

# FEDERATION VILLAGES FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN

FINAL





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## FEDERATION VILLAGES FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN

**FINAL**

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## LIST OF ACRONYMS

AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
ALS	Airborne Laser Scanning
ARR	Australian Rainfall and Runoff
BOM	Bureau of Meteorology
DECC	Department of Environment and Climate Change (now DPIE)
DNR	Department of Natural Resources (now DPIE)
DPIE	Department of Planning Industry and Environment
DRM	Direct Rainfall Method
DTM	Digital Terrain Model
GIS	Geographic Information System
GPS	Global Positioning System
IFD	Intensity, Frequency and Duration (Rainfall)
mAHD	meters above Australian Height Datum
OEH	Office of Environment and Heritage (now DPIE)
PMF	Probable Maximum Flood
SRTM	Shuttle Radar Topography Mission
TUFLOW	one-dimensional (1D) and two-dimensional (2D) flood and tide simulation software (hydraulic model)
WBNM	Watershed Bounded Network Model (hydrologic model)

## ADOPTED TERMINOLOGY

Australian Rainfall and Runoff (ARR, ed Ball et al, 2019) recommends terminology that is not misleading to the public and stakeholders. Therefore the use of terms such as “recurrence interval” and “return period” are no longer recommended as they imply that a given event magnitude is only exceeded at regular intervals such as every 100 years. However, rare events may occur in clusters. For example there are several instances of an event with a 1% chance of occurring within a short period, for example the 1949 and 1950 events at Kempsey. Historically the term Average Recurrence Interval (ARI) has been used.

ARR 2019 recommends the use of Annual Exceedance Probability (AEP). Annual Exceedance Probability (AEP) is the probability of an event being equalled or exceeded within a year. AEP may be expressed as either a percentage (%) or 1 in X. Floodplain management typically uses the percentage form of terminology. Therefore a 1% AEP event or 1 in 100 AEP has a 1% chance of being equalled or exceeded in any year.

ARI and AEP are often mistaken as being interchangeable for events equal to or more frequent than 10% AEP. The table below describes how they are subtly different.

For events more frequent than 50% AEP, expressing frequency in terms of Annual Exceedance Probability is not meaningful and misleading particularly in areas with strong seasonality. Therefore, the term Exceedances per Year (EY) is recommended. Statistically a 0.5 EY event is not the same as a 50% AEP event, and likewise an event with a 20% AEP is not the same as a 0.2 EY event. For example an event of 0.5 EY is an event which would, on average, occur every two years. A 2 EY event is equivalent to a design event with a 6 month Average Recurrence Interval where there is no seasonality, or an event that is likely to occur twice in one year.

The Probable Maximum Flood is the largest flood that could possibly occur on a catchment. It is related to the Probable Maximum Precipitation (PMP). The PMP has an approximate probability. Due to the conservativeness applied to other factors influencing flooding a PMP does not translate to a PMF of the same AEP. Therefore an AEP is not assigned to the PMF.

This report has adopted the approach recommended by ARR and uses % AEP for all events rarer than the 50 % AEP and EY for all events more frequent than this.

Frequency Descriptor	EY	AEP (%)	AEP	ARI
			(1 in x)	
Very Frequent	12			
	6	99.75	1.002	0.17
	4	98.17	1.02	0.25
	3	95.02	1.05	0.33
	2	86.47	1.16	0.5
	1	63.21	1.58	1
Frequent	0.69	50	2	1.44
	0.5	39.35	2.54	2
	0.22	20	5	4.48
	0.2	18.13	5.52	5
Rare	0.11	10	10	9.49
	0.05	5	20	19.5
	0.02	2	50	49.5
	0.01	1	100	99.5
Very Rare	0.005	0.5	200	199.5
	0.002	0.2	500	499.5
	0.001	0.1	1000	999.5
	0.0005	0.05	2000	1999.5
Extreme	0.0002	0.02	5000	4999.5
			↓	
			PMP/ PMP Flood	

## FOREWORD

The NSW State Government's Flood Prone Land Policy provides a framework to ensure the sustainable use of floodplain environments. The primary objective of the NSW Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods. At the same time, the Policy provides a means of ensuring that any new development is compatible with the flood hazard and does not create additional flooding problems in other areas.

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 Policy provides for technical and financial support by the Government through four sequential stages:

1. ***Data Collection***
  - Compilation of existing data and collection of additional data.
2. ***Flood Study***
  - Determine the nature and extent of the flood problem.
3. ***Floodplain Risk Management Study***
  - Determines and evaluates options in consideration of social, ecological and economic factors relating to flood risk.
4. ***Floodplain Risk Management Plan***
  - Plan of management for the floodplain including preferred options is publicly exhibited and public and stakeholder feedback is considered in the finalisation of the Plan. Formally adopted by Council after public exhibition of the final Plan.
5. ***Implementation of the Plan***
  - Implementation of flood mitigation works and measures to protect existing development, use of planning policies and controls to ensure new development is compatible with the flood risk and the incorporation of study outputs to improve flood preparedness and response.

The Federation Villages Floodplain Risk Management Study and Plan constitutes the third and fourth stage of the management process for Federation Council and is based on the prior flood study for the catchment (Reference 7) completed in 2017.

## 1. INTRODUCTION

This Study has been prepared by WMAwater on behalf of Federation Council (Council). The Study builds on flood modelling initially developed in the towns of Morundah, Boree Creek, Oaklands, Rand and Urana in the Federation Villages Flood Study (Jacobs, 2017, Reference 7). Work undertaken in these studies has been expanded upon in this Floodplain Risk Management Study and Plan (FRMS&P) to further understand and determine the nature and extent of the flood risk within each village, and to investigate and recommend potential flood risk management strategies, aligning with current best practice.

### 1.1. Structure of this Report

This FRMS&P relates to the definition and mitigation of flood risk in five villages. Each village is subject to distinct types of flood risk, being located on different river or creek systems, and having unique topographic and demographic characteristics. As such, the estimation of design flood behaviour (via hydrologic and hydraulic modelling) and assessment of flood risk mitigation options (particularly structural options) has been undertaken for each village individually. Conversely, as each village is located within the Federation Council LGA, matters relating to planning and development, and to an extent, emergency response management, will need to be managed consistently across the five villages as well as other communities in the LGA. For these reasons the following report structure has been adopted:

Table 1 Report Structure

Section	Contents
<b>Main Report</b>	Background document containing: <ul style="list-style-type: none"> <li>• Introduction to the NSW Floodplain Risk Management Process;</li> <li>• Overview of flood risk in each village;</li> <li>• Community Consultation;</li> <li>• Review of current planning policies</li> <li>• Economic Impacts of Flooding across all villages;</li> <li>• Introduction to flood risk mitigation options;</li> <li>• Consideration of options assessed for all villages;</li> <li>• Summary of options assessed in each village;</li> <li>• Multi-Criteria Matrix Assessment</li> <li>• Amalgamated Floodplain Risk Management Plan</li> </ul>
<b>Appendix A - E</b>	One appendix per village, containing: <ul style="list-style-type: none"> <li>• Background Information;</li> <li>• Review of previous studies and available data;</li> <li>• Flood model revisions and updates;</li> <li>• Design Flood Behaviour (including figures);</li> <li>• Assessment of Flood Risk Modification Measures</li> </ul>

## 1.2. Study Objectives

The overarching objective of the Floodplain Risk Management Study and Plan is to improve understanding of flood behaviour and impacts in the Federation Council Villages, and better inform management of flood risk in the study area in consideration of the available information, and relevant standards and guidelines, such as the NSW Government's Flood Prone Land Policy and the "Floodplain Development Manual: the management of flood liable land", New South Wales Government, April 2005 (Reference 5).

The Floodplain Risk Management Study will increase understanding of the impacts of floods on the existing and future community. It also allows testing and investigation of practical, feasible and economic management measures to treat existing, future and residual risk. The floodplain risk management study will provide a basis for informing the development of a floodplain risk management plan. The tasks required to achieve these objectives are more specifically described in Section 1.2.1 and 1.2.2 below.

### 1.2.1. Floodplain Risk Management Study Objectives

The objective of the Floodplain Risk Management Study is to investigate a range of flood mitigation works and measures to address the existing, future and continuing flood problems, in accordance with the NSW Government's Flood Policy. This includes:

- Review the current Flood Studies for the Towns of Urana, Morundah, Boree Creek, Oaklands and Rand, Jacobs Group 2017 and update the modelling to ensure consistency with the updated Australian Rainfall and Runoff, 2019 (ARR 2019) then re-assess the design flood discharges, velocities and flood levels for the Study Areas using the latest available data and technology, as appropriate. Up to date information is required for the full range of potential flood events i.e. up to the Probable Maximum Flood or an appropriate extreme flood.
- Review Council's existing environmental planning policies and instruments including the Council's long-term planning strategies for the study areas.
- Identify works, measures and restrictions aimed at reducing the social, environmental and economic impacts of flooding and the losses caused by flooding on the development and the communities, both existing and future, over the full range of potential flood events and taking into account the potential impacts of climate change. Council is looking for innovative solutions to the management of the flood hazards within the study areas and requires effective community consultation and participation throughout the Studies;
- To assess the effectiveness of these works and measures for reducing the effects of flooding on the communities and development, both existing and future and taking into account the potential impacts of climate change;
- To consider whether the proposed works and measures might produce adverse effects (environmental, social, economic, or flooding) in the floodplain and whether they can be minimised;
- In terms of the Department of Planning Industry and Environment Planning Circular PS 21-006 and Considering Flooding in Land Use Planning Guideline, determine how land use planning might consider flooding and flood related constraints.

- Review the local flood plan, identify deficiencies in information and address the issues identified in the DPIE Guideline “SES Requirements from the FRM Process.”
- Examination of the present flood warning systems, community flood awareness and emergency response measures in the context of the NSW State Emergency Service's developments and disaster planning requirements.
- Examine ways in which the river and floodplain environment may be enhanced without having a detrimental effect on flooding;
- Identification of modifications required to current policies in the light of investigations.

### **1.2.2. Floodplain Risk Management Draft Plan Objectives**

The Floodplain Risk Management Draft Plan makes a range of recommendations relating to flood mitigation works and measures that address the existing, future and continuing flood problems, in accordance with the NSW Government's Flood Prone Land Policy. The recommended works and measures presented in the Plan aim to:

- Reduce the flood hazard and risk to people and property in the existing communities and to ensure future development is controlled in a manner consistent with the flood hazard and risk (taking into account the potential impacts of climate change).
- Reduce private and public losses due to flooding.
- Protect and where possible enhance the river and floodplain environment.
- Be consistent with the objectives of relevant State policies, in particular, the Government's Flood Prone Land and State Rivers and Estuaries Policies and satisfy the objectives and requirements of the Environmental Planning and Assessment Act, 1979.
- Ensure that the draft floodplain risk management plans are fully integrated with Council's existing corporate, business and strategic plans, existing and proposed planning proposals, meets Council's obligations under the Local Government Act, 1993 and has the support of the local communities.
- Ensure actions arising out of the draft plans are sustainable in social, environmental, ecological and economic terms.
- Ensure that the draft floodplain risk management plans are fully integrated with the local emergency management plan (flood plan) and other relevant catchment management plans.
- Establish a program for implementation and suggest a mechanism for the funding of the plans and should include priorities, staging, funding, responsibilities, constraints, and monitoring.

## 2. OVERVIEW OF FLOOD RISK IN THE FEDERATION VILLAGES

A detailed description of the flood risk in each of the villages is provided in the respective appendices, with a brief overview provided below for context.

### 2.1. Boree Creek

The village of Boree Creek is located adjacent to Boree Creek, approximately 82 km west of the regional centre, Wagga Wagga. The region, including the town itself and surrounds, has a total population of 298 (2016 Census), and 121 private dwellings. Boree Creek drains a catchment area of approximately 141 km<sup>2</sup> to the town which flows in a south-westerly direction along the southern edge of the township. The creek continues southwest to Lake Cullivel and is joined by Brookong Creek before flowing into Urangeline Creek which discharges into Lake Urana.

The village of Boree Creek is affected by mainstream flooding from Boree Creek in events as frequent as a 20% AEP event. In a 1% AEP event, as many as 34 residential properties and 11 non-residential properties would be flooded above floor level. The Rock – Oaklands railway runs east-west through Boree Creek, with the embankment roughly perpendicular to Boree Creek. The railway embankment forms a major obstruction to flows and contributes substantially to flooding on the northern side of the railway line. In addition, access to the town is restricted by flood waters on all major roads, as observed in March 2012, which had a simulated peak flow of 270 m<sup>3</sup>/s (Reference 7), which is estimated as being between a 5% AEP and 2% AEP event (based on flood estimates derived using ARR 2019 methodologies). A full description of flood risk in Boree Creek, including design flood behaviour, and assessment of flood modification options, is provided in Appendix A.

### 2.2. Morundah

Morundah is the northern-most village in the Study Area, located approximately 31 km southwest of Narrandera and 44 km north of Urana. It is a small town in the Riverina region of New South Wales with a total regional population of 69 (2016 Census), and 53 private dwellings. The town is located on the left bank of the Colombo Creek, an effluent of Yanco Creek. The Tarabah Weir regulates the interaction of the two creeks and is located approximately 6 km north of the Morundah Village. Exchange of water between Yanco and Colombo Creeks also occurs naturally along the floodplain.

An earthen levee approximately 3.2 km in length is situated between the Morundah township and Colombo Creek, though its level of protection is not formally known. Local runoff from the local catchment to the east and north of the town (approximately 17.5 km<sup>2</sup>) contributes to Morundah's flood risk, particularly if it cannot drain through the levee in a timely manner. In the March 2012 event, for example, heavy rain over the local catchment caused local overland flows, affecting residential properties, while Colombo Creek peaked approximately one week later, reportedly overtopping the levee at nine locations and seeping into the racecourse area. Substantial works were undertaken following this event to raise the height of the levee on Crown land. A full description of flood risk in Morundah, including design flood behaviour, and assessment of flood modification options, is provided in Appendix B.



### **2.3. Oaklands**

Located approximately 105 km northwest of Albury, the Oaklands township has a population of 227 (2016 Census, region), and 134 private dwellings. Oaklands is located approximately 2 km south of Nowranie Creek, and is elevated some 20 m above the creek level. As such, the township is outside of the Nowranie Creek floodplain and is not subject to mainstream flood risk from this creek. Flood risk in Oaklands, rather, stems from overland flow generated by local rainfall. Characterised by shallow sheet flow, the flood risk is relatively limited, however does cause nuisance inundation of roads and lower lying parts of Oaklands. A full description of flood risk in Oaklands, including design flood behaviour, and assessment of flood modification options, is provided in Appendix C.

### **2.4. Rand**

The Rand township is located approximately 120 km south west of Wagga Wagga and 58 km northwest of Albury. The township straddles Billabong Creek and the region has a population of approximately 204 (2016 Census), and 110 private dwellings. Despite its proximity to Billabong Creek, Rand is elevated above the deeply incised creek channel, and protected by an informal levee along the right bank of the creek (travelling upstream to downstream). As such, the flood risk to residential and non-residential properties is relatively limited, with out-of-bank flow only affecting dwellings and other buildings in events equivalent to and rarer than the 0.2% AEP event. However, breakouts from Billabong Creek away from town can overtop roads (particularly Urana Road to the south) and restrict access for days or even weeks at a time. A full description of flood risk in Rand, including design flood behaviour, and assessment of flood modification options, is provided in Appendix D.

### **2.5. Urana**

The Urana township is located approximately 100 km northwest of Albury and 100 km southwest of Wagga Wagga. The Urana region has a population of approximately 384 (2016 Census) and 228 private dwellings, making it the largest of the Federation Villages included in this Study. Urangeline Creek runs adjacent to the township on its eastern side, just before discharging into Lake Urana which is approximately four kilometres to the west of the township. Urangeline Creek has a catchment area of approximately 2370 km<sup>2</sup> at Lake Urana. Tributaries of Urangeline Creek include Boree Creek and Brookong Creek from the north and Washpool Creek and Sandhill Creek from the south.

Flood risk in Urana arises from mainstream flooding when the banks of Urangeline Creek are overtopped, which occurs in events as frequent as a 10% AEP event, inundating approximately 6 properties over floor on the western side of town. Urangeline Creek is also affected by overland flow generated by local rainfall, draining from east to west towards the creek. There are a number of locations throughout Urana where nuisance ponding over roads and driveways occurs as a result of this overland flow. South of town, an overland flowpath travels through an area known locally as 'the tombstones', restricting southern access on Federation Way. A full description of flood risk in Urana, including design flood behaviour, and assessment of flood modification options, is provided in Appendix E.

### 3. STAKEHOLDER ENGAGEMENT

One of the central objectives of the FRMS&P process is to actively engage with the community and stakeholders throughout the process to achieve the following key outcomes:

- Inform the community about the current study;
- Identify community concerns in regard to flooding;
- Gather ideas and information on potential management options for the floodplain; and
- Seek feedback on recommended options via Public Exhibition.

“Community” refers to government (both state and local departments), business, industry and the general public. Consultation with the community is an important element of the Floodplain Risk Management process facilitating community engagement, building confidence in flood modelling tools, and leading to acceptance and ownership of the overall project.

#### 3.1. Floodplain Risk Management Committee

The process of managing flood risk in the Federation Villages (and Federation Council LGA) is assisted by the Floodplain Risk Management Committee. The committee is made up of Councillors, Council Staff from a variety of areas across Council, NSW Government Agencies and Community representatives, in this case, with a representative from each village. The Floodplain Risk Management Committee assists Council in the development and implementation of these strategies by providing a forum for discussion of the differing viewpoints within the study area, identifying management options and considering and making recommendations to Council on appropriate measures and controls for the study area. The committee is the driving force behind the study and may be required to vote to determine the majority opinion if consensus cannot be reached.

#### 3.2. Community Consultation Approach

In October 2018, WMAwater and Federation Council staff undertook community consultation sessions in Boree Creek, Morundah, Rand, Oaklands, and Urana as part of the Federation Villages Floodplain Risk Management Studies and Plans (FRMS&P).

The aims of the community consultation sessions were to inform the local community about the studies, involve the community in the process, and gather information about flood risk and suggestions for mitigation options to be investigated. Each session included a brief presentation from WMAwater to introduce the study and describe the Floodplain Risk Management Process, then a discussion session, in which attendees were encouraged to discuss flood issues specific to their village with each other and the WMAwater and Council staff present. Attendees had the opportunity to make written notes or draw on and annotate hardcopy maps. 23 survey responses were collected during the community consultation events and are summarised in the subsequent sections. More commonly, attendees tended to talk about their experiences and suggestions while WMAwater staff took notes. Following the meetings, information from residents regarding flow paths, and suggestions to reduce flood risk, were summarised and mapped. These are presented on Figure 2 (Sheets 1-5).

Note: The issues summarised herein are based on feedback received during the community consultation period, either at drop-in sessions or received subsequently via email, letters or telephone discussions. It is noted that the issues and suggestions raised do not necessarily reflect the views of WMAwater or Federation Council. The identified issues were used as a starting point for the identification of mitigation strategies to be assessed in subsequent stages.

### 3.2.1. Boree Creek

Table 2 Boree Creek Community Consultation

<b>Date:</b>	16 <sup>th</sup> October 2018
<b>Location:</b>	RFS Hall, Eades Street, Boree Creek
<b>Time</b>	7pm – 9pm
<b>No. Attendees</b>	5

#### 3.2.1.1. Summary of Key Issues

The community consultation session outlined key areas that have been observed to be affected by flooding in Boree Creek. Key issues identified for investigation included:

- The railway embankment acts as an obstruction to flood waters, with insufficient culvert capacity to convey flow from north to south (Note the current culvert size on Boree Creek through the railway embankment is 4 × 1.85 m wide × 1.25 m high box culverts);
- Emergency services unable to reach town during floods – access cut in both directions;
- No formal evacuation centre – the school (Cnr Strontian Rd and Namoi St) was used at first (in March 2012 event), but residents relocated to private property (3 km from Boree Creek on the Narrandera Road) before the school was flooded;
- Some dwellings in Lawrence St are badly (and frequently) affected. The property at No.12 is in a state of disrepair and currently uninhabited. The owner of No.9 noted the difficulty in obtaining flood insurance and developing the property;
- Debris in paddocks near Orme Street is swept into the creek and blocks waterways;
- The guardrails on the recently upgraded culvert over Boree Creek on Boree Creek Rd (1.5 km east of town) act as an obstruction and has been noted to snag debris (tree branches etc), causing a hazard to motorists; and
- “Rubberneckers” were an issue during the floods, with 4WD vehicles causing local bow waves leading to over-floor inundation of properties, and concerns about looting making residents hesitant to leave town.

#### 3.2.1.2. Potential Mitigation Options and their Challenges

Potential mitigation options were identified from the observed key issues outlined in Section 3.2.1.1, and include:

- Consideration of Voluntary Purchase for frequently flood-affected properties on Lawrence Street;
- Identification of a suitable site for a formal evacuation centre, noting residents may be hesitant to leave town due to security concerns;

- Identify the impact of increasing culvert capacity through the railway embankment;
- Reduce loose debris, branches etc. in paddocks and creeks that are carried by flood waters and cause obstructions elsewhere;
- Determine the impact of the existing guardrail on Boree Creek Road and investigate alternatives to prevent large debris being trapped;
- Improve road closure signage and flood depth signage on Boree Creek Road at Boree Creek crossing (one resident noted that depth gauges were not broadly understood by motorists);
- Community education to improve residents' and motorists' understanding of local flood risk;
- Identify evacuation routes or safe access for emergency services (e.g. some access noted via Sandigo); and
- The investigation into the potential impacts of diverting flow paths through Crown Land.

The implementation of these potential mitigation options may be influenced by challenges specific to each option. Potential challenges can influence the feasibility of the mitigation measure. Potential challenges for the suggested mitigation options above include:

- Community appetite for Voluntary Purchase scheme;
- Approvals and logistics for establishing and maintaining an official evacuation centre (if on private property);
- Obtaining approvals to implement mitigation options on private properties and Crown Land, or railway easements;
- Costs and construction difficulties of structural mitigation options, e.g. increasing culvert capacity; and
- Landholders would need to be responsible for trying down loose objects as well as maintaining clear paddocks as Council generally does not undertake works on private property.

### 3.2.2. Morundah

Table 3 Morundah Community Consultation

<b>Date:</b>	17 <sup>th</sup> October 2018
<b>Location:</b>	Morundah Hotel, Browley Street, Morundah
<b>Time</b>	2pm – 4pm
<b>No. Attendees</b>	6

#### 3.2.2.1. Summary of Key Issues

The community consultation session outlined key areas that have been observed to be affected by flooding in Morundah. Key issues identified for investigation included:

- Insufficient flood warnings issued to Morundah specifically, no estimation of creek heights was available from any agency. However, warnings issued to Wagga Wagga indicated that Colombo and Yanko Creeks would flood at Morundah;

- Conflicting advice was provided regarding evacuation orders and road closures, misinformation about which roads were open, several residents noted that local intelligence and observations were not acted upon by authorities;
- Morundah was cut off in all directions except the Urana Road (Federation Highway), access to Lockhart was cut before peak flooding occurred;
- Back Morundah Road was overtopped in two locations, residents noted culverts were frequently blocked or considered undersized;
- One (1) residence on Milvain Drive was inundated from local runoff, while other lots on this street were also flood affected;
- An informal Flood Planning Level (FPL) was applied;
- Use of informal flood warning systems, including sounding a siren, and picking up residents from their homes using the fire truck;
- A manually operated water pump;
- The levee was breached in 7 places through Tarabah and racecourse. Subsequent work was done to raise the levee through the racecourse, but the part of the levee on private property has not yet been raised; and
- The community was not notified when Yamma Road became inundated.

#### **3.2.2.2. Potential Mitigation Options and their Challenges**

Potential mitigation options were identified from the observed key issues outlined in Section 3.2.2.1, and include:

- Determine the impact of raising the levee through Tarabah (private property);
- Determine the impact of installing a backflow prevention valve on pipe near the railway line (location TBC);
- Determine the impact of increasing culvert capacity beneath Back Morundah Road;
- Consider swale drains to divert overland flow around dwellings on Milvain Drive;
- Improvement of community flood awareness through access to flood information such as community events or information on previous flood events;
- Improvements to flood warning systems, evacuation protocols and emergency response mechanisms; and
- Consider establishment of a centralised storage shed for flood materials, pumps, instruction manuals etc. as access to other towns can be restricted during floods.

The implementation of these potential mitigation options may be influenced by challenges specific to each option. Potential challenges can influence the feasibility of the mitigation measure. Potential challenges for the suggested mitigation options above include:

- Obtaining permission to implement mitigation options such as levee raising or increasing culvert size on private properties;
- Feasibility and cost of implementing flood warning and structural mitigation options; and
- Ensuring flood information is easily accessible by the community.

### 3.2.3. Oaklands

Table 4 Oaklands Community Consultation

<b>Date:</b>	18 <sup>th</sup> October 2018
<b>Location:</b>	Oaklands Hotel, Milthorpe St, Oaklands
<b>Time</b>	10:30am – 12pm
<b>No. Attendees</b>	5

#### 3.2.3.1. Summary of Key Issues

The community consultation session outlined key areas that have been observed to be affected by flooding in Oaklands. Key issues identified for investigation included:

- The Oaklands township is far away from Nowranie Creek, and town residents were generally not concerned with riverine flooding;
- The primary concern was regarding nuisance ponding over roads that occurred due to local rainfall (and subsequent overland flow). Residents considered the issues to be a result of undersized culverts, or inadequately maintained swale drains. Key areas/roads affected include:
  - Buller Street, especially around French Street;
  - Erosion at the eastern end of Buller Street;
  - Western end of Milthorpe Street;
  - Poorly defined flow path between Patey Street and Gunambil Street, resulting in ponding on sports field at Oaklands Recreation Reserve;
  - Ponding noted over Coreen Street at Thornber Street; and
  - No defined path in the vegetated area between Webster Street and Patey Street, causing localised ponding.

#### 3.2.3.2. Potential Mitigation Options and their Challenges

Potential mitigation options were identified from the observed key issues outlined in Section 3.2.3.1, and include:

- Increased frequency of drain/culvert maintenance and mowing/slashing swale drains;
- Culvert upgrades or relocation closer to roads (e.g. Buller Street and French Street);
- Improve the definition of flow paths through the vegetated area near Webster Street and Oaklands Recreation Reserve to improve conveyance and minimise ponding on the sports field;
- Installation of rip-rap to reduce erosion at eastern end of Buller Street;
- Improvement of community flood awareness through access to flood information such as community events or information; and
- Planning controls to support appropriate development and consideration of minimum floor levels in areas prone to overland flow.

The implementation of these potential mitigation options may be influenced by challenges specific to each option. Potential challenges can influence the feasibility of the mitigation measure. Potential challenges for the suggested mitigation options above include:

- Feasibility and cost of culvert upgrades and relocation;
- Technical feasibility of reaching adequate swale grades through the town, which has a relatively flat terrain;
- Environmental impact of creating flow paths through Oaklands Recreation Reserve; and
- Ensuring flood information is easily accessible by the community.

### 3.2.4. Rand

Table 5 Rand Community Consultation

Date:	18 <sup>th</sup> October 2018
Location:	Sports Ground Club Room, Rand
Time	1pm – 3pm
No. Attendees	5

#### 3.2.4.1. Summary of Key Issues

The community consultation session outlined key areas that have been observed to be affected by flooding in Rand. Key issues identified for investigation included:

- No current warning systems, information is available on State Government website (details not provided) however local residents were generally unsure of how information and warnings relate to Rand. Some residents, however, used flood predictions at Culcairn to estimate flooding at their property;
- Residents were unsure if there was a local SES representative;
- Afflux at the bridge has a large impact on the floodplain;
- Residents noted that if road closure signs were not put up and down in a timely manner, local motorists became complacent and would ignore 'Road Closed' signs;
- Informal levee in Rand constructed before the 1974 flood may need attention. Some flow can enter the town by running around the western end of the levee;
- Concerns about erosion of creek banks, as well as rubbish/debris in creek beds causing obstructions;
- Water on Walbundrie Road pools for extended periods of time; and
- An additional gauge is required on northern side of bridge to take readings. Little confidence in water level readings at the bridge.

#### 3.2.4.2. Potential Mitigation Options and their Challenges

Potential mitigation options were identified from the observed key issues outlined in Section 3.2.4.1, and include:

- The height relationship with Morgan's Lookout (towards Culcairn) may be utilised for improving warning systems and establishment of a local community network to receive and distribute warnings effectively;
- Consider installation of additional gauge boards (suggest additional gauge board on north side of bridge) for additional flood level information;
- Consider installation of permanent hinged or automatic flashing Flood Signs on Corowa Road;



- Improvement of community flood awareness through education activities;
- Determine areas for targeted vegetation management to ensure dense vegetation does not impede flows;
- Installation of additional rainfall gauges to improve confidence of water level readings at the bridge; and
- Improvements to the existing informal levee should be considered.

The implementation of these potential mitigation options may be influenced by challenges specific to each option. Potential challenges can influence the feasibility of the mitigation measure. Potential challenges for the suggested mitigation options above include:

- Cost and community reception of automatic flood warning signs on Corowa Road;
- Environmental impact or loss of habitat caused by removing vegetation or debris in the riparian area; and
- Identifying a reliable and useful relationship between the height at Morgan's Lookout and Rand, and establishing a reliable method of warning dissemination.

### 3.2.5. Urana

Table 6 Urana Community Consultation

<b>Date:</b>	17 <sup>th</sup> October 2018
<b>Location:</b>	Urana Bowling Club, Urana
<b>Time</b>	7pm – 9pm
<b>No. Attendees</b>	16

#### 3.2.5.1. Summary of Key Issues

The community consultation session outlined key areas that have been observed to be affected by flooding in Urana. Key issues identified for investigation included:

- Federation Way, approximately 2.7 km south of Mahonga Road obstructs a major overland flow path known as the Tombstones and causes diversion of the flow path to the north;
- Culvert beneath Federation Way (approximately 500 m south of Mahonga Road) (Tom Bourke's Driveway) is considered to be of insufficient capacity and the road is overtopped at this location;
- The Urana Aquatic Centre could potentially be utilised for flood mitigation if it could be drained prior to receiving inflows;
- 2-3 culverts in town are known to backwater when levels in the creek are elevated;
- Local stormwater runoff is noted to cause ponding at several locations throughout town:
  - William Street in front of the Public School;
  - Corner of Princess Street and Chapman Street, affecting a paddock on Princess Street and some residences on Osborne Street;
  - Corner of Princess Street and Church Street (box culvert obstructed by telegraph poles);

- Creek channel beneath Jerilderie Bridge east of town (Cocketgedong Road) is not wide enough to convey water when Lake Urana is reaching capacity, causing damage to the road;
- Late action from emergency services, caused by communication issues, overlooking local community input;
- Box culvert on Anna Street is impeded by telephone lines, preventing flow; and
- Lack of drainage beneath Anna Street causes ponding on Chapman Street.

### **3.2.5.2. Potential Mitigation Options and their Challenges**

Potential mitigation options were identified from the observed key issues outlined in Section 3.2.5.1, and include:

- Installation of culverts beneath Lake Road approximately 6 km northwest of Urana;
- Clearing of vegetation around Urangeline Creek;
- Installation of flap vales, drop boards, and headwalls to prevent backflow on Brougong Street;
- Investigate levee as per Coore Strategy alignment (or similar as appropriate);
- Investigation of various options at the Aquatic Centre, including:
  - Construction of a secondary bypass spillway on the southern bank;
  - Determine benefit of lowering water level prior to a flood event, and investigate the installation of new release valve (or relocation/ repair of existing valve) to achieve increased airspace;
- Installation or relocation of a release valve to lower the water level at the Aquatic Centre prior to flood events, consideration of operational constraints, using Boree Creek as a warning correlation;
- Lowering of Federation Way 2.7 km south of Mahonga Road (Tombstones) to surrounding natural surface levels to allow passage of overland flow;
- Increasing culvert capacity or converting Federation Highway to causeway 500 m south of Mahonga Road;
- Forming and grading of table drains where no curb or guttering has been established within town and appropriate upgrades to existing culverts to improve stormwater drainage;
- Lowering of drains on the corner of Anna / Chapman Streets to reduce ponding and direct water west to the creek;
- New drainage lines between the Aquatic Centre and Urangeline Creek towards Cocketgedong Road;
- Lowering of the road to surrounding natural surface levels on the west side of the Aquatic Centre;
- Improvement of community flood response awareness through access to flood information such as community events or information;
- Identifying road access issues and evacuation locations and routes.

**Potential challenges for suggested mitigation options:**

- Cost of mitigation options such as road lowering, drainage lines, and culvert upgrades;
- Responsibility and approvals for regrading non-Council roads;
- Consideration of competing operational objectives of the Aquatic Centre;
- Ensuring flood information is readily available to the community;
- Environmental impact and loss of habitat caused by removing vegetation in Urangeline Creek;
- Obtaining approval to implement mitigation options such as culvert upgrades and drainage lines on private properties or roads not managed by Council.

**3.3. Engagement with Local Primary Schools**

During the community consultation visit in October 2018, representatives from WMAwater and Federation Council visited students at Urana Public School and St Francis Xavier Primary School (held in the Federation Council chambers), Rand Public School and Oaklands Public School. The purpose of the school visits was to raise awareness of floods and flood safety through an interactive presentation and discussion. Given the current drought affecting each community, and indeed most of NSW, the presentation began with a discussion of how students and their families had been affected by drought, and why droughts occur. This provided context about the impacts of having not enough rainfall, which led to a discussion of the impacts of receiving *too much* rainfall instead, and how flooding is caused. During the discussion, primary school students (especially those in years 5 & 6) were asked to share their experiences of the 2012 flood, and students also heard from their teacher's own experiences of floods in other towns, highlighting how floods do not happen to one town in isolation, but that many towns in the same catchment or river system are also affected.

The session included a local knowledge quiz, discussion and activities relating to flood safety, addressing several reasons why you should never walk, drive or play in flood waters. The response from students was overwhelmingly positive, with all students (and teachers) participating in the discussion and activities.

One of the most effective means of reducing flood risk in a community is by improving residents' awareness and understanding of their own flood risk. As a result, Floodplain Risk Management Study and Plans can often make recommendations to improve flood education strategies within the community. The school visits undertaken during the community consultation period forms a basis for continued collaboration between Council and the local primary schools to improve flood awareness in each of the Federation Council villages.



Photo 1 Flood Safety activities with students in Urana at the Council chambers



Photo 2 Flood safety activities with students at Rand Public School

### 3.4. Public Exhibition Engagement

Public exhibition of the Draft Federation Villages Floodplain Risk Management Study and Plan is required by the Local Government Act (1993, Section 402). This section stipulates that Council must exhibit the studies and draft plan for public comment for a period of at least 28 days, and that submissions must be considered by the council before the plan is endorsed or amended.

The Draft Federation Villages Floodplain Risk Management Study and Plan, from December 15 2021 to February 9 2022, with copies of the report available from:

- Council's Urana Office,
- Billabong Agriculture, Oaklands
- Ag and Vet, Boree Creek,
- Morundah Pub,
- Rand Rural Supplies,
- Federation Council's website [www.federationcouncil.nsw.gov.au](http://www.federationcouncil.nsw.gov.au)(External link)

Five drop-in sessions were held at the following locations:

- Rand Recreation Ground, 10am to 12 noon, Tuesday February 1,
- Oaklands Recreation Ground, 1:30pm to 3:30pm, Tuesday February 1,
- Urana Council Offices, 4:30pm to 6:30pm, Tuesday February 1,
- Boree Creek Hall, 10am to 12 noon, Wednesday February 2,
- Morundah Paradise Palladium Theatre, 1:30pm to 3:30pm, Wednesday February 2.

The drop-in sessions provided an opportunity for residents and local business owners to discuss the Study and outcomes with WMAwater and Council staff in an informal setting. There was a total of 11 attendees across all sessions.

Common themes arising from discussions with the public included:

- Road closures and impacts of access during and following flood events, suggestion of depth gauges/warnings in preference to traditional “Road Closure” signage, as these signs can remain in place many weeks after flooding,
- Central access point for relevant flood information, attendees’ noted needing to visit a few different webpages to pull together a picture of flooding in the region,
- Flood risk awareness and education, particularly important for children,
- Impacts of rural floodplain levees,
- Improvements to emergency management, clearly defined and communicated procedures, roles and responsibilities, including who to contact,
- Management of vegetation in the creek, and the difficulties of striking a balance between reducing hydraulic roughness whilst maintaining bank stability and controlling erosion,
- Residents in Boree Creek indicated an interest in Voluntary Purchase,
- A recently suggested levee for Boree Creek would not be viable,
- The community in Morundah sees the levee formalisation and drainage improvements as priorities.

In addition to attending the drop-in session, community members were invited to make written submissions via the following:

- Post: Federation Council, PO Box 77, Corowa NSW, 2646
- Email: [council@federationcouncil.nsw.gov.au](mailto:council@federationcouncil.nsw.gov.au)([External link](#)); and
- Online.

In total, 3 submissions were received. A summary of the key points raised, responses and relevant changes to the document are provided below.

Table 7 Public Exhibition Submissions

Comment	Response	Report Change
<b>Indicated interest in Voluntary Purchase in Boree Creek</b>	Feedback noted	Indication of support included in report discussion
<b>Management of the impacts of vegetation</b>	The impacts of both increases and decreases in vegetation have been assessed as part of this project. Recommendation FMBC-07/FMU-09 are to maintain vegetation levels via a vegetation management program throughout the creek systems.	Nil
<b>Maintenance of drainage structures, including clearing of debris (including Jerilderie-Cocketgedong Road)</b>	Feedback noted and information passed to appropriate Council Team	Nil

<b>Urgency of works in Urana</b>	Through consultation with the Floodplain Risk Management Committee, considering the existing flood risk within each village and the effectiveness of the recommendations, recommended works have been prioritised.	Nil
<b>Support for FMU-03 Stormwater Drainage and suggestion it includes regular maintenance and non return values</b>	Feedback noted.	Comment added to Option discussion.
<b>Support for FMU-01 – Urana Levee Alignment 1 over the recommended FMU-02 – Urana Levee Alignment 2</b>	Through consultation with the Floodplain Risk Management Committee, the relevant benefits of FMU-01 and FMU-02 were discussed. Both levee alignments cover the future growth areas within Urana. FMU-01 includes approximately 30% additional levee length to benefit two additional properties only. The recommended levee feasibility study would review this recommendation and determine alternative mitigation strategies for the two properties.	Nil
<b>Need for improved system flood warning across the study area</b>	An additional recommendation has been added to review existing flood warning system.	RM-04 – Improvements to Flood Warning has been included and assigned a High priority.

## 4. CURRENT PLANNING CONTEXT

Federation Council (Council) is responsible for local planning and land management in the Federation LGA, including the management of the floodplain and drainage systems. The planning policies held and used by Council in their management of the floodplain are underpinned and bound by national and State planning legislation. It is important to understand the national and state overarching planning legislation prior to making recommendations for Council to amend its own local planning policies to ensure that any changes are consistent with the requirements of State and national legislation.

The national and state legislation instruments that influence or align with planning in relation to flood risk at the local government level have been summarised in this report to provide background and context.

### 4.1. National Planning Provisions - Building Code of Australia (May 2019, Reference 9)

The Building Code of Australia (BCA) is part of the National Construction Code (NCC) Series, an initiative of the Council of Australian Governments (COAG) developed to incorporate all on-site construction requirements into a single code. The BCA is produced and maintained by the Australian Building Codes Board on behalf of the Australian Government and each State and Territory Government.

The BCA is a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia. The goals of the BCA are to enable the achievement and maintenance of acceptable standards of structural sufficiency, safety, health and amenity for the benefit of the community now and in the future.

The BCA contains requirements to ensure new buildings and structures and, subject to State and Territory legislation, alterations and additions to existing buildings located in flood hazard areas do not collapse during a flood when subjected to flood actions resulting from the 'defined flood event'. The 'defined flood event' (DFE) is "*the flood event selected for the management of flood hazard for the location of specific development as determined by the appropriate authority.*" In NSW this is typically the 1% AEP event for residential development.

Flood hazard areas are identified by the relevant State/Territory or Local Government authority (such as via a Floodplain Risk Management Study). The BCA is produced and maintained by the Australian Building Codes Board and given legal effect through the *Building Act 1975*, which in turn is given legal effect by building regulatory legislation in each State and Territory. Any provision of the BCA may be overridden by, or subject to, State or Territory legislation. The BCA must, therefore, be read in conjunction with that legislation.



The BCA (Reference 9) provides general requirements for measures to keep water out of the building structure and foundations, such as setting minimum heights above ground, and minimum paved apron requirements graded to direct runoff away from the building. Section 3.1.2.3 refers specifically to drainage of surface water and finished slab heights, and contains the requirements shown overleaf:

Additional requirements for buildings in flood hazard areas, consistent with the objectives of the BCA, primarily aim to protect the lives of occupants of those buildings in events up to and including the defined flood event.

#### **Building Code of Australia (2019) (Reference 9)**

##### **3.1.3.3 Surface water drainage**

Surface water must be diverted away from Class 1 buildings as follows:

- (a) Slab-on-ground — finished ground level adjacent to buildings:  
the external finished surface surrounding the slab must be drained to move surface water away from the building and graded to give a slope of not less than (see Figure 3.1.3.2):
  - (i) 25 mm over the first 1 m from the building in low rainfall intensity areas for surfaces that are reasonably impermeable (such as concrete or clay paving); or
  - (ii) 50 mm over the first 1 m from the building in any other case.
- (b) Slab-on-ground — finished slab heights:  
the height of the slab-on-ground above external finished surfaces must be not less than (see Figure 3.1.3.2):
  - (i) 100 mm above the finished ground level in low rainfall intensity areas or sandy, well-drained areas; or
  - (ii) 50 mm above impermeable (paved or concreted areas) that slope away from the building in accordance with (a); or
  - (iii) 150 mm in any other case.

## **4.2. State Planning Provisions**

### **4.2.1. NSW Environmental Planning and Assessment Act 1979**

The NSW Environmental Planning and Assessment Act 1979 (EP&A Act) provides the framework for regulating and protecting the environment and controlling the impact of development. Pursuant to Section 117(2) of the EP&A Act, the Minister has directed that Councils have the responsibility to facilitate the implementation of the NSW Government's Flood Prone Land Policy. The policies and guidelines described in this Section fall under the EP&A Act. The objects of the Act are set out below:

**Environmental Planning and Assessment Act 1979 No 203****1.3 Objects of Act**

*The objects of this Act are as follows:*

- (a) to promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources,*
- (b) to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment,*
- (c) to promote the orderly and economic use and development of land,*
- (d) to promote the delivery and maintenance of affordable housing,*
- (e) to protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats,*
- (f) to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage),*
- (g) to promote good design and amenity of the built environment,*
- (h) to promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants,*
- (i) to promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State,*
- (j) to provide increased opportunity for community participation in environmental planning and assessment.*

**4.2.2. NSW Flood Prone Land Policy**

The primary objectives of the NSW Government's Flood Prone Land Policy are:

- (a) to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone land, and*
- (b) to reduce public and private losses resulting from floods whilst utilising ecologically positive methods wherever possible.*

The NSW Floodplain Development Manual 2005 (the Manual – Reference 5) relates to the development of flood prone land for the purposes of Section 733 of the Local Government Act 1993 and incorporates the NSW Flood Prone Land Policy. Section 733 of the Local Government Act 1993 provides councils with statutory indemnity for decisions made and information provided in good faith from the outcomes of the management process (undertaken in accordance with the Manual).

The Manual outlines a merits approach based on floodplain management and recognises differences between urban and rural floodplain issues. At the strategic level, this allows for the consideration of social, economic, cultural, ecological and flooding issues to determine strategies for the management of flood risk.

### **4.2.3. Flood Prone Land Package**

On the 14<sup>th</sup> July 2021, the Department of Planning, Industry and Environment (DPIE) implemented updates to the Flood Prone Land Package. The purpose of the package is to increase flood resilience in New South Wales, reduce loss of life and property damage. The package provides councils additional land use planning tools to manage flood risk beyond the 1% AEP flood event and strengthen evacuation consideration in land use planning.

The changes include:

- A revised Ministerial Direction 4.3 regarding flooding issued under Section 9.1 of the Environmental Planning and Assessment Act 1979,
- a revised planning circular on flooding
- a new guideline: Considering Flooding in Land Use Planning
- Revised Local Environmental Plan flood clauses,
- Amendments to Schedule 4, Section 7A of the Environmental Planning and Assessment Regulation 2000,
- State Environmental Planning Policy Amendment (Flood Planning) 2021.

The key changes and implications are outlined below:

- Amendments to Schedule 4 of EP&A Regulation including changes to Clause 7A(1), Clause 7A(2). These amendments now require councils to note on Section 10.7 certificates if any flood related development controls apply to the land relating to either the Flood Planning Area, hazardous materials / industry, sensitive, vulnerable or critical uses.
- The Ministerial Direction 4.3 has been amended to remove the requirement for councils to seek exceptional circumstances to apply residential development controls to land outside the 1% AEP flood event (currently included in Clause 7 of Direction 4.3).
- Two proposed LEP clauses relating to the Flood Planning Area, and Special Flood Consideration.
  - The Flood Planning Area clause allows council to extend the FPA to include more extreme flood events where the flood risk requires land use planning tools.
  - The clause relating to Special Flood Consideration provides councils the mechanism to apply development controls to land outside the FPA but within the PMF. This clause is specific to land with a significant risk to life, sensitive, vulnerable or critical uses, or land with hazardous materials or industry.

#### 4.2.3.1. Ministerial Direction

Direction 4.3 was one in a list of directions issued on the 1<sup>st</sup> July 2009. The directions were issued by the then Minister for Planning to relevant planning authorities under Section 9.1(2) (previously Section 117(2)) of the *Environmental Planning and Assessment Act 1979*. Direction 4 pertains to “Hazard and Risk”, with Direction 4.3 relating specifically to Flood Prone Land. Direction 4.3 was updated on the 14<sup>th</sup> July 2021, the revised clause is shown below.

##### *Objectives*

(1) *The objectives of this direction are:*

- (a) *to ensure that development of flood prone land is consistent with the NSW Government's Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005,*
- (b) *to ensure that the provisions of a local environmental plan that apply to flood prone land are commensurate with flood behaviour and include consideration of the potential flood impacts on and off the subject land.*

*Clause (3) of Direction 4.3 states:*

- (3) *This direction applies when a planning proposal authority prepares a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land.*

*Clauses (4)-(9) of Direction 4.3 state:*

(4) *A planning proposal or draft LEP must include provisions that give effect to and are consistent with:*

- (a) *The NSW Flood Prone Land Policy, and*
- (b) *The principles of the Floodplain Development Manual 2005 (or its update), and*
- (c) *The Considering flooding land use planning guideline.*

(5) *A planning proposal or draft LEP must not rezone land within the Flood Planning Area from Recreation, Rural, Special purpose zones or Environmental Zones to a Residential, Business, Industrial, or Special Purpose Zone*

(6) *A planning proposal or draft LEP must not contain provisions that apply to the Flood Planning Area which:*

- (a) *permit development in a floodway,*
- (b) *permit development that will result in significant flood impacts to other properties,*
- (c) *permit residential development in high hazard areas,*
- (d) *permit a significant increase in the dwelling density of that land,*
- (e) *permit the development of centre-based child care facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the development cannot effectively self-evacuate,*

*(f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, buildings structures or filling in floodways or high hazard areas, still require development consent,*

*(g) are likely to result in a significantly increased requirement for government spending on emergency management services, and flood mitigation and emergency response measures, which can include but not limited to road infrastructure, flood mitigation infrastructure and utilities or*

*(h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during floods.*

*(7) A planning proposal or draft LEP must not contain provisions that apply to the Regional Evacuation Consideration Area which:*

*(a) permit development in areas that will exceed the capacity of an established regional evacuation route(s).*

*(8) For the purposes of a draft LEP, a council's Flood Planning Level(s) must be consistent with the Floodplain Development Manual 2005 (or its update) or as otherwise determined by an adopted Floodplain Risk Management Study.*

*(9) A planning proposal may be inconsistent with the terms of this direction only if the planning proposal authority can satisfy the Secretary of the Department of Planning, Industry and Environment (or their nominee) that:*

*(a) the planning proposal is in accordance with a floodplain risk management plan prepared by the relevant council/s in accordance with the principles and guidelines of the Floodplain Development Manual 2005 (or its update), and/or*

*(b) the planning proposal is supported by a flood and risk impact assessment or Council adopted flood study consistent with the relevant planning authorities' requirements, and/or*

*(c) the provisions of the planning proposal that are inconsistent are of minor significance.*

*Note: In this direction:*

*(a) "flood prone land" "flood storage" "floodway" and "high hazard" have the same meaning as in the Floodplain Development Manual 2005.*

*(b) "flood planning level" "flood behaviour" and "flood planning area" has the same meaning as in the Considering flooding in land use planning guideline 20.*

*(c) Special flood considerations are outlined in the Considering flooding in land use planning guideline 2021 and an optional clause in the Standard Instrument (Local Environmental Plans) Order 2006.*

*(d) Under the floodplain risk management process outlined in the NSW Government's Floodplain Development Manual 2005, councils may produce a flood study followed by a floodplain risk management study and floodplain risk management plan.*

#### **4.2.3.2. Planning Circular PS 07-003 and PS 21-006**

Planning Circular PS 07-003 (31 January 2007) provided advice on a package of changes concerning flood-related development controls for land above the 1-in-100 year flood and up to the PMF. A revised planning circular '*Considering flooding in land use planning: guidance and statutory requirements*' PS 21-006 was released with the recent changes to the Flood Prone Land Package on 14<sup>th</sup> July 2021. The revised circular provides advice on a package of changes regarding how land use planning considers flooding and flood-related constraints, including Section 10.7 Planning Certificates, local planning direction 4.3, LEP clauses and associated guidelines.

In Planning Circular PS21-006 it is noted that: "*Section 733 of the Local Government Act 1993 (the LG Act) protects councils from liability if they have followed the requirements of the Manual*".

#### **4.2.3.3. Considering flooding in land use planning guideline**

The guideline aims to provide councils with mechanisms to manage flood risk for the full range of flooding up to the Probable Maximum Flood (PMF) and give further consideration to evacuation constraints. Within the proposed Flood Prone Land package, there are two main categories council can use to address flooding impacts namely, flood planning areas or special considerations.

Historically, the focus has been on managing the 1% AEP flood event. The Flood Prone Land Package aims to provide councils the ability to apply development controls to areas outside the flood extent where the flood risk requires it. The FDM identifies either the 1% AEP flood event or an equivalent historic event as an appropriate starting point when selecting the Defined Flood Event (DFE). However, it recommends considering selecting a more extreme flood event where there are significant economic, social, environmental or cultural risks associated with a larger event.

The Special Flood Considerations category provides council the ability to apply controls to land outside FPA but within the PMF flood event where there is a significant risk to life or risk of hazardous material impacting the community or environment.

#### **4.2.4. Section 10.7 Planning Certificates**

Formerly known as Section 149 Planning Certificates, Section 10.7 Planning Certificates describe how a property may be used and the development controls applicable to that property. The Planning Certificate is issued under Section 10.7 of the Environmental Planning and Assessment Act 1979.

When land is bought or sold, the Conveyancing Act 1919 and Conveyancing (Sale of Land) Regulation 2010 requires that a Section 10.7 Planning Certificate be attached to the contract of sale for the land.

Section 10.7 of the EP&A Act states:

- (1) *A person may, on payment of the prescribed fee, apply to a council for a certificate under this section (a planning certificate) with respect to any land within the area of the council.*
- (2) *On application made to it under subsection (1), the council shall, as soon as practicable, issue a planning certificate specifying such matters relating to the land to which the certificate relates as may be prescribed (whether arising under or connected with this or any other Act or otherwise).*
- (3) *(Repealed)*
- (4) *The regulations may provide that information to be furnished in a planning certificate shall be set out in the prescribed form and manner.*
- (5) *A council may, in a planning certificate, include advice on such other relevant matters affecting the land of which it may be aware.*
- (6) *A council shall not incur any liability in respect of any advice provided in good faith pursuant to subsection (5). However, this subsection does not apply to advice provided in relation to contaminated land (including the likelihood of land being contaminated land) or to the nature or extent of contamination of land within the meaning of Schedule 6.*
- (7) *For the purpose of any proceedings for an offence against this Act or the regulations which may be taken against a person who has obtained a planning certificate or who might reasonably be expected to rely on that certificate, that certificate shall, in favour of that person, be conclusively presumed to be true and correct.*

The Environmental Planning and Assessment Regulation 2000, Schedule 4 specifies the information to be disclosed on a Section 10.7 (2) Planning Certificate. In particular, Schedule 4, 7A refers to flood related development control information and requires councils to provide the following information:

- (1) If the land or part of the land is within the flood planning area and subject to flood related development controls.
- (2) If the land or part of the land is between the flood planning area and the probable maximum flood and subject to flood related development controls.
- (3) In this clause—

**flood planning area** has the same meaning as in the Floodplain Development Manual.

**Floodplain Development Manual** means the *Floodplain Development Manual* (ISBN 0 7347 5476 0) published by the NSW Government in April 2005.

**probable maximum flood** has the same meaning as in the Floodplain Development Manual.

Section 10.7 (2) and (5) certificates contain the information prescribed in Schedule 4 described above and additional information relating to the property. In a flooding context, additional information may include notations on flood hazard, percentage of the lot affected by flooding, or peak flood depths and levels on the property, or “*advice on other such relevant matters affecting the land of which it may be aware*” (EP&A Act, 10.7 (5)).



Federation Council provided two example Section 10.7(2) Planning Certificates for review. Item 6 on the Planning Certificate includes a notation for whether ‘*Development of the land restricted by the likelihood of land slip, bushfire, flooding, tidal inundation, subsidence, acid sulphate soils or any other risk.*’

With completion of the Flood Study (Reference 7) and this Floodplain Risk Management Study, up to date flood information will be available for Council to include on Section 10.7(2) and (5) Planning Certificates. Recommendations for types of additional information to include on Section 10.7 (5) Planning Certificates are provided in Section 6.4.7.

#### **4.2.5. State Environmental Planning Policy (Exempt and Complying Development Codes (2008))**

The aims of State Environmental Planning Policy (Exempt and Complying Development) 2008 are presented below.

*This Policy aims to provide streamlined assessment processes for development that complies with specified development standards by:*

- (a) providing exempt and complying development codes that have State-wide application, and*
- (b) identifying, in the exempt development codes, types of development that are of minimal environmental impact that may be carried out without the need for development consent, and*
- (c) identifying, in the complying development codes, types of complying development that may be carried out in accordance with a complying development certificate as defined in the Act, and*
- (d) enabling the progressive extension of the types of development in this Policy, and*
- (e) providing transitional arrangements for the introduction of the State-wide codes, including the amendment of other environmental planning instruments.*

#### **4.2.6. State Environmental Planning Policy (Exempt and Complying Development Codes) Amendment (Housing Code) 2017**

Part 3 of the SEPP relates to the “*Housing Code*”. This section replaces the former “*General Housing Code*”, which was repealed in June 2017. Part 3 is divided into 5 “Divisions”, with Division 2 containing General standards relating to land type. Part 3.5 specifically relates to Complying Development on flood control lots.

Section 3.5 is reproduced below.

### 3.5 Complying development on flood control lots

- 1) Development under this code must not be carried out on any part of a flood control lot, other than a part of the lot that the council or a professional engineer who specialises in hydraulic engineering has certified, for the purposes of the issue of the relevant complying development certificate, as not being any of the following:
  - a) a flood storage area,
  - b) a floodway area,
  - c) a flow path,
  - d) a high hazard area,
  - e) a high-risk area.
- 2) If complying development under this code is carried out on any part of a flood control lot, the following development standards also apply in addition to any other development standards:
  - a) if there is a minimum floor level adopted in a development control plan by the relevant council for the lot, the development must not cause any habitable room in the dwelling house to have a floor level lower than that floor level,
  - b) any part of the dwelling house or any attached development or detached development that is erected at or below the flood planning level is constructed of flood compatible material,
  - c) any part of the dwelling house and any attached development or detached development that is erected is able to withstand the forces exerted during a flood by water, debris and buoyancy up to the flood planning level (or if an on-site refuge is provided on the lot, the probable maximum flood level),
  - d) the development must not result in increased flooding elsewhere in the floodplain,
  - e) the lot must have pedestrian and vehicular access to a readily accessible refuge at a level equal to or higher than the lowest habitable floor level of the dwelling house,
  - f) vehicular access to the dwelling house will not be inundated by water to a level of more than 0.3m during a 1:100 ARI (average recurrent interval) flood event,
  - g) the lot must not have any open car parking spaces or carports lower than the level of a 1:20 ARI (average recurrent interval) flood event.
- 3) The requirements under subclause (2) (c) and (d) are satisfied if a joint report by a professional engineer specialising in hydraulic engineering and a professional engineer specialising in civil engineering states that the requirements are satisfied.
- 4) A word or expression used in this clause has the same meaning as it has in the **Floodplain Development Manual**, unless it is otherwise defined in this Policy.
- 5) In this clause:

*flood compatible material means building materials and surface finishes capable of withstanding prolonged immersion in water.*

*flood planning level means:*

- (a) the flood planning level adopted by a local environmental plan applying to the lot, or
- (b) if a flood planning level is not adopted by a local environmental plan applying to the lot, the flood planning level adopted in a development control plan by the relevant council for the lot.

*Floodplain Development Manual means the **Floodplain Development Manual** (ISBN 0 7347 5476 0) published by the NSW Government in April 2005.*

*flow path means a flow path identified in the council's flood study or floodplain risk management study carried out in accordance with the **Floodplain Development Manual**.*

*high hazard area means a high hazard area identified in the council's flood study or floodplain risk management study carried out in accordance with the **Floodplain Development Manual**.*

#### 4.2.7. Rural Housing Code

Part 3A of the SEPP contains the "*Rural Housing Code*", which applies to development that is specified in clauses 3A.2–3A.5 on lots in Zones RU1, RU2, RU3, RU4, RU6 and R5. Section 3A.38 contains "Complying development on flood control lots". The standards contained in this section are the same as those in Clause 3.5 provided in Section 4.2.6 with the exception of Clause 2 (c) which states:

- 2 (c) *any part of the dwelling house or any ancillary development that is erected is able to withstand the forces exerted during a flood by water, debris and buoyancy up to the flood planning level (or if an on-site refuge is provided on the lot, the probable maximum flood level)*

### 4.3. Local Planning Provisions

Appropriate planning restrictions that ensure development is compatible with flood risk can significantly reduce flood damages. Environmental Planning Instruments (EPIs) such as Local Environmental Plans (LEPs) guide land use and development by zoning all land, identifying appropriate land uses allowed in each zone. The Land Use Zoning within each of the Federation Villages are discussed in each village's FRMS report respectively. Development in appropriate zones is then managed through other planning standards such as Development Control Plans (DCPs) which can contain flood related development controls. Section 10.7 (formerly Section 149) Planning Certificates inform a property owner if such controls are required for development on their property. These instruments are described below.

This section provides an overview of the instruments currently in use in the Federation Council LGA, noting that separate LEPs and DCPs are currently in use in the former Corowa and Urana Shires respectively. At the time of writing, Council had engaged GHD Pty Ltd to prepare a comprehensive LEP and DCP for the Federation Council LGA. The Floodplain Risk Management Study and Plan will make recommendations for incorporation in these instruments to better manage flood risk in each of the villages, informed by the recently updated flood modelling, community consultation and discussion with Council directly.

#### 4.3.1. Local Environmental Plan

Local Environmental Plans (LEPs) are an integral part of the NSW planning system. In 2006, the NSW Government initiated the Standard Instrument LEP program and produced a new standard format to which all LEPs should conform. An LEP is a legal document prepared by Council and approved by the State Government to regulate land use and development. In regard to flooding,

LEPs are used as tools to guide new development away from high flood risk locations, ensure that new development does not increase flood risk elsewhere and significantly reduce flood damages. Where appropriate, outcomes from the Federation Villages FRMS&P will be incorporated into the development of the Comprehensive LEP for the amalgamated Councils to ensure that the most up to date flood information is being used to guide planning and development.

#### **4.3.1.1. Urana Local Environmental Plan 2011**

The Urana LEP 2011 was prepared under the Standard Instrument LEP program. The Urana LEP clause (Clause 5.21) relating to flooding has been provided below. It is noted that prior to the amalgamation of Corowa and Urana Shire Councils, all five villages included in the Federation Villages FRMS&Ps were located within the former Urana Shire Council LGA, and as such, are subject to the Urana LEP 2011.

On the 14<sup>th</sup> July 2021, the NSW Government's Flood Prone Land Package commenced and a revised flood clause (Clause 5.21 Flood Planning) was introduced across all LEPs in NSW, including the Urana Local Environmental Plan 2011 and Corowa Local Environmental Plan 2012, which apply to the study area. The revised clause will also be included in the Federation LEP when adopted. This clause allows for the flood planning area to include areas outside the 1% AEP event where the damages in more extreme flood events warrant additional development controls.

**Urana LEP 2011: Clause 5.21 Flood Planning**

(1) *The objectives of this clause are as follows—*

- (a) to minimise the flood risk to life and property associated with the use of land,*
- (b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change,*
- (c) to avoid adverse or cumulative impacts on flood behaviour and the environment,*
- (d) to enable the safe occupation and efficient evacuation of people in the event of a flood.*

(2) *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.*

(3) *In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters—*

- (a) the impact of the development on projected changes to flood behaviour as a result of climate change,*
- (b) the intended design and scale of buildings resulting from the development,*
- (c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,*
- (d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.*

(4) *A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.*

(5) *In this clause—*

**Considering Flooding in Land Use Planning Guideline** means the Considering Flooding in Land Use Planning Guideline published on the Department's website on 14 July 2021.

**flood planning area** has the same meaning as it has in the Floodplain Development Manual.

**Floodplain Development Manual** means the Floodplain Development Manual (ISBN 0 7347 5476 0) published by the NSW Government in April 2005.

The Flood Prone Land Package included a second optional clause 'Special Flood Consideration' which provides councils the mechanism to apply development controls to land outside the FPA but within the PMF. This clause is specific to land with a significant risk to life, sensitive, vulnerable or critical uses, or land with hazardous materials or industry. The Department is current preparing the associated amendments to allow implementation of the clause which is expect early in 2022. The current draft of the clause is described below.

*Provides specific controls relating to risk to life, hazardous materials and sensitive, vulnerable or critical uses. It provides councils mechanisms to additional development controls where there is a risk to life. Key extracts included in this clause are:*

*(1) The objectives of this clause are as follows—*

- (a) to enable the safe occupation and evacuation of people subject to flooding,*
- (b) to ensure development on land is compatible with the land's flood behaviour in the event of a flood,*
- (c) to avoid adverse or cumulative impacts on flood behaviour,*
- (d) to protect the operational capacity of emergency response facilities and critical infrastructure during flood events,*
- (e) to avoid adverse effects of hazardous development on the environment during flood events.*

*(2) This clause applies to—*

- (a) for sensitive and hazardous development—land between the flood planning area and the probable maximum flood, and*
- (b) for development that is not sensitive and hazardous development—land the consent authority considers to be land that, in the event of a flood, may—*
  - (i) cause a particular risk to life, and*
  - (ii) require the evacuation of people or other safety considerations.*

*(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development—*

- (a) will not affect the safe occupation and efficient evacuation of people in the event of a flood, and*
- (b) incorporates appropriate measures to manage risk to life in the event of a flood, and*
- (c) will not adversely affect the environment in the event of a flood.*

*(4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.*

*(5) In this clause:*

**Considering Flooding in Land Use Planning Guideline**—see clause 5.21(5).

**flood planning area**—see clause 5.21(5).

**Floodplain Development Manual**—see clause 5.21(5).

**probable maximum flood** has the same meaning as it has in the Floodplain Development Manual.

**sensitive and hazardous development** means development for the following purposes—

- (a) [list land uses]*

**Direction**— Only the following land uses are permitted to be included in the list—

- (a) boarding houses,*
- (b) caravan parks,*
- (c) correctional centres,*
- (d) early education and care facilities,*
- (e) eco-tourist facilities,*
- (f) educational establishments,*
- (g) emergency services facilities,*
- (h) group homes,*
- (i) hazardous industries,*
- (j) hazardous storage establishments,*
- (k) hospitals,*

- (l) hostels,
- (m) information and education facilities,
- (n) respite day care centres,
- (o) seniors housing,
- (p) sewerage systems,
- (q) tourist and visitor accommodation,
- (r) water supply systems.

### 4.3.2. Development Control Plan

Development Control Plans (DCPs) are used by Councils to guide development according to the aims of the corresponding LEP. Development in Urana, Morundah, Boree Creek, Oaklands and Rand is currently subject to controls documented in the Urana Shire Development Control Plan 2011. Section F1 of the Urana Shire DCP pertains to flood prone land, defined as the land identified on the Flood Planning Map (contained within the Urana LEP 2011, produced in the 2002 study (Reference 10). After the NSW Government's Flood Prone Land Package commenced on 14<sup>th</sup> July 2021, the Flood Planning Map has been repealed from the LEP. The following are noted from the Urana Shire DCP 2011:

#### 4.3.2.1. Urana DCP 2011

##### Residential Dwellings (Rural and Village Zones)

- Residential dwellings must not be constructed on flood prone land within a Village Zone without access to a public road which remains trafficable to light vehicles during a flood;
- The floor level of all habitable rooms of any dwelling in rural or village zones shall be in accordance with the flood planning level (i.e. 500 mm freeboard above the 1:100 ARI);
- The subfloor area may be utilised for garage, storeroom (or similar), but is not permitted to have any facilities such as sinks, wash troughs, basins, toilets, and baths or shower recesses installed;
- The sewer relief gully to dwellings will not be located below the 1:100 ARI. In rural zones effluent disposal systems are to be designed to avoid flooding so as not to cause pollution during flood events;
- All structural elements below the FPL are to be designed by a qualified practising structural engineer to withstand the impact of flooding. Any part of a dwelling below the flood planning level will be constructed using materials that are flood compatible;
- Subdivision of village zoned land within the floodplain for the purpose of erecting a dwelling house will require a minimum 550 m<sup>2</sup> of vacant land within each allotment that meets the flood planning standard and has direct vehicular access to a public road.

##### Caravan parks

Caravan parks are considered to be a 'residential' land use and will be considered on merit. Development of caravan parks on flood prone land must demonstrate that *"permanent, fail-safe, maintenance free measures are incorporated in the development to ensure the timely, orderly and safe evacuation of people from the park area should flooding occur...any annexes and movable dwellings must be able to be dismantled and removed within 24 hours."*

### **Commercial and Special Use Developments**

The Urana Shire DCP 2011 states that no commercial development nor 'special use developments' (such as schools, halls, churches and other facilities used for emergency purposes during periods of flood) are permitted on land below the flood planning level (i.e. within the flood planning area). It is noted that the placement of 'special use development', i.e. those with critical roles or vulnerable occupants, outside the FPA is consistent with Planning Circular PS 07-003 (see Section 4.2.3.2).

### **Industrial and Public Utilities**

Applications for industrial developments on flood prone land will be treated on their merits, and all portions of any industrial building located below the FPL are to be constructed using flood compatible materials. The DCP states that 'Public utility services are to be designed where possible to avoid flood impacts.'

### **Open space and recreation facilities**

Land below the flood planning level may be developed for open space or recreational facilities (on merit).

### **Agriculture**

There are no flood planning controls noted specifically for agricultural land uses.

#### **4.3.2.2. Consistency with Corowa Development Control Plan**

Generally following the amalgamation of two or more Councils, the newly formed Council is required to produce a DCP that can be used across the new LGA consistently. From Table 9 of the '*Guidance for merged councils on planning functions*' (May 2016):

*In the longer term, new councils need to prepare and amalgamated development control plan that brings together the different DCPs from the individual councils. A new DCP must be developed so that only one plan applies to any site in the council area.*

*This provides an opportunity for a new council to simplify and develop controls that can be used in an e-Planning environment so that clauses:*

- *Define the spatial area they apply to; or*
- *Define the types of development they apply to.*

*This approach allows systems to be developed where users can ask what planning controls are applicable based on where they propose development and what type of development it is.*

(cited from <https://www.planning.nsw.gov.au/-/media/Files/DPE/Guidelines/guidance-for-merged-councils-on-planning-functions-2016-05.ashx>)

At the time of writing, Council had engaged GHD Pty Ltd to undertake the Comprehensive Land Use Strategy and Local Environmental Plan (LEP) for Federation Council. Included in this scope is the preparation of a DCP that will apply consistently across the entire Federation Council LGA, and supersede the individual DCPs (Urana Shire DCP 2011 and Corowa DCP 2013). Where appropriate, any recommendations pertaining to flood related development controls arising from this Floodplain Risk Management Study and Plan will ultimately be incorporated into the development of the Comprehensive Federation Council DCP.



## 5. ECONOMIC IMPACTS OF FLOODING

### 5.1. Introduction

A flood damages assessment has been undertaken to determine the economic costs of flooding in each of the five villages. Damages can be defined either as tangible or intangible. Tangible damages are those for which a monetary value can be easily assigned, while intangible damages are those to which a monetary value cannot easily be attributed. Damages are further categorised as being either direct or indirect. Direct damages are caused by direct contact with flood water, for example, damages to buildings and their contents. Indirect damages refer to the knock-on effects of flood events, such as loss of wages or traffic disruption.

The below assessment focuses on the direct tangible damages to properties (i.e. residential and commercial/industrial buildings) caused by flooding. Other direct damages (e.g. to roads, bridges, other infrastructure) are not included in the assessment as there is currently no clear methodology available to do so. When investigating potential mitigation options, these sources of flood damage are considered via multi-criteria matrix assessments. Therefore, while the damages assessment is useful to get a “feel” for the magnitude of the flood problem, it is of limited value for absolute economic evaluation.

The damages assessment however forms a useful basis of quantifying the benefits of certain mitigation and a comparison to assess the relative economic merits of mitigation measures, in which their benefits (reduction in tangible property damages) are compared to the cost of implementation. Analysis of other tangible damages (e.g. to infrastructure), and intangible aspects, is captured via a multi-criteria matrix assessment in the option investigation process. The damages assessment methodology is based on DPIE guidelines and is summarised below.

### 5.2. Flood Damage Categories

The Floodplain Development Manual (Reference 5) broadly categorises flood damages as either tangible or intangible.

Tangible Damages:

- Financial in nature and can be readily measured in monetary terms, and include:
  - Damage or loss caused by floodwaters wetting goods and possessions (direct damages); and
  - Loss of wages and extra outlays incurred during clean-up operations and in the post-flood recovery period (indirect damages).

Intangible Damages:

- Intangible damages are difficult, if not impossible to quantify in financial terms, and may include:
  - increased levels of emotional stress and mental and physical illness caused by the flood episode;
  - Sense of loss and despondency caused by the destruction of memorabilia (family photographs and documents) or loss of pets;

- Stress caused by additional (and at times quite large) financial outlays to replace flood damaged possessions; and
- Stress caused by family disruption – including for example temporary accommodation, attend different schools, increased distances or time to travel to work.

Tangible damages can be further classified as direct or indirect, presented in 5.5. Direct damages are those caused by floodwaters wetting goods and possessions, thereby either damaging them irreparably or reducing their value. Indirect damages are the additional financial losses caused by the flood, including for example:

- The extra cost of food and accommodation for evacuees;
- Loss of wages by employees;
- Loss of actual and prospective production or sales by flood-affected commercial and industrial establishments; and
- Opportunity cost to the public caused by the closure or limited operation of public facilities.

### 5.3. Assessment Methodology

The flood damages assessment methodology is presented below:

- **Establish design flood modelling results** for the 20%, 10%, 5%, 1%, 0.5%, 0.2% AEP and the PMF events. Flood modelling results are derived from the models established in each village (Appendix A to Appendix E), and are based on an envelope of mainstream and overland flooding;
- **Obtain floor level data**
  - Floor levels for all properties within the PMF extent for each town were estimated by visual inspection and LiDAR data;
  - The number and type of properties included in the flood damages assessment for each village is provided in Table 8.
- **Determine the peak flood depth** that would occur at each property during each design flood event;
- **Apply stage-damage curves** (derived from DPIE (formerly OEH) Guidelines, Reference 8) to relate the depth of flooding to a monetary cost in each design flood event;
- **Calculate the Average Annual Damage (AAD)**. The AAD represents the estimated tangible damages sustained every year (on average), over a long period of time.

Note that the results are not an indicator of individual flood risk exposure, but part of a regional assessment of flood risk. Furthermore, the purpose of the damages assessment is not to calculate the actual damage that would be incurred in a flood, but to form a basis of comparison with other flood prone communities throughout NSW, and a baseline against which mitigation options can be assessed.

## 5.4. Floor Level Database

The flood damages assessment is, at its core, based on the depth of flooding that occurs above and below the floor level of each property in the PMF extent. To complete the damages assessment, a flood level database is compiled, including the below features:

- Ground Level (in mAHD);
- Indication of house size (number of storeys);
- Location of the front entrance to the property; and
- Local Environmental Plans (LEP) land use (residential, commercial, industrial, primary production, or public recreation and infrastructure).

A summary of the floor level database is provided in Table 8 below.

Table 8 Floor Level Database Summary (no. properties within estimated PMF extent)

Village	Residential	Non-Residential	Total (Internal)
<b>Boree Creek</b>	54	13	67
<b>Morundah</b>	35	5	40
<b>Oaklands</b>	132	43	175
<b>Rand</b>	30	13	43
<b>Urana</b>	171	61	232
<b>Total</b>	<b>422</b>	<b>135</b>	<b>557</b>

## 5.5. Flood Damage Assessment Results

Flood damages results are presented for each village, and are divided into residential damages, commercial damages and the total combined damages.

### 5.5.1. Boree Creek Flood Damage Results

Table 9 Boree Creek Combined (Residential and Commercial/Industrial) Flood Damages

Event	No. Properties Affected (Flooded below floor)	No. Properties Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
<b>20% AEP</b>	20	11	\$ 1,355,100	\$ 166,099	30%
<b>10% AEP</b>	30	18	\$ 2,104,400	\$ 189,293	26%
<b>5% AEP</b>	42	22	\$ 2,628,500	\$ 182,188	17%
<b>2% AEP</b>	51	34	\$ 3,703,000	\$ 217,246	14%
<b>1% AEP</b>	58	40	\$ 4,341,600	\$ 209,009	6%
<b>0.5% AEP</b>	61	41	\$ 4,591,800	\$ 203,667	3%
<b>0.2% AEP</b>	63	48	\$ 5,198,300	\$ 212,280	2%
<b>PMF</b>	66	66	\$ 10,006,400	\$ 381,925	2%
<b>Average Annual Damages (AAD)</b>			<b>\$ 677,200</b>	<b>\$ 34,983</b>	<b>100%</b>

Table 10 Boree Creek Residential Flood Damages

Event	No. Properties Affected (Flooded below floor)	No. Properties Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
20% AEP	13	4	\$ 416,900	\$ 32,071	21.2%
10% AEP	22	10	\$ 927,200	\$ 42,145	22.8%
5% AEP	33	14	\$ 1,359,700	\$ 41,202	19.4%
2% AEP	42	25	\$ 2,224,400	\$ 52,962	18.2%
1% AEP	47	30	\$ 2,666,600	\$ 56,736	8.3%
0.5% AEP	49	31	\$ 2,844,300	\$ 58,048	4.7%
0.2% AEP	50	37	\$ 3,295,500	\$ 65,911	3.1%
PMF	53	53	\$ 6,679,800	\$ 126,034	2.3%
Average Annual Damages (AAD)			\$ 294,800	\$ 5,600	100%

Table 11 Boree Creek Commercial/Industrial flood damages

Event	No. Properties Affected (Flooded below floor)	No. Properties Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
20% AEP	7	7	\$ 938,200	\$ 134,029	37%
10% AEP	8	8	\$ 1,177,200	\$ 147,149	28%
5% AEP	9	8	\$ 1,268,900	\$ 140,986	16%
2% AEP	9	9	\$ 1,478,600	\$ 164,284	11%
1% AEP	11	10	\$ 1,675,000	\$ 152,273	4%
0.5% AEP	12	10	\$ 1,747,400	\$ 145,619	2%
0.2% AEP	13	11	\$ 1,902,800	\$ 146,369	1%
PMF	13	13	\$ 3,326,600	\$ 255,891	1%
Average Annual Damages (AAD)			\$ 382,500	\$ 29,400	100%

### 5.5.2. Morundah Flood Damage Results

Table 12 Morundah Combined (Residential and Commercial/Industrial) Flood Damages

Event	No. Properties Affected (Flooded below floor)	No. Buildings Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
20% AEP	19	4	\$ 264,800	\$ 24,477	20%
10% AEP	23	9	\$ 671,000	\$ 60,127	24%
5% AEP	25	10	\$ 878,600	\$ 85,572	20%
2% AEP	26	15	\$ 1,219,400	\$ 103,447	16%
1% AEP	27	20	\$ 1,682,300	\$ 131,060	7%
0.5% AEP	29	28	\$ 2,547,100	\$ 197,903	5%
0.2% AEP	30	28	\$ 2,553,900	\$ 194,830	4%
PMF	34	31	\$ 3,981,100	\$ 298,807	3%
Average Annual Damages (AAD)			\$ 194,600	\$ 12,067	100%

Table 13 Morundah Residential Flood Damages

Event	No. Properties Affected (Flooded below floor)	No. Buildings Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
20% AEP	15	3	\$ 227,600	\$ 15,175	23%
10% AEP	18	7	\$ 512,900	\$ 28,492	25%
5% AEP	20	8	\$ 600,900	\$ 30,047	19%
2% AEP	21	13	\$ 921,600	\$ 43,883	15%
1% AEP	21	17	\$ 1,254,300	\$ 59,731	7%
0.5% AEP	22	21	\$ 1,703,900	\$ 77,450	5%
0.2% AEP	23	21	\$ 1,710,700	\$ 74,378	3%
PMF	27	24	\$ 2,550,800	\$ 94,475	2%
Average Annual Damages (AAD)			\$ 148,700	\$ 5,500	100%

Table 14 Morundah Commercial/Industrial flood damages

Event	No. Properties Affected (Flooded below floor)	No. Buildings Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
20% AEP	4	1	\$ 37,200	\$ 9,303	12%
10% AEP	5	2	\$ 158,200	\$ 31,635	21%
5% AEP	5	2	\$ 277,600	\$ 55,525	24%
2% AEP	5	2	\$ 297,800	\$ 59,563	19%
1% AEP	6	3	\$ 428,000	\$ 71,329	8%
0.5% AEP	7	7	\$ 843,200	\$ 120,453	7%
0.2% AEP	7	7	\$ 843,200	\$ 120,453	6%
PMF	7	7	\$ 1,430,300	\$ 204,332	4%
Average Annual Damages (AAD)			\$ 45,900	\$ 6,600	100%

### 5.5.3. Oaklands Flood Damage Results

Table 15 Oaklands Combined (Residential and Commercial/Industrial) Flood Damages

Event	No. Properties Affected (Flooded below floor)	No. Properties Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
20% AEP	37	1	\$ 313,200	\$ 16,256	41%
10% AEP	40	1	\$ 329,700	\$ 16,540	28%
5% AEP	43	1	\$ 349,600	\$ 16,668	15%
2% AEP	45	4	\$ 380,600	\$ 17,016	10%
1% AEP	47	5	\$ 401,800	\$ 16,846	3%
0.5% AEP	47	6	\$ 410,600	\$ 17,197	2%
0.2% AEP	50	7	\$ 437,100	\$ 17,249	1%
PMF	107	45	\$ 3,473,800	\$ 69,463	1%
Average Annual Damages (AAD)			\$ 115,200	\$ 2,601	100%

Table 16 Oaklands Residential Flood Damages

Event	No. Properties Affected (Flooded below floor)	No. Properties Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
20% AEP	5	0	\$ 38,300	\$ 7,667	34.2%
10% AEP	6	0	\$ 49,900	\$ 8,310	26.3%
5% AEP	7	0	\$ 60,500	\$ 8,637	16.4%
2% AEP	9	2	\$ 77,300	\$ 8,591	12.3%
1% AEP	11	3	\$ 90,000	\$ 8,186	5.0%
0.5% AEP	11	3	\$ 91,700	\$ 8,338	2.7%
0.2% AEP	13	4	\$ 108,900	\$ 8,379	1.8%
PMF	65	26	\$ 1,572,400	\$ 24,191	1.4%
Average Annual Damages (AAD)			\$ 16,800	\$ 300	100%

Table 17 Oaklands Commercial/Industrial flood damages

Event	No. Properties Affected (Flooded below floor)	No. Properties Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
20% AEP	32	1	\$ 274,800	\$ 8,588	42%
10% AEP	34	1	\$ 279,800	\$ 8,230	28%
5% AEP	36	1	\$ 289,100	\$ 8,031	14%
2% AEP	36	2	\$ 303,300	\$ 8,424	9%
1% AEP	36	2	\$ 311,800	\$ 8,660	3%
0.5% AEP	36	3	\$ 318,900	\$ 8,858	2%
0.2% AEP	37	3	\$ 328,200	\$ 8,870	1%
PMF	42	19	\$ 1,901,400	\$ 45,272	1%
Average Annual Damages (AAD)			\$ 98,400	\$ 2,300	100%

### 5.5.4. Rand Flood Damage Results

Table 18 Rand Combined (Residential and Commercial/Industrial) Flood Damages

Event	No. Properties Affected (Flooded below floor)	No. Buildings Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
20% AEP	0	0	\$ -	\$ -	0%
10% AEP	1	0	\$ 320	\$ 319	3%
5% AEP	1	0	\$ 4,865	\$ 4,864	21%
2% AEP	2	0	\$ 8,089	\$ 4,044	31%
1% AEP	3	0	\$ 12,850	\$ 6,952	17%
0.5% AEP	3	0	\$ 15,327	\$ 8,440	11%
0.2% AEP	4	1	\$ 18,514	\$ 7,725	8%
PMF	25	21	\$ 2,080,099	\$ 176,468	10%
Average Annual Damages (AAD)			\$ 630	\$ 41	100%

Table 19 Rand Residential Flood Damages

Event	No. Properties Affected (Flooded below floor)	No. Buildings Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
20% AEP	0	0	\$ -	\$ -	0%
10% AEP	1	0	\$ 320	\$ 319	3%
5% AEP	1	0	\$ 4,865	\$ 4,864	22%
2% AEP	2	0	\$ 8,089	\$ 4,044	33%
1% AEP	2	0	\$ 11,796	\$ 5,898	17%
0.5% AEP	2	0	\$ 13,774	\$ 6,887	11%
0.2% AEP	3	1	\$ 16,184	\$ 5,395	8%
PMF	16	12	\$ 1,124,308	\$ 70,269	8%
Average Annual Damages (AAD)			\$ 596	\$ 37	100%

Table 20 Rand Commercial/Industrial flood damages

Event	No. Properties Affected (Flooded below floor)	No. Buildings Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
20% AEP	0	0	\$ -	\$ -	0%
10% AEP	0	0	\$ -	\$ -	0%
5% AEP	0	0	\$ -	\$ -	0%
2% AEP	0	0	\$ -	\$ -	0%
1% AEP	1	0	\$ 1,055	\$ 1,055	15%
0.5% AEP	1	0	\$ 1,553	\$ 1,553	19%
0.2% AEP	1	0	\$ 2,330	\$ 2,330	17%
PMF	9	9	\$ 955,791	\$ 106,199	50%
Average Annual Damages (AAD)			\$ 35	\$ 4	100%

### 5.5.5. Urana Flood Damage Results

Table 21 Urana Combined (Residential and Commercial/Industrial) Flood Damages

Event	No. Properties Affected (Flooded below floor)	No. Buildings Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
20% AEP	12	0	\$ 32,200	\$ 5,712	2%
10% AEP	23	6	\$ 578,800	\$ 66,009	14%
5% AEP	34	10	\$ 1,129,300	\$ 104,042	19%
2% AEP	44	21	\$ 2,120,100	\$ 135,318	22%
1% AEP	75	40	\$ 3,814,200	\$ 110,887	13%
0.5% AEP	93	69	\$ 6,728,600	\$ 164,742	12%
0.2% AEP	109	87	\$ 8,989,000	\$ 194,850	10%
PMF	232	223	\$ 31,963,300	\$ 323,105	8%
Average Annual Damages (AAD)			\$ 225,200	\$ 2,418	100%

Table 22 Urana Residential Flood Damages

Event	No. Properties Affected (Flooded below floor)	No. Buildings Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
<b>20% AEP</b>	9	0	\$ 22,600	\$ 2,511	3%
<b>10% AEP</b>	17	4	\$ 282,400	\$ 16,610	13%
<b>5% AEP</b>	27	6	\$ 541,400	\$ 20,050	17%
<b>2% AEP</b>	35	15	\$ 1,214,600	\$ 34,703	22%
<b>1% AEP</b>	50	26	\$ 2,084,000	\$ 41,679	14%
<b>0.5% AEP</b>	64	45	\$ 3,567,800	\$ 55,746	12%
<b>0.2% AEP</b>	77	57	\$ 4,712,100	\$ 61,196	10%
<b>PMF</b>	170	162	\$ 18,780,000	\$ 110,470	8%
<b>Average Annual Damages (AAD)</b>			<b>\$ 118,500</b>	<b>\$ 700</b>	<b>100%</b>

Table 23 Urana Commercial/Industrial flood damages

Event	No. Properties Affected (Flooded below floor)	No. Buildings Flooded Above Floor Level	Total Damages for Event	Ave. Damage Per Flood Affected Property	% Contribution to AAD
<b>20% AEP</b>	3	0	\$ 9,600	\$ 3,201	1%
<b>10% AEP</b>	6	2	\$ 296,400	\$ 49,400	14%
<b>5% AEP</b>	7	4	\$ 587,900	\$ 83,992	21%
<b>2% AEP</b>	9	6	\$ 905,500	\$ 100,615	21%
<b>1% AEP</b>	25	14	\$ 1,730,200	\$ 69,208	12%
<b>0.5% AEP</b>	29	24	\$ 3,160,900	\$ 108,995	11%
<b>0.2% AEP</b>	32	30	\$ 4,276,900	\$ 133,654	10%
<b>PMF</b>	62	61	\$ 13,183,400	\$ 212,635	8%
<b>Average Annual Damages (AAD)</b>			<b>\$ 106,700</b>	<b>\$ 1,700</b>	<b>100%</b>

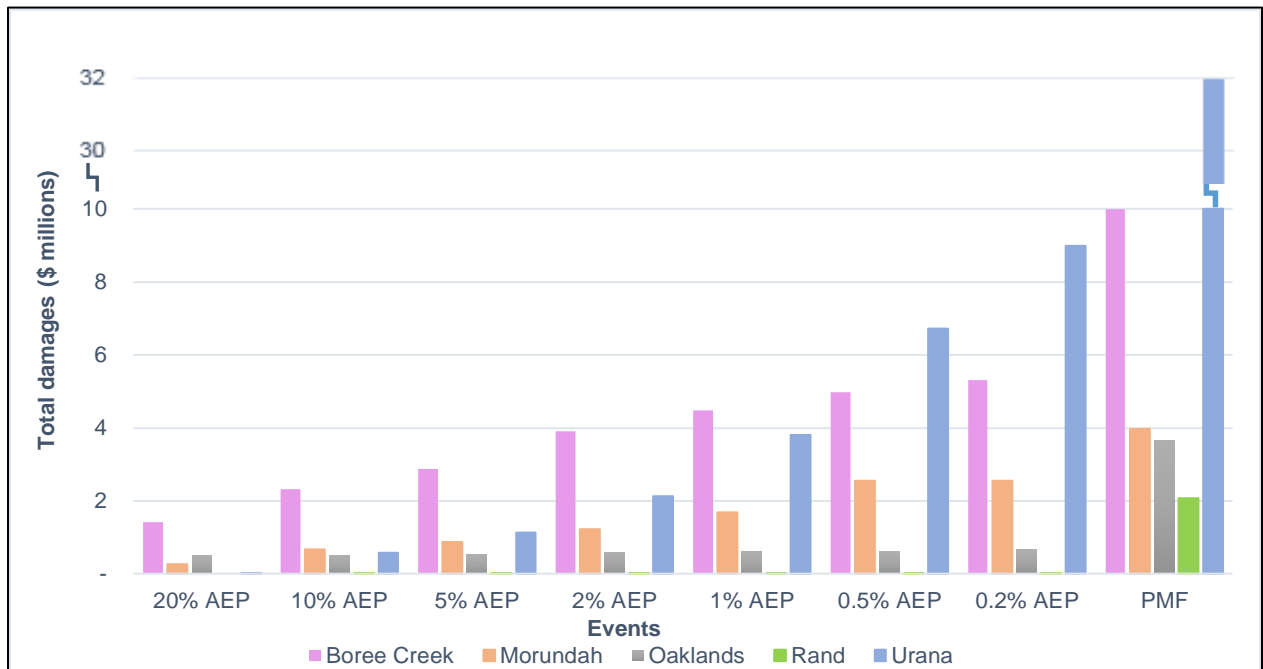


## 5.6. Discussion of Results

### 5.6.1. Total Flood Damages

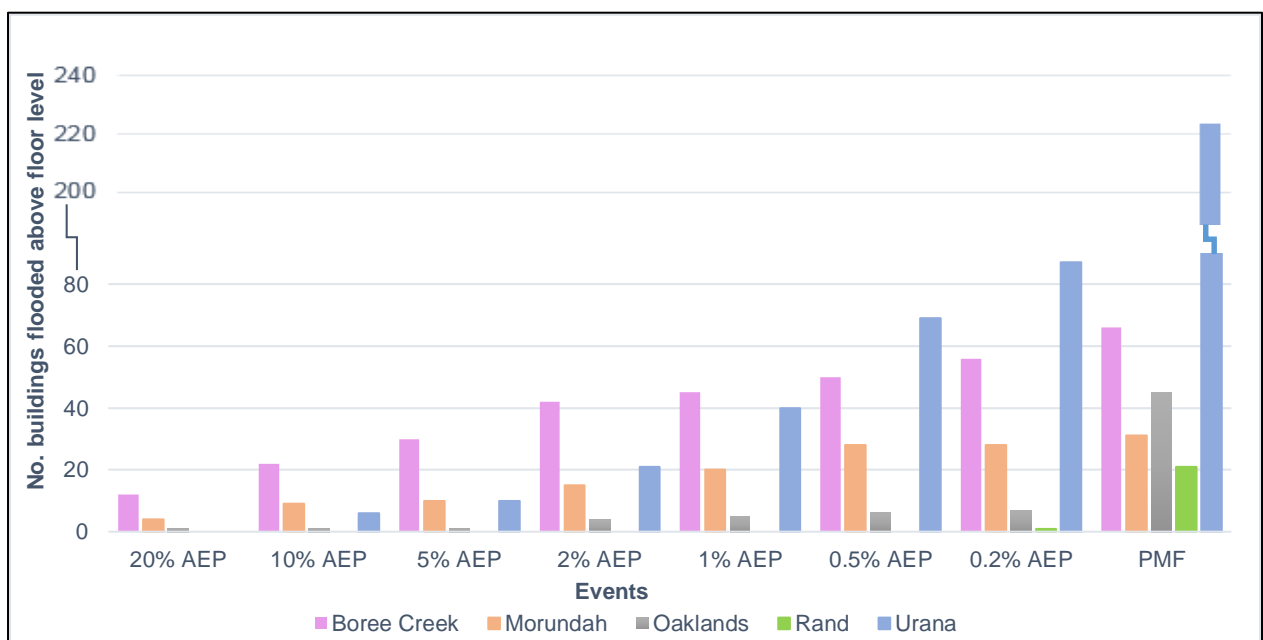
Flood damages are calculated for each design flood event. Chart 1 indicates the total damages occurring in each village, in each event, while Chart 2 presents the total number of buildings (both residential and commercial) flooded above floor in each event, in each village.

Chart 1 Total Damages per AEP Event (for each Village)



Note the y-axis is discontinuous to allow data to be presented on one chart (damages in the PMF are significantly higher than all other events).

Chart 2 No. Buildings Flooded Above Floor in Each AEP Event (for each Village)



Note the y-axis is discontinuous to allow data to be presented on one chart (No. properties flooded above floor in the PMF is significantly higher than all other events).

As indicated by the results in Chart 1 and Chart 2, Boree Creek exhibits the greatest susceptibility to flood damage in events up to and including the 1% AEP. This is consistent with the town being affected by mainstream flooding from Boree Creek in frequent events, while mainstream flooding in other villages is typically confined to creek channels in these events, or if not, generally occurs away from development which may be on higher ground. In events including and rarer than the 0.5% AEP event, Urana is subject to the greatest flood damage, owing to the greater population and number of properties that become inundated in this size event, when Urangeline Creek breaks its banks and inundates the township.

As can be seen on both Chart 1 and Chart 2, buildings in Rand are not inundated above floor until the 0.2% AEP event, as Billabong Creek is generally confined to the deep main creek channel in more frequent events (at least in the vicinity of development). Property affectation similarly is low in Oaklands, as flood risk is derived from local overland flow, characterised by shallow sheet flow that does not increase materially between different design events.

It is important to understand the level of flood risk (or lack thereof) to properties in each village when considering floodplain risk mitigation options, particularly structural works. For example, towns with limited property affectation may benefit more from options that improve access routes or emergency response, rather than works designed to protect properties, such as levees or basins. In addition, structural flood mitigation works often require significant capital and ongoing costs, and may not be economically feasible in locations where only a few properties would be benefitted.

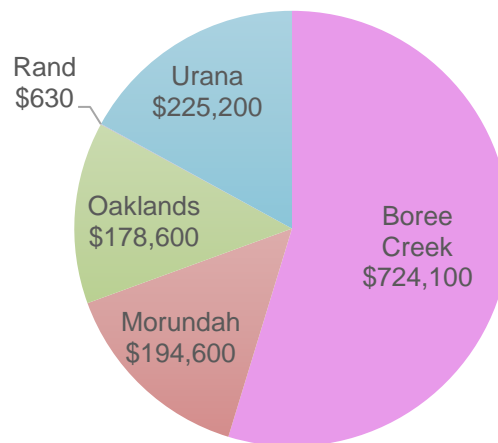
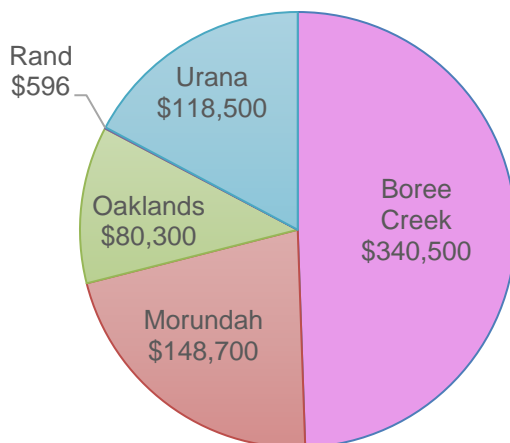
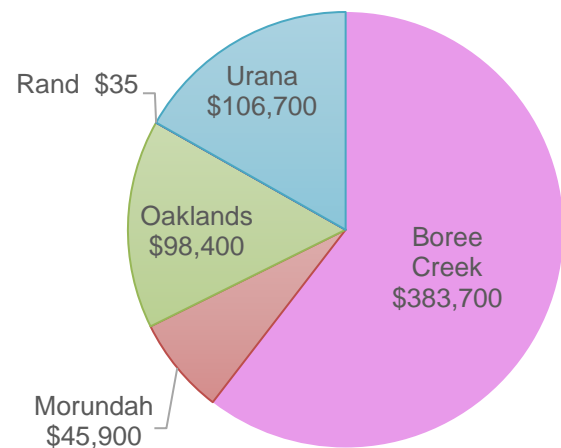
### 5.6.2. Annual Average Damages

Depending on its size (or severity), each flood will cause a different amount of flood damage within a flood prone area. Annual Average Damage (AAD) is the average damage per year that would occur in a nominated development situation (i.e. current catchment conditions in each village) from flooding over a very long period of time (Reference 5). That is, the AAD is equal to the total damage caused by *all* floods over a long period of time divided by the number of years in that period. Note that it is assumed that the development situation is constant over the analysis period.

Table 24 summarises the AAD incurred in each village, and indicates the contribution of residential and commercial damages to this amount. Chart 3 to Chart 5 present the division of AAD by property type (residential and commercial) in each village.

Table 24 Annual Average Damages in each Village

Village	Residential AAD (% of total)	Non-Residential AAD (% of total)	Total (AAD)
<b>Boree Creek</b>	\$340,500 (47%)	\$383,700 (53%)	<b>\$724,100</b>
<b>Morundah</b>	\$148,700 (76%)	\$45,900 (24%)	<b>\$194,600</b>
<b>Oaklands</b>	\$80,300 (45%)	\$98,400 (55%)	<b>\$178,600</b>
<b>Rand</b>	\$596 (94%)	\$35 (6%)	<b>\$630</b>
<b>Urana</b>	\$118,500 (53%)	\$106,700 (47%)	<b>\$225,200</b>

**Chart 3 Breakdown of Total Annual Average Damages by Village**

**Chart 4 Distribution of Residential AAD across the Villages**

**Chart 5 Distribution of Commercial AAD across the Villages**


### 5.6.3. First Event Flooded

In addition to estimating direct tangible costs in design flood events and determining Annual Average Damages, the damages assessment is useful in identifying the frequency of event in which residential and commercial buildings are likely to first be flooded above floor level, and identifying these buildings spatially. Figure 3 (Sheets 1-5) show all buildings in each village's Study Area estimated to be flooded above floor, categorised by the design event in which they are expected to be subject to over-floor flooding. This information can assist in identifying areas subject to the greatest flood risk, where investment in flood mitigation works may be warranted, as well as highlight areas where planning controls (such as land use zoning and minimum floor level controls) have been implemented effectively.

The results are consistent with the above charts and discussion: that is, Boree Creek has the greatest number, and highest proportion, of buildings flooded above floor level, with 11 buildings subject to internal flooding in a 20% AEP event. These include two residential dwellings on Lawrence Street and a further two downstream of town, south of Urana-Boree Creek Road. Five of the seven commercial properties also flooded above floor in a 20% AEP event are located on Richmond Street, with the final two on Orara Street at the north-eastern end of town.

The dwellings most at risk of over-floor flooding in Morundah are located on Milvain Drive, and are subject to flooding from overland flow from the land north of Morundah, and on the bank of Colombo Creek to the west of town. A further 7 dwellings are first subject to above-floor flooding in the 5% or 2% AEP event, while the remainder of dwellings would not be flooded until the 1% AEP event or rarer.

Buildings in Oaklands are relatively safe from over-floor inundation, with majority of both residential and commercial premises not flooded above floor until the PMF event, or not flooded at all. Two low lying dwellings are flooded above floor in the 2% AEP event. A similar trend is seen in Rand, with all buildings well above Billabong Creek, and only experiencing over-floor inundation in the PMF event, if at all.

In Urana, the frequency of above-floor inundation decreases with distance from Urangeline Creek. The most frequently affected buildings (flooded above floor in a 10% AEP event) are located close to the creek, on the western side of the township. No dwellings or commercial buildings are estimated to be internally flooded in a 20% AEP event. Generally, properties on the eastern side of William Street are not flooded above floor in events more frequent than an 0.5% AEP event.

## 6. FLOODPLAIN RISK MANAGEMENT OPTIONS

This FRMS aims identify and assess risk management measures which could be put in place to mitigate flood risk and reduce flood damages. As well as the hydraulic impacts, flood risk management measures are assessed against a range of criteria including technical and legal feasibility, economic, social and environmental impacts, and constraints of the local area. In the following sections a range of management options are considered to identify the preferred suite of options to effectively manage existing and potential future flood risks in the Federation villages.

### 6.1. Categories of Available Measures

The 2005 NSW Government's Floodplain Development Manual (Reference 5) separates risk management measures into three broad categories, outlined below:



**Property modification measures** modify existing properties, and land use and development controls for future new development or redevelopment. This is generally accomplished through such means as flood proofing, house raising or sealing entrances, strategic planning such as land use zoning, building regulations such as flood-related development controls, or voluntary purchase/voluntary house raising.

*Property modification measures are assessed across the Study Area as a whole, presented in this report.*



**Response modification measures** modify the response of the community to flood hazard by educating flood affected property owners about the nature of flooding so that they can make better informed decisions. Examples of such measures include provision of flood warning, emergency services, and improved awareness and education of the community.

*Response modification measures are assessed across the Study Area as a whole, presented in Appendix A - E and this report where they apply to the entire LGA.*



**Flood Modification Measures** modify the physical behaviour of a flood including depth, velocity and redirection of flow paths. Typical measures include flood mitigation dams, retarding basins, channel improvements, levees or defined floodways. Pit and pipe improvement and even pumps may be considered where practical.

*Flood modification measures are assessed for each village individually, presented in Appendix A to Appendix E*

### 6.2. Assessment Methodology

A key objective of this FRMS&P is to assess a range of options to reduce flood risk to property and residents of the Federation Villages. The assessment process starts with identifying areas that are subject to the greatest flood risk. These "hotspots" are identified via engagement with a range of stakeholders, and examination of modelled flood behaviour to locate areas of significant depth or hazard.

In addition, review of the flood damages results and 'First Event Flooded' (Figure 3 Sheets 1-5) can help indicate the areas most at risk of property damage, and clusters of properties frequently affected by flooding. Options are then shortlisted for hydraulic assessment, and if effective, proceed to detailed assessment and multicriteria analysis. Options that are scored positively in the multicriteria analysis are typically included in the Draft Floodplain Risk Management Plan for implementation.

As part of the community consultation carried out in October 2018, community members provided valuable insight into the key issues in the study area, as well as suggestions for ways to manage flood risk, as described in Section 3.2. This information has been used to both identify potential options, as well as assess the possible social impacts and acceptance of options as part of the more detailed assessment.

### 6.3. Flood Modification Measures

Flood modification measures aim to modify the behaviour of a flood itself by reducing flood levels or velocities, or by excluding water from areas under threat. Typical measures involve structural works such as levee banks, retarding basins and drainage networks, and are generally installed to modify flood behaviour on a wider scale. Depending on the type of flood behaviour, spatial constraints and catchment conditions, different flood modification measures will be better suited to reducing flood risk than others. A key consideration when assessing potential flood modification options is ensuring that, in the pursuit of reducing flood risk in one area, the option (e.g. a basin or levee) does not adversely affect other areas.

Potential flood modification options were identified and assessed for each village, described in detail in the relevant appendices. From this, the following recommendations are made.

#### FM: Flood Modification Options

- ☒ **FMBC-02: Boree Creek Western Culvert Upgrades** to be further investigated as a measure to manage local drainage.
- ☒ **FMBC-03: Boree Creek Kywong Road Upgrade** to be further investigated as a possible evacuation route and to manage local drainage.
- ☒ **FMBC-04/05/06: Boree Creek Railway Line Augmentation** to be further assessed if modification or removal of the railway line is considered in the future.
- ☒ **FMBC-07: Boree Creek Vegetation Management** maintain vegetation levels to minimise impacts on flood behaviour. Can be achieved through other Council programs.
- ☒ **FMM-01: Morundah Levee (Carry On)** existing level to be maintained, further investigation of levee structural integrity and repair works, as required.
- ☒ **FMM-02: Morundah Internal Drainage Improvements (Pipes only)** to be implemented to minimise impacts during overland flow events.

### FM: Flood Modification Options

- ☒ **FMM-04: Morundah Milvain Drive Diversion Bund and Culvert Upgrades** to be implemented to minimise impacts during overland flow events.
- ☒ **FMO-03: Oaklands Buller Street Trunk Drainage** undertake localised drainage improvements at intersections when opportunities arise.
- ☒ **FMO-05: Oaklands Recreation Reserve Spectator Bund** construct spectator bund to benefit local stormwater drainage.
- ☒ **FMR-01: Rand Levee Investigation (Maintenance)** Further investigate the informal Rand levee to identify the beneficiaries of the current system, understand the condition of the levee and land ownership.
- ☒ **FMU-02: Urana Levee Upgrade Alignment 2** to be further investigated to manage the impacts of mainstream flooding.
- ☒ **FMU-03: Urana Stormwater Drainage Upgrades** to be further investigated to manage the impacts of overland flooding due to the town levee.
- ☒ **FMU-07: Urana Aquatic Centre Dam Outlet Upgrade** improve existing outlet to prevent 'sunny day' failures.
- ☒ **FMU-09: Urana Vegetation Management** maintain vegetation levels to minimise impacts on flood behaviour. Can be achieved through other Council programs.
- ☒ **FMU-10: Urana Coonong Street Bund** to be implemented to improve local overland flooding.
- ☒ **FMU-11: Urana Cockatgedong Road Causeway** to be implemented to improve conveyance during flood events and reduce damage to roadway.
- ☒ **FMU-12: Urana Tombstones Causeway** to be implemented when opportunities arise to improve conveyance.

## 6.4. Property Modification Options

Property modification measures modify the existing land use as well as consider development controls for future development. This includes options such as land use zoning, building regulations and or voluntary purchase / voluntary house raising.

### 6.4.1. Flood Planning Levels

Flood Planning Levels (FPLs) are an important tool in floodplain risk management. Appendix K of the NSW Floodplain Development Manual (Reference 5) provides a comprehensive guide to the purpose and determination of FPLs. The FPL for planning purposes is generally the height at which new (or redeveloped) building floor levels should be built to minimise frequency of inundation and associated damage. It may also refer to the height to which flood proofing should be applied to reduce damages to commercial properties.

The FPL is derived from a combination of a design flood event and a freeboard. FPLs can vary for different types of land use categories depending on the level of risk, consequences of inoperability or vulnerability of occupants.

For example, residential development could be considered more vulnerable due to people being present, whilst commercial development could be considered less vulnerable, acknowledging that businesses may be better placed to recover from flood related damages.

Until recently the NSW Government planning framework allowed for the FPL to be initially defined within the LEP and supported through subsequent controls in the DCP. As discussed in Section 4.2.3 changes to the NSW Government planning framework in relation to flooding came into effect on the 14<sup>th</sup> July 2021. These changes removed the definition of the FPL from the LEP. Flood planning controls including FPLs are typically defined via the DCP.

The subsequent sections discuss the selection of the design flood event, and freeboard, used to make up Flood Planning Levels appropriate for use in the Federation Villages.

#### **6.4.1.1. Selection of Design Flood Event**

A variety of factors need to be considered when determining the FPL for an area. A key consideration is the flood behaviour and resultant risk to life and property. Selecting the appropriate FPL involves trading off the social and economic benefits of a reduction in the frequency, inconvenience, damage and risk to life caused by flooding against the social, economic and environmental costs of restricting land use in flood prone areas and of implementing management measures. The NSW Floodplain Development Manual identifies the following issues to be considered:

- Risk to life;
- Long term strategic plan for land use near and on the floodplain;
- Existing and potential land use;
- Current flood level used for planning purposes;
- Land availability and its needs;
- FPL for flood modification measures (levee banks etc.);
- Changes in potential flood damages caused by selecting a particular flood planning level;
- Consequences of floods larger than that selected for the FPL;
- Environmental issues along the flood corridor;
- Flood warning, emergency response and evacuation issues;
- Flood readiness of the community (both present and future);
- Possibility of creating a false sense of security within the community;
- Land values and social equity;
- Potential impact of future development on flooding; and
- Duty of care.

As detailed in Section 1.1.2 of the Manual, the NSW Flood Prone Land Policy provides for a merit-based approach to selection of appropriate flood planning levels (FPLs).



This recognises the need to consider the full range of flood sizes, up to and including the PMF and the corresponding risks associated with each flood, whilst noting that with few exceptions, it is neither feasible nor socially or economically justifiable to adopt the PMF as the basis for FPLs [for residential purposes].

FPLs for typical residential development would generally be based on the 1% AEP event plus an appropriate freeboard. Justification for the use of the 1% AEP event, and discussion on the determination of appropriate freeboard is provided below.

As a guide, Table K1 from the NSW Floodplain Development Manual (Reference 5) has been reproduced (Table 25), and indicates the likelihood of the occurrence of an event in an average lifetime. The data indicates that there is a 50% chance of a 1 in 100 Annual Exceedance Probability (1% AEP) event occurring at least once in a 70 year period. Given this potential, it is reasonable from a risk management perspective to consider adopting of the 1% AEP flood event as the basis for the FPL. Given the social issues associated with a flood event, and the non-tangible effects such as stress and trauma, it is appropriate to limit the exposure of people to floods.

Note that there still remains a 30% chance of exposure to at least one flood of a 1 in 200 (0.5%) AEP magnitude over a 70 year period. This gives rise to the consideration of the adoption of a rarer flood event (such as the PMF) as the flood planning level for some types of more vulnerable development. The Flood Prone Land Package acknowledges this risk and prompts Councils to consider the suitability of critical or vulnerable facilities within the floodplain (even if outside the Flood Planning Area) (see Section 6.4.2). Additionally, it is appropriate to consider a more frequent risk of exposure such as the 5% AEP for recreational and non urban uses, such as recreation facilities.

Table 25: Likelihood of given design events occurring in a period of 70 years

Size of Flood (Chance of Occurrence in Any Year) ARI/(AEP)	Probability of Experiencing At Least One Event in 70 Years (%)	Probability of Experiencing At Least Two Events in 70 Years (%)
<b>1 in 10 (10%)</b>	99.9	99.3
<b>1 in 20 (5%)</b>	97.0	86.4
<b>1 in 50 (2%)</b>	75.3	40.8
<b>1 in 100 (1%)</b>	50.3	15.6
<b>1 in 200 (0.5%)</b>	29.5	4.9

#### 6.4.1.2. Freeboard Selection

As noted above, the Flood Planning Level is typically derived from a design flood event (usually the 1% AEP) plus a freeboard allowance. The freeboard can be considered as a compulsory 'safety factor' used to provide reasonable certainty that the reduced flood risk exposure provided by selection of a particular flood as the basis of an FPL, is actually provided given the following factors:

### **Uncertainty in estimating flood levels**

The determination of design flood levels comprises a number of factors and parameters, each containing a degree of uncertainty. These factors may include:

- How well the theoretical ARI-Discharge curve fits known flood events, and if it has changed since an historic event;
- Availability of detailed survey and other topographic data;
- Reliability of historical flood data; and
- Estimated parameters including afflux, surface roughness, evapotranspiration, rainfall patterns etc.

These uncertainties can have localised or cumulative effects on the accuracy of hydrologic and hydraulic modelling, and hence, the resulting design flood levels produced. A component of the freeboard accounts for this uncertainty in the design flood levels.

The component is determined through an analysis of the sensitivity of design flood levels to changes in various modelling assumptions.

- Varying hydraulic roughness values of Manning's "n" by +/-20% for all parts of the hydraulic domain;
- Increasing the blockage factors at hydraulic structures to 50%

### **Local water surge**

Local flood water levels can be higher than the general flood level due to local blockages or obstructions in the floodplain, or, for mitigation works, if the levee alignment is oblique to the direction of the flow. Local surge can also be generated by trucks or boats passing through floodwaters. Some examples of local surge are shown below.



Results of flood modelling can be used to understand the sensitivity of design flood levels to the influences that cause local surge. The impacts of blockage were considered as part of the sensitivity analysis and this level of sensitivity has been used to derive the freeboard component related to local surge. The sensitivity assessment applied a blockage factor of 50% to bridges and culverts, and compared the resulting peak flood levels (in the 1% AEP event) to the design results to determine the influence of the increased blockage as a proxy for variations caused by local surge.

## **Wave Action**

Increases in water level as a result of wave action are not determined in floodplain modelling. Wind-induced waves across fetches of open water are important to consider in the wide floodplains of the Murrumbidgee River or areas of high wind speeds, that is towns in valleys such as Gundagai. Design wave actions are a product of:

- Fetch – the distance the wave is assumed to travel;
- Wind speed and direction;
- Wave Height;
- Wind Set-up, and
- Wave Run-up – when a wave reaches a sloping embankment (e.g. levee) it will break on the embankment and run up the slope. Run-up would not apply to flood planning levels.

For this freeboard assessment ‘wave action’ is assumed to mean the surface waves generated by wind across the water surface. The wave height is a product of the windspeed in the direction of the fetch, and the fetch distance across which the wind travels.

## **Climate change**

The Floodplain Development Manual (Reference 5) indicates that climate change should be considered in the development and implementation of floodplain risk management works, to ensure that the level of protection can be maintained under future conditions. The impacts of climate change on flood-producing rainfall events will have a flow on effect on flood behaviour. This may result in key flood levels being reached more frequently. The freeboard allowance required to cater for climate change is greatly affected by the uncertainties in future climate model projections, and is therefore somewhat of an estimation, though is considered appropriate for the purpose of this assessment.

The potential impacts of climate change, and the flood model’s sensitivity to these impacts can be understood by comparing the 0.5% and 0.2% AEP events with the 1% AEP event. These events are commonly used as proxies to assess an increase in rainfall intensity. The response or scale of flood events in each of the towns differs as does the factor applied.

## **Factor Probability of Occurrence**

*Joint probability analyses* was used to address the chance of two or more conditions occurring at the same time. The analysis recognises that design flood characteristics could result from a variety of combinations of flood-producing factors, and that in reality not all freeboard components would occur concurrently. The following probability factors have been assigned in this freeboard assessment

Freeboard Component	Probability Factor
Uncertainties in Flood Levels	1
Local Water Surge	0.5
Wave Action	0.5
Climate Change	1

A freeboard assessment has been undertaken based on the factors and considerations discussed above, to determine the appropriate freeboard for Flood Planning Levels in the Federation Villages. A summary is provided in Table 26.

Table 26: Summary of Freeboard Assessment

Freeboard Element	Boree Creek	Morundah		Oaklands	Rand		Urana	
	MS/O	MS	O	O	MS	O	MS	O
<b>Uncertainties in Estimated Flood Levels</b>	0.06	0.1	0.01	0.01	0.1	0.02	0.15	0.01
<b>Local Water Surge</b>	0.0075	0.007	0.01	0.01	0.09	0.01	0.015	0.05
<b>Wave Action</b>	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
<b>Climate Change</b>	0.1	0.05	0.25	0.02	0.08	0.03	0.18	0.2
<b>Total</b>	<b>0.18</b>	<b>0.17</b>	<b>0.28</b>	<b>0.05</b>	<b>0.28</b>	<b>0.07</b>	<b>0.36</b>	<b>0.47</b>

MS – Mainstream Flooding

O – Overland Flooding

Typically, the freeboard assessment would identify freeboard that would be appropriate for each flow mechanism. As shown above, the freeboard requirement across the study area is variable with mainstream requirements varying from 0.18 – 0.36m and overland requirements varying from 0.07 – 0.47mm. Following discussions with Council and the FRMC, the preferred approach is to apply a consistent freeboard across the study area and flow mechanisms. It is therefore concluded that a 0.3m freeboard is required to provide reasonable certainty that the flood risk in the 1% AEP is accounted for, for both overland flow and mainstream flooding.

#### 6.4.1.3. Flood Planning Levels

The residential Flood Planning Level (FPL) is recommended to be based on the 1% AEP event plus freeboard. Justification for the selection of the 1% AEP event as the basis is provided in Section 6.4.1.1, and the assessment of applicable freeboard is as described in Section 6.4.1.2.

Depending on the nature of the development and the level of flood risk, commercial FPLs can be varied based on either the design flood event selected or the choice of freeboard, acknowledging that businesses may be better placed to recover from flood related damages or implement flood protection/mitigation measures compared to residents. Section K4.4.1 of the Manual (Reference 5) states the following:

*“The greater flexibility of business in managing risk and recovering financially from flooding, means that FPLs for industrial and commercial development may be based upon a more frequent flood event. An acceptable level of risk may become a business decision for the owner or occupier. This allows for trade-offs between council’s responsibility to present and future owners and occupiers and the latter’s natural preference to accept the risk and potential damages as a business cost to lower initial set up costs.” (Reference 5).*

In some catchments, potential damages to commercial premises may be adequately avoided or limited by setting Flood Planning Levels based on a more frequent (i.e. 'smaller') design flood event. For simplicity however, adoption of the 1% AEP as the basis for commercial flood planning levels is recommended at this stage, subject to discussion with stakeholders, including the Floodplain Risk Management Committee and Council's planning staff. As such, the FPL for commercial development is also recommended as 1% AEP + 0.3 m.

*Commercial FPLs in Action: Note that the above recommendation does not necessarily mean that commercial developments are to have floor levels at these levels (whether mainstream or overland). Depending on the required height above ground, it may be more appropriate to ensure new commercial developments (or redevelopments), are flood-proofed to the FPL, in order to balance the competing objectives of street activation, accessibility and flood protection.*

### **Sensitive and Hazardous Uses Flood Planning Levels**

The FPL may also be raised depending on the vulnerability of the building/development to flooding. The vulnerability of a building may arise from its use (e.g. power supply, sewerage treatment plant) or from its occupants (e.g. children or the elderly). The Manual lists the following as examples of critical facilities: fire, ambulance and police stations, hospitals and nursing homes, schools, water and electricity supply installations, interstate highways, bus stations and chemical plants." For such facilities, the consequences of flooding are significantly more severe, and so the avoidance (or limitation) of flood damage is particularly important. In addition, the changes to the NSW Government planning framework in relation to flooding (refer to Section 4.2.2) that came into effect on the 14<sup>th</sup> July 2021, allows council's to opt into a second LEP clause to allow controls to be applied to these more vulnerable land uses, particularly in the area between the flood planning area and the PMF extent or land that is subject to non direct evacuation constraints.

As for commercial development, the FPLs for critical utilities may refer to the minimum level to which flood proofing is applied, if it is impractical to elevate floor levels to the FPL. However, the risk to the lives of occupants of vulnerable facilities must be appreciated when considering the application of the FPL requirement. If the lowest habitable floor level cannot practically be raised to the FPL, the suitability of the vulnerable facility (such as residential aged care or child care) in the proposed location must be carefully considered.

In these cases, the use of a design flood event rarer than the 1% AEP (e.g. 0.2% AEP or even PMF) as the basis for flood planning levels may be justified.

For the Federation Villages, it is recommended that critical utilities and vulnerable uses are located outside the floodplain (that is, beyond the PMF extent). However, where this is not possible, a FPL of the PMF should be adopted.

#### 6.4.1.4. Recommendation

##### PM-01: Flood Planning Levels



**Residential and Commercial** the Flood Planning Level (FPL) is recommended to be based on the 1% AEP event plus 0.3m freeboard



##### **Critical Utilities and Vulnerable Facilities**

Avoidance of the floodplain is preferred, however where this is not possible, the FPL should be based on the PMF event (without freeboard).

#### 6.4.2. Flood Planning Area

The FPL, and other flood related development controls, are applied to properties within the Flood Planning Area (FPA). The FPA is typically the land at or below the flood planning level. It is important to define the boundaries of the FPA to ensure flood related planning controls are applied where necessary and not to those lots unaffected by flood risk. It is also important to define the FPA on criteria defined in the NSW Floodplain Development Manual (Reference 5).

The Urana Shire DCP 2011 notes that *‘the extent of the floodplain within Urana Shire has been determined using the Department of Water Resources Murrumbidgee Valley Floodplain Atlas “Yanco, Colombo and Billabong Creeks” [1987], and in some areas, local knowledge.’* These maps broadly indicate areas subject to mainstream flooding only (not overland flow), including reaches of the main waterways between the five villages.

A provisional flood planning area (FPA) map was later developed for each village as part of the Flood Study for the Towns of Urana, Morundah, Boree Creek, Oaklands and Rand (Reference 7). The Provisional FPA was based on the extent of the 1% AEP event plus 0.3 m freeboard, trimmed to the PMF extent. Due to the relatively flat terrain in each village, this tends to result in the FPA covering approximately the same extent as the PMF. This is a conservative approach that encompasses properties that may not be subject to flood risk in events more frequent than the PMF, and can lead to development controls being applied where they are not warranted. This can make development applications (and their assessment by Council) overly onerous, and in some cases, prevent appropriate developments from being approved within the floodplain.

This FRMS&P provides an opportunity to assess the suitability of this approach, particularly in areas subject to shallow overland flow affectation. Whilst there is an opportunity to vary the FPA based on the source of flooding (that is differentiate mainstream and overland flow) this does create further potential confusion. As such, it was agreed with Council that the FPA would be defined based on mainstream flooding (which encompasses overland flow areas).

#### 6.4.2.1.

#### 6.4.2.2. Determine Mainstream FPA

Following the freeboard selection described in Section 6.4.1.2, a freeboard of 0.3 m was added to the peak 1% AEP flood level and the resulting level was extended laterally (“stretched”) on either side of the channel or creek, to intersect with the ground (using topographic data) (Figure Figure 4. This approximates the extent of a flood that is 0.3 m higher than the 1% AEP flood, and forms the boundary of the mainstream FPA. The Mainstream FPA therefore represents the area beneath the Mainstream Flood Planning Level, as defined in Section 6.4.1.3.

#### 6.4.2.3. Recommendation

It is recommended that Council adopt the Flood Planning Areas based on the extent formed by the 1% AEP mainstream flooding event plus 0.3 m freeboard. Mapping is shown on Figure 4.

With the Flood Planning Area defined in the LEP, it is not necessary for the map itself to be contained within the LEP in accordance with the Flood Prone Land Package. The Flood Planning Area may be updated following future Floodplain Risk Management Studies in the LGA, and it is useful to be able to update the Flood Planning Area map as future FRMS&Ps are adopted, without going through the planning proposal process (to amend the LEP) each time a study is completed.

#### PM-02: Flood Planning Area



FPA derived from the 1% AEP plus 300 mm mainstream flood extent.

#### 6.4.3. Voluntary House Raising

Voluntary house raising (VHR) seeks to reduce the frequency of exposure to flood damage of the house and its contents by raising the house above the Flood Planning Level (FPL). This results in a reduction in the frequency of household disruption and associated trauma and anxiety, however other external flood risks remain, such as the need to evacuate prior to properties being isolated by floodwaters. Council’s development controls would act to reduce flood risk to these properties in the long term as redevelopment would require floor levels to be raised to the FPL. While this would ultimately have a similar outcome to VHR, it would take significantly longer to achieve as house redevelopment would be contingent on residents’ appetite to rebuild, and properties would be subject to risk from floods occurring in the interim.

The potential for voluntary house raising schemes were considered and assessed for each village, described in detail in the relevant appendices. From this, the following options are recommendations are made.



#### 6.4.3.1. Recommendation

##### PM-04: Voluntary House Raising



Further investigate viability of a VHR schemes for **Boree Creek, Morundah and Urana**, and prepare funding application documentation for any viable properties. This should include confirmation of the structural compatibility of the identified buildings and a more accurate cost estimate of raising first floor levels to at least the 1% AEP plus 300mm level.

#### 6.4.4. Voluntary Purchase

Voluntary Purchase (VP) Schemes are a long-term option to remove residential properties from areas of high flood hazard. The potential for voluntary house purchase schemes were considered and assessed for each village, described in detail in the relevant appendices. From this, the following options are recommendations are made.

#### 6.4.4.1. Recommendation

##### PM-05: Voluntary Purchase



Further investigate viability of a VP schemes for **Boree Creek and Urana** and prepare funding application documentation for any viable properties.

#### 6.4.5. Planning controls to manage development in flood prone areas

Appropriate planning controls which ensure that development is compatible with flood risk can significantly reduce flood damages. Planning instruments can be used as tools achieve the objectives shown in Table 27.

Table 27 Planning Instrument Objectives – Control Type

Objective	Type of Control
<b>Reduce Risk to Life</b>	Evacuation considerations, vulnerable land use and occupant considerations, flood awareness and education (Section 10.7 certificates), prevention of ingress of water to car parks.
<b>Flood Damage to New Development</b>	Flood Planning Levels, location considerations including, hydraulic hazard and category considerations, structural requirements.
<b>Flood Damage to Existing Development</b>	Flood impact consideration, design considerations, location considerations including, hydraulic hazard and category considerations.

In this section, 'development' is as defined in the Environmental Planning Assessment Act 1979, and includes buildings of all types, infrastructure, levees, roads, etc. The Floodplain Development Manual (Reference 5) describes the following types of development:

- **Infill development:** refers to the development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land.



- **New development:** refers to development of a completely different nature to that associated with the former land use. E.g. the urban subdivision of an area previously used for rural purposes. New developments typically require extensions of existing urban services such as roads, water supply, sewerage and electricity.
- **Redevelopment:** refers to rebuilding in an area. E.g. as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require major extensions to urban services.

At the time of writing, Council had engaged GHD Pty Ltd to prepare the Federation LEP and Comprehensive DCP to be applied across the Federation LGA (i.e. covering the former Corowa and Urana LGAs). Through this work, consistency between Urana and Corowa DCPs should be resolved, and consideration of new controls to assist in the management of development on flood prone land as discussed in this FRMS&P.

#### 6.4.5.1. Recommendation

##### PM-06: Flood Planning Controls – Existing Zoned Land



Amalgamate the Urana and Corowa planning documents to ensure consistency in controls.

#### 6.4.6. Planning Controls to Managing Future Development

In addition to investigating ways to mitigate flood risk under current conditions, a key objective of this Floodplain Risk Management Study & Plan (FRMS&P) is to consider the continuing and future flood risk in the Federation Villages. This allows Council to plan future growth areas with flood risk in mind, and ideally, approve development compatible with the flood risk in that area. At the time of writing, Council had not identified official areas for strategic development, however commented that due to being commuting distance to Albury, Oaklands and Rand would be the villages most likely to see demand for future growth. Review of the current land use zoning (from Urana LEP 2011) shows that in these villages there is some vacant land already zoned as RU5 (Village), and (in Rand), R5 (Large Lot Residential), that would support residential development. (Note: Figures showing the Land use zoning for each village are provided in each village's respective Appendix to the main FRMS&P report.) However, depending on the degree and type of growth proposed, it may be necessary to rezone additional land that surrounds the towns from RU1 (Primary Production) to a classification that supports the type of development desired, e.g. RU5, R5 or other. The following section provides high level advice for Council to take into account when considering land use planning in future growth areas.

Whilst Council has not identified any official areas for strategic development Oaklands and Rand would be the villages most likely to see demand for future growth due to being commuting distance to Albury. Review of the current land use zoning (from Urana LEP 2011) shows that in these villages there is some vacant land already zoned as RU5 (Village), and (in Rand), R5 (Large Lot Residential), that would support residential development. However, depending on the degree and type of growth proposed, it may be necessary to rezone additional land that surrounds the towns from RU1 (Primary Production) to a classification that supports the type of development desired, e.g. RU5, R5 or other.

With the hydraulic assessments underpinning this FRMS&P (underway), Council will be able to take advantage of the high-resolution flood information available when considering changes to land use zoning in these future growth areas. Direction No. 15 – Flood Prone Land (Section 117 Ministerial Directions, Revised direction no. 15, 31 January 2007 (Planning Circular PS 07-003)) applies when a council prepares a draft LEP that creates, removes or alters a zone or provision that affects flood prone land.

Well informed decisions at the planning proposal stage regarding land use zoning will yield a range of benefits well into the future in the Federation Villages (and the broader Federation Council LGA), including but not limited to:

- Limit risk to life by prohibiting development (both residential and commercial) in known floodways, and therefore limiting the number of occupants in hazardous areas that may be subject to flash flooding;
- Limit risk to proposed development by only making land that is either flood free or subject to low flood hazard available for development and thereby reducing the potential financial burden following severe floods for future residents;
- Ensure flood risk to the broader floodplain is not exacerbated (e.g. by prohibiting development in locations that would obstruct flowpaths and redistribute flows);

Following on from the above, sensible decisions at the land-use planning stage will assist Council (and developers) in the long term. By limiting development to areas of low (or no) flood risk, there will be a reduced need for reliance on development controls to manage flood risk to new development. This will make lodgement and assessment of Development Applications less onerous on both developers and Council's planning staff, and likely result in improved aesthetic and/or street activation outcomes (for example, suitability of lower floor levels for retail premises). However, the Manual also states that the NSW Government's Flood Prone Land Policy does not support the use of zoning to unjustifiably restrict development simply because land is flood prone. Zoning of flood prone land should be based on an objective assessment of land suitability and capability, flood risk, environmental and other factors (Reference 5).

#### 6.4.6.1. Recommendation

##### **PM-07: Flood Planning Controls – Future Zoned Land**



Council to consider the high-resolution flood information developed as part of this study when considering changes to land use zoning in these future growth areas. And wherever possible, limit future development to areas classified as low or no flood risk

#### 6.4.7. Section 10.7 Planning Certificates

When development is proposed on flood prone land, it can be useful to directly share flood information with residents or developers so that the flood risk and constraints at the site are well understood, and so that the applicable flood related development controls (e.g. from Council's DCP) can be readily identified.

This information can then be used to inform building siting and design (such as fill extents and minimum floor levels), and submitted back to Council along with the Development Application (DA), to enable Council planning staff to make informed decisions when approving or rejecting the DA, or stipulating conditions for consent.

Sophisticated data and mapping produced in this study will assist in the dissemination of accurate and site-specific information to the community. A GIS based map can provide useful information to a property owner and simplify the identification of issues by a Council staff member. Section 17.2 and 17.3 of Appendix I to the FDM (Reference 5) detail typical examples of information for inclusion in Section 10.7 (2) and (5) Planning Certificates, and include the following:

- Whether the land is within the FPA (overland, riverine, or both) and if flood related development controls apply, (10.7(2));
- Design flood levels/depths specific to the property for the 1% AEP, 5% AEP and PMF events, (10.7(2) and (5));
- Percentages of lots affected by the FPA(s) if not 100%, (10.7(2) and (5));
- Likelihood of flooding and mechanism (riverine/ overland flow/ both) (10.7(2) and (5));
- Flood hazard (10.7(2) and (5));
- Hydraulic categorisation (e.g. floodway) (10.7(2) and (5));
- Evacuation routes/ constraints (10.7(2) and (5)); and
- Associated Mapping for the above items (10.7(2) and (5)).

Land owners will be required to be notified of changes to both the 10.7 (2) and 10.7 (5) Planning Certificates. Land owners can be concerned as to how a notification may impact on their property value or insurance, for example. The Insurance Council of Australia provides detailed fact sheets on how flood information is used for insurance pricing. This should be taken into account when developing a consultation strategy for notification of any changes related to S10.7 Planning Certificates.

With the completion of this FRMS&P, Council will be provided with high resolution GIS layers for a range of flood metrics, including the following:

- Flood Planning Area;
- Peak flood depths, levels, velocity for each AEP design event;
- Hazard classification and hydraulic categorisation;

It is recommended that Council implement a system through which flood information produced in this FRMS&P can be efficiently provided to those wishing to develop on flood prone land. While a degree of automation is recommended to streamline the delivery of information (e.g. generating maps or standard text, use of online request forms), interpretation by a qualified Council officer (e.g. engineer) is recommended to ensure relevant and correct information is provided, taking the following into account (for example):

- Flood mechanism(s) occurring at the site (overland or mainstream);
- Appropriate peak flood level on which Flood Planning Levels are to be based (note, this may not be the highest peak flood level within the cadastral lot, particularly if the site is sloping);

- Interpretation of hazard classification and hydraulic categorisation;
- Potential access and evacuation constraints (particularly for critical or vulnerable facilities)

Other elements to be determined within Council include the format in which information is to be provided, fee (if any) to be charged, and what to call the flood information reports/forms. It is noted that though commonly referred to as 'Flood Certificates', this term has a specific meaning under the State Environmental Planning Policy (Exempt and Complying Development) Codes 2008, which may not apply to general flood information provided by the Council.

#### 6.4.7.1. Recommendation

##### PM-08: Section 10.7 Planning Certificates



It is recommended that Council implement a system through which flood information produced in this FRMS&P can be efficiently provided to those wishing to develop on flood prone land.



Updated Section 10.7 certificates with data provided in this FRMS&P.

### 6.5. Response Modification Measures

The measures described in this section relate to how communities receive information about floods, and how they respond to and recover from flood emergencies. Response modification measures aim to reduce risk to life and property in the event of flooding through improvements to flood prediction and warning, improvements to emergency management capabilities, evacuation and planning, and supporting greater community flood awareness and preparedness.

Additionally, potential response modification options were identified and assessed for each village, and described in detail in the relevant appendices. From this, the following recommendations are made.

##### RM: Response Modification Options



**RMBC-01: Boree Creek – Formal Evacuation Location** consult with the community and further assess feasibility.



**RMM-01: Morundah – Formal Evacuation Location** consult with the community and further assess feasibility.



**RMR-01: Rand – Automated Road Closure Warning System** further assess feasibility of automated road closure signage for Rand.

### 6.5.1. Flood Emergency Management Planning

Effective planning for emergency response is a vital way of reducing risks to life and property. The SES is the legislated combat agency for floods in NSW and is responsible for the control of flood operations, including flood planning.

The NSW SES prepares a range of documents that cover preparedness, response and coordination measures that are essential to the management of storm and flood risk. These documents include FloodSafe brochures, Local Flood Plans, regionally based information webpages, StormSafe brochures in addition to information and brochures on preparedness strategies.

It is recommended that flood information regarding flood risk in the study area is incorporated into these documents, for two main reasons.

- To allow SES and Council to better prepare for and respond to flood risk.
- To understand the areas and roads at risk when an event occurs.

In addition, the availability of these documents should be included as part of an ongoing flood education and awareness program.

Following completion of this study, Council and the SES will be provided with a range of outputs that can be used to develop plans relating to flood risk. Such outputs include:

- High resolution GIS results including peak flood depths and levels, hazard and hydraulic categories;
- Information pack with GIS layers that can be used to relate rainfall intensities and durations, to design flood events;
- Identification of parts of the study area at greatest risk; and
- Identification of roads that are prone to flooding.

Importantly, the recommendations made in the subsequent sections of this report should also be considered when updating the various Flood Plans. The subsequent recommendations endeavour to reduce flood risk to the community without increasing the burden on SES and Council staff.

#### 6.5.1.1. Recommendation

##### RM01: Update Local Flood Plan



Update Local Flood Plan for the study area which incorporates the flood behaviour information and other supporting data from this study.

### 6.5.2. Community Flood Awareness and Education

A key step towards modifying the community's response to a flood event is to ensure that the community is fully aware that floods are, at times, likely to interfere with normal activities in the floodplain. Flood awareness is a vital component of flood risk management for people residing and working in the floodplain, as well as for those reliant on services operated from within flood prone areas.

Flood awareness can be developed through a range of strategies with varying levels of community participation. Strong flood awareness can significantly improve the way a community prepares for, and recovers from, flooding.


Based on learnings from recent disasters, the focus of community disaster education has now turned from a concentration on raising awareness and preparedness to building community resilience through learning. Simply disseminating information to community does not necessarily trigger changed attitudes and behaviours. Flood education programs are most effective when they:

- Are participatory i.e. not only consisting of top-down provision of information but where the community has input to the development, implementation and evaluation of education activities;
- Involve a range of learning styles including experimental learning (e.g. field trips, flood commemorations), information provision (e.g. via pamphlets, DVDs, the media), collaborative group learning (e.g. scenario role plays with community groups) and community discourse (e.g. forums, post-event debriefs);
- Are aligned with structural and other non-structural methods used in floodplain risk management and with emergency management measures such as operations and flooding;
- Are ongoing programs rather than one-off, unintegrated 'campaigns', with activities varied for the learner; and
- Consider the influence of the community demographics, that is by targeting approaches which consider aspects such as single parent households, a higher elderly population and non English speaking.

It is difficult to accurately assess the benefits of a community flood education program, but the consensus is that the benefits far outweigh the costs. Nevertheless, sponsors must appreciate that ongoing funding is required to sustain the gain that has been made.

Table provides a list of commonly applied methods to build and sustain flood readiness, which may be developed and supported by NSW SES and Council. These include methods both to inform and to prepare the community, with the objective of building resilience.

Table 25: Methods to Increase Flood Awareness and Preparedness

Method	Comment
<b>Council website</b>	<p>It is recommended that upon completion of this study, that Council update the website to provide up to date flood information for the Federation villages information. In addition, it is recommended that information about what to do in the event of a flood (either riverine or overland) and how to stay safe, is also provided. This could include, for example, links to SES Floodsafe Materials and campaigns such as “15 to Float”, “If it’s flooded forget it” and “Turn Around Don’t Drown”, which aim to improve driver safety during flood events.</p> <p>The Council website and social media accounts could also be used to warning information and where to access further support if required.</p>
<b>Community Champions Program</b>	<p>There could be an opportunity for the SES and Council to liaise with these trusted community members to trial a community champion program. This would also provide a valuable two way conduit between the local residents and Council. The SES Community Action Team Volunteers is an SES program where community members volunteer to help prepare and protect their community during severe weather events. There may be members of the local communities well suited for involvement in an SES Community Action Team group and this team should be more widely promoted to encourage involvement.</p>
<b>Letter/certificate/pamphlet from Council</b>	<p>A leaflet containing specific information about flood behaviour, and what to do in the event of a flood is an effective way of providing information without necessarily requiring active participation from residents. A leaflet/pamphlet from Council may be sent (annually or biannually) with the rate notice (electronically or by mail). The property database developed as part of this FRMS could be used to inform Council of the flood liable properties/addresses (i.e. properties within specific at-risk areas, or within the Flood Planning Area), makes this a relatively inexpensive and effective measure. The pamphlet can inform residents of on-going implementation of actions identified in the FRMS&amp;P, changes to flood levels or development controls, reinforce the differences between sources of flooding, and provide information on the actions Council is taking to reduce the flood risk in their area. It could be also be combined with other general council information, reducing the potential fatigue from repeated messages.</p> 



Method	Comment
<b>School project</b>	<p>Engagement with school students can be a successful means of not only informing the younger generation about flooding but can also lead to infiltration to parents. This can be implemented through various techniques including:</p> <ul style="list-style-type: none"> <li>• adopting messaging about not playing in or driving in floodwaters into appropriate lessons,</li> <li>• school projects where students can learn about historical floods by interviewing older residents and documenting what happened, and</li> <li>• hosting “flood awareness” days where members of the local SES visit schools and participate in flood safety activities.</li> </ul> <p>While this FRMS focuses on flood risk only, this approach can be combined to include other topics relating to water quality, drainage management, etc.</p>
<b>S10.7 certificate notifications</b>	<p>This option is discussed in detail in Section 6.4.7 and is a useful tool as a ‘point in time’ awareness exercise, but has limited use as method to maintain flood awareness in the community, as generally the certificates will only be requested when a property is to be redeveloped or sold.</p>
<b>A range of media</b>	<p>A range of media and community engagement methods should be used to publish interest pieces on flooding, and to promote flood awareness activities. Communication means include council newsletters, social media, local newspapers and the radio. Ongoing pieces in newsletters or the local paper will ensure that flood issues are not forgotten.</p>
<b>Library display</b>	<p>The library could collect historical flood photos and stories to prepare a display, which could be accompanied by appropriate flood safety messages and tips for responding to future flood events.</p>
<b>NSW SES Business FloodSafe Breakfast</b>	<p>The NSW SES has prepared a FloodSafe Business template, which businesses can use to plan for flooding. A breakfast barbeque could be convened at an appropriate location to promote completion of plans and to provide site-specific flood information.</p>



Method	Comment
<b>'Meet the street' events</b>	'Meet-the-street' events involve NSW SES and Council setting up a 'stall' at an appropriate time and visible location. The event would be advertised through a specific letter box drop to the targeted neighbourhood or vulnerable site. The stall could consist of flood maps on boards, NSW SES banners, NSW SES materials to hand out. These materials are used to engage with people and make them aware of flood risk, encourage preparedness behaviours (e.g. develop emergency plans) and help them understand what to do during and after a flood. A meeting could also encourage property owners to develop self-help networks and particularly people checking on neighbours if a flood is imminent. Longer-term residents with flood experience could be used to help provide other residents with an understanding of previous floods and how to prepare for future flooding.
<b>Flood Information Signage</b>	Flood information signs could be implemented in locations known to flood to inform residents of the risk, and appropriate responses.

#### 6.5.2.1. Recommendation

##### RM02: Community Flood Awareness and Education



Design and implement an ongoing community flood education program to maintain a high level of flood awareness and understanding of the risk, and appropriate response, to flooding in the study area.

#### 6.5.3. Improvements to Driver Safety

One of the key hazards associated with floods in the study area is flooding across roads. The section below contains a discussion of the practical considerations that are involved when installing new flood signage on roads within the local catchments, in addition to suggested locations. It is recommended that an investigation be undertaken by Council to confirm the most appropriate locations for and types of flood signage, and complementary education programs to reduce flood risk most effectively to motorists and consequences to flood behaviour in surrounding areas (such as wave action and flow diversion).

One of the main hazards that occurs during local rain events is flash flooding across roads. With the quick catchment response to local rainfall in the study area, water can rise to dangerous depths and velocities before a formal road closure can be implemented, and traffic rerouted safely. Flooding in the study area can cause a number of roadways to become overtopped, depending on the location and intensity of rainfall.

In most cases, alternative safe routes can be taken, however, unless residents are aware of them, some may attempt to cross through flood waters, putting themselves and others at risk. This is particularly likely if visibility is poor during heavy rain, as water over the road is either not noticed, or the risk of driving through it is not appreciated.

A recent campaign by the Victorian State Government (15tofloat.com.au) highlighted that “it only takes 15 cm to float” – i.e. for water flowing with a velocity of 3.6 km/h (1 m/s), a depth of 15 cm is enough for a small car (1.05 tonnes) to become buoyant, causing the driver to lose control. Therefore, driving through even shallow floodwater can put the driver at risk, and increase the demand on SES resources (and risk to their lives) if rescue is required.

To communicate potential flood risk to drivers, it is recommended that appropriate signage is installed at key locations. Such signage might include depth indicators, warning signs, hinged flood signs, or signs fitted with flashing lights.

Flood signs must be installed in accordance with AS1742.2-2009 *Manual of Uniform Traffic Control Devices Part 2: Traffic Control Devices for General Use*, which stipulates that “The ‘ROAD SUBJECT TO FLOODING, INDICATORS SHOW DEPTH’ sign shall be erected on the left side of the road on which Depth Indicators are used, to advise drivers that the road ahead may be covered by floodwaters...the NEXT x km sign may be used in conjunction with this sign when there are two or more floodways ahead, not more than 2km apart.” (Clause 4.10.6.9)

Where flood depths are more than 1.5 m, the G9-22-1 depth indicator sign is to be used (refer to Diagram 1).

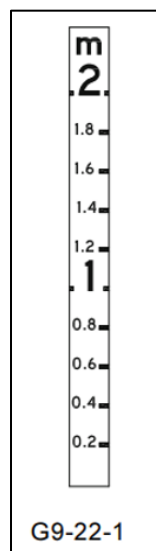


Diagram 1: G9-22-1 Flood Depth Indicators

Where special attention is required due to the “extreme severity of the hazard to which they refer, or lack of adequate sight distance to the hazard, or a combination of the two”, flashing lights can be set up alongside the warning signs. The flashing lights must comply with the requirements of AS2144 and consist of 200 mm diameter traffic signal lanterns flashing at a rate of 40 to 60 flashes per minute with the light on for 40 to 60% of the time. Examples are provided in Diagram 2.



Diagram 2: Examples of Warnings Signs with Flashing Lights

Placement of depth markers in an area requires careful consideration. If depth markers are placed where flooding is short-lived or shallow, they may be dismissed, which may lead to drivers ignoring depth markers at roads overtopped by fast flowing water. In addition, residents may be concerned that installation of depth markers or other flood warning signs may detract from the amenity of their area, and or perceived to affect property values.

Conversely, if road closure signs are left out for hours or days after water has drained away, drivers are likely to ignore the signs and drive through. This may lead to future complacency or dismissiveness when the road is flooded.

Installation of depth markers or other flood signs should be undertaken in conjunction with extensive community education, for three key reasons:

- to ensure drivers understand what the depth marker shows (i.e. depth of water over road);
- to educate the community about the potential flood risk associated with water at that depth, and the danger of driving through even shallow water, as velocity can be hard to judge, and
- to educate the community regarding the potential consequences to flood behaviour such as wave generation, flow diversion and impacts on property.

Recommendations relating to community flood education and awareness are provided in Section 6.5.

With the potential for Council resources to be focused on storm-related responses (e.g. debris removal from roads), it is recommended that where possible, flood signs that require manual activation are not installed. Instead, warning signs and/or depth indicators (with or without automated flashing lights), that can give information to or warn drivers, without increasing the burden on Council's staff are likely to be preferable. Depending on the location and size of the event, installation of depth indicators or warning signs will not replace the need for Council to formally close roads, though they may assist in dissuading drivers to enter flood waters before the road is officially closed.

It is noted also that during local overland events, regional roads within the LGA outside of the study area may also be affected and require closure. To ensure that Council can respond to these as efficiently as possible, it is recommended that the locations of existing and new flood signs, and roads where official closure is commonplace in local rain events, are captured in GIS format, along with available information regarding the flow path or specific actions required.

#### 6.5.3.1. Recommendation

##### RM03: Improvements to Driver Safety



Design and implement an ongoing community flood education program to understand the risk to drivers during flood events.

#### 6.5.4. Improvements to Flood Warning

The purpose of a flood warning is to provide advice on impending flooding so people can take action to minimise its negative impacts. An effective flood warning system requires integration of a number of components:

- modelling and monitoring of rainfall and river flows that may lead to flooding;
- prediction of flood severity and the time of onset of particular levels of flooding;
- interpretation of the prediction to determine the likely flood impacts on the community;
- construction of warning messages describing what is happening and will happen, the expected impact and what actions should be taken;
- dissemination of warning messages;
- response to the warnings by the agencies involved and community members; and
- review of the warning system after flood events.

Where effective flood warnings are provided, risk to life and property can be significantly reduced. Studies have shown that flood warning systems generally have high B/C ratios if sufficient warning time is provided and if the population at risk is aware of the threat and prepared to respond appropriately. In addition, greater warning time can lead to improved outcomes for vulnerable occupants. However, increasing warning time generally needs to be balanced against loss of warning accuracy. A reduced accuracy can result in an increased frequency of false alarms, which in turn, may lead to complacency with residents and business owners (the “cry wolf” effect) and negative outcomes for vulnerable occupants who may be particularly sensitive to relocations associated with false alarms.

It should be noted that whilst an increase in available warning time may lead to improved damages and loss outcomes, a warning system will not alter the flood behaviour in any way and the following consequences would remain unchanged:

- structural damage to roads and buildings,
- loss of services (power, phone, water, sewer),
- clean-up costs and time may be reduced but not completely prevented.

The forecasting responsibility is the statutory responsibility of the Bureau of Meteorology (BOM). BOM issues Flood Watch and Flood Warning products, not Council or NSW SES. Any improvements to current warning products is to be undertaken by BOM itself, in conjunction with NSW SES and Council.

The Federation Villages (other than Morundah) sit in a zone of sparse warning gauge locations. While the community generally has a good understanding of how floods move through the system and tend to operate on an informal warning system by reviewing levels and rainfalls at upstream locations, improvements to the either the collation of this information or additional reporting locations would improve the benefits of a warning system.

A wide range of prediction tools are available, from basic flood information systems that use real-time rainfall triggers, to complex flood warning systems that run real-time hydrodynamic models informed by radar rainfall estimates. Systems such as these have high computational requirements to continuously run detailed models, high initial and ongoing costs, and are generally unable to be run in-house within Council and so are typically outsourced to specialist consultancies. At a simple level, a system may include a webpage or similar that collates all the available information and includes discussion on how to interpret. Hydrodynamic models are often not suitable for flash flood forecasting applications due to the time they take to run and the complex computing environment required. When determining a suitable warning system, there is therefore a need to find an appropriate balance between model complexity (and cost), length of warning time, and accuracy of prediction.

Discussions with those who issue and receive warnings indicates that there is some room for improvement in the delivery of flood warnings and evacuation warnings/orders. This includes:

- Better engagement of the media, including consistent messages from the emergency services and countering of false information;
- Multi-platform delivery of messages to the public including through social media, SMS and Apps such as EWN (Early Warning Network);
- The use of graphics in Evacuation Orders;
- Delivery of messages by known, trusted persons;
- Ongoing community engagement.

It is recommended that a review of the Flood Warning System for the Federation Villages is undertaken. The review should include the following elements:

- A review of the existing system, if any,
- Assessment of the trigger levels (rainfall and water levels) and warning time applicable to each village using the hydrologic and hydraulic modelling that supports this study;
- Assessment of the potential benefits of installing additional rain and/or stream level gauges and identification of suitable locations;
- A review of the maintenance requirements and costs, and messaging (alerts and recipients, including identifying vulnerable occupants);
- A review of how the existing of new information could be displayed and better communicated to the community; and

- Recommendation for an alternative system (if any), commensurate with the tangible and intangible benefits it would offer.

#### 6.5.4.1. Recommendation

##### RM04: Improvements to Flood Warning



Undertake a review of the existing and identify improvements to the Flood Warning System for the Federation Villages.

#### 6.5.5. Flood Emergency Response Coordination

The NSW SES is the legislated Combat Agency for floods and is responsible for the control of flood operations, including the coordination of evacuation and welfare of affected communities. The SES Local Controller is responsible for dealing with floods as detailed in the NSW State Flood Plan.

A key responsibility of the SES is the coordination of other agencies and organisations for flood management tasks. These may include Council, the Rural Fire Service and NSW Fire and Rescue, as well as interfacing directly with local business owners and residents. Effective communication, identification and prioritisation of vulnerable occupants, data sharing, and clarity of roles and responsibilities is essential for the efficient and safe execution of flood response actions.

The Floodplain Risk Management Committee highlighted the importance of volunteer coordination, particularly with the arrival of volunteers from outside the area. To make the most of available volunteer resources, it is recommended that investment is made in developing a clear action guide with well-defined and clearly communicated roles and responsibilities. This guide recommended to be developed during 'peace time', i.e. between floods (or other threats), and will be particularly beneficial for the recovery period immediately following a flood event.

Feedback following flood events has shown the during response times SES resources are stretched, improvements to the knowledge of public sector agencies and the community on emergency and crisis management response and recovery arrangements would be beneficial and could be achieved by closer collaboration and co-operation amongst the Emergency Services Agencies. Following on from this recommendation, the below suggestions are made to improve coordination between and within emergency service agencies.

- Regular Meetings of the Local Emergency Management Committee (Council), ensuring the inclusion and involvement of responders 'on the ground,' e.g. volunteers and Council outdoor staff,
- Hold 'peace time exercises' between flood events (or other threats) to maintain relationships and familiarity with roles and responsibilities;
- Develop plans for the effective coordination of out-of-area volunteers who may travel to Picton to assist during the recovery period immediately following a flood;

- Communicate the role and responsibilities to the community (Section 6.5.2).

#### RM04: Flood Emergency Response Coordination



Ongoing development of improved coordination between all emergency service agencies, including communication of roles and responsibilities.

## 6.6. Summary of Recommended Options

Based on the assessment detailed in the preceding sections, the following options are recommended to managing the flood risk across the Federation Villages.

Table 28: Summary of recommended options

Reference	Name	Type	Location
<b>FMBC-02</b>	Western Culvert Upgrades	Flood modification	Boree Creek
<b>FMBC-03</b>	Boree Creek - Kywong Road Upgrade	Flood modification	Boree Creek
<b>FMBC-04/05/06</b>	Railway Line Augmentation	Flood modification	Boree Creek
<b>FMBC-07/FMU-09</b>	Vegetation Management	Flood modification	Boree Creek Urana
<b>FMM-01</b>	Levee (Carry On)	Flood modification	Morundah
<b>FMM-02</b>	Internal Drainage Improvements (pipes only)	Flood modification	Morundah
<b>FMM-04</b>	Milvain Drive Diversion Bund and Culvert Upgrades	Flood modification	Morundah
<b>FMO-03</b>	Buller Street Trunk Drainage	Flood modification	Oaklands
<b>FMO-05</b>	Recreation Reserve Spectator Bund	Flood modification	Oaklands
<b>FMR-01</b>	Levee Investigation (Maintenance)	Flood modification	Rand
<b>FMU-02</b>	Levee Upgrade Alignment 2	Flood modification	Urana
<b>FMU-03</b>	Stormwater Drainage Upgrades	Flood modification	Urana
<b>FMU-07</b>	Aquatic Centre Dam Outlet Upgrade	Flood modification	Urana
<b>FMU-10</b>	Coonong Street Bund	Flood modification	Urana
<b>FMU-11</b>	Cocketgedong Road Causeway	Flood modification	Urana
<b>FMU-12</b>	Tombstones Causeway	Flood modification	Urana
<b>PM-01</b>	Flood Planning Levels	Property modification	Study area
<b>PM-02</b>	Flood Planning Area	Property modification	Study area
<b>PM-03</b>	LEP Update	Property modification	Urana #
<b>PM-04</b>	Voluntary House Raising	Property modification	Boree Creek
<b>PM-05</b>	Voluntary Purchase	Property modification	Boree Creek Urana
<b>PM-06</b>	Flood Planning Controls – existing zoned land	Property modification	Study area
<b>PM-07</b>	Flood Planning Controls – future zoned land	Property modification	Study area
<b>PM-08</b>	Section 10.7 Planning Certificates	Property modification	Study area
<b>RMBC-01/RMM-01</b>	Formal Evacuation Location	Response modification	Boree Creek Morundah
<b>RMR-01</b>	Automated Road Crossing Warning System	Response modification	Rand

Reference	Name	Type	Location
<b>RM-01</b>	Update Local Flood Plan	Response modification	Study area
<b>RM-02</b>	Community Flood Awareness and Education	Response modification	Study area
<b>RM-03</b>	Improvements to Driver Safety	Response modification	Study area
<b>RM-04</b>	Improvements to Flood Warning	Response modification	Study area
<b>RM-05</b>	Flood Emergency Response Coordination	Response modification	Study area

<sup>#</sup> recommended for the Urana LEP, or the overarching Federation LEP when / should this be developed



## 7. MULTI CRITERIA MATRIX ASSESSMENT

### 7.1. Introduction

The Floodplain Development Manual (Reference 5) recommends the use of multi-criteria assessment matrices when assessing flood risk mitigation measures. A multi-criteria matrix assessment (MCMA) provides a method by which options can be assessed against a range of criteria, and offers a greater breadth of assessment than is available by considering only the reduction in flood risk or economic damages, for example. Such additional criteria may include social, political and environmental considerations and intangible flood impacts that cannot be quantified or included in a Cost-Benefit Analysis. It should be noted that the assessment of the suitability of floodplain mitigation options is a complex matter, and an MCMA will not give a definitive 'right' answer, but will provide a tool to debate the relative merits of each option.

### 7.2. Scoring System

A scoring system has been devised to allow stakeholders to assess the various options across a consistent basis to allow for direct comparison. The scoring system is divided into four key criteria: Flood Behaviour, Economic, Social and Environmental. The scoring system was presented to the FRMC and discussed at various stages when considering options. The FRMC did not identify any changes needed to the presented scoring system. Scores for each criterion were assigned to each option then summed to determine the overall score. The relative scoring was presented to the FRMC and the FRMC did not identify any specific changes needed. Options with higher scores indicate benefits across a range of criteria and should be prioritised over those with lower positive scores, which may be more neutral or have a combination of pros and cons. Conversely, options with the lowest negative scores indicate the option would cause adverse outcomes in a number of criteria and should not be considered further. The intent of the MCMA is to rank *all* options, across *all* villages, to guide Council's applications for funding and allocation of resources. Consideration will be needed to ensure options are compared appropriately between towns. The scoring system is provided in, and the outcomes of the assessment shown in Table 30. Discussion of the results is provided in Section 7.4.

Table 29 Multicriteria Matrix Assessment – Scoring System

Criteria		Metric	-3	-2	-1	Score 0	1	2	3
Economic	Economic Merits	Comparison of the economic benefits against the capital and ongoing costs	BC < 0.1	BC: 0.1- 0.5	BC: 0.5-0.9	BC = 1 (Or NA)	BC: 1.0 - 1.4	BC: 1.4 - 1.7	BC >1.7
	Implementation Complexity	Potential design, implementation and operational challenges and constraints. Risk can increase with implementation timeframe	Major constraints and uncertainties which may render the option unfeasible	Constraints or uncertainties which may significantly increase costs or timeframes	Constraints or uncertainties which may increase costs or timeframes moderately	NA	Constraints that can be overcome with moderate investment of time and resources	Constraints that can be overcome easily	No constraints or uncertainties
	Staging of Works	Ability to stage proposed works			Works cannot be staged	NA	Some minor components of the works may be staged	Some major components of the works may be staged	
Social	Impact on Emergency Services	Change in demand on emergency services (SES, Police, Ambulance, Fire, RFS etc).	Major disbenefit	Moderate Disbenefit	Minor Disbenefit	Neutral	Minor Benefit	Moderate Benefit	Major Benefit
	Emergency Access	Flood depths and duration changes for critical transport routes	Key access roads become flooded that were previously flood free	Significant increase in main road flooding	Moderate increase in local or main road flooding	No Change	Moderate decrease in local or main road flooding	Significant decrease in main road flooding	Local and main roads previously flooded now flood free
	Impact on critical and/or vulnerable facilities <sup>1</sup>	Disruption to critical facilities	Inoperational for several days	Inoperational for one day	Inoperational for several hours	No Change	Period of inoperation reduced by 0-4 hours	Period of inoperation reduced by > 4 hours	Prevents disruption of critical facility altogether
	Impact on Properties	No. of properties flooded over floor. Across all events	>5 adversely affected	2-5 adversely affected	<2 adversely affected	None	<2 benefitted	2 to 5 benefitted	>5 benefitted
	Impact on flood hazard	Change in hazard classification	Significantly increased in highly populated area (Increasing to H5/H6)	Moderately increased in populated area (Increasing by 2 or more categories)	Slightly increased (Increase by 1 category)	No Change	Slightly reduced (Decrease by 1 category)	Moderately reduced in populated area (Decrease by 2 or more categories)	Significantly reduced in highly populated area (Decrease from H5/H6)
	Community Flood Awareness	Change in community flood awareness, preparedness and response	Significantly reduced	Moderately reduced	Slightly reduced	No Change	Slightly improved	Moderately improved	Significantly improved
	Social disruption	Closure of or restricted access to community facilities (including recreation)	Normal access significantly reduced or facilities disrupted for > 5 days	Normal access routes moderately reduced or facilities disrupted for 2-4 days	No Change to access but facilities disrupted for up to 12 hours	No Change	Reduces duration of access disruption or facility disruption by up to 12 hours	Reduces duration of access disruption or facility disruption by 2-4 days	Prevents disruption of access or facility altogether
	Community and stakeholder support <sup>2</sup>	Level of agreement (expressed via formal submissions and informal discussions)	Strong opposition by numerous submissions	Moderate opposition in several submissions	Individual submissions with opposition	Neutral	Individual submissions with support	Moderate support in several submissions	Strong support by numerous submissions
Environmental	Impacts on Flora & Fauna (inc. street trees)	Impacts or benefits to flora/fauna	Likely broad-scale vegetation/habitat impacts	Likely isolated vegetation/habitat impacts	Removal of isolated trees, minor landscapng.	Neutral	Planting of isolated trees, minor landscapng.	Likely isolated vegetation/habitat benefits	Likely broad-scale vegetation/habitat benefits
	Heritage Conservation Areas and Heritage Items	Impacts to heritage items	Likely impact on State, National or Aboriginal Heritage Item	Likely impact on local heritage item	Likely impact on contributory item within a heritage conservation area	No impact	Reduced impact on contributory item within a heritage conservation area	Reduced impact on local heritage item	Reduced impact on State, National or Aboriginal Heritage item
Other Aspects	Financial Feasibility and Funding Availability	Capital and ongoing costs and funding sources available	Significant capital and ongoing costs, or no external funding or assistance available	Moderate capital and ongoing costs, no funding available	High capital and ongoing costs, partial funding available	NA	Moderate capital and ongoing costs, partial funding available; or low capital and ongoing costs, no funding available	Low to moderate capital and ongoing costs, partial funding available	Full external funding and management available
	Compatibility with existing Council plans, policies or projects	Level of compatibility	Conflicts directly with objectives of several plans, policies or projects	Conflicts with several objectives or direct conflict with one or few objectives	Minor conflicts with some objectives, with scope to overcome conflict	Not relevant	Minor support for one or few objectives	Some support for several objectives, or achieving one objective	Achieving objectives of several plans, policies or projects

<sup>1</sup> Critical facilities are those properties that, if flooded, would result in severe consequences to public health and safety. These may include fire, ambulance and police stations, hospitals, water and electricity supply, buses/train stations and chemical plants. Vulnerable facilities refer to those properties with vulnerable occupants, such as nursing homes or schools.

<sup>2</sup> Community and stakeholder support scores will be completed following Public Exhibition

### 7.3. Results

Table 30 Multicriteria Matrix Assessment Results

Category	ID	Option	Economic Merits	Implementation Complexity	Staging of Works	Impact on Emergency Services	Road Access	Impact on critical and/or vulnerable facilities <sup>1</sup>	Impact on Properties	Impact on flood hazard	Community Flood Awareness	Social disruption	Community and Stakeholder Support	Impacts on Flora & Fauna (inc. street trees)	Heritage Conservation Areas and	Financial Feasibility and Funding	Compatibility with existing Council plans, policies or	Total Score
Response Modification	RMBC-01/RMM-01	Evacuation Assembly and Shelter (Boree Creek - Morundah)	0	1	-1	2	0	0	0	0	2	0	0	0	0	2	1	7
	RMR-01/RM-03	Automated Road Crossing Warning System/Road Closure Informaiton	0	1	1	2	0	0	0	1	2	0	2	0	0	2	1	12
	RM-01	Flood emergency management planning	0	1	2	3	0	0	0	0	2	0	2	0	0	1	1	12
	RM-02	Community Education and Awareness	0	2	2	3	0	0	0	0	3	0	2	0	0	1	3	16
	RM-04	Improvements to Flood Warning	1	-1	1	3	0	1	0	0	1	0	2	0	0	2	0	10
	RM-05	Flood Emergency Response Coordination	0	3	2	3	0	1	0	0	2	1	1	0	0	2	1	16
Property Modification	PM-01	Flood Planning Levels	1	1	1	1	0	2	3	1	1	0	0	0	0	2	3	16
	PM-02	Flood Planning Area	1	3	0	1	0	0	3	0	1	0	0	0	0	2	3	14
	PM-03	LEP Update	0	2	1	0	0	0	3	0	1	0	0	0	0	2	3	12
	P0-06/07	Managing Development in the Flood Prone Areas (Existing/Future)	1	1	2	2	1	2	3	1	1	1	0	0	0	1	3	19
	PM-08	Section 10.7 Certificates	0	2	1	0	0	0	3	0	2	0	0	0	0	2	3	13
	PM-04	Voluntary House Raising	0	1	1	1	0	0	1	0	1	0	0	0	0	2	3	10
Flood Modification	PM-05	Voluntary Purchase	3	1	1	2	0	0	3	3	1	0	1	0	0	2	3	20
	FMBC-02	Boree Creek Western Culvert Upgrades	-2	1	1	1	1	0	1	1	0	0	1	0	0	1	1	7
	FMBC-03	Boree Creek – Kywong Road Upgrade	-2	1	2	1	2	0	1	1	0	0	0	0	0	-1	1	6
	FMBC-04/05/06	Boree Creek Railway Augmentation	1	-1	1	2	2	0	2	2	0	1	0	-1	0	-1	1	9
	FMBC-07/FMU-09	Vegetation Management	0	2	2	0	0	0	1	1	0	0	2	-1	0	1	1	9
	FMM-01	Morundah Levee Formalisation	1	-1	2	1	0	0	1	1	0	0	2	-1	0	-2	1	5
	FMM-02	Internal Drainage Improvements	3	1	2	2	2	0	2	1	0	0	0	-1	0	2	1	15
	FMM-04	Milvain Drive Diversion Bund and Culvert Upgrades	3	1	1	2	2	0	2	1	0	0	1	-1	0	2	1	15
	FMO-03	Buller Street Trunk Drainage	-3	-1	1	1	1	0	0	1	0	0	0	-1	0	-2	1	-2
	FMO-05	Oaklands Recreation Reserve Spectator Bund	-3	1	-1	0	0	0	0	1	0	1	0	-1	0	1	1	0
	FMR-01	Rand Levee Maintenance	-2	1	1	0	0	0	0	0	0	0	1	0	0	1	1	3
	FMU-02	Urana Levee Alignment 2	1	-1	-1	1	1	1	3	2	0	1	2	-1	0	-1	1	9
	FMU-03	Stormwater Drainage Upgrades	-1	1	-1	1	0	0	1	1	0	1	2	-1	0	1	1	6
	FMU-07	Aquatic Centre Dam Outlet Upgrade	-3	-1	-1	0	0	0	0	1	0	0	0	-1	0	-2	1	-6
	FMU-10	Coonong Street Bund	-3	1	-1	1	0	0	0	1	0	0	0	-1	0	1	1	0
	FMU-11	Cocketgedong Road Causeway	-3	1	-1	1	1	1	0	0	0	0	0	0	0	-2	1	-1
	FMU-12	Tombstones Causeway	-3	1	-1	1	1	0	0	0	0	0	0	0	0	-2	1	-2

<sup>1</sup> Critical facilities are those properties that, if flooded, would result in severe consequences to public health and safety. These may include fire, ambulance and police stations, hospitals, water and electricity supply, buses/train stations and chemical plants. Vulnerable facilities refer to those properties with vulnerable occupants, such as nursing homes or schools.

## 7.4. Discussion of Results

The multi-criteria matrix assessment results, presented in Table 30, can be used to both understand the benefits and disadvantages of individual options, but to also see trends across the full suite of options assessed in the FRMS&P. The following results and trends are noted:

- Managing Development in the Flood Prone Areas (PM-06/07) and Voluntary Purchase (PM-05) received the highest score, as they deliver benefits across a range of criteria including economics, reduction in flood risk, property affectation, as well as playing a small role in community flood awareness;
- Flood Planning Level (PM-01), Flood Planning Area (PM-02), and Community Education and Awareness (RM-02) are the next highest scoring as they are effective methods to reduce property damages in the study area, and have additional benefits relating to improvements to community flood awareness.
- Response Modification Measures and Property Modification Measures tend to score more highly than Flood Modification measures, as they can be implemented for a relatively low cost, lead to the reduction of property damage and improvement in community resilience in the long term, and do not incur negative environmental impacts;
- Majority of flood modification measures, that is, structural options, do not score well in terms of economic merits. Reasons for this include:
  - “Tangible Benefits” included in the Cost Benefit Analysis are determined from the reduction in property damages (Annual Average Damages (AAD), Section 5.5).
  - In the same vein, to reduce property damages, structural options need to effectively reduce flood risk in rare events. To do this, structural options need to be substantial in size, i.e. levee height or basin storage capacity – leading to high capital costs, land purchase requirements, and ongoing maintenance costs.
- The lowest scoring option Aquatic Centre Dam Outlet Upgrade (FMU-07), which involve replacement of the Aquatic Centre Dam Outlet involves substantial capital works for very little benefit in terms of flood risk reduction. Other lower scoring options are drainage focused options and therefore do not have significant benefits in larger flood event.

## **8. DRAFT FLOODPLAIN RISK MANAGEMENT PLAN**

The Floodplain Risk Management Plan summarises the recommended measures that have been investigated as part of the Floodplain Risk Management Study. Measures have been assessed for effectiveness against a range of criteria. The assessment criteria included how the option affected property damages, community flood awareness, impact on the SES, and economic merits, and a range of other factors. Recommended options are prioritised based upon how readily the management measures can be implemented, their capital cost, what constraints exist and how effective the measures are. Measures with little cost that can readily be implemented, and which are effective in reducing damage or personal danger would have high priority.

Table 31 lists the mitigation measures that have been recommended by the Floodplain Risk Management Study for implementation and describes the purpose of the measure, as well as its priority, cost, timeframe and the party responsible for its implementation. Detailed description of each recommendation is provided in Section 6 of the Study.

The Floodplain Risk Management Plan has been prepared in accordance with the NSW Floodplain Development Manual.

Table 31: Floodplain Risk Management Plan

FLOODPLAIN RISK MANAGEMENT MEASURES										
Option ID	Type	Option	Description	Benefits	Concerns	Responsibility	Funding	Cost	B/C Ratio	Priority
RMBC-01/RMM-01	Response Measure	Evacuation Assembly and Shelter (Boree Creek - Morundah)	Engage with the local community regarding the formalisation of a shelter and further assess the feasibility.	An identified location will allow the community safe refuge during a flood event without the need to relocate. The selected location can also store supplies.	Aspects such as maximum capacity, land tenure, trigger levels and structure requirements will need to be considered.	Council/Community	Council/Community	In house, possible community grants may be available	N/A	Medium
RMR-01/RM-03	Response Measure	Improvements to Driver Safety	Undertake an investigation using the outputs from the FRMS&P to identify locations for the installation of road flood signage.	The installation of appropriate road signage pointing to routes likely to be cut and alternate routes, reduces the risk to drivers during floods, reducing the number of incidences of motorists driving through floodwater. Could potentially reduce demand on SES with a reduced number of incidents.	Community attitudes, awareness of, and behaviour during flood events will need to be considered. Signage needs to be as automated as possible to reduce additional demand on Council resources.	Council	Council/ TfNSW	In house	N/A	Medium
RM-01	Response Measure	Update Local Flood Plans to include Flood Information	Update local flood plans and operational plans to include information on flood risk, drawing on modelling and information provided in this FRMS&P	Detailed information will allow for better management and recovery of flood risk and will increase understanding of the different levels and types of risk present in the study area.	Modelled results should be used as a guide only, as real flood behaviour may vary from modelled design results.	SES	SES	In house	N/A	High
RM-02	Response Measure	Community Flood Awareness	Establish and implement ongoing and collaborative education to improve flood awareness.	Flood awareness significantly improves preparedness for and recovery from flood events, building a more flood resilient community.	Ongoing efforts to ensure information is not forgotten. Potential for residents to become bored or complacent with messaging.	Council in collaboration with other response agencies and community organisations.	Council	Annual Budget to be determined and allocated.	N/A	High
RM-04	Response Measure	Improvements to Flood Warning	Undertake a review of the existing and identify improvements to the Flood Warning System for the Federation Villages. Review current flood warning system in relation to trigger levels, maintenance requirements, messaging and recipients. Conduct a high level assessment of alternative flood warning systems.	Improve current system using outputs from the Federation Villages FRMS&P. Potentially increase warning time available to the community.	May not be possible to increase warning time in all villages due to short catchment response time. Trade off between accuracy and warning time is necessary.	SES, Council, gauge operators	SES and Council	\$40,000 - \$60,000	N/A	High
RM-05	Response Measure	Flood Emergency Response Coordination	Ongoing development of improved coordination between all emergency service agencies, including communication of roles and responsibilities.	Improved understanding of roles and responsibilities for more effective, efficient, and safe actions during and following flood events.	Challenges include change of personnel, difficulty in organising meetings and exercises between flood events.	All response agencies, including but not limited to the SES, Council, RFS, Fire and Rescue, and community organisations.	May be eligible for NSW Government funding	Minimal - In house	N/A	Medium
PM-01	Property	Flood Planning Levels	Adopt Flood Planning Levels for residential, commercial, sensitive and hazardous uses and car park entries developed in the FRMS&P.	FPLs are effective tools to limit property damage to new development and redevelopment. FPLs may pertain to minimum floor levels or flood proofing levels depending on the type of development.	May be considered more onerous for developers.	Council	Council	In house	N/A	High
PM-02	Property	Flood Planning Area	Adopt the Flood Planning Area developed in the FRMS&P.	The FPA defines the area to which flood planning controls apply.	May be considered more onerous for developers. Need to ensure map is readily available due to changed in NSW Government flood planning framework.	Council	Council	In house	N/A	High
PM-03	Property	LEP Update	Amendments to the LEP to achieve consistency with the recommendations of the Flood Prone Land Package	Provides consistency across the state.	Stakeholder education may be required.	Council	Council	In house	N/A	High

FLOODPLAIN RISK MANAGEMENT MEASURES										
Option ID	Type	Option	Description	Benefits	Concerns	Responsibility	Funding	Cost	B/C Ratio	Priority
PM06/07	Property	Managing Development in Flood Prone Areas	Develop consolidated DCP for the former Urana and Corowa Shires	<p>Ensure developments are designed, constructed and managed in such a way as to minimise flood risk to the structure and (if relevant) its occupants, in addition to minimising the impacts of flooding.</p> <ul style="list-style-type: none"> <li>Limit risk to life by prohibiting development (both residential and commercial) in known floodways, and therefore limiting the number of occupants in hazardous areas that may be subject to flash flooding;</li> <li>Limit risk to proposed development by only making land that is either flood free or subject to low flood hazard available for development and thereby reducing the potential financial burden following severe floods for future residents;</li> <li>Ensure flood risk to the broader floodplain is not exacerbated (e.g. by prohibiting development in locations that would obstruct flowpaths and redistribute flows).</li> </ul>	There may be resistance from developers who consider new controls to be onerous or likely to reduce the development yield.	Council	Council	In house	N/A	High
PM-08	Property	Inclusion of Overland Flow flood information on Section 10.7 Planning Certificates	In Section 10.7 Planning Certificates, notations regarding flooding should provide information on all mechanisms of flood risk at the site, including riverine, overland flow, or if appropriate, both. A greater level of detail can be provided via Section 10.7(5) certificates using high-resolution outputs from this Study and Council's other Floodplain Risk Management Studies.	The more informed a home owner is, the greater the understanding of their flood risk. During a flood event this information can help prepare residents to evacuate and reduces the number of residents that elect to take shelter in high hazard areas.	Limited - s10.7(2) certificates already contain basic information, Council to provide further detail from current FRMS&P results. May increase demand on Council staff, however GIS systems can be established to provide this information efficiently.	Council	Council	In house	N/A	High
PM-04	Property	Voluntary House Raising	Feasibility study to further investigate a Voluntary House Raising scheme in Boree Creek.	Reduces flood damages to dwellings in frequently flooded areas.	Community appetite for or acceptance of VHR may be a challenge. VHR schemes are long term options and may take approximately a decade to implement.	Council in consultation with affected residents.	Eligible for DPIE funding	\$50,000 (study only) House raising ~\$500,000	0.82	High
PM-05	Property	Voluntary Purchase	Feasibility study to further investigate a Voluntary Purchase scheme in Boree Creek and Urana	Remove residents and dwellings from high hazard areas, thus reducing risk to life, potential need for rescue, and increasing conveyance through the floodplain.	Community appetite for or acceptance of VP may be a challenge. VP schemes are long term options and may take approximately a decade to implement.	Council in consultation with affected residents.	Eligible for DPIE funding	\$50,000 (study only) Property purchase ~\$1.7M	1.17/2.54	High
FMBC-02	Flood	Boree Creek Western Culvert Upgrades	Double the capacity of existing culverts through the railway and road embankments at the western end of Richmond Street with the aim of providing benefits to local stormwater drainage.	The increased capacity assists in draining the shallow overland flow caused by local rainfall over the town, in very frequent events or in the early part of the storm. The option results in benefits to nuisance flooding.	Once the mainstream flow exceeds the capacity of the Boree Creek channel, the flow (even in a 20% AEP event) exceeds the culvert capacity and no additional benefit is provided. Costs are likely to exceed the direct flood damage benefits to property.	Council	Council (unlikely to be eligible for funding through the NSW Floodplain Management Program, other opportunities may be available)	In house	<<1.0	Medium
FMBC-03	Flood	Boree Creek – Kywong Road Upgrade	<p>The road has been identified as a potential alternate evacuation route during flood events. The road is currently overtopped at multiple locations limiting its use currently as an effective evacuation route.</p> <p>Undertake a feasibility study of formalising the Boree Creek – Kywong Road as an evacuation route for the entire length of road. This would include modifications of all existing creek crossings, as well as the Boree Creek crossing.</p> <p>In the absence of road upgrades, consideration of additional signage to improve driver safety.</p>	The option would provide an alternative evacuation route for the town of Boree Creek and as a minimum will improve driver safety through the installation of signage.	The option does not provide benefits to property damage during flood events. Upgrade of the entire route is likely to be costly and would need to be undertaken over the long term.	Council/TfNSW	Council/TfNSW (unlikely to be eligible for funding through the NSW Floodplain Management Program, other opportunities may be available, study only may be eligible for DPIE funding)	\$80,000 (study only)	<<1.0	Medium



FLOODPLAIN RISK MANAGEMENT MEASURES										
Option ID	Type	Option	Description	Benefits	Concerns	Responsibility	Funding	Cost	B/C Ratio	Priority
FMBC-04/05/06	Flood	Boree Creek Railway Augmentation	<p>The railway line embankment has been identified as a significant obstruction to floodwaters moving through the township of Boree Creek.</p> <p>Undertake further optioneering and feasibility assessment to identify options to reduce this obstruction. This should include engagement with the line owners and operators to determine if significant changes, or complete decommissioning of the line, is foreseen or there is an appetite for changes to the line.</p>	The modelled scenarios showed that a number of potential options including widening the existing bridge over Boree Creek, channel works, removal of sections of the embankment can significantly reduce flood impacts in the Boree Creek township. Flood levels could be reduced by up to 0.4m and 0.3m in the 5% and 1 % AEP events, respectively. The existing flood extent can also be significantly reduced.	The works required are likely to be significant and multi stakeholder negotiations and agreement would be required. Given the scale of the works environmental impacts would need to be managed, such as limiting tree removal. Creek stabilization works may be required.	Council/Railway Line Owner	Council/Railway Line Owner Potentially eligible for DPIE funding	\$80,000 (study only)	1.4 (FMBC-05)	High (study)
FMBC-07/FMU-09	Flood	Vegetation Management	<p>Modelling showed that the impacts of increased vegetation are relatively minor and localized and large scale clearing would not significantly reduce flood levels. It is however important to maintain vegetation at current levels.</p> <p>Maintain current vegetation practices while considering opportunities for environmental and weed management through Council programs.</p>	By maintaining current levels of vegetation minor localized impacts are reduced.	Managing community perception around the impacts of vegetation in waterways. Ensuring that current levels of vegetation are maintained.	Council	Council	In house	Neutral	High
FMM-01	Flood	Morundah Levee 'Carry on' approach	<p>The crest level of the existing Morundah Levee is for the most part at or above the 1% AEP flood level plus 0.5m freeboard. The benefits to property affectation from raising the levee would be minimal, although the structural integrity of the levee is unknown which complicates emergency management operations as the levee design height is unknown.</p> <p>Maintain the levee at its existing height, undertake an assessment to understand the structural integrity of the levee and formalise the privately held sections. This would include geotechnical investigations, repairs, confirmation of the required freeboard, easement acquisition and ongoing maintenance. Works to offset the impacts to overland flow (FMM-02 and FMM-04) will be required.</p>	The benefits to mainstream flooding are maintained, the structural integrity of the levee will be confirmed, and a design height assigned which will assist in emergency management operations. With works to reduce the impacts of overland flooding (FMM-02 and FMM-04) the AAD for Morundah will be reduced.	<p>The structural integrity of the levee and therefore the scale of repairs is unknown. Easement acquisition may present challenges. Community education will be required.</p> <p>Works to offset the impacts to overland flow (FMM-02 and FMM-04) are also required.</p>	Council	Eligible for DPIE funding	\$550,000	1.25	High
FMM-02	Flood	Internal Drainage Improvements	<p>Local overland flow draining towards Colombo Creek is obstructed by the existing levee embankment and ponds on the upstream (eastern) side. There are currently three local drainage pipes through the existing levee.</p> <p>Upgrade the existing pipes to <math>\phi</math> 0.75m, including adjusting pipe inverts and installing a fourth pipe. Determine appropriate gate operations.</p>	<p>Internal drainage from overland flow events will drain more readily through the pipes and reduce the depth of ponding and property affectation behind the levee. Flood levels are reduced by up to 0.15m in the 5% AEP event, up to 0.1m in the 1% AEP event and four properties are no longer flooded over floor.</p> <p>May reduce pumping requirements during coincident (mainstream and overland) events.</p> <p>Works could be undertaken at the same time as repair works on the levee (FMM-01) and form part of a larger levee project.</p>	<p>Benefits will be reduced in coincident (mainstream and overland) flood events.</p> <p>Potential challenges during construction may increase the capital cost.</p>	Council	Eligible for DPIE funding (if combined with FMM-01)	\$130,000	3.15	High



FLOODPLAIN RISK MANAGEMENT MEASURES										
Option ID	Type	Option	Description	Benefits	Concerns	Responsibility	Funding	Cost	B/C Ratio	Priority
FMM-04	Flood	Milvain Drive Diversion Bund and Culvert Upgrades	<p>Dwellings in Milvain Drive experienced inundation during the 2012 flood event as a result of overland flows.</p> <p>Construct a low bund (or embankment) (0.6m in height) to redirect overland flow from the northeast around these dwellings, to prevent property damage during overland flow events. The bund extends to the southeast across Back Morundah Road.</p>	<p>The bund completely protects properties in Milvain Drive and some properties on Yamma Street (a total of six properties) during a 5% AEP event. Reduced flood levels are experienced in the 1% AEP event.</p>	<p>There is a slight increase in flood levels upstream of the bund, although there are no dwellings in the area of impact.</p> <p>A small portion of the roadway at Browley Street experiences slightly higher flood depths.</p> <p>Easement acquisition may present a challenge.</p> <p>Stakeholder consultation will be required to manage inequity perceptions around which properties are included and excluded from protection.</p>	Council	Eligible for DPIE funding	\$370,000	3.32	High
FMO-03	Flood	Buller Street Trunk Drainage	<p>Buller Street does not follow a consistent grade and has several sag points, that trap this runoff and cause ponding for extended periods.</p> <p>Intersection improvement works from the high point to the intersection between Buller Street and White Street so that it retains a consistent 0.85% grade. Works undertaken as the opportunity arises.</p>	<p>Localised flooding is reduced with a decrease in flood depth of up to 0.1m.</p> <p>The refined flowpath allows for the utilisation of the existing dam south of Corowa Road for flood storage.</p>	<p>Reduces nuisance roadway flooding but does not benefit property affectation.</p> <p>Refinements through the design process may improve the benefits achieved.</p> <p>Significant earthworks are required which have a high capital cost. Buller Street would require temporary closure during constructions. Stakeholder consultation will be required to manage equity issues around impacted areas.</p>	Council	Council. Unlikely to be eligible for funding through the NSW Floodplain Management Program, other opportunities may be available.	High	<<1.0	Low
FMO-05	Flood	Oaklands Recreation Reserve Spectator Bund	<p>Construct a 0.5 km long low-level mound, or 'bund', around the northern side Oaklands Recreation Reserve.</p>	<p>Prevents runoff from flowing onto the sports field and reduces ponding and the duration for which the field cannot be used. Rainfall that falls over the oval drains to the east via a culvert through the bund.</p> <p>Provides the dual benefit of elevated spectator seating.</p> <p>Flood levels within the field are reduced by up to 0.15m in the 5% AEP flood event.</p>	<p>There are no benefits to property affectation.</p> <p>Flood levels are increased immediately upstream of the proposed bund but property affectation is not increased.</p>	Council	Council. Unlikely to be eligible for funding through the NSW Floodplain Management Program, other opportunities may be available.	\$200,000	<<1.0	Low
FMR-01	Flood	Rand Levee Maintenance	<p>The crest level of the existing informal Rand Levee is for the most part at or above the 1% AEP flood level plus 0.5m freeboard. The levee has been shown to protect the Rand Hotel and Rural Fire Service building and adjacent open land. The levee does not provide any other property benefits. There is no data on the built form or condition (structural integrity).</p> <p>Maintain the levee at its existing height, undertake an assessment to understand the structural integrity of the levee confirm beneficiaries and formalise easements. This would include geotechnical investigations, repairs, easement acquisition and ongoing maintenance.</p>	<p>The existing protection provided to the Rand Hotel and Rural Fire Service building and adjacent open land would be maintained.</p>	<p>Ongoing maintenance cost for limited property affectation improvements.</p>	Council	Council. Unlikely to be eligible for funding through the NSW Floodplain Management Program, other opportunities may be available.	\$50,000 (investigation)	<<1.0	Medium

FLOODPLAIN RISK MANAGEMENT MEASURES										
Option ID	Type	Option	Description	Benefits	Concerns	Responsibility	Funding	Cost	B/C Ratio	Priority
FMU-02	Flood	Urana Levee Alignment 2	<p>An existing levee protections parts of Urana.</p> <p>Upgrade the existing Urana levee to a 1% AEP level of protection including an appropriate freeboard allowance.</p> <p>The first stage will be a concept design and assessment of third party impacts.</p>	<p>The levee upgrade would protect the main township of Urana to the 1% AEP flood event significantly reducing property damage. The levee does not exacerbate the isolation risk.</p> <p>Flood level increases as a result of the levee do not impact on dwellings.</p> <p>Properties excluded from the extent of the levee have elevated floor levels, however third party impacts at the properties should be confirmed and appropriate compensatory measures identified if required.</p>	<p>The levee would obstruct overland flow moving towards Urangeline Creek. FMU-03 aims to address this during overland flow events.</p> <p>Flood risk on Cocketgedong Road is increased. These impacts and those on agricultural land need to be investigated further through the levee design stages.</p> <p>Costs would be high and land acquisition requirements will require broad stakeholder engagement.</p> <p>Visual amenity may be a concern.</p>	Council	Eligible for DPIE funding	\$2,860,000	0.54	High
FMU-03	Flood	Combined Levee plus culvert/stormwater improvements	<p>There is currently no comprehensive sub-surface stormwater drainage network in Urana resulting in poor drainage.</p> <p>Improve the drainage system in Urana by duplicating the Chapman Street trunk drain, installation of additional pits and culverts throughout the town and regrading adjacent to the levee to facilitate drainage to the low points.</p>	<p>Improve poor stormwater drainage through town, reducing flood levels by up to 0.15m.</p> <p>Property affectation and nuisance flooding is reduced.</p> <p>Can be undertaken as part of levee upgrade works (FMU-02).</p>	<p>The impacts of the extended levee on stormwater drainage should be confirmed and the stormwater upgrade possibly expanded.</p> <p>Benefits will be reduced in coincident (mainstream and overland) flood events.</p> <p>Temporary road closures will be required during construction.</p>	Council	Eligible for DPIE funding (if combined with FMU-02)	\$510,000 (Drainage upgrade only)	0.49 (Levee and drainage upgrade)	High
FMU-07	Flood	Aquatic Centre Dam Outlet Upgrade	<p>Failure of the aquatic centre embankment (as occurred in the 2012 flood event) has the potential to increase flood levels immediately downstream.</p> <p>The current condition suggests that an upgrade to the outlet configuration is required. The impact of “sunny day” failures would result in a sharp increase in flood levels immediately downstream of the outlet structure.</p> <p>Due to the limited capacity of the aquatic centre relative to a flood event, flood mitigation benefits cannot be provided however the outlet configuration should be upgraded to avoid the risks associated with “sunny day” failures.</p>	<p>The upgraded outlet configuration will reduce the risk associated with “sunny day” failures.</p>	<p>Flood mitigation benefits can not be achieved.</p> <p>Further design investigations will be required.</p> <p>Works are likely to have a high capital cost.</p>	Council	Council. Unlikely to be eligible for funding through the NSW Floodplain Management Program, other opportunities may be available.	TBC	<<1.0	Low
FMU-10	Flood	Coonong Street Bund	<p>A small flowpath moves through the township between Chapman and Osborne Streets originating from the Coonong Street area. The flowpath results in nuisance flooding.</p> <p>Construct a small bund (0.3m high) adjacent to the unnamed street to the east of Coonong Street.</p>	<p>The bund reduces flood levels through the Chapman and Osborne Street areas by up to 0.1m, reducing nuisance flooding.</p>	<p>There are no benefits to property affectation.</p>	Council	Council. Unlikely to be eligible for funding through the NSW Floodplain Management Program, other opportunities may be available.	\$300,000	0.07	Low
FMU-11	Flood	Cocketgedong Road Causeway	<p>Cocketgedong Road was significantly damaged during the 2012 flood event.</p> <p>Install a causeway on Cocketgedong Road adjacent to the twon levee to prevent damage in future flood events.</p>	<p>Reduced damage to the road.</p>	<p>There are no benefits to property affectation.</p>	Council	Council. Unlikely to be eligible for funding through the NSW Floodplain Management Program, other opportunities may be available.	TBC	<<1.0	Medium

FLOODPLAIN RISK MANAGEMENT MEASURES										
Option ID	Type	Option	Description	Benefits	Concerns	Responsibility	Funding	Cost	B/C Ratio	Priority
FMU-12	Flood	Tombstones Causeway	<p>During past flood events such as the 2012 flood event, the Tombstones flowapth crossing of Federation Way has been observed to be undersized, diverting flow towards the township.</p> <p>Upgrade the structure at the Tombstones flowapth crossing of Federation Way.</p>	Reduce flow diverted towards the township and damage to the structure and roadway.	<p>The structure is not currently included in the hydraulic model extend and the required capacity has been estimated. The required capacity should be confirmed through future design stages.</p> <p>There are no benefits to property affectation.</p>	Council/TfNSW	Council/TfNSW (unlikely to be eligible for funding through the NSW Floodplain Management Program, other opportunities may be available, study only may be eligible for DPIE funding)	TBC	<<1.0	Low

## **9. ACKNOWLEDGEMENTS**

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## 11. GLOSSARY

Taken from the Floodplain Development Manual 2005 (Reference 5)

<b>acid sulfate soils</b>	Are sediments which contain sulfidic mineral pyrite which may become extremely acid following disturbance or drainage as sulfur compounds react when exposed to oxygen to form sulfuric acid. More detailed explanation and definition can be found in the NSW Government Acid Sulfate Soil Manual published by Acid Sulfate Soil Management Advisory Committee.
<b>Annual Exceedance Probability (AEP)</b>	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m <sup>3</sup> /s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a 500 m <sup>3</sup> /s or larger event occurring in any one year (see ARI).
<b>Australian Height Datum (AHD)</b>	A common national surface level datum approximately corresponding to mean sea level.
<b>Average Annual Damage (AAD)</b>	Depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time.
<b>Average Recurrence Interval (ARI)</b>	The long term average number of years between the occurrence of a flood as big as, or larger than, the selected event. For example, floods with a discharge as great as, or greater than, the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.
<b>caravan and moveable home parks</b>	Caravans and moveable dwellings are being increasingly used for long-term and permanent accommodation purposes. Standards relating to their siting, design, construction and management can be found in the Regulations under the LG Act.
<b>Catchment</b>	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.
<b>consent authority</b>	The Council, government agency or person having the function to determine a development application for land use under the EP&A Act. The consent authority is most often the Council, however legislation or an EPI may specify a Minister or public authority (other than a Council), or the Director General of DIPNR, as having the function to determine an application.
<b>development</b>	Is defined in Part 4 of the Environmental Planning and Assessment Act (EP&A Act).  <b>infill development:</b> refers to the development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as minimum floor levels may be imposed on infill development.  <b>new development:</b> refers to development of a completely different nature to that associated with the former land use. For example, the urban subdivision of an area previously used for rural purposes. New developments involve rezoning and typically require major extensions of existing urban services, such as roads, water supply, sewerage and electric power.  <b>redevelopment:</b> refers to rebuilding in an area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large

	scale. Redevelopment generally does not require either rezoning or major extensions to urban services.
<b>disaster plan (DISPLAN)</b>	A step by step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations, with the object of ensuring the coordinated response by all agencies having responsibilities and functions in emergencies.
<b>Discharge</b>	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m <sup>3</sup> /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).
<b>ecologically sustainable development (ESD)</b>	Using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the Local Government Act 1993. The use of sustainability and sustainable in this manual relate to ESD.
<b>effective warning time</b>	The time available after receiving advice of an impending flood and before the 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.
<b>emergency management</b>	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.
<b>flash flooding</b>	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.
<b>Flood</b>	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.
<b>flood awareness</b>	Flood awareness is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.
<b>flood education</b>	Flood education seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.
<b>flood fringe areas</b>	The remaining area of flood prone land after floodway and flood storage areas have been defined.
<b>flood liable land</b>	Is synonymous with flood prone land (i.e. land susceptible to flooding by the probable maximum flood (PMF) event). Note that the term flood liable land covers the whole of the floodplain, not just that part below the flood planning level (see flood planning area).
<b>flood mitigation standard</b>	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.



<b>Floodplain</b>	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
<b>floodplain risk management options</b>	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.
<b>floodplain risk management plan</b>	A management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
<b>flood plan (local)</b>	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 State Emergency Service.
<b>flood planning area</b>	The area of land below the flood planning level and thus subject to flood related development controls. The concept of flood planning area generally supersedes the 'flood liable land' concept in the 1986 Manual.
<b>Flood Planning Levels (FPLs)</b>	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. FPLs supersede the 'standard flood event' in the 1986 manual.
<b>flood proofing</b>	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.
<b>flood prone land</b>	Is land susceptible to flooding by the Probable Maximum Flood (PMF) event. Flood prone land is synonymous with flood liable land.
<b>flood readiness</b>	Flood readiness is an ability to react within the effective warning time.
<b>flood risk</b>	<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 this manual is divided into 3 types, existing, future and continuing risks. They are described below.</p> <p><b>existing flood risk:</b> the risk a community is exposed to as a result of its location on the floodplain.</p> <p><b>future flood risk:</b> the risk a community may be exposed to as a result of new development on the floodplain.</p> <p><b>continuing flood risk:</b> 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>

<b>flood storage areas</b>	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.
<b>floodway areas</b>	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 flows, or a significant increase in flood levels.
<b>Freeboard</b>	Freeboard 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.
<b>habitable room</b>	<p><b>in a residential situation:</b> a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom.</p> <p><b>in an industrial or commercial situation:</b> an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.</p>
<b>Hazard</b>	A source of potential harm or a situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community. Definitions of high and low hazard categories are provided in the Manual.
<b>Hydraulics</b>	Term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.
<b>Hydrograph</b>	A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
<b>Hydrology</b>	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.
<b>local overland flooding</b>	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
<b>local drainage</b>	Are smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.
<b>mainstream flooding</b>	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
<b>major drainage</b>	<p>Councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purpose of this manual major drainage involves:</p> <ul style="list-style-type: none"> <li>the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or</li> <li>water depths generally in excess of 0.3 m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; and/or</li> </ul>

	<ul style="list-style-type: none"> <li>major overland flow paths through developed areas outside of defined drainage reserves; and/or</li> <li>the potential to affect a number of buildings along the major flow path.</li> </ul>
<b>mathematical/computer models</b>	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.
<b>merit approach</b>	<p>The merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State's rivers and floodplains.</p> <p>The merit approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into Council plans, policy and EPIs. At a site specific level, it involves consideration of the best way of conditioning development allowable under the floodplain risk management plan, local floodplain risk management policy and EPIs.</p>
<b>minor, moderate and major flooding</b>	<p>Both the State Emergency Service and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood:</p> <p><b>minor flooding:</b> causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded.</p> <p><b>moderate flooding:</b> low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered.</p> <p><b>major flooding:</b> appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.</p>
<b>modification measures</b>	Measures that modify either the flood, the property or the response to flooding. Examples are indicated in Table 2.1 with further discussion in the Manual.
<b>peak discharge</b>	The maximum discharge occurring during a flood event.
<b>Probable Maximum Flood (PMF)</b>	The PMF is 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. The PMF defines the extent of flood prone land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation works and controlling development, up to and including the PMF event should be addressed in a floodplain risk management study.
<b>Probable Maximum Precipitation (PMP)</b>	The PMP is 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.

<b>Probability</b>	A statistical measure of the expected chance of flooding (see AEP).
<b>Risk</b>	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.
<b>Runoff</b>	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
<b>Stage</b>	Equivalent to water level. Both are measured with reference to a specified datum.
<b>stage hydrograph</b>	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.
<b>survey plan</b>	A plan prepared by a registered surveyor.
<b>water surface profile</b>	A graph showing the flood stage at any given location along a watercourse at a particular time.
<b>wind fetch</b>	The horizontal distance in the direction of wind over which wind waves are generated.