namoi River and Coxs Creek crossings and rural roads being inundated. Per Section 5.6.1, access to the Braymont Road bridge and Rangari Road bridge (the Iron Bridge) are cut in frequent flood events (smaller than the 20% AEP design flood). Hence even though many rural roads and rural buildings may not be inundated until flood levels reach rare levels, any access to Boggabri evacuation centres (by car or truck) will be cut early in any flood event.

Table 5.5 details design flood behaviour in the Rural community, including the flood depths over the key evacuation routes and the number of buildings flooded for design flood events. The first buildings inundated are situated north of Braymont Road in the Rural ERP community.

The Rural community is generally a low flood island area, hence evacuation is key to avoid being cut-off from evacuation centres. Isolation can occur for most of this community for events as frequent as 20% AEP, while 50% of the area in this community will be inundated by more than 0.3 m for the 5% AEP design event. While many rural residents would likely choose to wait out a flood event the lack of severe flood events in recent memory may lead to complacency, and with evacuation routes cut early in an event, this may lead to resupply and evacuation needing to occur via air and/or water.



Table 5.5 Predicted flood behaviour, Rural ERP community

Design event (AEP)	Predicted Namoi Rv (419012) and Coxs Ck (419032) gauge heights	Approx. flood depth over road crown (m)			No. buildings potentially flood affected*
		Kamilaroi Hwy between Binalong Rd & Milchengowrie	Braymont Rd @ East of bridge	Rangari Rd @ East of bridge	
20%	7.76 & 6.76	<0.1	0.7	1.8	0
10%	8.51 & 7.65	0.5	1.2	2.6	1
5%	9.28 & 8.31	0.9	1.6	3.4	5
2%	10.16 & 8.96	1.3	2.3	4.3	15
1%	10.79 & 9.33	1.6	2.9	4.9	22
0.5%	11.52 & 9.63	2.0	3.5	>5	25
0.2%	12.69 & 9.94	2.6	4.5	>5	31
PMF	21.15 & N/A	>5	>5	>5	34

* Buildings not surveyed, hence floor level is unclear

5.7 DISCUSSION

Further to the analysis conducted in the preceding sections, Coxs Creek flooding can occur independently of Namoi River flooding. Due to the smaller catchment size there is generally reduced warning time available for Coxs Creek flooding.

Significant issues identified in the preceding sections that may require further consideration include:

- Getting evacuation information to residents outside of urban Boggabri and convincing them of the need to evacuate prior to significant flooding arriving and inundating roads (and at higher levels, inundating houses);
- Getting rural residents to the Kamilaroi Highway bridge which is the only route and bridge with sufficient flood immunity to access town once the Iron Bridge gauge level exceeds 6.3 m; and
- When flood levels continue to rise and rural properties become affected above floor level boat and/or helicopter evacuation becomes necessary.

5.8 FLOOD EMERGENCY PLANNING MITIGATION OPTIONS

5.8.1 Overview

As discussed in previous sections, the principal residual flood risk management option for Boggabri is evacuation. The existing Narrabri Shire Flood Emergency Sub Plan covers issues such as flood warning, resupply, evacuations and flood recovery (NSW SES, 2023). The additional and updated information provided in the previous sections can be used to update volumes 2 and 3 of the Flood Emergency Sub Plan. In particular, the information on the locations of road inundation for the various events could assist prioritisation of evacuations for flood events.



5.8.2 Evacuation centres

As detailed in Section 5.4, there are currently two evacuation centres listed in the Narrabri Shire Flood Emergency Sub Plan (NSW SES, 2023). These two locations provide refuge up to very rare to extreme flood events. These evacuation centres would need to be evacuated for the most extreme flood events, which would be very difficult. An evacuation centre off the floodplain should be considered.

The existing (and any future) evacuation centres require the following provisions:

- a clear plan on how to get the population of Boggabri to the evacuation area, including:
 - knowledge of when evacuation routes are cut; and
 - provision for evacuation once roads are cut.
- essential services to this area would need to be flood proofed to ensure that the area could sustain an influx in population during a flood event, including:
 - provision of supplies (food and medical supplies);
 - potable water; and
 - sewer service.

The obvious place to establish a formal evacuation area outside of the floodplain is Boggabri West given its lack of flood risk. However, there are limited buildings within Boggabri West large enough to accommodate an evacuating population.

Regardless of whether the existing nominated evacuation centres are maintained or an alternative Boggabri West evacuation centre is formalised, the early evacuation of the population east of the Namoi River and Coxs Creek would be critical in the event of a significant flood.

As discussed in Section 5.4.1, the Flood Emergency Sub Plan requires revision to correct the naming of the designated Boggabri evacuation centres so that new residents are familiar with the evacuation centres.

5.8.3 Other evacuation considerations

As shown in Figure 5.2, NSC's road network is particularly susceptible to flooding. At least one bridge structure around Boggabri is in the process of being replaced. For these projects, and future road-related projects, the significance of each road's flood immunity should be reviewed, and where a road is identified as being of potential significance to flood evacuation the upgrade should take this into account (i.e., some road raising may be justified). Section 6.4 details potential structural options to assist evacuation.

NSC should continue to liaise with the SES to ensure that any changes to the road network are communicated to the SES so that potential impacts on evacuation routes can be considered.

Volume 3 of the Narrabri Shire Flood Emergency Sub Plan states that low-lying Boggabri houses are at risk of over floor inundation when the Iron Bridge gauge reaches heights between 10.3 and 10.7 metres (NSW SES, 2023). This study has found that at least five residential buildings are flooded above floor level at the 2% AEP flood level (10.16 m at the Iron Bridge). This content in the Flood Emergency Sub Plan requires revision.

5.8.4 Flood warning updates

As discussed in Section 5.5.3, BOM's Namoi and Peel River Valley flood warning service only defines a minor flood level (7.0 m) for Boggabri. Community consultation and discussion with current and



former SES volunteers revealed that the Kamilaroi Highway is the only trafficable crossing of the Namoi River or Coxs Creek once the Namoi River at Boggabri gauge (Iron Bridge) level exceeds 6.3 m. Hence by the time minor flood levels are reached many key evacuation routes are already inundated. For this reason there is community support to reduce the minor flood level at Boggabri from 7.0 m to a lower level (suggested level is 6.0 m) to enable SES mobilisation and sufficient warning prior to key roads being cut.

Based on the results presented in the Boggabri Flood Study (WRM, 2021), the analysis presented herein, and BOM's definitions of moderate and major flooding, the following levels for the Namoi River at Boggabri gauge (419012) (the Iron Bridge) may be appropriate for adoption by BOM:

- Moderate flood classification: 9.2 m; and
- Major flood classification: 10.2 m.

The adoption of a moderate and major flood level for Boggabri will provide additional context to the severity of flood warnings, as current warnings will reference only the minor flood level which does not provide sufficient information for the community to gauge the severity of the flood warning.

Some community members believed that additional gauges, particularly in the Coxs Creek catchment would aid flood warning (refer Section 7.2). Given that there are three water level gauges on Coxs Creek and two gauges on tributaries of Coxs Creek and these gauges are evenly distributed throughout the catchment it is unlikely that funding would be available for additional gauges in the Coxs Creek catchment.

Discussions could be had with BOM to investigate the feasibility of including Coxs Creek in their flood forecasting and warning services for the Namoi and Peel River Valley. While Coxs Creek has a much smaller catchment and response time than the Namoi River catchment, the catchment totals over 3,800 km² and hence has response times that makes it suitable for inclusion in BOM's riverine flood warning service (rather than requiring a non-BOM flash flood warning service). As a significant tributary of the Namoi River, Coxs Creek flows would already be accounted for in BOMs flood warning service for Namoi River gauges, hence the suggestion would be to include an additional stream gauge (Coxs Creek at Boggabri) in BOMs forecasting and warning service to provide additional flood warning to residents of Boggabri and surrounds (as flooding at Boggabri is not always Namoi River driven).

Based on some of the community feedback it would appear that not many residents are aware of the WaterNSW real time water data portal (<https://realtimedata.watarnsw.com.au>) where anyone with internet access can view the water level at any gauge in the Namoi River basin (including Coxs Creek gauges) (or indeed in the whole state) in real time.

5.8.5 Flood and floor level information

With historic flood level, design flood level and surveyed floor level information available for most properties within the study area (some rural properties were not surveyed), there is now an abundance of flooding information available to Council. In the interest of promoting a flood resilient and informed community, building floor levels and relevant flood levels should be made publicly available. This will enable property owners to evaluate their own flood risk ahead of time, enabling them to make plans prior to any future flood events, rather than being caught by surprise.

NSC has recently released flood information to the community via an online Council Flood Data portal (<https://waterride.net/FloodData/Narrabri/>). This portal allows users to select any location within the mapped flood extent to find the ground level, flood level and flood depth data for the selected location for the 1% AEP and PMF design floods (at Boggabri, Narrabri and Wee Waa).



6 STRUCTURAL FLOOD MANAGEMENT OPTIONS

6.1 OVERVIEW

A range of preliminary structural flood management options were identified for Boggabri based on previous investigations, feedback from the community and observations by the study team. A subset of the identified options was investigated based on a review of the flood risk zones, with the primary aim of reducing the existing flood risk, and/or improving flood emergency response and evacuation. The options investigated include:

- voluntary purchase and house raising programs; and
- structural management options to improve emergency response during a flood event.

This section outlines a preliminary assessment of the tangible and intangible benefits and indicative cost of each potential structural flood management measure. The concepts and associated modelling results have not been endorsed by NSC, or this the FRMSP, but have been assessed to determine whether they are potentially viable for more detailed investigation.

6.2 COMMUNITY FEEDBACK

6.2.1 Overview

The community consultation program for the FRMSP is described in Chapter 4. Specific feedback on structural flood management measures is detailed below.

6.2.2 Feedback at study commencement

Community consultation undertaken in early 2023 sought feedback on potential flood management options (including structural options). Responses to a community questionnaire and discussions with community members about potential structural flood mitigation options revealed:

- Approximately 20% of respondents replied no or N/A to the structural flood mitigation question;
- Approximately 30% of respondents did not reply to this question;
- Of the approximately 50% who did respond in detail or discussed this with FRMSP team members at the community barbecue:
 - Road raising for evacuation was mentioned by many respondents. The potential locations suggested for raising varied widely;
 - Options to raise existing rural levees, install new urban levees, clean out waterways and upgrade urban drains were raised by individuals but none of the suggested options were mentioned by more than one individual; and
 - For each response suggesting levees or other structural measures, there was many responses suggesting that structural measures will just disadvantage certain parts of the community and for this reason they should not be pursued.

Community feedback did not identify a consistent preferred option(s), instead many responses focussed on non-structural options. As a result of feedback from the community and later from the floodplain risk management advisory committee (FRMAC), the number of investigated structural flood management options was limited due to the lack of appetite in the local community and the fact that concentrated populations in the study area (i.e., urban Boggabri) are not inundated by frequent or even infrequent flood events (only rare and extreme events).



6.2.3 Draft FRMS public exhibition feedback

A draft version of this document was released for public exhibition in late 2023. Responses to a community questionnaire and discussions with community members about structural options revealed:

- There was majority support for all of the structural management options presented in the draft document for community consultation (road safety upgrades, consideration of a voluntary purchase scheme and not progressing a voluntary house raising scheme).
- It was noted that the support for consideration of a voluntary purchase scheme was significantly lower than the support for other recommendations (though still had majority support). This is likely reflective of the benefit cost ratio for this option being low (apart from one property) and some unease about very rare flood events being considered in the delineation of high flood risk areas;
- There was concern about the potential flood impact of the recent Boston Street bridge upgrade; and
- There was extensive discussion about the locations and options for road safety upgrades. Concerns about signage obstructing machinery and wide loads were noted, as were concerns about the potential drawbacks of automated/manual drop gates. Generally non-static warning signage was the preferred option.

With majority support for all recommendations in the draft document, all recommendations remain in this FRMSP. Based on the feedback gathered during public exhibition there were minor modifications made to this FRMSP, particularly in relation to the preferred road safety upgrade options.

6.3 VOLUNTARY PURCHASE AND HOUSE RAISING

6.3.1 Purpose

The primary objectives of a voluntary purchase and house raising program is to:

- reduce the impact of flooding, including human safety and property damage;
- reduce flood liability on individual owners and occupiers of flood prone property; and
- reduce private and public losses resulting from floods.

If enacted, the voluntary purchase component of the program would be targeted at the most at-risk properties, i.e., properties in floodways (refer Figure 3.5). The house raising component would then be targeted at residential properties able to be raised (i.e., not slab-on-ground properties) with an existing floor level below the flood planning level (0.5% AEP flood level).

6.3.2 Considerations

Considering current government legislation and practicalities, a voluntary purchase program would likely only apply to:

- residential buildings constructed prior to 1986 when the original Floodplain Development Manual was gazetted by the State Government; and
- residential buildings located in floodways (high risk zones).

Considering current government legislation and practicalities, a house raising program would likely only apply to:



- residential properties constructed prior to 1986 when the original Floodplain Development Manual was gazetted by the State Government;
- single storey residential buildings located outside of floodways. (A voluntary purchase program is recommended for residential properties in floodways);
- residential buildings structurally able to be raised (i.e., buildings on stumps, not slab-on-ground); and
- residential buildings where the floor level of the residence is below the adopted residential flood planning level (0.5% AEP flood level). Any house raising should result in the new floor level being, as a minimum, at the flood planning level.

Given the above criteria, there would be approximately 3 surveyed residential properties and up to 8 additional unsurveyed properties potentially eligible for voluntary purchase, and approximately 53 surveyed residential properties and up to 19 additional unsurveyed properties potentially eligible for house raising. No investigation of building age has been undertaken, so the actual number of eligible properties will be less than this. Approximately 19 residential properties in Boggabri below the flood planning level are of slab-on-ground construction. As a result, a residual flood problem would remain, even if all eligible residential properties were raised.

Subject to Government agreement, funding for the program could potentially be provided at ratio of \$2 from the State Government for every \$1 provided by the property owner (or council), in accordance with the NSW Government's Floodplain Management Program for voluntary house raising schemes.

A potential house raising priority list was developed based on depth of flooding above floor level, with the highest priority has given to properties inundated above floor level by the most frequent floods. Residential properties located within floodways were not considered for house raising. These properties have instead been identified for potential voluntary purchase. No analysis of the age of a property has been undertaken, hence there may be some properties on the priority list, constructed after 1986, that may not be eligible.

The list of potential voluntary purchase properties and list of prioritised properties for potential house raising has been confidentially provided to NSC for consideration.

6.3.3 Tangible benefits

Table 6.1 shows the number of surveyed properties flooded above and below floor level and the estimated residential and commercial damages (in March 2023 dollar values) assuming all potential voluntary purchase properties have been removed from the floodway and all potentially eligible residential properties have been raised. The estimated building average annual damage (AAD) under the fully implemented scenario is also shown.

With respect to the 1% AEP flood and comparing to existing conditions, the results show that:

- the number of flood affected residential properties would reduce by 3 (from 45);
- the number of residential properties flooded above floor level would reduce by 12 (from 14); and
- the total residential flood damages would reduce by approximately \$1.32 million (from \$3.882 million under existing conditions).



Table 6.1 Number of properties flooded and flood damage costs, fully implemented voluntary purchase and house raising program

Parameter	Event (AEP)							
	20%	10%	5%	2%	1%	0.5%	0.2%	PMF
No. residential buildings flooded AGL *	-	-	2	12	42	99	151	340
No. residential buildings flooded AFL *	-	-	-	1	2	19	132	340
Total residential damages (\$K)	\$0	\$0	\$72	\$687	\$2,562	\$9,571	\$21,396	\$97,187
No. non-residential buildings flooded AGL *	-	-	-	4	9	9	16	72
No. non-residential buildings flooded AFL *	-	-	-	-	7	9	16	72
Total non-residential damages (\$K)	\$0	\$0	\$0	\$0	\$44	\$240	\$981	\$11,413
Building average annual damage	\$241,755							

AGL – above ground level (count includes buildings flooded above both ground level and floor level), AFL – above floor level, * buildings with a surveyed floor level.

The total building average annual damage from flooding, assuming complete uptake of a voluntary purchase and house raising program, is \$241,755. This is approximately \$50,805 less than existing conditions. Approximately \$32,740 (64%) of this reduction is from the potential voluntary purchase component of the program (i.e., purchase of 3 residential properties), with the remaining \$18,065 reduction from the potential raising of residential buildings.

6.3.4 Estimated cost

The estimated costing undertaken for the properties identified for voluntary purchase has been based on a simplified assessment. The median house price in Boggabri over the 12 months to June 2023 was \$255,000 (REA Group, 2023) and this was adopted for the purpose of costing. However, one of the three properties identified for voluntary purchase was listed for sale at the time of publication and the advertised price for this property was adopted. The cost of house raising can vary widely depending upon the size of the house and the availability of suitable contractors. In Southeast Queensland, house raise quotations typically range from \$15,000 to \$50,000. Molino Stewart (2014) estimated the cost of house raising in Moree to be \$80,000 per structure. For this assessment, a cost of \$100,645 per structure was assumed for this study (the Molino Stewart estimate was factored using CPI as an indicator of price rise). Recent anecdotal evidence suggests that house raising costs likely exceed the \$100,645 assumed for this study by up to 50%.

6.3.5 Economic evaluation

Table 6.2 shows an economic evaluation of the voluntary purchase component of the program. The reduction in average annual damage was calculated for each individual property. The net present value of the savings was then determined for discount rates of 4%, 7% and 10% over a period of 20 years, which was compared to the cost of the purchase to determine the benefit cost ratio.



The economic evaluation results suggest that the most flood affected property is economically viable to purchase with the purchase price recouped in flood damage savings over a period of 9 to 13 years (dependent on the adopted discount rate). The second and third properties do not achieve a benefit cost ratio of 1 over a 20 year time period.

It should be noted that costs and tangible benefits given in Table 6.2, consider only the voluntary purchase component of the program and have not accounted for any demolition of buildings post purchase.

Table 6.2 Economic evaluation of the proposed voluntary purchase program

Property	Total building AAD after each year	AAD savings	NPV savings over 20 years			Cost of year	Benefit cost ratio		
			@4%	@7%	@10%		@4%	@7%	@10%
	\$292,556	-							
1	\$271,225	\$21,331	\$289,896	\$225,981	\$181,603	\$147,500	1.97	1.53	1.23
2	\$262,984	\$8,241	\$111,998	\$87,306	\$70,160	\$255,000	0.44	0.34	0.28
3	\$259,817	\$3,167	\$43,042	\$33,552	\$26,963	\$255,000	0.17	0.13	0.11

NPV – net present value

Table 6.3 shows an economic evaluation of the voluntary house raising component of the program. The reduction in average annual damage was calculated assuming that the two highest priority houses were raised to the flood planning level every year. The net present value of the savings was then determined for discount rates of 4%, 7% and 10% over a period of 20 years, which was compared to the cost of the raising to determine the benefit cost ratio.

The economic evaluation results suggest that the house raising component of the proposed program is not economically viable for any of the surveyed properties in and around Boggabri.

It should be noted that costs and tangible benefits given in Table 6.3, consider only the house raising component of the program.



Table 6.3 Economic evaluation of the proposed house raising program

Year	Total building AAD after each year	AAD savings	NPV savings over 20 years			Cost of year	Benefit cost ratio		
			@4%	@7%	@10%		@4%	@7%	@10%
	\$292,556	-							
1	\$287,959	\$4,597	\$62,468	\$48,696	\$39,133	\$201,290	0.31	0.24	0.19
2	\$285,944	\$2,015	\$27,390	\$21,352	\$17,159	\$201,290	0.14	0.11	0.09
3	\$283,661	\$2,283	\$31,024	\$24,184	\$19,435	\$201,290	0.15	0.12	0.10
4	\$281,918	\$1,743	\$23,690	\$18,467	\$14,841	\$201,290	0.12	0.09	0.07
5	\$280,533	\$1,385	\$18,823	\$14,673	\$11,792	\$201,290	0.09	0.07	0.06
6	\$279,970	\$563	\$7,655	\$5,967	\$4,795	\$201,290	0.04	0.03	0.02
7	\$279,179	\$790	\$10,740	\$8,372	\$6,728	\$201,290	0.05	0.04	0.03
8	\$278,754	\$425	\$5,779	\$4,505	\$3,620	\$201,290	0.03	0.02	0.02
9	\$278,110	\$644	\$8,751	\$6,822	\$5,482	\$201,290	0.04	0.03	0.03
10	\$277,508	\$602	\$8,184	\$6,380	\$5,127	\$201,290	0.04	0.03	0.03
11	\$277,155	\$353	\$4,791	\$3,735	\$3,002	\$201,290	0.02	0.02	0.01
12	\$276,818	\$338	\$4,593	\$3,580	\$2,877	\$201,290	0.02	0.02	0.01
13	\$276,534	\$284	\$3,854	\$3,004	\$2,414	\$201,290	0.02	0.01	0.01
14	\$276,117	\$416	\$5,660	\$4,412	\$3,546	\$201,290	0.03	0.02	0.02
15	\$275,890	\$227	\$3,088	\$2,407	\$1,935	\$201,290	0.02	0.01	0.01
16	\$275,701	\$189	\$2,569	\$2,003	\$1,609	\$201,290	0.01	0.01	0.01
17	\$275,512	\$189	\$2,569	\$2,003	\$1,609	\$201,290	0.01	0.01	0.01
18	\$275,352	\$160	\$2,172	\$1,693	\$1,361	\$201,290	0.01	0.01	0.01
19	\$275,145	\$207	\$2,816	\$2,195	\$1,764	\$201,290	0.01	0.01	0.01
20	\$275,045	\$100	\$1,359	\$1,059	\$851	\$201,290	0.01	0.01	0.00

NPV – net present value

6.3.6 Environmental impacts

There are no detrimental environmental impacts associated with a voluntary purchase and house raising program. There would be minor localised reductions in flood impacts due to a less obstructed floodplain.

6.3.7 Social impacts

A voluntary purchase and house raising program would have largely positive social impacts on the Boggabri community. Potential positive social impacts of the program include:



- reduced community impact during rare flood events; and
- reduced stress towards flooding for house owners who participate in the program.

Potential negative social impacts of the program include:

- house owner's financial pressure of partly funding house raising;
- house owner's need to relocate if opting for voluntary purchase and to find a comparable property; and
- potential inequity for residents that are ineligible or unsuitable for house raising/voluntary purchase.

6.4 POTENTIAL STRUCTURAL EMERGENCY RESPONSE MEASURES

6.4.1 Purpose

The flood emergency response planning, detailed in Chapter 4, revealed that some roads used to access Boggabri (and the designated evacuation centres and medical services) would be cut for extended periods in frequent flood events. The existing evacuation centres are themselves located in flood prone areas (only for very rare to extreme floods).

Vehicle access to the evacuation centres is generally progressively cut for residents west of the Namoi River and Coxs Creek as their local streets are inundated. Evacuation centre access is however cut to most residents east of the Namoi River and Coxs Creek for frequent flood events before the 20% AEP level is even reached (see Figure 5.2). This would leave some residents of the Boggabri region unable to access evacuation centres or medical care without the assistance of boats or helicopters before the Iron Bridge gauge reaches the minor flood level. Hence a possible structural emergency response measure would be improving road immunity to assist residents east of the Namoi River.

6.4.2 Road raising

The number of roads cut by flooding make it difficult to prioritise structural emergency response measures (i.e., road raising). The key to evacuation and/or resupply of residents east of the Namoi River and Coxs Creek is a route across those watercourses. The Kamilaroi Highway crossing of Coxs Creek remains flood free up to rare flood events however there are small sections of the Highway east of the bridge that become untrafficable during a 5% AEP flood event. The Braymont Road and Rangari Road crossings of the Namoi River have significant sections of road east of their respective bridges that inundates and becomes untrafficable for events more frequent than 20% AEP. Hence improved evacuation and/or resupply routes would require significant upgrades to many kilometres of either Braymont Road or Rangari Road. Local access roads that link to these roads would also then need to be assessed for upgrade.

Raising either Braymont Road or Rangari Road to be passable for the 5% AEP flood (to get similar immunity to the Kamilaroi Highway) would increase flood levels at properties immediately upstream of these roads. Given urban Boggabri is upstream of these roads it is possible that flood levels in urban Boggabri could be impacted by any road upgrades. Given the considerable constraints and likely high cost, hydraulic analysis of raising Braymont Road or Rangari Road has not been undertaken in this study.



6.4.3 Aerial evacuation

In rare or extreme flood events it is likely that helicopter or boat supply and/or evacuation will be necessary in the rural areas around Boggabri. The options for landing helicopters in Boggabri would need to be quantified prior to any aerial evacuation. There is a helipad at the Boggabri Multi-Purpose Service, however an alternate landing location would likely be required.

6.5 ROAD SAFETY UPGRADES

6.5.1 Purpose

There were multiple comments received during community consultation about repeated instances of vehicles entering floodwaters and requiring assistance and/or rescue from local landholders, particularly on the Namoi River floodplain east of Boggabri. Locations that were noted in community consultation included:

- Bollol Creek at Rangari Road; and
- Barbers Lagoon causeway (unclear if Braymont Road or Rangari Road).

6.5.2 Potential options

Based on community feedback it is understood that existing signage is not deterring vehicles from attempting to cross flooded road crossings. Feedback indicates that some drivers entering flood waters are workers from nearby mine sites who may not have a good understanding of local conditions.

Additional options to attempt to deter vehicles entering floodwater could include:

- **Temporary road closed signage**, physically placed by Council and/or SES and/or Police on either side of inundation;
 - This option is not preferred as it redirects Council and/or SES and/or Police staff away from other areas and potentially places these resources in danger. There is also a responsibility for staff to monitor road closures and re-open roads when safe to do so;
- **Additional static signage**.
 - This option is not preferred as current static signage is not having the desired effect of stopping vehicles entering floodwaters;
- **Non-static signage** (i.e., signs with flashing lights);
 - This option could be solar powered and automatically triggered by low-cost sensors placed around the invert of floodways;
- **Automated boom gates** that physically close across the road. This option could be solar powered and automatically triggered by low-cost sensors placed around the invert of floodways.
 - This option is not preferred based on community feedback.

Any of the above options should be accompanied with:

- Road closure notice on Council's website (already occurs);
- Education campaigns at nearby mine sites to ensure that mine site staff (who may not be locals) are aware of the flood risk on nearby roads back to Boggabri;
- Early evacuation of nearby mine sites so that staff get back to Boggabri prior to roads being overtopped and / or confirmation that staff can safely stay at site until flooding recedes; and



- Information about possible alternate routes, helping drivers to find higher ground where possible.

6.5.3 Tangible benefits

It is difficult to associate a dollar value cost to the benefits from deterring drivers from entering floodwaters. The intangible benefits to individuals and the community are significant: driving into flood water is the leading cause of flood-related death in Australia.

6.5.4 Estimated cost

There are examples of commercial lighted warning signs available for less than \$7,000 per sign plus installation (an example is: <https://www.customizedled.com.au/product/led-flood-zone-warning-signs/>). Based on community feedback it is likely that four signs would likely be required (one east and one west of both problem locations).

6.6 EVALUATION OF STRUCTURAL MITIGATION OPTIONS

Table 6.4 provides a comparative assessment of the structural mitigation options. A relative ranking ranging from minus 3 (major negative impacts) through to plus 3 (major positive impacts) has been provided for four criteria:

- Tangible benefit (reduction in the number of properties inundated / increase in safety);
- Relative cost;
- Environmental constraint; and
- Social impact (related to the reduction in flooding for smaller events and flood impacts).

An objective ranking has been applied based on the discussion provided in the above sections. Given the disparity between the relative costs and tangible benefits, a comparative ranking has been applied to these criteria.

Based on the investigations conducted in this chapter the following is recommended:

- The voluntary purchase program was ranked the second priority. Voluntary purchase directly addresses the most at-risk properties on the floodplain. This option is recommended for adoption and implementation (subject to further investigation on the benefit cost ratio which may dictate the availability of funding).
- The house raising program has a poor benefit cost ratio for all rounds of the scheme and is therefore unlikely to attract funding. This option is not recommended to be further pursued.
- Road safety upgrades were a common theme in the community consultation, hence will have community support. This is a low cost option that has the potential to save lives. This option is recommended as the highest priority for further consideration.

Table 6.4 Comparative assessment of mitigation options

Option	Tangible benefit	Relative cost	Environmental constraint	Social impact	Total
Voluntary purchase	3	-1	0	1	3
House raising	2	-2	0	1	1
Road safety upgrades	3	1	0	2	6



7 NON-STRUCTURAL FLOOD MANAGEMENT OPTIONS

7.1 EXISTING NON-STRUCTURAL FLOOD MANAGEMENT

NSC currently manage the development of flood prone land via land use zoning within the LEP (refer Figure 2.1) and development requirements specified in the Narrabri Development Control Plans (DCPs).

The LEP defines land use zones in and around Narrabri and defines the flood planning area and flood planning level. The current LEP flood planning area mapping is similar to, but smaller than, the flood planning area shown in Figure 3.3. The LEP stipulates that:

Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development —

- a. is compatible with the flood function and behaviour on the land, and*
- b. will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and*
- c. will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and*
- d. incorporates appropriate measures to manage risk to life in the event of a flood, and*
- e. will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.*

The DCPs set standards for new developments and modifications to existing developments within the flood planning area. The DCP for Exempt & Complying Development references the Narrabri Shire Interim Floodplain Management Policy, which is an extract of the study undertaken by Max Winders & Associates (2002). This extract requires that:

- all habitable floor levels for residential properties shall be at least 0.5 m above the estimated 1% AEP flood level at the site;*
- floor levels for commercial and industrial properties shall be at least 0.1 m above the estimated 2% AEP flood level at the site;*
- a Certificate of Structural Adequacy, prepared by a suitably qualified structural engineer shall be submitted for all buildings to be erected on flood liable land;*
- filling of land affected by the 1% AEP design flood event shall require Council consent where the height of filling exceeds 225 mm.*

Other DCPs also specify several ‘soft’ flood-related requirements that are open to interpretation. The current DCPs do not vary development controls between low and high flood hazard (or flood risk) areas (this information was not published for Boggabri when the DCPs were written).

The flood warning service provided by BOM (Section 5.5.3) is another example of existing non-structural flood management.

7.2 COMMUNITY FEEDBACK

7.2.1 Overview

The community consultation program for the FRMSP is described in Chapter 4. Specific feedback on non-structural flood management measures is detailed below.



7.2.2 Feedback at study commencement

Community consultation undertaken in early 2023 sought feedback on potential flood management options (including non-structural (planning) flood mitigation options). Responses to a community questionnaire and discussions with community members about potential non-structural flood mitigation options revealed:

- Approximately 50% of respondents did not reply to the non-structural/emergency response flood mitigation question;
- Of the approximately 50% who did respond or discussed this with FRMS team members at the community barbecue:
 - There were various concerns about resupply options during times of flood (lack of helicopter landing sites);
 - There was support for minimum floor level requirements;
 - Installation of flood markers in Hull Street showing 1955 flood levels was suggested;
 - Installation of flood markers on the new Boston Street bridge was suggested;
 - There was support for public awareness and flood education programs;
 - There was discussion around the need to keep floodways and flowpaths on the floodplain free of obstructions (farm levee banks, roads etc.);
 - There was concern about the impact of mining and resource extraction land use in the Namoi River catchment affecting flooding; and
 - There was mixed feedback on current land use zoning with some believing no changes were required and others believing that areas near to flooding in 1955 should have zoning reflective of this.

7.2.3 Draft FRMS public exhibition feedback

A draft version of this document was released for public exhibition in late 2023. Responses to a community questionnaire and discussions with community members about non-structural options revealed:

- There was majority support for all of the non-structural management options presented in the draft document for community consultation (increased flood education, modified building and development controls, modified land use zoning and consideration of an upgraded/new Boggabri helipad);
- There was support for additional flood mapping and educational resources that would allow residents to easily relate predicted gauge levels at the Iron Bridge to predicted inundation extents and road closures;
- There was some support and some opposition to flood markers being included in flood education programs;
- There were questions raised about who holds responsibility for progressing investigations of an upgraded/new Boggabri helipad;
- There were concerns expressed about the delineation of the flood risk map, particularly the boundary between high and medium risk in certain specific areas; and



- There were questions about proposed building and development controls and the applicability of the proposed measures in the case of building replacement rather than construction of a new (additional) building.

With majority support for all recommendations in the draft document, all recommendations remain in this FRMSP. Based on the feedback gathered during public exhibition there were minor modifications made to this FRMSP, particularly in relation to improving resupply options, the flood risk mapping and the wording of proposed building and development controls.

7.3 OPTIONS FOR FUTURE NON-STRUCTURAL FLOOD MANAGEMENT

The flood modelling presented in the Boggabri Flood Study, along with the flood behaviour information presented in Section 3 of this report have been used to recommend the following non-structural flood management options be considered for Boggabri:

- A risk-based approach to land use planning, including updated land use zoning and associated building and development controls, with adoption of the optional LEP clause 5.22 Special flood considerations;
- Improved flood forecasting, flood warning systems and strategic emergency response planning (addressed in Section 5.8); and
- Improved public awareness and education; and
- Improved resupply options.

7.4 LAND USE PLANNING - LAND USE ZONING

7.4.1 Purpose

The application of land use zoning is an effective and long-term means of controlling development in flood affected areas. The Australian Disaster Resilience Guideline 7-5 Flood Information to Support Land-use Planning (AIDR, 2017) recommends “limiting the growth in flood risk because of new land uses and development in the floodplain”. Land use zoning is therefore key to restricting or preventing incompatible development on flood prone land.

7.4.2 Considerations

Land use zonings over flood prone land should be based on an objective assessment of flood hazard and risk, environmental and social factors including:

- the NSW Government’s Flood Prone Land Policy;
- whether the land is in a high flood risk area;
- the potential for future development to have an adverse impact on flood behaviour and thereby negatively impact existing development;
- whether adequate access is available during floods;
- whether certain activities should be excluded because of additional or special risk to their users, e.g., accommodation for aged people, hospitals etc.; and
- consideration of existing settlement patterns and planning controls.

7.4.3 Proposed strategy

It is proposed that the zoning of land in and around Boggabri consider the flood function map (Figure 3.5), flood risk information presented in Section 3.7 and the associated risk mapping



(Figure 3.6). Figure 7.1 shows the existing LEP land use zones and the designated floodways (consistent with the extreme and high flood risk zones). Figure 7.1 shows that all the land cover by proposed floodways is currently zoned RU1 or RE1, except for four lots partly covered by proposed floodways. It is recommended that:

- any vacant land within the floodway be zoned as RU1 (primary production) or RE1 or RE2 (public or private recreation) to prevent future development on this land;
- any existing development within floodways be considered for voluntary purchase (refer Section 6.3 discussion), with any that take up voluntary purchase to be followed by removal of those structures and rezoning the lots (per the above); and
- as further flood studies are conducted for the region, once these studies are adopted by NSC the modelling from these further studies be used to expand the flood function and flood risk mapping presented in Sections 3.6 and 3.7 (Figure 3.5 and Figure 3.6).

Given there is some existing development in Boggabri within the flood storage zone (consistent with the medium flood risk zone), the rezoning of land within this area would not be practical. Any future rezoning of RU1 (primary production) to residential, commercial or industrial land uses to encourage development should be preferentially directed toward land covered by low risk or no risk zones (i.e., flood fringe or land outside of the modelled flood extent). This would ensure new development within Boggabri is focused on areas with a suitably low flood risk.

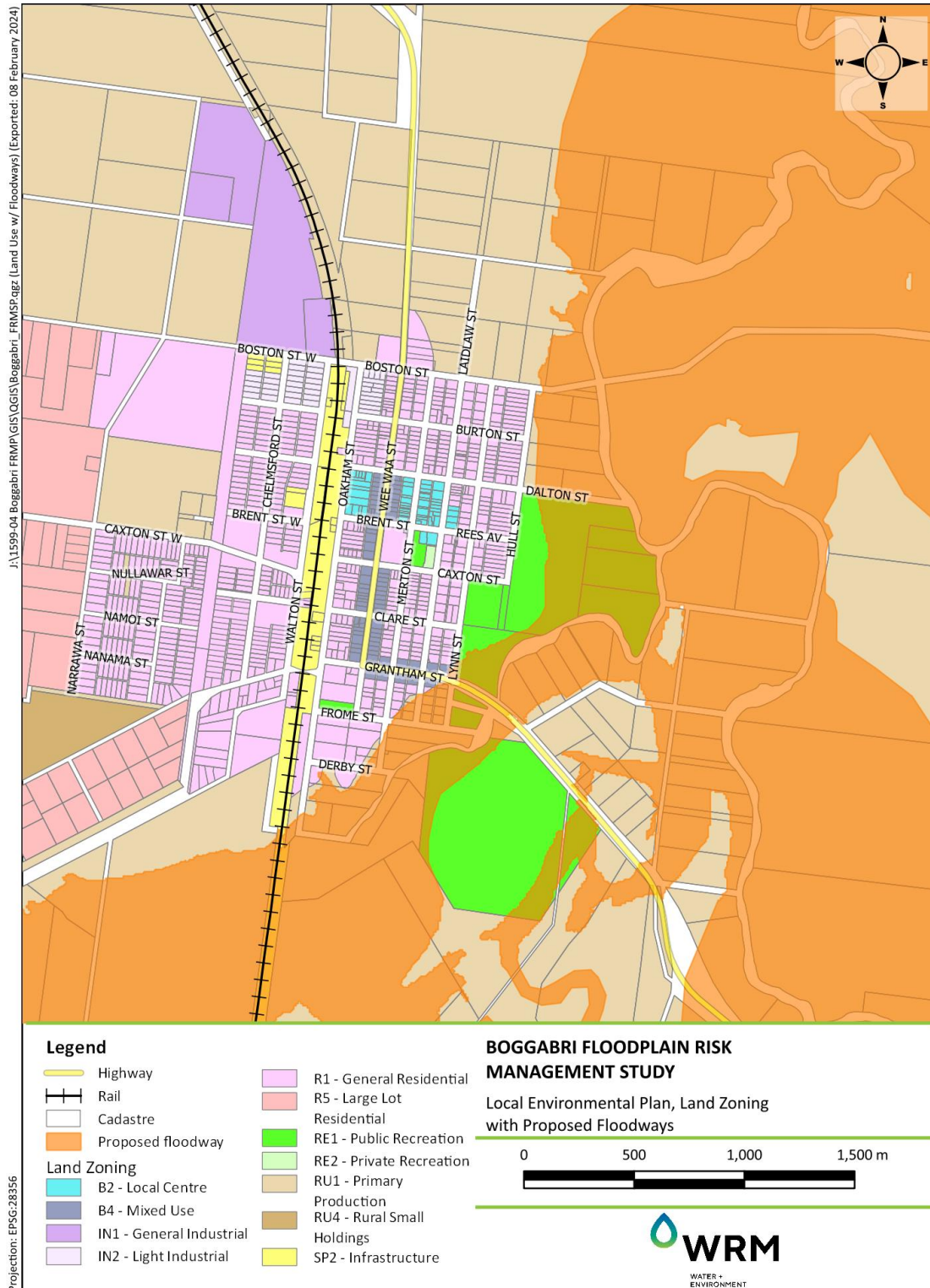


Figure 7.1 Floodway overlaid on existing land use zones



7.5 LAND USE PLANNING - BUILDING AND DEVELOPMENT CONTROLS

7.5.1 Purpose

The NSC DCPs are the primary instrument for managing development on the floodplain to ensure development is compatible with the potential flood risk.

7.5.2 Considerations

Sections of the current NSC DCPs that reference flooding are based on a Narrabri study undertaken by Max Winders & Associates (2002) and the flood planning area (FPA) maps for NSC. The Boggabri FPA map referenced by the DCPs has not been updated in the last decade and appears to have been based on the 1955 flood extent. The flood mapping provided in Section 3 details flood risk, something that was not previously available for Boggabri. The Narrabri Floodplain Risk Management Study and Draft Plan (FRMSP) (WRM, 2023) was recently adopted by NSC and contains recommendations to update the NSC DCPs to consider flood risk mapping. For this reason, the DCP should be updated to reflect this extra information (i.e., Figure 3.6 and Figure 3.7).

In particular, the floodways and high risk zones shown in Figure 3.5 and Figure 3.6 should specifically be addressed in the DCPs (historically the land zoning has reflected the floodways but no specific mention of floodways is made in the current DCPs). Flood management best practice would suggest that further intensification of development within any floodway or high flood risk zone should be prevented. These areas are frequently flooded, generally have poor evacuation access and generally are subject to high flood hazard for moderate sized (frequent) flood events.

The proposed strategy has been formulated considering the existing flood risk in Boggabri (and the recommendations in the recently adopted Narrabri FRMSP). With some population situated in the defined medium flood risk area, allowance is made for small scale intensification of this area, where appropriate, without allowing large scale intensification that would increase flood risk for neighbouring properties and emergency services.

7.5.3 Proposed strategy

It is recommended that development within the flood planning area be managed using the flood risk map (Figure 3.6). The updated flood planning area map (Figure 3.3 - recommended to be included in the DCPs) would be used to define when floodplain development controls would be required, and the flood risk map would be used to define the development controls.

Outlined below are general principles that are recommended for inclusion into the revised DCPs. Some of these measures are consistent with the existing DCPs. While the existing DCPs include specific controls for several areas (in Narrabri), it is proposed that one set of rules be adopted for all of Boggabri and surrounds (consistent with the recommendations made for Narrabri in the Narrabri FRMSP). It is recommended:

For development within flood free land (refer Figure 3.6):

- no flood related development controls be enforced (apart from general drainage related clauses).

For development within the low risk zone (as defined in Figure 3.6):

- the floor level of all new residential buildings be above the flood planning level (0.5% AEP flood level);
- the floor level of all new commercial buildings be above the 1% AEP level;



- where the height of fill for residential single detached dwellings does not exceed 225 mm, the filling need not be assessed for flood impact;
- where the fill for residential development exceeds 225 mm and is greater than 50 m², or more than 20% of the lot area (whichever is smaller), it will be required to be assessed for flood impact;
- foundations and other construction below the flood planning level be of suitable flood compatible materials, or utilise equivalent alternative methods of flood proofing;
- the floor level of a minor extension be required to not be less than the habitable floor level of the existing structure;
- the use and storage of hazardous materials be prohibited at levels below the flood planning level in all circumstances, unless suitably bundled (i.e., service station fuel tanks etc.); and
- for new commercial buildings, a flood management plan would be required to detail what measures would be enacted to reduce flood damage, manage hazardous materials and ensure employees are safe.

For development within the medium risk zone (as defined by Figure 3.6), development controls be per low risk, with the addition of:

- prohibition of land use intensification (i.e., subdivision, construction of additional habitable residential structures on already developed lots);
- prohibition of development for which assisted evacuation would be required (aged care, some medical facilities etc.);
- minor extensions to existing habitable residential buildings would be encouraged to raise the floor level to the flood planning level (not mandatory);
- extensions that increase the gross floor area of a residential dwelling by 50% would be required to have the new floor level above the flood planning level;
- non-habitable buildings such as a shed (Building Code of Australia Class 10A) be constructed with flood resilient materials: and
- all new habitable residential buildings, and extensions of existing habitable residential buildings be required to prepare a flood evacuation plan.

For development within the high risk zone (consistent with the designated floodways) (as defined by Figure 3.6):

- prohibition of all new buildings (not applicable to replacement buildings);
- prohibition of subdivision, which would create an additional building entitlement;
- prohibition of filling, other than that required to fill local depressions to the natural level of the surrounding land;
- prohibition of any extensions to existing buildings within the floodway:
 - with the exception of house raising, which is to be accompanied by an adequate flood management/evacuation plan.

For lots covered by multiple flood risk zones the applicable development controls are based on the portion of the lot on which the development is being planned. It is also recommended that a consistent acceptable flood impact threshold be adopted by NSC. This threshold can be used to evaluate developments with assessable fill. A notional acceptable impact would be 0.01 m on urban zoned land.



7.6 PUBLIC AWARENESS, COMMUNITY CONSULTATION AND EDUCATION

7.6.1 Purpose

Appropriate and timely public response during flooding is related to the level of understanding in the community of:

- the nature, frequency and extent of flooding;
- the rate of rise of floodwaters; and
- the degree of risk.

Therefore, public awareness of the potential flood risk should be an integral and ongoing part of managing flood affected areas.

7.6.2 Considerations

A significant flood event has not occurred in urban Boggabri for over 50 years. Historically the Boggabri community have had a high level of flood awareness, however due to extended low flow conditions and lack of recent significant flooding events, this awareness may be waning. A continuing public education programme is recommended on the basis that a well-prepared community will suffer less damage and other flood related problems during a significant flood event.

Public education is relatively inexpensive and has the potential to reduce the risk to life and property. Significant flood events are infrequent. Therefore, a programme of public information must be ongoing and sustained if it is to be effective.

7.6.3 Proposed strategy

The following public awareness strategies are proposed:

- publish the Boggabri Flood Study (WRM, 2021) on the NSC website [already achieved] and in the Boggabri Library;
- display historical flood marks and the 1% AEP flood level throughout Boggabri and the surrounding areas (i.e., with signs on electricity poles etc.);
- provide flood related property information on the NSC website or make this available to anyone enquiring through NSC, including:
 - property ground level and floor levels;
 - design flood levels; and
 - the flood planning level.
- incorporate the flood risk categorisation map presented in Section 3.7 (Figure 3.6) in the Boggabri DCP alongside the flood planning area mapping (Figure 3.3). Links to this mapping to be prominently displayed on NSC's website;
- send a flier to residents annually, potentially as part of the rates notice reminding residents to review their flood evacuation plan. The flier could highlight Boggabri's exposure to flood risk, identify nominated evacuation centres and provide information on emergency response numbers;
- residents located within designated floodways may need the flier to be hand delivered to ensure all residents (including renters) are aware of the flood risk and know their best evacuation route (and to ensure these residents are aware of the voluntary purchase policy (if adopted by NSC)).



7.7 IMPROVING RESUPPLY OPTIONS

7.7.1 Purpose

Flood mapping undertaken for Boggabri identified that highways and major arterial roads to Boggabri are cut by floodwaters for events as frequent as 20% AEP for some roads. The Kamilaroi Highway north and south of town is cut by floodwaters before a 5% AEP event level is reached, isolating Boggabri by road.

Namoi River flood events can last for days or weeks, so in a significant flood event there is a real possibility that Boggabri township would be isolated by road for multiple days. Without access to road traffic, resupply of essential items for those living in, or taking shelter in Boggabri becomes a concern. Resupply would therefore need to be via rail (unlikely to be feasible in a major flood event), boat (potentially dangerous and difficult to transport large quantities) or by air.

7.7.2 Considerations

The Boggabri Multi-Purpose Service (hospital, ambulance station and residential aged care facility) has a helipad, however this facility should not be relied on for resupply during a flood event as the helipad will likely be required for other purposes (and is reportedly not suitable). The Boggabri Aerodrome is flood-prone in rare flood events and is therefore also unlikely to be an option.

Volume 3 of the Narrabri Shire Flood Emergency Sub Plan states that suitable helicopter landing points in Boggabri are: Boggabri Hospital, Boggabri Sporting Oval and Boggabri Showground (NSW SES, 2023). Boggabri Sporting Oval and Boggabri Showground (and the access roads to these locations) are flood-prone in rare flood events. The Boggabri Hospital (Multi-Purpose Service) helipad issues are discussed above. Hence in a very rare or extreme flood event the suitable landing points identified by the SES are all unlikely to be available. For this reason additional suitable landing points are required to be identified and planned for.

The construction of a helipad elsewhere in town (or upgrade of the Multi-Purpose Service helipad) would provide a known resupply option during times of flood (or other natural disasters). The primary consideration of helipad construction at Boggabri is identifying a location that is accessible and flood free. The flood mapping presented in the Boggabri Flood Study (WRM, 2021) identifies flood free areas of Boggabri for consideration.

7.7.3 Proposed strategy

The organisations responsible for emergency response in times of natural disaster (the local emergency management committee (LEMC), SES and others) should consider possible locations for a helipad and any other ancillary infrastructure that may be required for resupply operations during a significant flood event. Once a preferred location is identified potential funding sources should be investigated. Suitable informal aircraft landing points should be catalogued until such time that the Multi-Purpose Service helipad is upgraded or an additional helipad is constructed,



8 CONCLUSIONS AND RECOMMENDATIONS

This floodplain risk management study and draft plan has highlighted the existing flood risk in Boggabri. The results of hydraulic modelling from the Boggabri Flood Study (WRM, 2021) have been used to assess the flood hazard, which has then been summarised into a single flood risk map, independent of flood severity.

The existing flood risk analysis has been complemented with a comprehensive building flood damage assessment. The total average annual damage to buildings in Boggabri due to flooding has been estimated at \$292,560.

The existing problem, future problem and continuing flood problem have been analysed with various structural measures, non-structural (planning) measures and emergency response measures considered to address these problems.

Following consideration of hydraulic, environmental, economic and social issues, and based on community feedback, few structural flood risk management measures have been assessed and recommended for implementation as part of the Boggabri Floodplain Risk Management Plan. Many non-structural and emergency response measures have instead been assessed and recommended for implementation.

The assessment of all structural and non-structural measures has been subject to community feedback which has informed the prioritisation and refinement of these mitigation measures prior to Council adoption. The structural and non-structural mitigation measures recommended for adoption by Council, in order of highest priority to lowest priority, (i.e., the draft Boggabri Floodplain Risk Management Plan) are given in Table 8.1. Further community consultation and feedback is likely to be beneficial to ensure the successful implementation of the draft Boggabri Floodplain Risk Management Plan (Table 8.1).

**Table 8.1 Recommended floodplain risk management actions for Boggabri**

Action	Report section	Recommendation	Priority	Responsibility	Costing
Flood education plan	7.6	<ul style="list-style-type: none"> Develop and implement an ongoing flood education plan. Display the flood study and floodplain risk management study and draft plan on Council's website and in hardcopy in Boggabri library. 	High	Council/SES	Low
Road safety upgrades	6.5	<ul style="list-style-type: none"> Investigate locations and options for additional signage on commonly flooded road sections. 	High	Council	Low-Medium
Voluntary purchase scheme	0	<ul style="list-style-type: none"> Consult with properties currently identified for voluntary purchase. 	High	Council	Medium-High
Flood warning	5.8.4	<ul style="list-style-type: none"> Converse with BOM about establishing moderate and major flood levels and altering the minor flood level for Boggabri as part of their Namoi and Peel River Valley flood warning system. Converse with BOM about establishing flood forecasting and warning services for Coxs Creek. 	High	Council/SES/BOM	Low
Building floor levels and flood levels	5.8.5	<ul style="list-style-type: none"> Enable access to building floor level information (where available) and flood level information upon request. 	High	Council	Low
Building and development controls	7.5	<ul style="list-style-type: none"> Incorporate flood risk map into the DCPs. Consider proposed flood risk measures in DCP updates. 	Medium	Council	Low
Narrabri Shire Flood Emergency Sub Plan	5.8	<ul style="list-style-type: none"> Review and update the Narrabri Shire Flood Emergency Sub Plan to incorporate the latest information on flood risks to properties and include additional information on road inundation and flood warning. Update references to evacuation centres and update suitable helicopter landing points to include at least one location that will be available in a very rare or extreme flood event. Communicate the updates and content of the plan to the community. 	Medium	SES	Low
Boggabri helipad	7.7	<ul style="list-style-type: none"> Consider potential locations for construction of a helipad. Investigate funding sources for construction/upgrade of a helipad. 	Medium	LEMC	Medium-High
Land use zoning	7.4	<ul style="list-style-type: none"> Consider rezoning parts of vacant lots zoned RE1 or RE2 that are partly covered by proposed floodways. 	Low	Council	Low
Voluntary house raising scheme	0	<ul style="list-style-type: none"> Benefit cost ratio not sufficient to access funding. Do not progress. 	Do not progress	N/A	N/A



9 REFERENCES

- ABS, 2021 Australian Bureau of Statistics, Search Census Data, (accessed 15 June 2023) <<https://www.abs.gov.au/census/find-census-data/search-by-area>>.
- AIDR, 2017 *'Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia'* Commonwealth of Australia 2017 third edition.
- Ball et al., 2019 *'Australian Rainfall and Runoff: A Guide to Flood Estimation'*, Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) Commonwealth of Australia (Geoscience Australia), 2019.
- BOM, 2013 *'Service Level Specification for Flood Forecasting and Warning Services for New South Wales and the Australian Capital Territory – Version 3.13'*, Australian Government Bureau of Meteorology, 2013.
- CSIRO & BOM, 2015 *'Central Slopes Cluster Report, Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports'*, eds. Ekström, M et al., CSIRO and Bureau of Meteorology, Australia, 2015.
- Geoscience Australia, 2019 AR&R Datahub (software), Geoscience Australia, Version 2022_v1, September 2022, <<http://data.arr-software.org/>>.
- Laurie, Montgomerie & Pettit, 1980 *'Namoi Valley: Flood Mitigation Study'*, Laurie, Montgomerie & Pettit Pty Ltd, NSW, June 1980.
- Laurie, Montgomerie & Pettit, 1982 *'New South Wales Inland Rivers Flood Plain Management Studies: Summary Report – Namoi Valley'*, Laurie, Montgomerie & Pettit Pty Ltd, NSW, 1982.
- Max Winders & Associates, 2002 *'Narrabri Supplementary Floodplain Management Study'*, Max Winders & Associates, QLD, February 2002.
- Molino Stewart, 2014 *'Moree House Raising Scheme: Final Report'*, Molino Stewart, Parramatta, NSW, May 2014.
- Molino Stewart, 2016 *'State of the Environment Report: Moree and Narrabri Local Government Areas (2015-2016)'*, report prepared for Moree Plains Shire Council and Narrabri Shire Council, Molino Stewart, Parramatta, NSW, 2016.
- Namoi CMA, 2013 *'Narrabri Catchment Action Plan 2010-2020: 2013 Update'*, Namoi Catchment Management Authority, NSW, August 2013.
- NSC, 2012 *'Narrabri Local Environmental Plan 2012'*, Narrabri Shire Council, NSW, current version 26 April 2023.
- NSW DNR, 2005 *'Upper Coxs Creek Floodplain Management Plan'*, NSW Department of Natural Resources, Sydney NSW, November 2005.
- NSW DNR, 2006 *'Carrol to Boggabri Floodplain Management Plan'*, NSW Department of Natural Resources, Sydney NSW, September 2006.
- NSW DPE, 2022 *'Flood Function: Flood Risk Management Guide FB02'*, New South Wales Government, NSW Department of Planning and Environment, NSW, February 2022.
- NSW DPE, 2023 NSW Department of Planning and Environment website, (accessed 13 June 2023) <<https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species>>.



NSW Government, 2005 *'Floodplain Development Manual – the management of flood liable land'*, New South Wales Government, Department of Infrastructure, Planning and Natural Resources, NSW, April 2005.

NSW Government, 2007 *'Flood Risk Management Guideline: Flood Emergency Response Planning Classification Of Communities'*, New South Wales Government, Department of Environment and Climate Change, NSW, October 2007.

NSW Government, 2014 *'New South Wales Climate change snapshot'*, New South Wales Government, Office of Environment and Heritage, NSW, November 2014.

NSW Government, 2019 *'Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019'*. State of NSW, June 2019.

NSW Government, 2023 *'Floodplain risk management manual – the policy and manual for the management of flood liable land'*, New South Wales Government, Department of Planning and Environment, NSW, June 2023.

NSW OEH, 2013 *'Lower Coxs Creek Floodplain Management Plan'*, New South Wales Government, Office of Environment and Heritage, NSW, July 2013.

NSW OEH, 2019 *'Floodplain Risk Management Guide: Incorporating 2016 Australian Rainfall and Runoff in Studies'*, New South Wales Government, Office of Environment and Heritage, NSW, January 2019.

NSW SES, 2023 *'Narrabri Shire Local Flood Emergency Sub Plan'*, Version 3.0, New South Wales State Emergency Service, NSW, November 2023.

REA Group, 2023 realestate.com.au website, (accessed 1 August 2023) <<https://www.realestate.com.au/nsw/boggabri-2382/?sourcePage=rea:sold:pdp&sourceElement=suburb-profile&bed=3>>.

WRM, 2021 *'Boggabri Flood Study'*, Report prepared for Narrabri Shire Council by WRM Water & Environment Pty Ltd, QLD, January 2021.

WRM, 2023 *'Narrabri Floodplain Risk Management Study and Draft Plan'*, Report prepared for Narrabri Shire Council by WRM Water & Environment Pty Ltd, QLD, May 2023.



10 GLOSSARY

annual exceedance probability (AEP)	the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. (see ARI)
Australian Height Datum (AHD)	a common national surface level datum approximately corresponding to mean sea level.
average recurrence interval (ARI)	the long-term average number of years between the occurrence of a flood as big as or larger than the selected event.
catchment	the land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
development control plan (DCP)	provides detailed planning and design guidelines to support the planning controls in the Local Environmental Plan (LEP).
discharge	the rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m ³ /s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).
effective warning time	the time available after receiving advice of an impending flood and before floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.
emergency management	a range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
flash flooding	flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.
flood	relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunamis.
flood awareness	an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.
flood fringe areas	the remaining area of flood prone land after floodway and flood storage areas have been defined.
flood liable land	is synonymous with flood prone land, i.e., land susceptible to flooding by the PMF event. Note that the term flood liable land covers the whole floodplain, not just that part below the FPL (see flood planning area).
flood mitigation standard	the average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding.
floodplain	area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
floodplain risk management options	the measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.
floodplain risk management plan	a management plan developed in accordance with the principles and guidelines in the Manual. Usually includes both written and



	<p>diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.</p>
flood plan (local)	<p>a sub-plan of a disaster plan that deals specifically with flooding. They can exist at state, division and local levels. Local flood plans are prepared under the leadership of the SES.</p>
flood planning area	<p>the area of land below the FPL and thus subject to flood related development controls.</p>
flood planning levels (FPLs)	<p>are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans.</p>
flood prone land	<p>land susceptible to flooding by the PMF event. Flood prone land is synonymous with flood liable land.</p>
flood proofing	<p>a combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.</p>
flood readiness	<p>readiness is an ability to react within the effective warning time.</p>
flood risk	<p>potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in the Manual is divided into 3 types, existing, future and continuing risks. They are described below.</p> <p>existing flood risk: the risk a community is exposed to as a result of its location on the floodplain.</p> <p>future flood risk: the risk a community may be exposed to as a result of new development on the floodplain.</p> <p>continuing flood risk: the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.</p>
flood storage areas	<p>those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.</p>
floodway areas	<p>those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.</p>
freeboard	<p>an additional margin that provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the flood planning level.</p>
FRMAC	<p>floodplain risk management advisory committee. The Narrabri Shire Council FRMAC is an advisory committee to council tasked with assisting in the development and implementation of floodplain risk management plans.</p>



hazard	a source of potential harm or a situation with a potential to cause loss. In relation to this study the hazard is flooding which has the potential to cause damage to the community. Definitions of high and low hazard categories are provided in Appendix L of the Floodplain Development Manual (NSW Government, 2005).
historical flood	a flood which has actually occurred.
hydraulics	term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.
hydrograph	a graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
hydrology	term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
local environmental plan (LEP)	guide planning decisions for local government areas. They do this through zoning and development controls, which provide a framework for the way land can be used.
mathematical / computer models	the mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.
MIKE-FLOOD	one-dimensional and two-dimensional flood simulation software. It simulates the complex movement of floodwaters across a particular area of interest using mathematical approximations to derive information on floodwater depths, velocities and levels.
peak discharge	the maximum discharge occurring during a flood event.
probability	a statistical measure of the expected chance of flooding (see annual exceedance probability).
probable maximum flood (PMF)	the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event.
probable maximum precipitation (PMP)	the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.
risk	chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the Manual, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
runoff	the amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
stage	equivalent to water level (both measured with reference to a specified datum).
stage hydrograph	a graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum.
velocity	the speed or rate of motion (distance per unit of time, e.g., metres per second) in a specific direction at which the flood waters are moving.
water surface profile	a graph showing the flood stage at any given location along a watercourse at a particular time.

APPENDIX A PROPERTY FLOODING MAPS

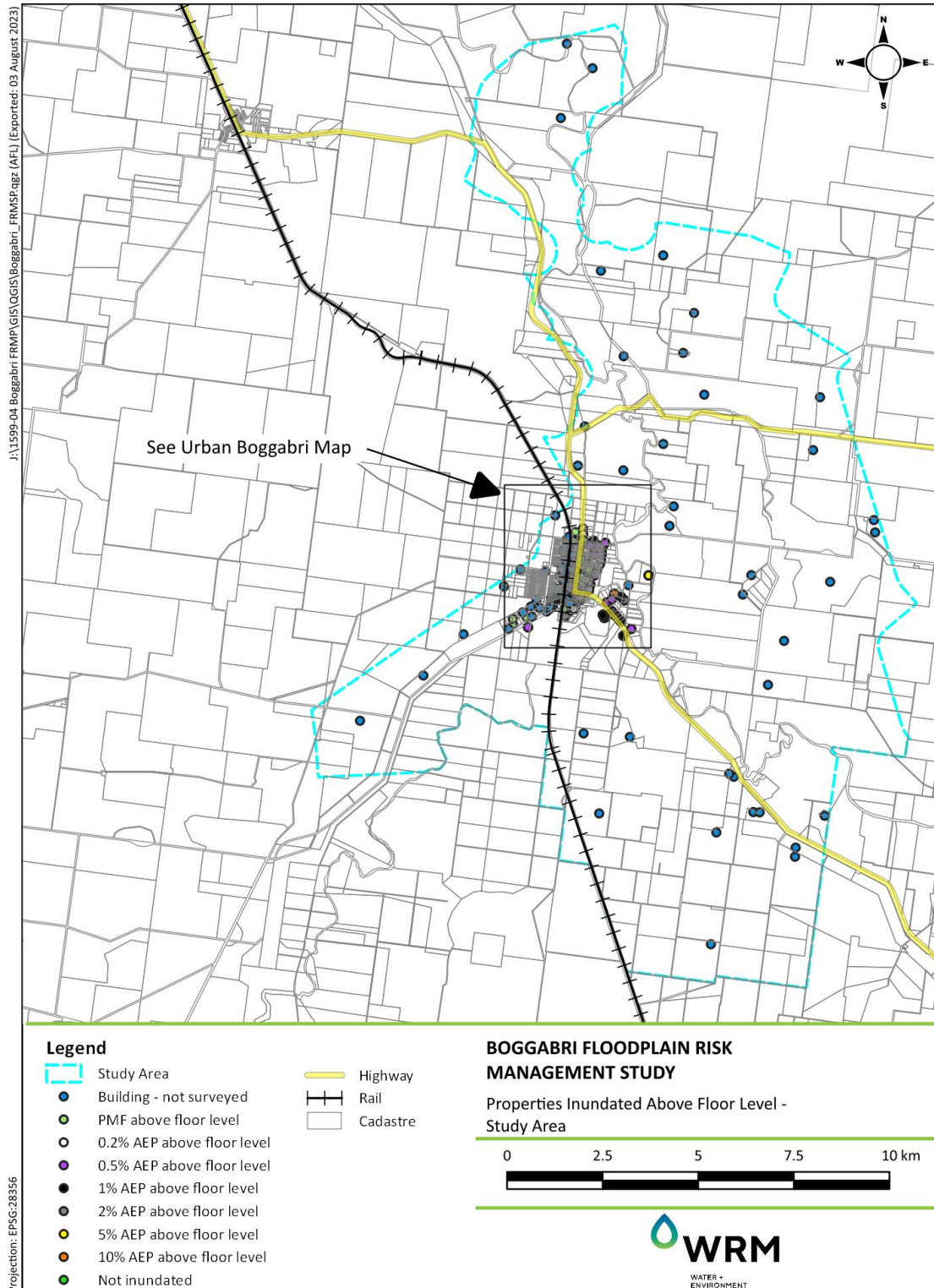


Figure A.1 Properties inundated above floor level, Boggabri and surrounds

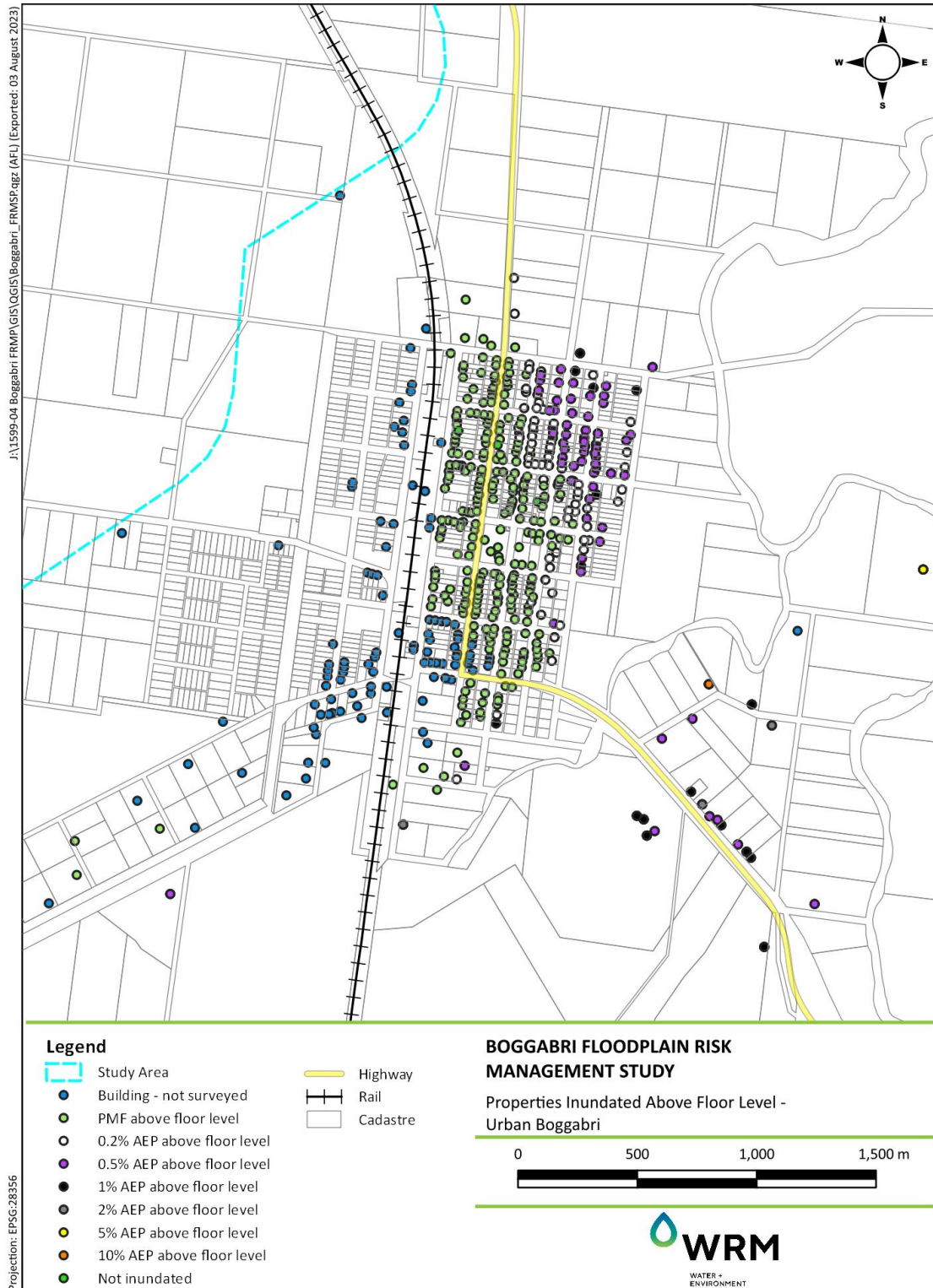


Figure A.2 Properties inundated above floor level, urban Boggabri



APPENDIX B EMERGENCY RESPONSE COMMUNITY MAPPING

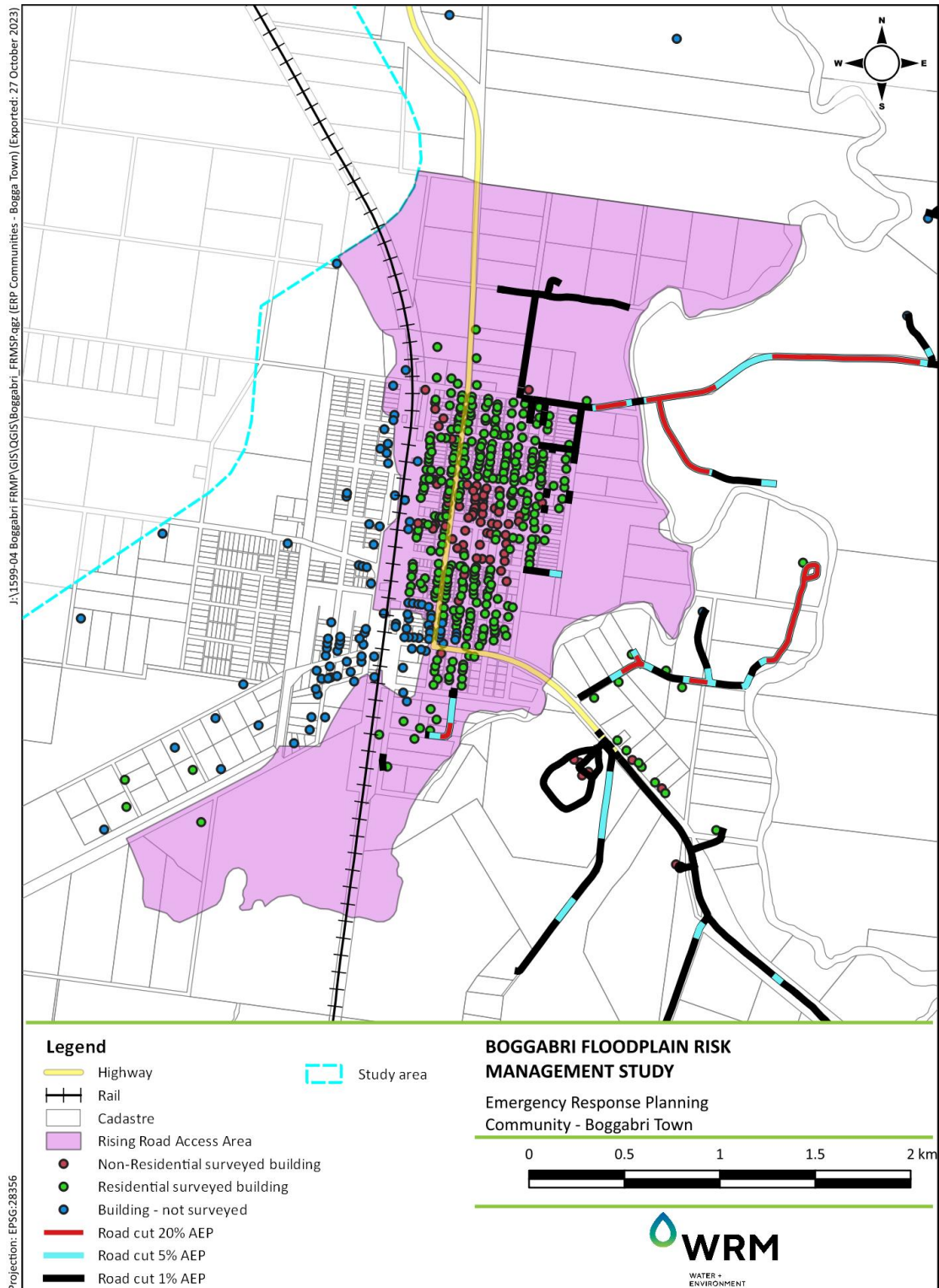


Figure B.1 Boggabri Town ERP community

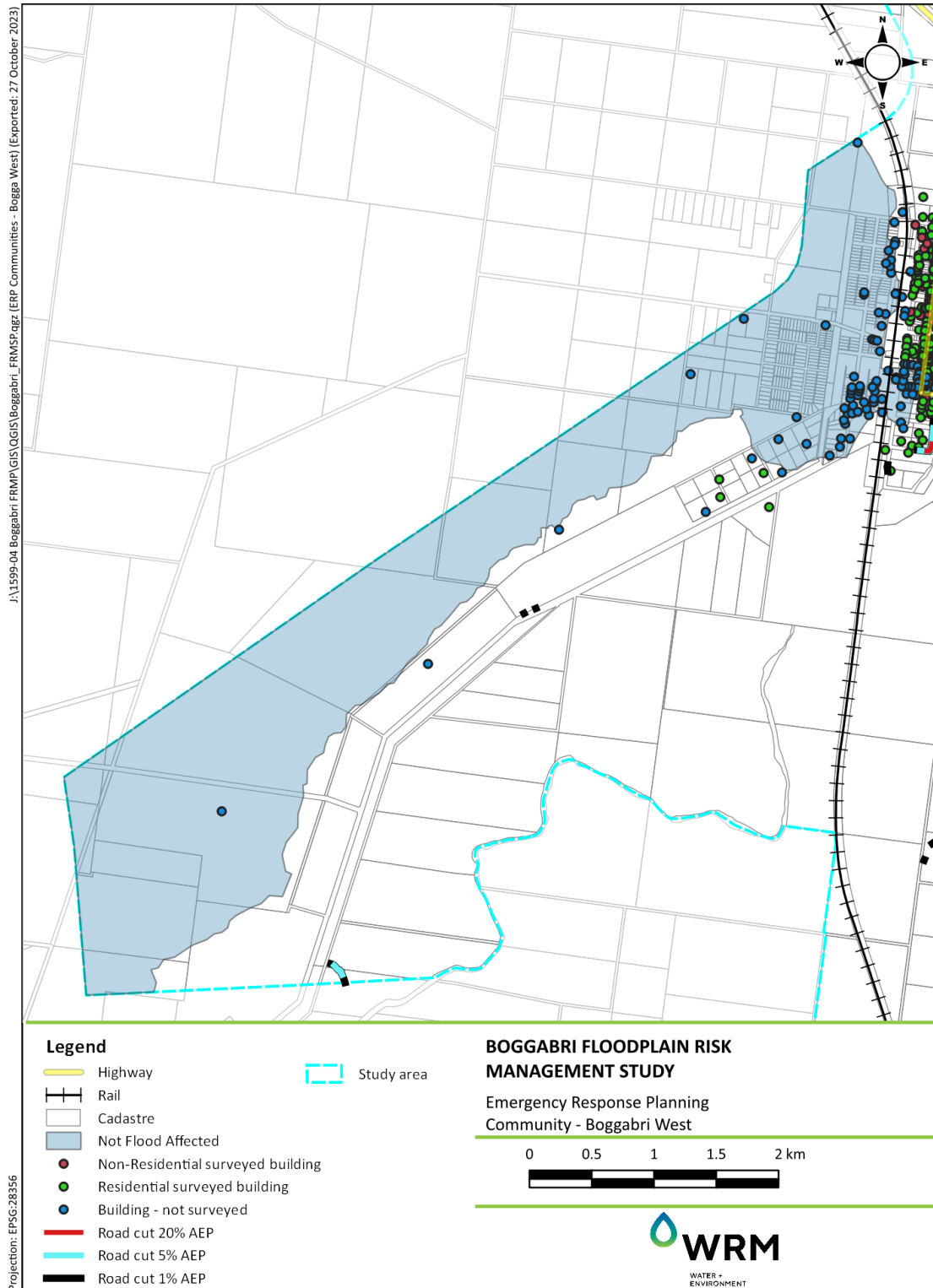


Figure B.2 Boggabri West ERP community

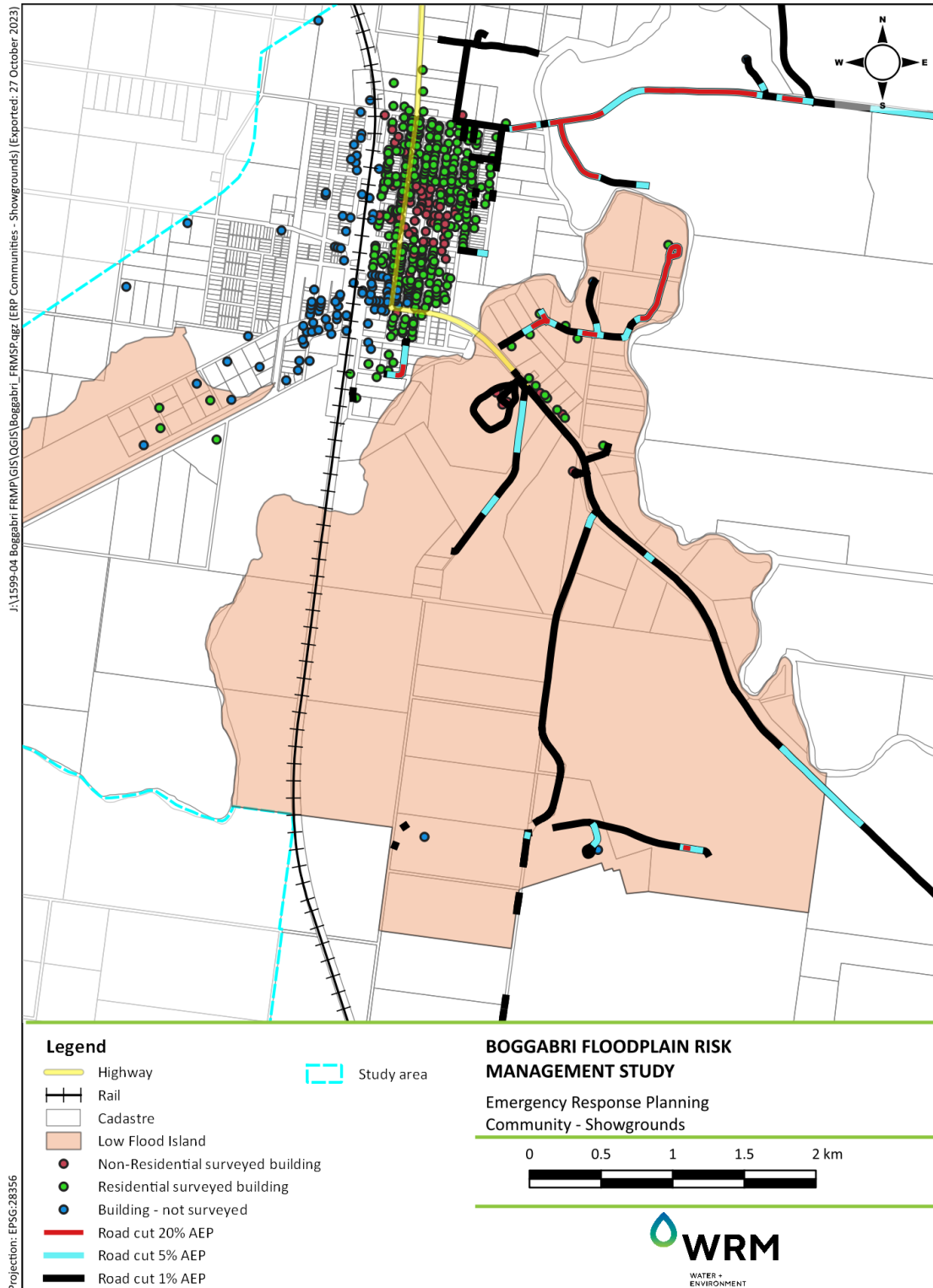


Figure B.3 Showgrounds ERP community

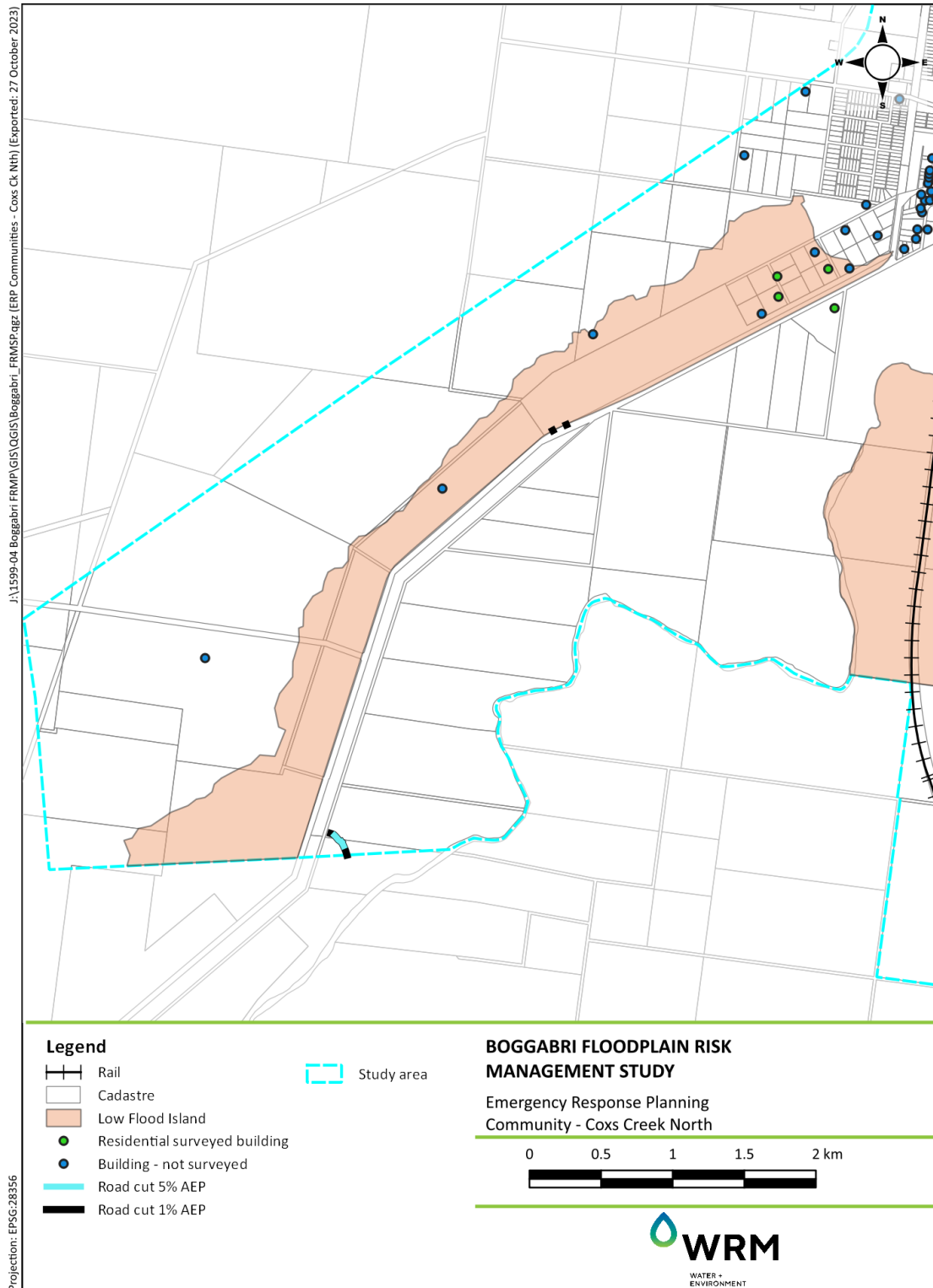


Figure B.4 Coks Creek North ERP community

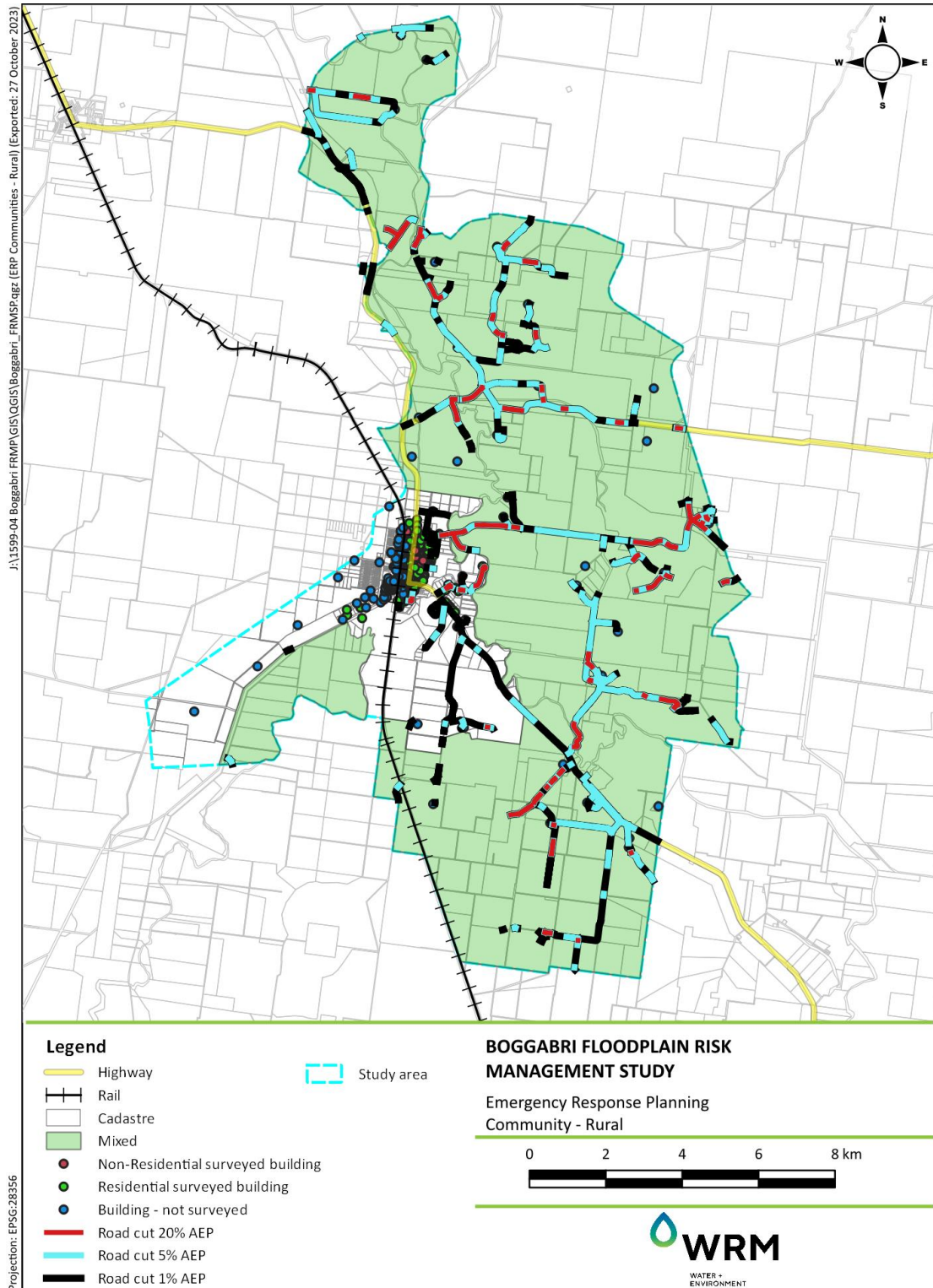


Figure B.5 Rural ERP community



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