Clyde River Floodplain Risk Management Plan

Draft

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Document Control

Ver	Effective Date	Description of Revision	Prepared by:	Reviewed by:
1	19 September 2024	Issue to Client for comment	LRE	RST
2	6 October 2024	Issue for Public Exhibition	LRE	RST

Prepared For: Shoalhaven City Council

Project Name: Clyde River Floodplain Risk Management Study and Plan

Rhelm Reference: J1838

Document Location: RR_04c_1838_02 - Clyde River FRMP.docx

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Acknowledgement of Country

Walawaani (welcome),

Shoalhaven City Council recognises the First Peoples of the Shoalhaven and their ongoing connection to culture and country. We acknowledge Aboriginal people as the Traditional Owners, Custodians and Lore Keepers of the world's oldest living culture and pay respects to their Elders past, present and emerging.

Walawaani njindiwan (safe journey to you all)

This acknowledgment includes Dhurga language. We recognise and understand that there are many diverse languages spoken within the Shoalhaven.

Acknowledgements

Shoalhaven City Council has prepared this document with financial assistance from the Australian Government through the National Recovery and Resilience Agency's *Preparing Australian Communities Program – Local Stream*.

Council has undertaken this study with technical assistance from the NSW Government through the NSW Department of Climate Change, Energy, Environment and Water (DCCEEW) and NSW State Emergency Service (SES).

This document does not necessarily represent the opinions of the Australian Government, NSW Government or the DCCEEW.

Report Structure

The reporting for the Clyde River Flood Study and Floodplain Risk Management Study and Plan has been presented in five key documents:

- **Flood Study** – establishes the flood behaviour and risk within the study area.
- **The Floodplain Risk Management Study** – details the assessments undertaken as part of the study.
- **Floodplain Risk Management Plan** – presents an implementation strategy for Council to prioritise floodplain management options.
- **Map Compendium** – a set of A3 maps as referenced in the Study and Plan.
- **Emergency Response Plan** – presents a condensed version of the above documents for reference by the SES during flood events.

Foreword

The primary objective of the New South Wales (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, utilising ecologically positive methods wherever possible.

Through the NSW Department of Climate Change, Energy, the Environment, and Water (DCCEEW) and the NSW State Emergency Service (SES), the NSW Government provides specialist technical assistance to local government on all flooding, flood risk management, flood emergency management and land-use planning matters.

The *Flood Risk Management Manual* (DPE, 2023) is provided to assist councils to meet their obligations through the preparation and implementation of floodplain risk management plans, through a staged process. **Figure i**, taken from this manual, documents the process for plan preparation, implementation, and review.

The *Flood Risk Management Manual* is consistent with Australian Emergency Management Handbook 7: *Managing the floodplain: best practice in flood risk management in Australia* (AEM Handbook 7) (AIDR, 2017).

Figure i **The Floodplain Risk Management Process (DPE, 2023)**

Shoalhaven City Council is responsible for local land use planning in its service area, including in the Clyde River catchment. Council has committed to prepare a comprehensive floodplain risk management plan for the study area in accordance with the NSW Government's *Flood Risk Management Manual* (2023). This document relates to the Floodplain Risk Management Plan phase of the process.

Executive Summary

The Clyde River Floodplain Risk Management Study and Floodplain Risk Management Plan has been prepared for Shoalhaven City Council (Council) to assess and address the flood risks present in the catchment. No prior flood study or risk management study has been undertaken for the catchment within the Shoalhaven Local Government Area (LGA), and as such flood information has been limited to historical data, complemented by rainfall and stream gauge data.

Flooding is a known risk within the catchment, affecting road access and levels of service (with respect to frequency of inundation), nuisance flooding, as well as risk to private and public property. The flooding of key crossings also restricts the response of emergency personnel during emergencies.

Study Area

The Clyde River has a total catchment area of approximately 1,800km^2, of which 1,100km^2 is located within the Shoalhaven LGA. The topography is typically steep, with the river moving through large reaches where it is highly constrained by steep adjacent banks. This landscape drives the quick response and rapid rise of river levels that has historically characterised flooding in the system.

The primary study area of the project is the 50km reach of river from immediately upstream of the Yadboro River confluence, through the above localities, to the LGA boundary at the confluence of the Currowan River. A second, smaller focus is the Boyne Creek Bridge on Yadboro Road. The objective of this secondary study area is to understand which events overtop the roadway in order to assist with flood evacuation planning and emergency response.

Objectives

The overall objective of this study is to improve understanding of flood behaviour and impacts, and better inform management of flood risk in the study area in consideration of the available information, and relevant standards and guidelines. The project will also assist Council with planning for future development and will provide flood information to the NSW State Emergency Service (SES) to enable them to progress their emergency management planning for the region.

The Floodplain Risk Management Study (FRMS) has provided an understanding of the impacts of floods on the existing and future community. Testing and investigation of practical, feasible and economic management measures to treat existing, future, and residual risk has also be undertaken. Recommendations for the implementation and staging of these measures is detailed in the Floodplain Risk Management Plan (FRMP).

The FRMP outlines a range of measures to manage existing, future, and residual flood risk effectively and efficiently. This includes a prioritised implementation strategy; what measures are proposed and how they will be implemented.

Consultation

Community and stakeholder consultation is an important element of understanding and managing flood risk. The engagement approach undertaken as part of this study was in accordance with the IAP2 framework and the requirements of the NSW Government's Flood Risk Management Manual (2023).

The community and stakeholders have been engaged through a public exhibition process to provide input on flooding issues experienced in the catchment and how they could be addressed.

Floodplain Risk Management Study

The Clyde River Floodplain Risk Management Study (Rhelm, 2024) provided a comprehensive evaluation of the flood risks in the catchment and identified potential options to mitigate these risks.

The key outcomes of the FRMS include:

- Evaluation of flood risk to the community based on the flood behaviour of the catchment. This analysis included flood hazard and emergency response mapping, and economic damages assessments.
- Review of flood planning policy, including flood-related controls covered by the Local Environment Plan (LEP), relevant Development Control Plans (DCPs), Council policies and plans. The recommendations proposed as an outcome of this review are presented in this FRMP.
- Identification of a range of flood mitigation measures to address existing and future flood risk and evaluation of these measures with the use of a Multi-Criteria Assessment (MCA) approach. The MCA enabled the comparative assessment of all options based on their economic, and social aspects, as well as on their effectiveness in mitigating flood risk.

This floodplain risk management plan draws from the conclusions of the analysis undertaken in the FRMS and present the recommended measures for managing flood risk within the catchment, as well as the strategy to implement these measures.

Recommended Floodplain Risk Management Measures and Implementation Program

The outcomes of the options analysis undertaken in the FRMS form the basis of this FRMP. A detailed description of the recommended floodplain risk management measures is provided in **Section 3**.

Table i summarises the measures recommended as part of this FRMP.

Table i Summary of Recommended Floodplain Risk Management Measures

Management Scenario	ID	Name	Priority
Emergency Response Management Measures	EM1	Data handover to SES	High
	EM2	Update of Emergency response documentation	High
	EM3	Installation of additional gauges	High
	EM4	Flood education	High
	EM5	Campground education campaign	Medium
	EM6	Flood depth markers	Medium
	EM8	Online reporting of road closures	Medium
	EM14	Improve Immunity of Flood Crossings	Low
Property Management Measures	FP1	Planning and Development Controls	High
	FP4	Voluntary house purchase	Low
	FP5	Voluntary house relocation	Low
	FP6	Post flood data collection	Medium

To achieve the implementation of relevant management actions, a program of implementation has been developed. The proposed implementation strategy is presented in **Section 4**. The proposed program provides information on the estimated costs of each measure, the agency / organisation responsible for the action, as well as the priority and timeline for implementation.

It is recommended that 2 – 5 year monitoring of the plan be undertaken for progress against the recommended actions, and to ensure that the findings of the plan continue to be referenced as development is undertaken in the catchment.

It is also recommended that the Plan be reviewed every 10 years for relevance and ongoing suitability. This would be a modest review, as opposed to a revision of the full FRMSP.

Conclusions and Recommendations

This FRMP provides a practical framework and implementation plan for managing existing, future, and continuing flood risk within the study area.

The effective implementation of development controls will be of key importance in reducing the damages and risk to life associated with flooding into the future through the construction of flood compatible buildings and assets. Improving emergency response, and improved community awareness of flooding, is critical to reducing the risks associated with flooding in the study area.

This FRMP fulfils its objectives in accordance with the NSW Flood Prone Land Policy (NSW Government, 2023) and the principles of the Flood Risk Management Manual (DPE, 2023).

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1 Introduction

The Clyde River Flood Study, Floodplain Risk Management Study and Floodplain Risk Management Plan has been undertaken with Shoalhaven City Council (Council) to refine the understanding of flood risk in the study area. No prior flood study or management study has been undertaken for the catchment, and as such flood intelligence has been limited to historical data, complemented by rainfall and stream gauge data.

Flooding is a known risk within the catchment, affecting road access and levels of service (with respect to frequency of inundation), nuisance flooding, as well as risk to private and public property. The flooding of key crossings also restricts the response of emergency personal during emergencies.

Flooding poses a significant risk to both occupants and emergency responders due to:

- The short timeframes with which access routes and properties become affected in a flood event;
- The duration for which access is lost and properties are isolated;
- The lack of detailed flood intelligence;
- The isolated nature of properties which makes warning and evacuation by the SES difficult; and,
- High velocity and hazard of floodwaters in the Clyde River that make rescue or resupply by boat unviable.

The plan provides a suggested implementation schedule for Council to action the recommended risk mitigation strategies that were developed in the Floodplain Risk Management Study.

1.1 Study Area

The Clyde River has a total catchment area of approximately 1,800km^2 of which 1,100km^2 is located within the Shoalhaven LGA. The topography is typically steep, with the river moving through large reaches where it is highly constrained by steep adjacent banks. This landscape drives the quick response and rapid rise of river levels that has historically characterised flooding in the system.

Porters Creek Dam, constructed in 1967 and upgraded in 2016, provides water to the southern region of the Shoalhaven LGA, when levels permit. It was constructed on Porters Creek, which joins with Pigeon House Creek and then the Clyde River at Yadboro, east of Byangee Mountain. The Clyde River discharges to the Tasman Sea at Batemans Bay, approximately 30km downstream of the Shoalhaven LGA boundary.

Within the Shoalhaven LGA, the Clyde River catchment comprises the localities of Yadboro, Mogood, Morton, Brooman and Currowan. Based on the 2021 census, these localities have a permanent population of approximately 340 people (an increase of 35 over the 2016 census). However, the study area also includes a number of remote campgrounds and properties with short stay accommodation, hence weekend and holiday populations may be markedly higher, particularly in peak tourist seasons. The population within the study area is typically located along the river, between Yadboro and Currowan.

The primary study area of the project is the 50km reach of river from immediately upstream of the Yadboro River confluence, through the above localities, to the LGA boundary at the confluence of the Currowan River. A second, smaller focus is the Boyne Creek Bridge on Yadboro Road. The objective of this study area is to understand which events overtop the roadway in order to assist with flood evacuation planning and emergency response.

Figure 1-1 provides an overview of the Clyde River study area and the wider regional context.

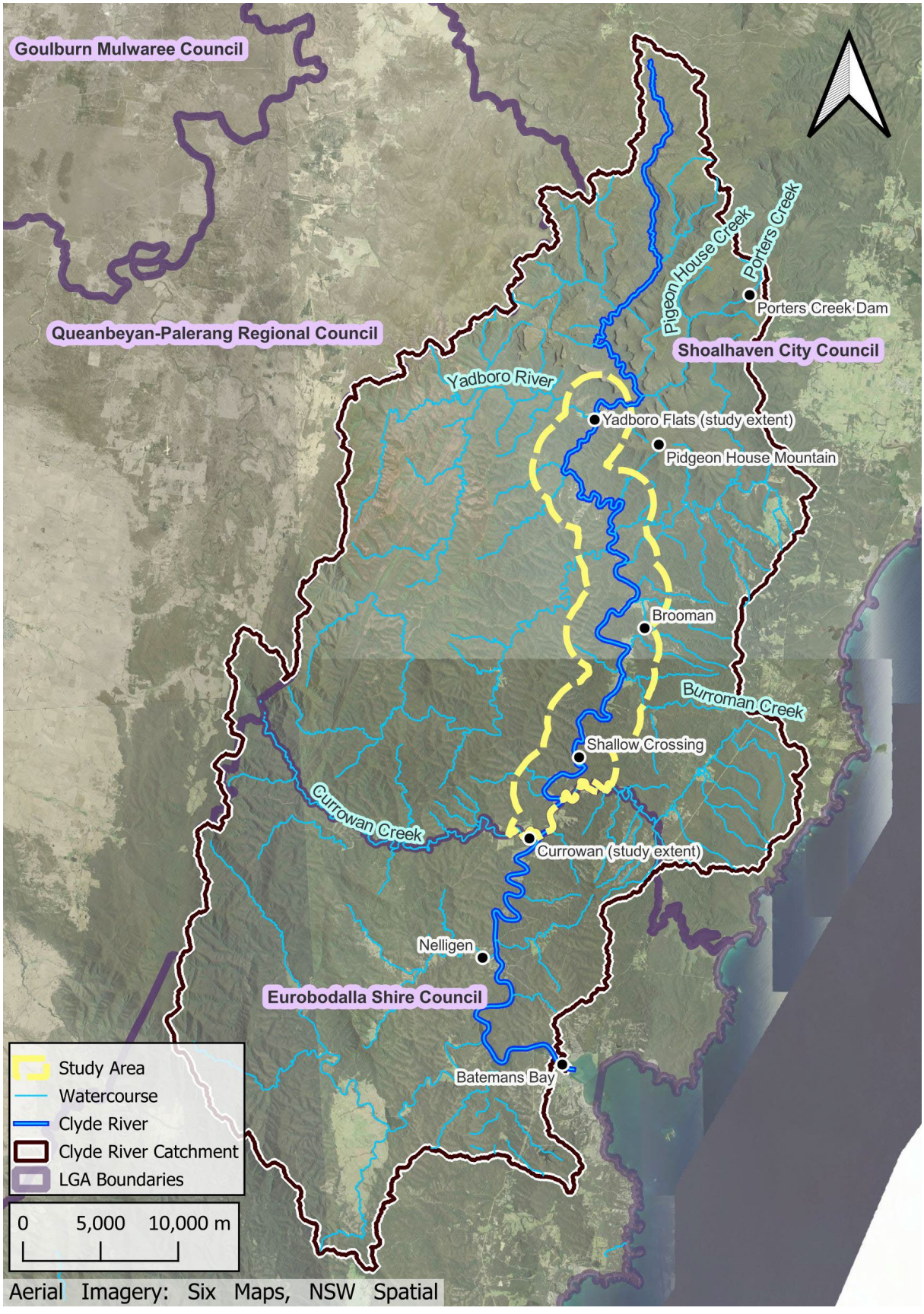

Figure 1-1 **Study Area and Regional Context**

1.2 Study Objectives

The overall objective of this study is to improve understanding of flood behaviour and impacts, better informing the management of flood risk in the study area in consideration of the available information, and relevant standards and guidelines. The project will also assist Council with planning for future development and will provide flood information to the SES to enable them to progress their emergency management planning for the region.

The FRMS provided an understanding of the impacts of floods on the existing and future community. Testing and investigation of practical, feasible and economic management measures to treat existing, future, and residual risk was also undertaken. Recommendations for the implementation and staging of these measures are detailed in the FRMP (this document).

The FRMP documents and conveys the decisions on the management of flood risk into the future. The FRMP outlines a range of measures to manage existing, future, and residual flood risk effectively and efficiently. This includes a prioritised implementation strategy; what measures are proposed and how they will be implemented.

2 Flood Risk

2.1 Flood Affectation

The existing and future flood behaviour was defined in the Clyde River Flood Study (2024).

The incised nature of the major channels, and steep overbank regions, resulted in a highly confined flood behaviour, characterised by high depth and high velocity flow with little adjacent flood storage or flood fringe.

Flood levels increased significant as design flood events increased, with the PMF typically seven to eight meters higher than the 1% AEP event.

Despite the significant increase in flood depths, the steep banks meant that there was relatively little lateral increase in flood extent.

Due to river geography, characterised by a narrow, deep channel and steep overbank areas, the flow is relatively constrained within the study area, both on the Clyde River and its tributaries.

A notable exception is the floodplain at Brooman, which is the only location that experiences significant overbank flows. The breakout occurs in the 50% AEP event, from both the Clyde River and the nearby tributaries. In the 50% AEP, the depths and velocities are typically low (less than 0.1m and 0.1m/s respectively). However, in the 20% AEP, whilst the velocities remain low, the depths rapidly increase to above 1m. In more extreme events, such as the 1% AEP and PMF, depths increase significantly to 6m and 15m respectively. Velocities however remain less than 1m/s through this overbank area for all events up to and including the PMF.

The majority of the flooding is classed as H5 or H6 in all design events, including the 50% AEP. This is due to the highly incised nature of the Clyde River, resulting in riverine flows that are both deep and fast. The steep banks, which serve to drive the confined nature of the flood behaviour, also serve to prevent wide regions of lower hazard flooding adjacent to the banks.

Lower hazard flow was observed in the smaller tributaries, as well as across the floodplain at Brooman in smaller events in the 50% and 20% AEP events. It is noted that this floodplain at Brooman transitions to H5 and H6 in the 10% AEP event.

Climate change had relatively little impact on overall flood behaviour. Flows in both 2050 and 2100 remained well contained up to and including in the PMF. There were no new flow paths activated, nor any major change in flood function.

Whilst the behaviour remained similar, there were significant changes in peak flood levels. The incised nature of the channels means that increased flows have a modest impact on behaviour and extent, but a large impact on levels. Typical level increases in the 2100 scenario were observed of:

- 1.5 – 2m in the 50% AEP;
- 2 – 2.5m in the 1% AEP; and,
- 3 – 4m in the PMF.

The mapping compendium contains a comprehensive mapping set of existing, 2050 and 2100 horizon flood behaviour. Further details of existing flood behaviour are discussed in the Clyde River Flood Study (2024).

2.2 Economic Flood Damages

To quantify the economic impacts of flooding, a flood damage assessment has been undertaken. A property may suffer economic impacts from flooding through several ways. These are broadly grouped into three categories, as summarised in **Table 2-1**.

Table 2-1 Types of Flood Damages

Type of Flood Damages		Description
Tangible	**Direct**	Building contents Structure (building repair and clean) External items (vehicles, contents of sheds etc.) Infrastructure
	Indirect	Clean-up (immediate removal of debris) Financial (loss of revenue, extra expenditure) Opportunity (non-provision of public services)
Intangible		Social – increased levels of insecurity, depression, stress General inconvenience in post-flood stage

Damage impacts to a property or its contents (direct damages) are only a component of the total damages accrued during a flood event. Indirect costs, while also tangible, arise because of consequences of the flood event, such as clean-up costs, opportunity costs, and other financial impacts.

In addition to tangible damages, there are also a category of damages referred to as intangible damages. Intangible costs relate to social impacts, such as insecurity and depression, that arise because of major flood event, or general inconveniences that occur during the post-flood stage.

The damages calculated for each design event are used to estimate the Annual Average Damages (AAD). The AAD is the typical method that is adopted in economics to annualise damage costs such as those in flooding based on their probabilities. This allows for the conversion of the different flood event damages into a singular annual average that represents (based on the overall probabilities of events) the most likely damage that is likely to be experienced in any given year.

The AAD provides a representation of the estimated amount of capital that Council would theoretically need to invest every year to address damages caused by flooding (both frequent and rare). The calculation process is described in detail in the Floodplain Risk Management Manual (2023).

The average annual damage (AAD) for the study area under existing conditions is **$341,700**.

Over a 50-year assessment period and under a seven per cent discount rate, this is equivalent to a Net Present Value (NPV) of **$6.2 million**.

A summary of flood damages and property affectation is provided for design events in **Table 2-2**.

Table 2-2 Existing Damages Assessment Results

AEP + Breakdown	Flooding Count (Over Floor Level / Over Ground)	Max Depth (m) (Over Floor Level)	Total Damages	AAD per Property
PMF	22 / 35	13.2	$12,014,160	**$626,456**
Residential	21 / 34	13.2	$12,014,160	**$572,103**
Commercial	1	7.27	$350,477	**$350,477**
Public	0	0	$0	**$0**
0.2% AEP	19	6.5	$8,484,792	**$555,110**
Residential	18	6.5	$8,370,511	**$516,596**
Commercial	1	0.33	$114,281	**$114,281**
Public	0	0	$0	**$0**
1% AEP	13 / 14	4.1	$5,743,846	**$533,110**
Residential	13 / 14	4.1	$5,743,846	**$484,645**
Commercial	0	0	$0	**$0**
Public	0	0	$0	**$0**
2% AEP	13 / 13	3.08	$4,867,572	**$448,745**
Residential	13 / 13	3.08	$4,867,572	**$407,950**
Commercial	0	0	$0	**$0**
Public	0	0	$0	**$0**
5% AEP	7-Sep	1.28	$1,905,965	**$316,193**
Residential	7-Sep	1.28	$1,905,965	**$287,448**
Commercial	0	0	$0	**$0**
Public	0	0	$0	**$0**
10% AEP	2-May	0.23	$319,038	**$160,584**
Residential	2-May	0.23	$319,038	**$145,985**
Commercial	0	0	$0	**$0**
Public	0	0	$0	**$0**
20% AEP	0	0	$0	**$0**
Residential	0	0	$0	**$0**
Commercial	0	0	$0	**$0**
Public	0	0	$0	**$0**
50% AEP	0	0	$0	**$0**
Residential	0	0	$0	**$0**
Commercial	0	0	$0	**$0**
Public	0	0	$0	**$0**

3 Floodplain Risk Management Options

3.1 Background

Flood risk is a combination of the likelihood of occurrence of a flood event and the consequences of that event when it occurs. It is the human interaction with a flood that results in a flood risk to the community. This risk will vary with the frequency of exposure to this hazard, the severity of the hazard, and the vulnerability of the community and its supporting infrastructure to the hazard. Understanding this interaction can inform decisions on which treatments to use in managing flood risk.

As defined in the *Australian Disaster Resilience Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR, 2017), there are three types of flood risk:

- Existing flood risk – the risk associated with current development in the floodplain. Knowing the likelihood and consequences of various scales of floods can assist with decisions on whether to treat this risk and, if so, how.
- Future flood risk – the risk associated with any new development of the floodplain. Knowing the likelihood and consequences of flooding can inform decisions on where not to develop and where and how to develop the floodplain to ensure risks to new development and its occupants are acceptable. This information can feed into strategic land-use planning.
- Residual flood risk – the risk remaining in both existing and future development areas after management measures, such as works and land-use planning and development controls, are implemented. This is the risk from rarer floods like the PMF, which may exceed the management measures. Residual risk can vary significantly within and between floodplains. Emergency management and recovery planning, supported by systems and infrastructure, can assist to reduce residual risk.

Measures available for the management of flood risk can be categorised according to the way in which the risk is managed. There are three broad categories of management:

- Flood modification measures – options aimed at preventing/avoiding or reducing the likelihood of flood risks through modification of flood behaviour in the catchment.
- Property modification measures – options focused on preventing/avoiding or reducing the consequences of flood risk through modification to existing properties (e.g. by house raising) and/or impose controls on property and infrastructure development. Property modification measures, such as effective land use planning and development controls for future properties, are essential for ensuring that future flood damages are appropriately contained, while at the same time allowing ongoing development and use of the floodplain.
- Emergency response modification measures – options focused on reducing the consequences of flood risks, by generally aiming to modify the behaviour of people during a flood event.

A comprehensive range of possible flood risk management measures for study area were examined, as part of the Floodplain Risk Management Study (2024). The identified measures were a product of an extensive investigation of the flood risks in the study area, which flood behaviour, flood hazard, emergency response mapping, and economic damages assessments undertaken as part of the FRMS, and inputs obtained through workshops with stakeholders and community engagement activities.

The identified measures were then evaluated through a Multi-Criteria Assessment (MCA) approach, which enabled the comparative assessment of all options based on their economic, social, and environmental aspects, as well as on their effectiveness in mitigating flood risk.

As an outcome of this assessment, the options that were identified as being the most advantageous have been recommended as part of this FRMP and are further discussed below.

A range of flood risk management measures are recommended as part of this FRMP.

The recommended measures are presented in:

- **Section 3.1.1** for emergency response options; and.
- **Section 3.1.2**, for property modification options.

No flood modification options (structural options) were found suitable for inclusion in the FRMP. This was due to the highly incised nature of the Clyde River that resulted in high depths and velocities for much of the floodplain, that precluded any works to change the way the flood behaves.

3.1.1 Emergency Response Options

Emergency response modification measures aim to reduce the consequences of flood risks by:

- Increasing the effective warning time, such as via the use of flood warning systems
- Planning the evacuation of an area so that it proceeds smoothly during a flood event;
- Preparing for a flood event (e.g., stockpiling sand and sandbags for future deployment); and,
- Enabling recovery following a flood event.

Of all the floodplain risk management options available for consideration, it is only emergency management modifications (which includes community planning) that addresses the residual flood risk after all the flood and property modification options have been implemented. Emergency management and education measures are an effective ongoing flood risk management tool.

Table 3-1 summarises the emergency response measures that were found in the FRMS to be beneficial in a program of flood risk management.

Table 3-1 Recommended Measures – Emergency Response

Option ID	Option Name	Reference Section
EM1	Information Transfer	Section 3.1.1.1
EM2	Update of Emergency response documentation	Section 3.1.1.2
EM3	Installation of Rainfall and/or Stream Gauges	Section 3.1.1.3
EM4	Flood Education	Section 3.1.1.4
EM5	Campground Education Campaign	Section 3.1.1.5
EM6	Depth Markers	Section 3.1.1.6
EM8	Online reporting of road closures	Section 3.1.1.7
EM14	Improve flood immunity at crossings	Section 3.1.1.8

3.1.1.1 *EM1 – Information Transfer*

<table>
<tr><th colspan="3">EM1: Data Handover to the NSW SES</th></tr>
<tr><td>Flood Management Type: Emergency Response</td><td colspan="2">Responsibility: Council / SES</td></tr>
<tr><td rowspan="2">MCA Priority: High</td><td rowspan="2">Associated Costs:</td><td>Initial Cost: $0</td></tr>
<tr><td>Recurrent Cost: $0</td></tr>
<tr><td colspan="3">Overview and Flooding issue addressed:
The flood data developed as part of the Flood Study and Floodplain Risk Management Sutdy should be transferred to the SES for incorporation into their own flood intelligence database. This would be facilitated by the NSW Government Flood Data Portal following the completion of these flood investigations.
The provision of the hazard mapping and flood emergency response classifications would also assist the SES is prioritising and scheduling actions as a flood event progresses through the catchment.
The flood data developed as part of the FRMS could potentially assist the SES to plan and carry out emergency actions. All flood data will be uploaded to the SES Data Portal at the conclusion of the study.</td></tr>
<tr><td colspan="2">Expected Mitigation Outcomes:
The flood data developed as part of the flood study and FRMS will assist the SES in prioritising and scheduling actions, as a flood event progresses through the catchment area.</td><td>Considerations:
The provision of flood information to the SES should also be ongoing. For example, if Council collects any post-flood survey, or receives reports of local flooding issues, this should also be passed to the SES for their consideration. This would be achieved by uploading this data to the NSW Flood Data Portal.</td></tr>
</table>

3.1.1.2 *EM2 – Update of Emergency Response Documentation*

<table>
<tr><th colspan="3">EM2: Update of Emergency Response Documentation</th></tr>
<tr><td>Flood Management Type: Emergency Response</td><td colspan="2">Responsibility: SES</td></tr>
<tr><td rowspan="2">MCA Priority: High</td><td rowspan="2">Associated Costs:</td><td>Initial Cost: $0</td></tr>
<tr><td>Recurrent Cost: $0</td></tr>
<tr><td colspan="3">Overview and Flooding issue addressed:
The Shoalhaven City Flood Emergency Sub-Plan (the Flood Plan) was prepared in 2022, and covers the preparation for, response to and recovery from flooding emergencies for the Shoalhaven LGA. The Flood Plan focuses exclusively on flooding emergencies, and more explicitly defines the roles and responsibilities of parties in a flood event. It also makes note of which key roads can be flood affected.
The Clyde River catchment is discussed specifically in Volume 2 (Hazard and Risk in Shoalhaven City).
It is recommended that the Flood Plan (specifically Volume 2 Annex B) be updated to incorporate the learnings from this study relating to:
• Effects of flooding on the community (Volume 2 Annex B); and,
• Road closures (Volume 2 Annex B).
It is noted that the plan includes a section on caravan parks, but not on campgrounds. It is recommended that a section be added to explicitly note flood affected campgrounds, and the data from this study incorporated as appropriate.</td></tr>
<tr><td colspan="2">Expected Mitigation Outcomes:
Improved flood response from emergency responders.</td><td>Considerations:
If other risk management studies have been undertaken, but have not yet been incorporated into these documents, this opportunity should be taken to do so.</td></tr>
</table>

3.1.1.3 EM3 – Installation of Additional Rainfall and/or Stream Gauges

EM3: Installation of additional rainfall and/or stream gauges		
Flood Management Type: Emergency Response	**Responsibility: Council / SES / BoM**	
MCA Priority: High	**Associated Costs:**	**Initial Cost:** $60,000 **Ongoing Cost:** $10,000
Overview and Flooding issue addressed: Rainfall and stream gauges serve to improve flood forecasting and flood warning options. Within the study area, the Clyde River catchment currently has gauges located at Porters Creek Dam and Brooman. Additional gauges are located within the Eurobodalla LGA region of the Clyde River catchment at Buckenbowra, Nelligen, and Princess Jetty (Batemans Bay). Several additional gauges are located outside the catchment down the coastline at Bendalong, Milton, Burril Lake, and Kioloa. These gauges are focused on the central and eastern regions of the catchment. There is currently no telemetry of rainfall or stream data in the upper and western regions of the catchment. Pending available resources, it is recommended that additional gauges be placed at (in order of priority) Yadboro Flats (water level, and potentially rainfall as well depending on tree coverage), downstream of the confluence of the Clyde River and Yadboro River, and in the upper reaches of the Bimberamala River (rainfall).		
Expected Mitigation Outcomes: The installation of these gauges would provide improved flood warning for the upper catchment, as well as a better definition of the orographic effects of the western range. The water level gauge at Yadboro Flats would assist to provide flooding intelligence for crossings downstream of this, such as Clyde Ridge Road and Shallow Crossing.	**Considerations:** It is suggested that SES and BoM be consulted in the implementation of this option to ensure the proposed locations are suitable for their use also.	

3.1.1.4 EM4 – Flood Education

EM4: Flood Education		
Flood Management Type: Emergency Response	**Responsibility: Council / SES**	
MCA Priority: Medium	**Associated Costs:**	**Initial Cost:** $30,000 **Ongoing Cost:** $2,000 every 5 years.
Overview and Flooding issue addressed: Community awareness and behaviour is an important aspect of reducing flood risk within a catchment. If a community is aware of how flood risks develop within their local area, and the correct ways in which to respond, risk to life can be substantially reduced. It is recommended that Council take the adoption of the Flood Study and Floodplain Risk Management Study and Plan as an opportunity to engage with the community in discussions relating to flood risk, management, and responses. At a minimum, it is recommended that Council's website and the Shoalhaven Interactive Flood Map be updated with the outcomes and recommendations of the Flood Study and Floodplain Risk Management Study and Plan. Further community awareness could be raised by issuing media releases. The involvement of NSW SES members in community engagement and educations programs has been successful in engagement activities undertaken by Council and across NSW. SES members could be invited to participate in face-to-face education activities at community events or pop up stalls.		
Expected Mitigation Outcomes: Improved awareness of flood risk by the community, who will be empowered to make better and safer decisions during flood events.	**Considerations:** Awareness will fade in the community over time, and be diluted as new residents move in. The education campaign should be refreshed every 2-5 years, during forecast La Niña years, to maintain awareness.	

3.1.1.5 EM5 – Campground Education Campaign

EM5: Campground Education Campaign		
Flood Management Type: Emergency Response	**Responsibility: Council / National Parks / Forestry**	
MCA Priority: Medium	**Associated Costs:**	**Initial Cost:** $20,000 **Ongoing Cost:** $2,000 every 5 years

Overview and Flooding issue addressed:

There are several campgrounds located within the study area. They present a significant flood risk during flood events as occupants (campers and/or tourists) are unlikely to be as familiar with the flood behaviour and risks as long term residents. They are also going to be restricted to far less refuges (tents) than residents (houses) and would be less prepared for long periods of isolation.

Hawkesbury-Nepean Valley Flood Risk Management Directorate recently undertook a project to support caravan park operators along the Hawkesbury-Nepean River to improve their flood preparedness and responsiveness. Central to this project was the development of a highly collaborative working group that involved all key stakeholders, including the local councils, communications and engagement specialists, NSW SES, local SES volunteers, and flood specialists.

It is noted that the requirements for an education and engagement process within the Clyde River catchment are on a significantly smaller scale than what was undertaken for the Hawkesbury-Nepean River. It is also noted that Council have limited influence over campgrounds on land owned by other agencies.

A challenge with the Clyde River campgrounds is that the campgrounds to not appear to have on-site managers. This fact should be kept in mind in developing any flood response actions.

It is recommended that Council communicate the findings of this study with the relevant camp ground owners to enable owners to better plan for and manage flood risks. Council may also wish to invite further consultation with campground owners, such that they are positioned to offer future advice if requested.

Expected Mitigation Outcomes:

The transfer of the flood information generated in the Clyde River Flood Study and FRMS to the operators of campgrounds within the Clyde River catchment would serve to increase the awareness of the flood behaviour and risks of campground operators.

The dissemination of this information may also serve as a starting point for an ongoing conversation with these operators about how they could improve their campgrounds flood risk profile.

3.1.1.6 EM6 – Flood Depth Markers

EM6: Flood Depth Markers		
Flood Management Type: Emergency Response	**Responsibility: Council / Forestry NSW / NPWS**	
MCA Priority: High	**Associated Costs:**	**Initial Cost:** $40,000 **Ongoing Cost:** $5,000 as required
Overview and Flooding issue addressed: Flood warning and information signs may be used to educate the community on flood risk, or to provide them with flood information during a flood event (such as depth markers) to allow them to make informed decisions. Due to the significant flood depths that can occur at these crossings, a depth mark showing overtopping depth up to rare or extreme flood events is not feasible. Rather, a series of markers would be staggered up the bank to a depth of 4 – 5m. Beyond this, it would be apparent from the river conditions that crossing is not advisable. It is recommended that depth markers be placed at those roads which are subject to frequent inundation, as identified in **Section 8.3.6** of the FRMS. It is also recommended that these works be aligned with the installation of any new rainfall or stream gauges installed at the same location as part of other risk management measures recommended by this Plan. It is noted that not all these roads are owned by Council. The installation of depth marks on non-Council owned roads would require consultation with and agreement from the relevant agency. Where approval cannot be obtained, it is recommended that the road overtopping behaviour documented in the FRMS be provided to the relevant road owners for consideration.		
Expected Mitigation Outcomes: Improved awareness of flood risk by the community. The depth gauges will assist in preventing people driving into flood waters.		

3.1.1.7 EM8 – Online Warning of Road Closures

EM8: Online Warning of Road Closures		
Flood Management Type: Emergency Response	**Responsibility: Council / National Parks / Forestry**	
MCA Priority: Medium	**Associated Costs:**	**Initial Cost:** $90,000 **Ongoing Cost:** $5,000
Overview and Flooding issue addressed: A major risk within the Clyde River catchment is the rapid loss of access of key crossings. This risk is compounded by the fact that few alternatives to these crossing exist, and they are located some distance from major roads. This may lead drivers to attempt a dangerous crossing to avoid long (and potentially equally flood affected) detours. To manage this risk, the option would see a water level gauge would be installed on major crossings (Yadboro Road, Upside Down Bridge, and Shallow Crossing), with overtopping depth data provided to the BoM. The BoM would then report the overtopping depths on their website. Signage would be provided at key turn off locations from the Princes Highway informing drivers of this service, and where to access the information.		
Expected Mitigation Outcomes: Telemetry would be required to be installed at each crossing, and a communication system set up that would permit real time transfer of water levels to the BoM. The BoM website would then advertise whether the road is open or closed.	**Considerations:** A key challenge with this is option is the mobile reception limitations within the catchment. The system would also need to be robust enough to successfully operate during large flood events. Several key crossings are also owned by others. The option would require their support for the option to be successful.	

3.1.1.8 EM14 – Improve flood Immunity of crossings

EM13: Improve flood immunity of crossings		
Flood Management Type: Emergency Response	**Responsibility: Council**	
MCA Priority: Low	**Associated Costs:**	**Initial Cost:** $1,500,000 **Ongoing Cost:** $5,000
Overview and Flooding issue addressed: There are three key crossings of the Clyde River within the study area, namely, Yadboro Flats, Upside Down Bridge, and Shallow Crossing. The crossing level at each of these locations is low, such that access is lost in even minor flood events. Of the three, only Shallow Crossing is a Council asset, and is the only crossing covered by this recommendation. The option would see the flood immunity of Shallow Crossing increased by raising the road level. Raising would also assist in retaining access during high tides in the future and provide other environmental benefits such as improved fish passage. The climate change assessment undertaken in the Flood Study found that by 2100 Shallow Crossing may be inundated by 0.6m during a HHWSS tide. It is not suggested that this option seek to be implemented immediately. Rather, it could be incorporated in part of future crossing improvements or updates.		
Expected Mitigation Outcomes: The 50% AEP is currently higher than the adjacent landform at both Yadboro Flats and Upside Down Bridge. Raising would still provide benefits in flood immunity, but these crossings will always be low lying. At Shallow Crossing, the adjacent terrain would allow the crossing to be raised to the 50% AEP or slightly higher. It is noted that climate change will result in this crossing becoming increasingly unpassable during high tides and so an upgrade of this structure will likely become necessary in the future.	**Considerations:** Council only owns one of these crossings, and this recommendation is applicable only to that one crossing. It is recommended that the findings of this study be shared with the asset owners, along with this recommendation from the FRMP, so that they are aware of this flood risks if/when the other bridges are replaced.	

3.1.2 Property Modification Options

Property modification measures refer to modifications to existing development and / or development controls on property and community infrastructure for future development. These are aimed at steering inappropriate development away from areas with a high potential for damage and ensuring that potential damage to development likely to be affected by flooding is limited to acceptable levels by means of measures such as minimum floor levels, and flood proofing requirements.

Table 3-2 summarises the property modification measures that were found in the FRMS to be beneficial in a program of flood risk management.

Table 3-2 Recommended Measures – Property Modification Options

Option ID	Option Name	Reference Section
FP1	Planning and Building Control Review	Section 3.1.2.1
FP4	Voluntary House Purchase	Section 3.1.2.2
FP5	Voluntary House Relocation	Section 3.1.2.3
FP6	Post Flood Data Collection	Section 3.1.2.4

3.1.2.1 *FP1 – Planning and Building Control Review*

FP1: Planning and Building Control Review		
Flood Management Type: Property Modification	**Responsibility: Council**	
MCA Priority: High	**Associated Costs:**	**Initial Cost:** $25,000
		Recurrent Cost: 0
Overview: Council's existing land use planning and building controls were reviewed in the FRMS. As an outcome of this review, a series of recommendations have been made to assist Council in achieving best practice flood planning in the catchment and across the LGA. Recommended planning controls updates are described in **Section 5.7** of the FRMS.		

3.1.2.2 *FP4 – Voluntary House Purchase*

FP4: Voluntary House Purchase		
Flood Management Type: Emergency Response	**Responsibility: Council**	
MCA Priority: Low	**Associated Costs:**	**Per Property:** $700,000 **Total:** $5 million
Overview and Flooding issue addressed: Voluntary house purchase (VP) is a flood risk management tool, used in high hazard residential areas when there are no other feasible options for protecting an existing community from severe flooding, such as building levees, diverting flood flows, or improving evacuation access. The main aim of VP is to permanently remove at risk people from high flood hazard areas (areas with high flood depths and velocities) by purchasing their properties. The dwelling is then removed ,and the property is zoned to a more flood compatible land use. Within the Clyde River study area, there are seven properties located within either the high hazard 1% AEP floodway or a low flood island. The lots of each of these properties are fully inundated in the PMF event. At each location, the PMF is at least 7.5m above ground level (and up to 13.5m at some locations). The lack of flood free land on the lot precludes an option to relocate the property.		
Expected Mitigation Outcomes: The removal of residents from this high hazard region of flooding will result in a significant reduction in risk to life during flood events	**Considerations:** The scheme is a long-term proposition. Whilst Council can implement a scheme, the schemes success it is dependent on owners electing to take part and Council's financial ability to provide the 1/3 contribution. A feasibility study would initially be required to confirm the suitability of the identified properties. Council would need to initially gauge interest in VP from the seven property owners. If there is interest from property owners, then a VP feasibility investigation should be undertaken.	

3.1.2.3 FP5 – Voluntary House Relocation

<table>
<tr><th colspan="3">FP5: Voluntary House Relocation</th></tr>
<tr><td>Flood Management Type: Emergency Response</td><td colspan="2">Responsibility: Council</td></tr>
<tr><td>MCA Priority: Low</td><td>Associated Costs:</td><td>Paid for by owners, with potential grant funding from the NSW Government Flood Program</td></tr>
<tr><td colspan="3">Overview and Flooding issue addressed:
Early loss of access requires occupants to remain in place during flood events in the study area. However, the PMF flood depths are sufficient to result in over floor flooding of the second floor of all identified properties, meaning that there is unlikely to be a safe refuge at the property during extreme flood events. Given this, it is not considered suitable to raise floor levels in existing locations, due to the high residual risk posed by PMF depths. Rather, the scheme would be used to relocate properties to a more suitable location on the lot. As such, the option is only suitable where there is flood free land above the PMF within the lot for the dwelling to be moved to.
A total of seven properties were identified that experienced over floor flooding in the 1% AEP for which sufficient flood free land was available on site for relocation. These sites are in storage and fringe areas, as well as floodways. As the properties would be relocated, the restriction on VHR within floodways is not applicable.</td></tr>
<tr><td>Expected Mitigation Outcomes:
The removal of residents from this high risk region of flooding will result in a significant reduction in risk to life during flood events.</td><td colspan="2">Considerations:
The scheme is a long-term proposition.
Whilst Council can apply for a scheme, the schemes success it is dependent on owners electing to take part, and the approval of grant funding from the NSW Government Flood Program (under a funding scheme the government contributes 2/3 of the total cost, and the property owner the remaining 1/3).
A feasibility study would initially be required to confirm the suitability of the identified properties.</td></tr>
</table>

3.1.2.4 FP6 – Post Flood Data Collection

FP6: Post Flood Data Collection		
Flood Management Type: Emergency Response	**Responsibility: Council**	
MCA Priority: Medium	**Associated Costs:**	**Per Event:** $5,000 to 15,000
Overview and Flooding issue addressed: The availability of historical flood data provides numerous benefits to Council and the SES, namely: • Identification of areas that experience frequent flooding issues; • Confirmation (or not) that Council and SES records of high-risk locations and road overtopping behaviour is correct; • Confirmation (or not) that the flood modelling undertaken to date accurately reflects flood behaviour observed during flood events; and, • Allows for a more comprehensive calibration and validation process. To supplement the historical data already held by Council, the collection of flood data following flood events should be continuously undertaken. Depending on the size of the event, such data may include records of complaints or observations made by the community, photographs taken during or after the flood event, notes made of road inundation locations and durations, and survey of flood marks following the event. There are several challenges to timely and accurate data collection within the Clyde River catchment: • Access difficulties immediately following a flood event, as road conditions may make accessing the Clyde River challenging; • The use of debris marks as data points may pose challenges as the Flood Study found that whilst debris marks show that the river reached a particular level, they could not be relied upon as being reflective of the flood peak; • A lack of structures and access routes to the river would also limit the locations at which survey could be collected. It is noted that other management measures may assist with data capture, namely EM3 (installation of additional gauges) and EM6 (depth markers at road crossings).		
Expected Mitigation Outcomes: Improved historical data to increase future calibration and validation of flood models, and to assist SES in refining their data on at-risk zones.	**Considerations:** It is recommended that a formal process be developed within Council for this collection, that outlines the type of data required (location, level, etc), the steps to collect the data, and the identification of safety measures surrounding collecting the data.	

4 Implementation Program

The actions listed in **Table 4-1** are recommended for implementation as an outcome of the NSW Government Floodplain Risk Management Process. To achieve the implementation of relevant management actions, a program of implementation has been development.

Table 4-1 provides the following information relevant to the implementation of the management actions:

- An estimate of capital and recurrent costs for each action (this may, in some cases, include existing staff and funding);
- The agency or organisation likely to be responsible for the action;
- The timeline for implementation (immediate or staged) and priority for implementation (high, medium, or low).

The following provides further detail on the implementation timelines:

- **Short** – this indicates actions that could be implemented in the short term (less than 5 years) if funding and resources permit.
- **Mid** – this indicates actions that could be implemented in the mid- term (5 to 10 years) if funding and resourcing permits. Feasibility of the action is generally high and additional investigations or further development of the management strategy would be minimal.
- **Long** – this indicates actions that could be undertaken in the long term (up to 10 years plus). However, additional investigations, feasibility studies or further development of the management strategy are likely to be required. Where appropriate, interim policy and planning measures could be employed in the intervening time.

The following provides further detail on the priorities:

- **High priority:**
  - Typically (but not always) require relatively low implementation effort and cost.
  - Achieved a high priority rating in the MCA.
- **Medium Priority:**
  - Require a substantial effort and cost.
  - Achieved a medium priority rating in the MCA.
- **Low:**
  - Require highly significant effort and cost.
  - Achieved a relatively low priority rating in the MCA.

It is recommended monitoring of the plan be undertaken every 2 – 5 years for progress against the recommended actions, and to ensure that the findings of the plan continue to be referenced as development is undertaken in the catchment.

Table 4-1 Implementation Action List

ID	Recommended Action	Indicative Costs		Potential Funding / Responsibility	Time Frame	Priority
		Capital	Recurrent			
EM1	Data handover to SES	$0	$0	Council / SES	Short	High
EM2	Update of Emergency response documentation	$0	$0	Council / SES	Mid	High
EM3	Installation of additional rain gauges	$60,000	$10,000	Council / SES / BoM	Mid	High
EM4	Flood Education	$30,000	$2,000 every 5 years	Council	Mid	High
EM5	Campground Education Campaign	$20,000	$2,000 every 5 years	Council / Forestry / National Parks	Mid	Medium
EM6	Flood depth markers	$40,000	$5,000 as required	Council / Forestry / National Parks	Mid	Medium
EM8	Online warning of road closures	$90,000	$5,000	Council / Forestry / National Parks	Mid	Medium
EM14	Improve flood immunity of crossings	$1,500,000	$5,000	Council	Long	Low
FP1	Planning and Development Controls	$25,000	$0	Council	Short	High
FP4	Voluntary House Purchase	$5 Million +	$0	Council	Long	Low
FP5	Voluntary House Relocation	Paid for by owners (with possible grant funding)	$0	Property owners / DCCEEW	Long	Low
FP6	Post flood data collection	$0	$5,000 - 15,000 per event	Council	Short	Medium

5 Conclusions

This FRMP provides a practical framework and implementation plan for managing existing, future, and continuing flood risk within the study area.

Overall, it is considered that existing catchment flooding risks to the Clyde River catchment can be managed appropriately through the implementation of development controls, and emergency response measures.

The isolated nature of development within the catchment will rely heavily on emergency response measures to ensure the safety of residents and visitors during times of flooding. The effective implementation of development controls will be of key importance in reducing the damages and risk to life associated with flooding through the construction of flood compatible buildings and assets.

To achieve the implementation of relevant management actions, a program of implementation has been developed. The actions listed in **Section 4** are recommended for implementation.

The steps in progressing the floodplain risk management process from this point onwards are:

- Council will consider adopting the final FRMP and submit applications for funding assistance to relevant State and Commonwealth agencies, as appropriate and within Council's available resources;
- The flood management actions will be prioritised for funding through the Integrated Planning and Reporting Process; and
- As funds become available from NSW DCCEEW, the Commonwealth, other state government agencies and/or from Council's own resources, recommended management actions will be implemented in accordance with the established priorities.

This FRMP fulfils its objectives in accordance with the New South Wales (NSW) Flood Prone Land Policy (NSW Government, 2023) and the principles of the Flood Risk Management Manual (DPE, 2023).

6 References

AIDR. (2017). *Australian Disaster Resilience Handbook 7: Managing the Floodplain: A guide to best practice in flood risk management in Australia.* East Melbourne VIC: AIDR, on behalf of the Australian Government Attorney-General's Department.

State of NSW and Department of Planning and Environment. (2023). *Flood Risk Management Manual: The policy and manual for the management of flood liable land.* Parramatta NSW: Environment and Heritage Group, Department of Planning and Environment.

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