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Rapid Project Prioritisation for Flood Resilience in the Northern Rivers region

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Acknowledgments

This project was made possible through funding by the National Emergency Management Agency and we thank them for their involvement and input into the project, especially the on-ground staff who assisted us with arrangements and helped coordinate our community engagement activities.

We also want to recognise the extremely valuable contributions we received from the community, and local and state government agency staff as part of the project. More than 400 community members, both individuals and organised community groups, took the time to tell us their experiences, many of which were harrowing and still very fresh in their minds. It was a privilege for us to hear these and as many told us, for what they felt was the first time, to really listen to the impacts that the flooding had on them. Local council staff, many who were personally affected or worked long and arduous hours during the events, provided us with great insight and understanding of what was likely to be beneficial to managing future events of this nature. State agency staff, many of whom have worked in the region for long periods, also provided guidance and advice and assisted the project team on a number of occasions with access to data and information.

For your trust in us, especially during a very short-term project such as this, we thank you.

This report was reviewed by an independent expert, Associate Professor Barry Croke, Australian National University. Dr Croke is an expert in multi criteria analysis and hydrological modelling, including streamflow and groundwater in gauged and ungauged catchments.

Executive summary

Flooding across the Eastern states of Australia was extensive in 2022 and in particular, the events of February and March saw widespread flooding, damage and loss of life in the Northern Rivers region in NSW. Funding of $150 million was made available through the Federal Government's Emergency Response Fund, managed through the National Emergency Management Agency (NEMA), to help recovery and build resilience as a response to both the February/March 2022 event and previous flooding in the region.

As part of that, the CSIRO was commissioned by NEMA to undertake the Northern Rivers Resilience Initiative (NRRI) to:

- understand the catchment and climate characteristics which led to the February/March 2022 flooding,
- rapidly prioritise projects suitable to be funded through the available $150M; and
- a longer term project to collect suitable data and construct a whole of catchment model for the Richmond River.

This report outlines the results of the rapid prioritisation of projects work.

To undertake the rapid prioritisation, we completed several key tasks to identify projects that had been previously identified through studies and reports but were not yet implemented, in addition to consulting directly with local government and state agency staff to help refine these and to incorporate any more recent information available. We also engaged widely across the region with community members and organised community groups through an ethically approved process that included dedicated 7 hour "drop-in" sessions at 15 different locations across the Northern Rivers region. The engagement was designed around listening to the community's concerns, project ideas and what should be the major focus for investment of the $150M.

The outcome of this work was that we received more than 330 projects identified through local government, state agency and community feedback. More than 400 people attended the engagement sessions and 345 surveys were completed by community members to give us important inputs into how we weighted key themes and individual criteria in a Multi-Criteria Assessment (MCA) of the identified projects. From the community, we received 59 formal submissions of which 9 had sufficient detailed information to be included in the overall project list.

The MCA approach was designed based on assessment criteria identified through the NSW Department of Planning and Environment's Floodplain Risk Management planning guidelines and expanded using insights from recent Queensland Reconstruction Authority flood management investment approaches.

From the projects identified, all were assessed for eligibility for the $150M funding based on guidance from NEMA, potential to be funded from other sources, and advice from local government staff. In total, 62 projects were short-listed through this process and scored according to the MCA process. The raw scores were then weighted according to the results of the community engagement surveys and the overall lists ranked. The MCA process does also provide the ability to investigate other rankings, and three different investment scenarios were considered, in addition to different methods to consider funding distribution.

A number of emerging themes became obvious through undertaking this rapid prioritisation process, including:

- Improved dynamic understanding of the system for all stakeholders – which includes developing a better, more robust and reliable flood gauging, information collation and advice provision process to ensure that timely flood information is appropriately communicated to all affected stakeholders and that flood awareness is a key focus of emergency planning.
- Improved static understanding of the system – including developing a whole of system understanding of the role of catchment vs local scale flood mitigation, improved governance and legislation around flood mitigation and maintenance and building robustness of community resilience and communication networks.
- Better understanding the role of nature-based solutions for flood management - this includes evaluating the effectiveness of nature-based solutions at the whole of catchment scale and fundamental research into the role of vegetation in flood mitigation and resilience.
- Evaluate the economic resilience and strategic direction for the region – focusing on developing a long term strategy for the region including identifying critical infrastructure needed for economic sustainability.

Finally, eight key opportunities were proposed, including:

Key Opportunity 1 – Develop the emerging themes into detailed project scopes suitable for inclusion in this funding round or future funding.

Key Opportunity 2 – Consideration be given to allocation of funding according to proportion of population in the flood footprint. This would help to ensure that those likely to have been impacted from the February/March 2022 event, wherever that occurred (urban or rural) receive relatively equitable access to funding.

Key Opportunity 3 – Development of a comprehensive flood gauging, information and communication network that centralises information and makes it readily accessible to all stakeholders.

Key Opportunity 4 – Caution must be exercised when considering the implementation of any large-scale infrastructure projects until a whole-of-catchment assessment is undertaken to ensure that they will provide an overall net benefit to the region.

Key Opportunity 5 – Further consideration of the needs of rural landholders and the role of infrastructure in rural areas is needed in flood mitigation.

Key Opportunity 6 – As a matter of urgency, funding of maintenance of flood management and mitigation structures/infrastructure needs to be significantly improved

Key Opportunity 7 – Projects identified for funding will likely need further detailed scoping and design. It is likely that this will change costs and priorities. Care needs to be taken around the allocation of funds to ensure that flexibility is provided where these costs may vary.

Key Opportunity 8 – Economic resilience needs to be considered for regional centres and the entire Northern Rivers region to identify critical infrastructure and services that are essential for flood resilience and recovery.

1 Introduction

The National Emergency Management Agency (NEMA) engaged CSIRO to deliver the Northern Rivers Resilience Initiative (NRRI). The NRRI project was funded in July 2022 following extensive and devastating floods in northern NSW in February and March of 2022. The project considers the climate, catchment and hydrological systems, and broader influences of land-use practice and infrastructure, to generate opportunities for mitigating flood risk, to build a more resilient region.

Part 1 of the project was a rapid review and assessment of flood mitigation options during the first six months of the project. As part of this, previous studies have been reviewed to identify flood mitigation options across the Northern Rivers region (Figure 1). Each of the seven flood-affected Local Government Areas in the region – Ballina, Byron, Clarence Valley, Kyogle, Lismore, Richmond Valley and Tweed – were consulted to identify and prioritise effective intervention options. The outcome of this work (this report) is to inform investment in the Northern Rivers region in 2022–23, to support recovery and resilience efforts. This work was undertaken by CSIRO and Alluvium Consulting Australia.

Figure 1. Northern Rivers region (source: CSIRO 2022).

Part 2 of the project will follow after this initial assessment and involve detailed modelling over the next two years of the project. This program of work will collate and generate high quality Light Detection and Ranging (LiDAR) data to provide spatial analysis and to underpin hydrological/ hydrodynamic modelling of water movement for the Northern Rivers region. It will also collect detailed bathymetry for the Richmond and Tweed rivers. Detailed hydrological and hydrodynamic models will be developed and implemented for the entire Richmond River Catchment to investigate scenarios and actions to mitigate flood risk in the Richmond River catchment. It will involve examining and evaluating possible events or scenarios that could take place in the future

and predict possible outcomes, drawing on local knowledge and expertise on the catchment and flooding. This area has been identified as a priority due to the extent of the impact of recent floods on this area and the likely impact of climate changes in the future.

This report covers the body of work being undertaken by CSIRO and Alluvium to implement a rapid project prioritisation process that can assist in identifying suitable projects that may be funded through the Emergency Response Fund.

The Emergency Response Fund Act allows the Australian Government to draw up to $200 million in any given year, beyond what is already available to fund emergency response and natural disaster recovery and preparedness.

The Act allows the Government to draw up to:

- $50 million each financial year to build resilience, to prepare for or reduce the risk of future natural disasters.
- $150 million each financial year to fund recovery and post-disaster resilience in accordance with the Emergency Response Fund Act following a natural disaster that has a significant or catastrophic impact.

This project therefore seeks to determine, in partnership with local and state agencies, and the community, projects that may be most suitable to address the key needs of the community in post flood recovery and future flood resilience.

This report outlines the process undertaken and the results of analysis and provides rankings of projects that may be considered for funding, such that NEMA can present this to decision makers to assist in the final funding decisions.

It should be noted that the findings presented in this report are based on our analysis and from what we have heard from all stakeholders consulted. They represent our best understanding of what may be required, but we also note that such funding decisions may have other constraints of which we will not be aware. For those reasons, the projects put forward here should be seen as recommendations only, and not definitive about what will be funded.

2 Project Background

This overview provides a brief contextual analysis for the project and identifies the key areas on which the project will focus. In addition to this, CSIRO have prepared a detailed catchment and climate assessment of the February/March 2022 event available at Lerat et al., 2022.

2.1 February/March Flood Extent and Context

2.1.1 Region Wide

In this report, the February/March flood refers to the event that started on the 22nd February and ended on the 15th March 2022. These dates are arbitrary and are defined based on analysis by Lerat et al. (2022) of when rainfall, water level and streamflow data remained above average values. There was a second major flood that occurred in late March, but the February/March flood event will be the focus of this brief contextual summary.

The onset of the February/March flood was driven by a chain of weather events. Firstly, there was an East Coast Low (ECL) that developed off the south coast of Queensland on 23rd February. The development of ECLs is not uncommon at that time of year, however two additional factors resulted in a significant increase in both the intensity and duration of its associated rainfall (JBA Risk Management, 2022).

The first factor was an area of high pressure that simultaneously formed over New Zealand, which blocked the normal progression of the ECL from west to east. The ECL became stuck over the Australian mainland, resulting in the extended duration of torrential rainfall.

The other factor was the formation of a secondary area of low pressure high above the surface over western Queensland, which had developed from a pocket of cold air moving northwards from the South Pole. By 25th February, this 'upper low' had drifted above the ECL, intensifying the surface-level disturbance and leading to the formation of a 'rain bomb'. This additional factor exacerbated the ongoing floods.

Over February and March, the Tweed, Brunswick, Richmond and Wilsons river catchments recorded seven-day average rainfalls that were 37-61% higher than previous records (Bureau of Meteorology, 2022). During the first event, rainfall totals were the highest daily rainfall on record for many parts of the Richmond, Tweed and Brunswick basins (Lerat et al., 2022). The rainfall followed a summer of higher-than-average rainfall driven by the La Niña phenomenon, with rainfall totals 200-400% higher than average in the two months leading up to the first event (Fuller and O'Kane, 2022). Figure 2 and Figure 3 highlight the consistency of high total rainfall across the region in February and depict how high above the averages these totals were. These antecedent conditions meant catchments were saturated, which contributed to the extreme volumes of runoff and flow rates seen throughout the region during the event.

Submissions to the 2022 Flood Inquiry indicated that residents were, for the most part, unprepared for the extreme intensity and duration of the rain events (Fuller and O'Kane, 2022). It was reported that official warnings failed to indicate the potential scale of event. People who were accustomed to flooding, based their response to the flood warnings on prior experiences, moving vehicles to land that had always been above flood levels or moving possessions upstairs, for example. Many homes and businesses sold in 'flood-free' locations, or that had never previously been flood-impacted, were completely inundated. The overall unpreparedness of the region, especially the inability to evacuate, added to the collective trauma experienced.

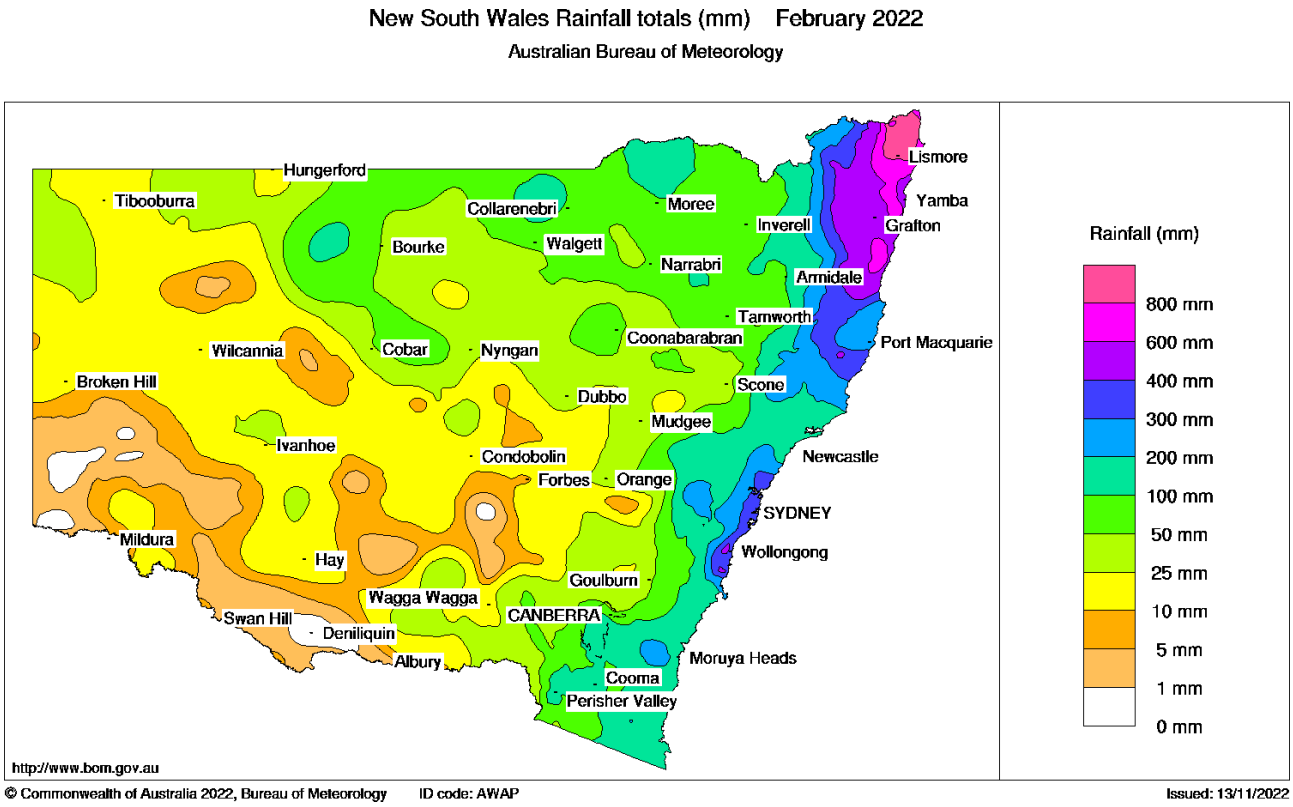


Figure 2. Rainfall totals for February 2022 over NSW (source: BoM 2022)

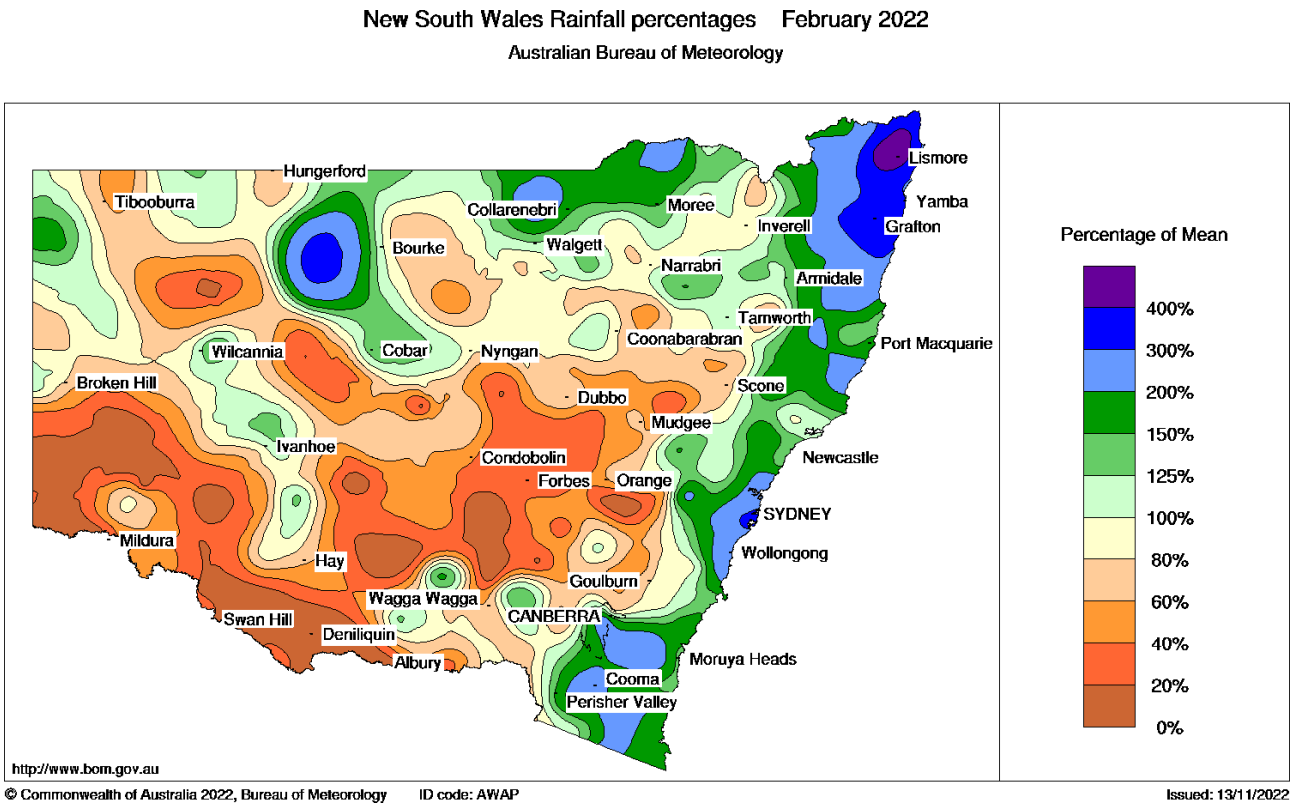


Figure 3. Rainfall percentages for February 2022 across NSW (source: BoM 2022)

2.1.2 Tweed River

The Tweed River experienced major flooding over February and March 2022, inundating properties throughout the catchment. River level gauges along the Tweed River recorded peak levels at Chinderah, Tumbulgum and North Murwillumbah of 2.98 m, 4.77 m and 6.51 m, respectively (WaterNSW, 2022), classifying as major flood events by a large margin.

The upper Tweed catchment was heavily impacted by landslips, which caused mass damage to road infrastructure (an estimated $80 million of repairs) and communication infrastructure (NSW Parliament, 2022). The ongoing lack of access and communication has affected residents long after the flood waters receded.

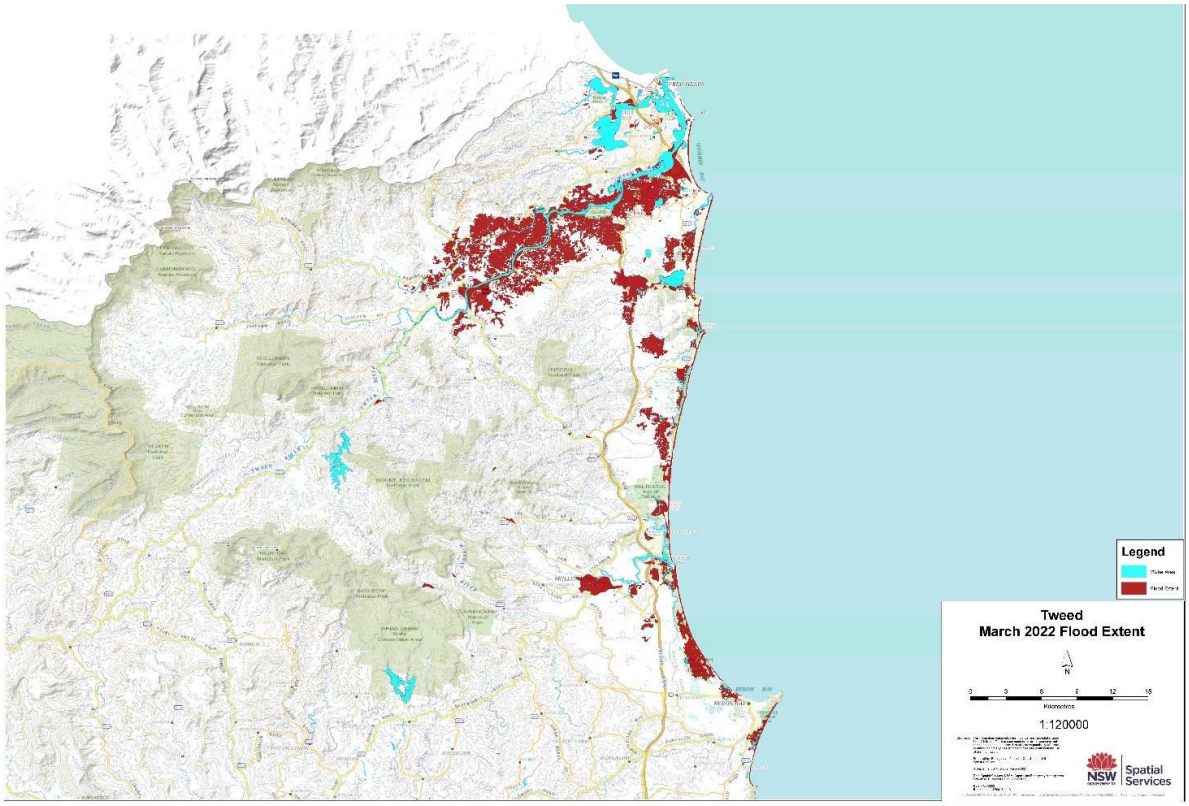


Figure 4. Tweed River region March 2022 flood inundation areas (source: NSW Spatial Services 2022)

2.1.3 Clarence River

While the magnitude of the flood event experienced across the Clarence Valley was lower than elsewhere in the Northern Rivers region, significant flooding still occurred.

The levees in Grafton and Maclean did not overtop. In Grafton, the peak river height reached 7.67m (0.13m below overtopping height) and in Maclean, the peak river height of 3.37m (0.07m above overtopping height) did not overtop the town levee thanks to emergency sandbagging by community members along the length of the levee. The levee in Ulmarra overtopped the 5.9m levee, reaching a peak level of 6.03m.

While the major towns in the Clarence Valley largely avoided the scale of flooding seen elsewhere in the Northern Rivers region, significant widespread inundation particularly affected agricultural landholders who experienced crop losses.

Several towns including Yamba, Iluka and Wooli, were cut off for a number of days by floodwaters inundating access roads, which both delayed flood recovery activities and caused issues for obtaining food and medical supplies.

Peak river levels unfolded down the river system as follows (WaterNSW, 2022):

- Tabulam: 10.60 mAHD at 7:30 pm on the 28th February
- Grafton: 7.67 mAHD at 10:30 pm on the 28th of February 2022. Levee overtops at 7.8 m in North Grafton and 8.05 m in South Grafton.
- Ulmarra: 6.03 mAHD at 7:30 am on the 1st of March 2022. Levee overtops at 5.9 m
- Maclean: 3.37 mAHD at 10:45 pm on the 1st of March 2022. Levee overtops at 3.60 m
- Yamba: 1.60 mAHD at 7:30 pm on the 1st of March 2022

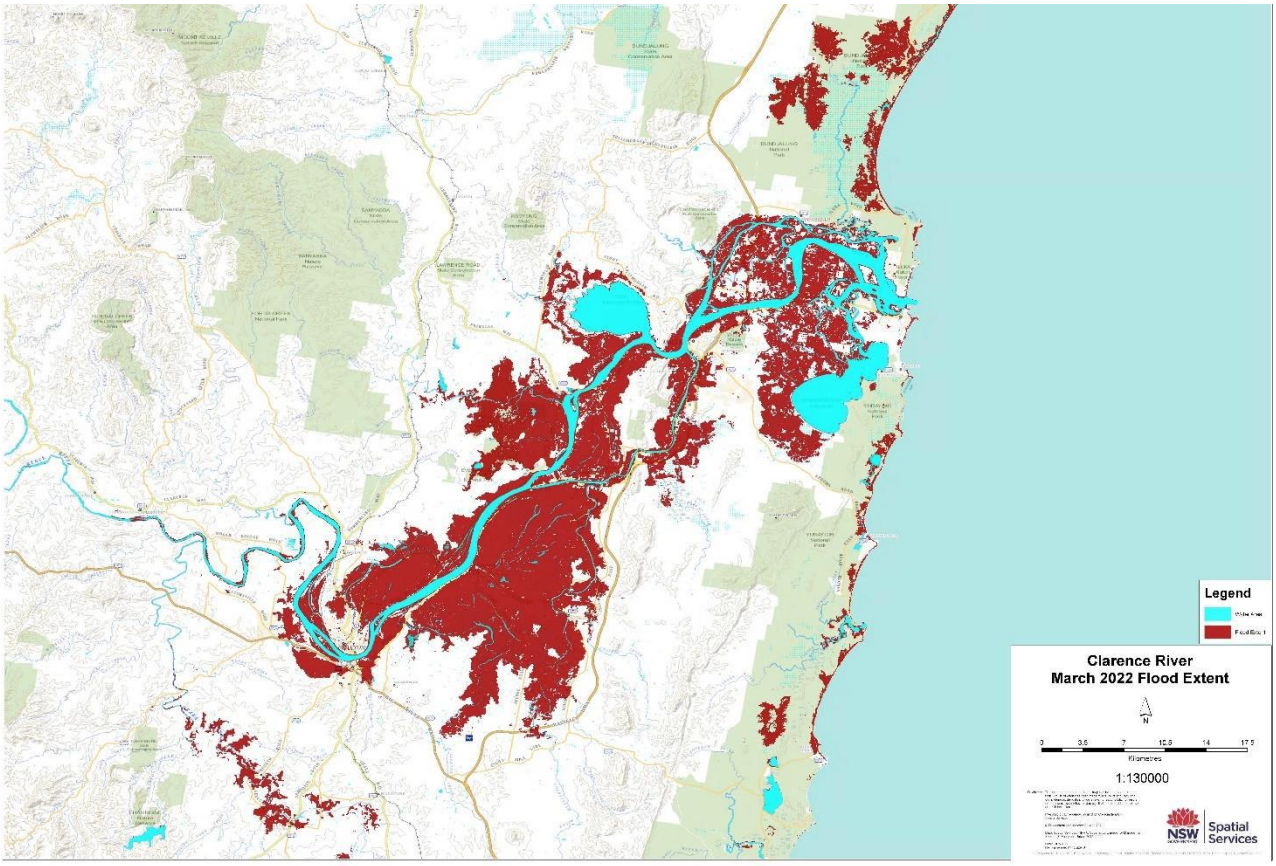


Figure 5. Clarence River region March 2022 flood inundation areas (source: NSW Spatial Services 2022)

2.1.4 Richmond River and Wilsons River

Flooding in the Wilsons and Richmond Rivers reached heights exceeding any previously recorded flood levels. In Lismore, the Wilsons River reached 14.37 m on 28/2/2022, which is more than 2 m higher than the flood heights recorded in the 1974 and 1954 floods (Visual Story, 2022). Notably, the February flood peak was far greater than the modelled 1% AEP flood level of 12.38 m. The Lismore CBD levee system was breached during both the 28th February peak and subsequent 30th March peak of 11.4 m.

The additional 2m of floodwater depth at the Lismore gauge meant there was approximately 4,000 evacuees instead of 500 ("Resilience NSW missing in action during Lismore floods says Local MP", 2022). Major roads connecting Lismore were cut off including the Bruxner Highway, Ballina Road and Dawson Street (Visual Story, 2022).

Casino: Flooding was observed in the Casino CBD on the 1st of March with 330 homes also inundated (Saunders and Rubbo, 2022).

Bungawalbin: A major catchment, whose contribution to downstream flooding is often forgotten, had extensive flooding across the rural floodplains.

Coraki: Coraki is situated at the confluence of the Richmond and Wilsons River and was very heavily impacted. Flooding in Coraki led to the town being cut off for five days with the Army only able to gain access on Sunday the 6th of March 2022.

Woodburn: Heavily impacted with some residents trapped on the bridge over the Richmond River.

Broadwater: Not a formal forecasting location with no designated flood warning gauges. No warnings received.

Wardell: Access to Wardell was cut off during the flood event with many residents not able to evacuate.

Ballina: Ballina was isolated for three to four days which affected the ability of support services to access the region. Over 700 properties were impacted and 250 people accessed evacuation centres in Ballina. Cabbage Tree Island was severely impacted with 26 of the 27 homes and school destroyed beyond repair (NSW Parliament, 2022).

River Gauge Peak levels down the Richmond River unfolded as follows (WaterNSW, 2022):

- Wiangaree: 16.68 m at 12:30 am on the 28th of February
- Kyogle: 17.86 m at 12:45 am on the 28th of February
- Casino: 16.49 m at 7:30 pm on the 28th of February
- Coraki: 6.65 m at 1:00 am on the 1st of March
- Woodburn: 7.17 m at 10:45 pm on the 1st of March
- Wardell: 3.75 m at 7:45 am on the 2nd of March
- Ballina (Breakwall): 1.4 m at 7:15 am on the 1st of March

River Gauge peak levels in the Wilsons River and tributaries were as follows (WaterNSW, 2022):

- Nimbin: 9.34 m at 4:45 am on the 28th of February
- Eltham: 10.54 m at 3:30 am on the 28th of February
- Lismore (Dawson Street): 14.79 m at 11:48 am on the 28th of February

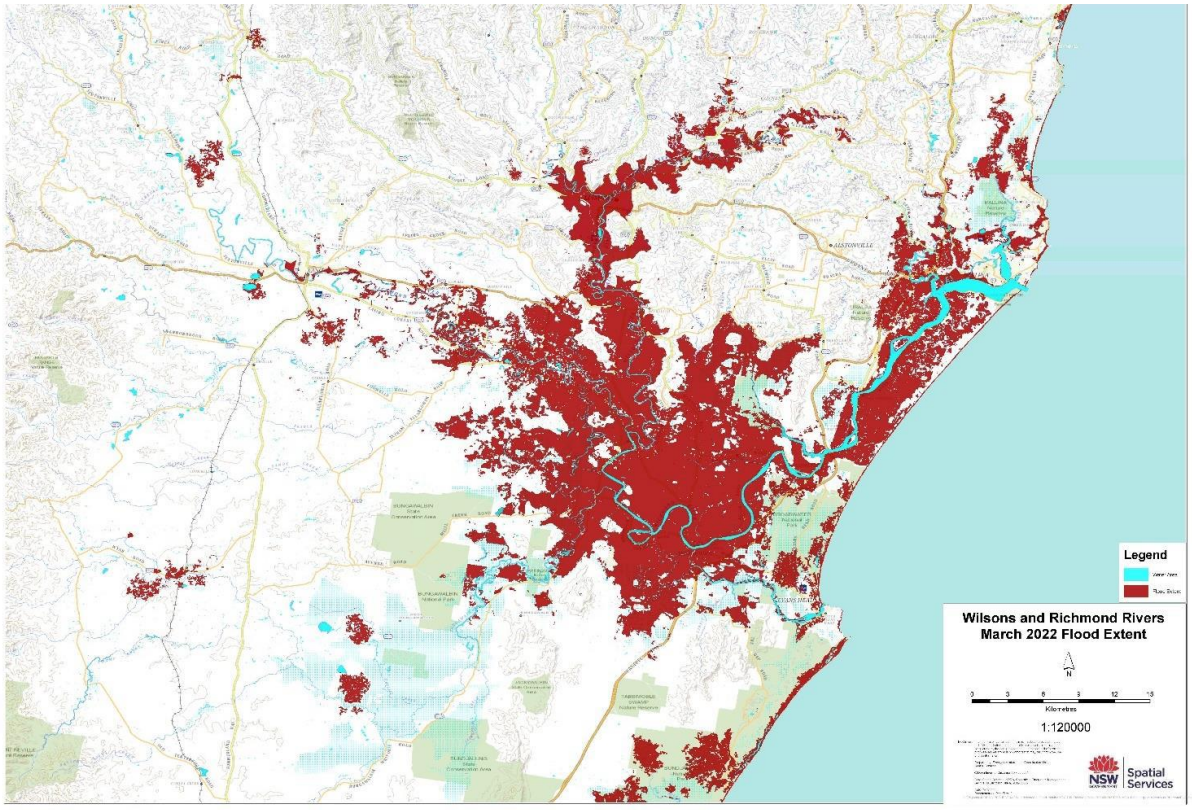


Figure 6. Wilsons and Richmond River region March 2022 flood inundation areas (source: NSW Spatial Services 2022)

Figure 7 below represents the relationship between daily catchment rainfall in the Richmond Valley and river level response at Bungawalbin Junction gauge.

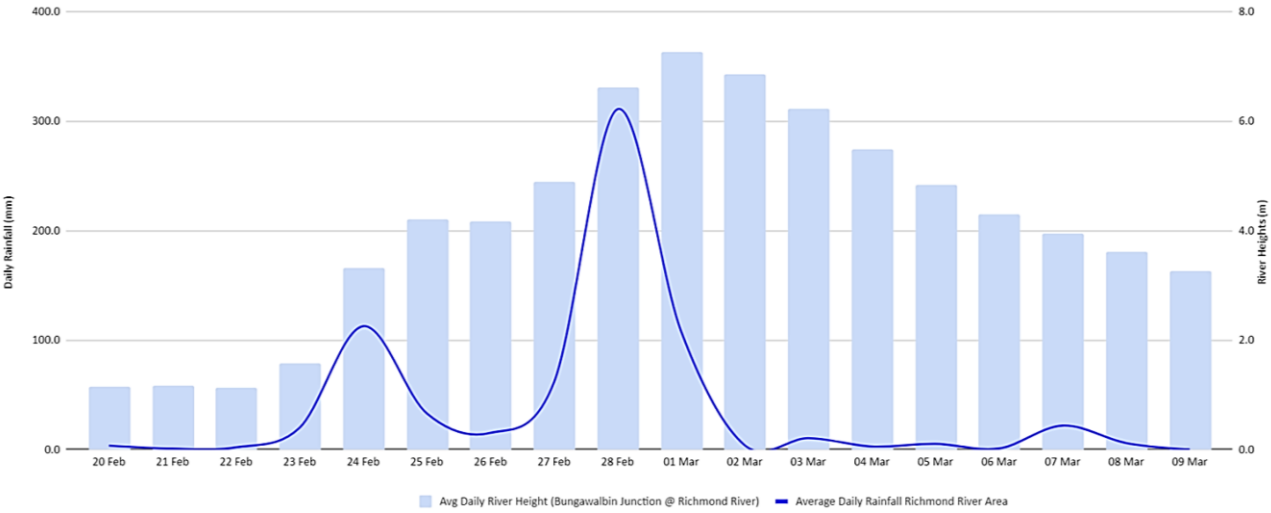


Figure 7. Water levels and Rainfall for the Richmond River at Bungawalbin Junction March 2022 (source: League of Scholars, 2022)

2.1.5 Byron Bay Region

The Byron Local Government Area (LGA) experienced flash flooding through the coastal creeks in the north of the LGA as well as significant riverine flooding and landslips which continued after the flooding had subsided.

Within the LGA, approximately 1600 properties were inundated with hundreds of additional properties within the flood extent but positioned above the peak flood level (NSW Parliament, 2022).

The hinterland areas around Byron experienced a significant number of landslips which were driven in part by the volume of rain falling on these areas. Landslips resulted in the isolation of 192 properties and the key public and private access routes being cut hampered the ability for some in the area to recover from the event (NSW Parliament, 2022).

Byron Bay experienced additional flooding in late March with a number of businesses inundated in central Byron Bay – areas largely not impacted in the previous February/March flood.

Mullumbimby experienced significant flooding. The impacts were exacerbated by a lack of telecommunications service preventing some flood warnings from being issued. Damage was seen in the CBD and in a number of residential areas and also impacted the town water supply. A similar situation was observed at South Golden Beach, Ocean Shores and New Brighton where the smaller local catchments runoff response to rainfall was much faster than the large river systems in the region (Fuller and O'Kane, 2022).

3 Scope

The scope of this rapid prioritisation project (Part 1 of the overall project) was to develop a list of suitable flood resilience projects, develop a method of assessing those projects and to consult widely with the community, local and state governments and other interested stakeholders to understand the key issues that the funded projects should address.

This scope was developed collaboratively with CSIRO to ensure that it would provide the necessary outcomes to NEMA upon completion.

The activities undertaken are presented in Table 1 below.

Table 1. Scope of project

Task	Description	Elements
1.	Review existing materials	❖ Preliminary project identification (existing studies and proposals) ❖ Circulate to project staff and NEMA
2.	Stakeholder engagement planning	❖ Understand and document the "why" ➢ engagement objectives and outcomes ➢ what success looks like ❖ Define engagement principles ❖ Conduct stakeholder analysis ➢ Identify stakeholders (primary and secondary audiences) ➢ Develop stakeholder governance arrangements ❖ Define key communication messages ❖ Establish community and project team support approaches ❖ Develop comms and engagement strategies ➢ Branding, platform, materials ➢ Targeted briefings (agency focus) ➢ Workshops/forums (community focus) ➢ Individual discussions ➢ Social media approaches ➢ Define approvals processes and seek approval for implementation
3.	Develop initial assessment criteria	❖ Define initial list ready for consultation ❖ Where possible, scope out project details (extent, likely effectiveness, capex and opex requirements)
4.	Refine project list and priorities	❖ From identified projects, conduct further scoping to establish project details and data inputs for the multi-criteria assessment (MCA) ❖ Prepare a revised list for circulation to stakeholders prior to MCA
5.	Undertake economic assessment	❖ Establish assessment criteria ❖ Evaluate project outcomes
6.	Develop MCA Approach	❖ Refine criteria identified through Task 4 (e.g. flood protection, social, financial, feasibility, resilience, mitigation, environmental) ❖ Define scoring methods ❖ Outline weightings from consultation outputs ❖ Prepare likely scenarios (e.g. recovery, resilience, mitigation, adaptation, focused, broad scale) ❖ Undertake MCA ❖ Prepare draft prioritised projects/options list

Task	Description	Elements
7.	Conduct stakeholder engagement	❖ 8 targeted briefings with Councils, 15 public forums/workshops ❖ Document: ➢ Project ideas ➢ Priorities ➢ Assessment criteria ➢ Weightings ➢ Scenarios
8.	Develop options/MCA assessment report	❖ Project report ❖ Covers scope, briefly describes council and public consultations, methodology, MCA criteria and justification, analysis ❖ Final prioritised project list

The overall outcome of the project was to develop a prioritised list of proposals for possible funding under the Emergency Response Fund allocation. This report summarises all the activities relevant to achieving the overall outcome.

4 Review of Existing Studies

4.1 Information Assessed

A range of sources were provided by local and state government agencies, but also through information sourced by the project team or that we were made aware of during consultation activities. In terms of initial documents, the following sources were reviewed.

Table 2. Information sources

Local Government Area	Source Study
Byron Shire	North Byron Floodplain Risk Management Study (WMAwater 2020)
Byron Shire	Belongil Ck Floodplain Risk Management Study & Plan (BMT WBM 2015)
Byron Shire	Tallow Creek Floodplain Risk Management Study and Plan (SKM 2009)
Tweed Shire	Tweed Coastal Creeks Floodplain Risk Management Plan (BMT WBM 2015)
Tweed Shire	Tweed Valley Floodplain Risk Management Plan (BMT WBM 2014)
Tweed Shire	South Murwillumbah Floodplain Risk Management Study & Plan (CSS 2019)
Tweed Shire	Murwillumbah Levee & Drainage Study (CSS 2018)
Kyogle	Tabulam Floodplain Risk Management Plan (Jacobs 2019)
Kyogle	Kyogle Floodplain Risk Management Plan (BMT WBM 2009)
Kyogle	Bonalbo Flood Study (BG&E 2021)
Lismore	Lismore Floodplain Risk Management Study (Engeny 2020)
Lismore	Rous County Council Flood Mitigation Projects 2022
Lismore	Notes from discussions with Rous County Council staff 2022
Ballina Shire	Wardell Floodplain Risk Management Plan (Worley Parsons 2009
Ballina Shire	Ballina Floodplain Risk Management Plan (BMT 2015)
Ballina Shire	Ross Lane Upgrade Options Assessment (BMT 2021)
Ballina Shire	Cumbalum Area Flood study (WMAwater 2022)
Ballina Shire	Notes from discussions with Council staff regarding 2022 flood event
Ballina Shire	Rous County Council Flood Mitigation Projects 2022
Ballina Shire	Ballina Island and West Ballina Floodplain Risk Management Study and Plan DRAFT (GHD 2021)
Richmond Valley	Notes from discussions with Rous County Council staff 2022
Richmond Valley	Casino Floodplain Risk Management Plan (WBM Oceanics 2002)
Richmond Valley	Mid-Richmond Floodplain Risk Management Plan (WBM Oceanics 2002)
Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan (Bewsher Consulting 2007)
Clarence Valley	Wooli River Floodplain Risk Management Plan (Patterson Britton & Partners 1999)
Clarence Valley	Yamba Floodplain Risk Management Plan (Webb McKeown & Associates 2009)
Clarence Valley	Alipou Creek Floodplain Risk Management Plan (Webb McKeown & Associates 2006)
Clarence Valley	Iluka Floodplain Risk Management Plan (Webb McKeown & Associates 2007)
Clarence Valley	Glenreagh Floodplain Risk Plan (GHD 2018)
Clarence Valley	Assessment Report North St Pump Station (SMEC) / Notes from discussions with Council staff 2022
Clarence Valley	Council's floodplain prioritisation list (as adopted) 2020

In addition to these, 59 formal submissions and proposals were received from the community engagement process in addition to hundreds of project ideas and suggestions. Of these public submissions, 9 had sufficient information to be added to our projects list and fully assessed in the MCA.

4.2 Project Identification

In total, more than 330 projects were identified through this process and information gathered on each to determine the following characteristics of the project:

- Basin – high-level physical area that the project sits within (Tweed, Richmond, Brunswick or Clarence)
- Watercourses – watercourse along which the project is located or that the project may impact (positively or negatively)
- Option – project name
- Option description – brief description of the project details
- Cost – cost of the project, both at the time it was originally costed and converted to 2022-equivalent $AUD
- Year of identification – year the project was suggested (e.g. published in a FRMP)
- Option type – classifies the project as a Flood modification measure, Property modification measure or Response modification measure (see below)
- Priority within the report – original priority within the report it was published (if applicable)
- Funding – potential alternative sources of funding (e.g. a specific grant application had been submitted)
- Council's recommendations – feedback and recommendations from council received through the engagement process

From this list, further analysis was undertaken to determine each project's likely eligibility for funding through the NRRI based on funding principles provided by NEMA and advice received by local and state agencies regarding other funding potentially available for particular project types, with a final list of 62 projects shortlisted for prioritisation (as outlined in Appendix B). For example, during the finalisation of our project list, funding was announced for house buy-backs across LGAs in the Northern Rivers region, so options relating to Voluntary House Purchase were no longer considered eligible. We were also made aware of funding available for levee repairs through NSW Public Works as per the statement below:

The Flood Levee Repair and Maintenance Program funding will be aimed on the three following focus areas:

1. *Repair / Maintenance*
    - *Covering works not funded by the Natural Disaster Relief and Recovery Arrangements (NDRRA)*
2. *Betterment*
    - *Improvement and/upgrades to existing infrastructure*
3. *New Levees*
    - *New Levees identified in existing floodplain risk management strategies*

Whilst we have made every attempt to clarify potential funding sources, considerable funding from a range of sources is likely to be available in the region and it was difficult to be definitive as to whether a project may have potential to be funded from those other sources already. Council staff provided further input into this process and also identified that co-funding may be beneficial where funds from one source may provide leverage for other funding or assist Councils in provision of required funds through arrangements such as 2:2:1 (Fed:State:Local) type funding.

The projects identified were classified according to whether they were:

- **Flood modification projects** such as levees, reconfiguration of the landscape (reshaping, moving barriers etc), floodway channels, detention basins, floodgates and similar
- **Property modifications** such as house raising, house purchase, flood proofing, and land use planning
- **Response modifications** including technical studies, flood warnings, awareness and education and similar

A full list of the types of projects identified are shown in Table 3.

Table 3. Option types

OPTION TYPE Flood Modification	OPTION TYPE Property Modification	OPTION TYPE Response Modification
Floodways	House Raising	Technical Study
Levees	House Purchase	Flood prediction and warning
Floodgates	Land use planning / zoning	Other non-infrastructure
Detention Basins	Flood proofing / building control	Flood access and evacuation
Temporary Flood Barriers	House relocation	Flood-awareness, education and readiness
Landscape Management	Evacuation Route Raising	Emergency response
Other Infrastructure		

These option types are further described in Section 4.2.1.

4.2.1 Option type - Flood modification measures

Floodways

These are dedicated channels, usually manmade or enhanced natural channels, that direct floodwaters in a different direction or to a different location than that which would occur naturally. Tuckombil Canal near Woodburn NSW is an example of a floodway where it directs water from the Richmond River into the Evans River during significant flood events (Figure 8).

Figure 8. Tuckombil Canal (source: T Weber)

Levees

Levees are typically constructed to protect high value areas of property or the landscape such that lower lying areas protected by the levees are prevented from flooding up to the events that the levees have been designed for. They are also often supported by pumping systems to ensure that runoff that collects behind the levee in the protected zone also does not cause inundation. In the Northern Rivers region, many of the larger regional centres and some rural areas have levee systems (Figure 9). During the extreme flooding of February/March 2022, many of these were overtopped and/or damaged.

Figure 9. Part of the South Grafton levee system (source: T Weber)

Floodgates

Floodgates are typically installed on drainage channels in lower lying areas to prevent tidal and flood waters moving up into these areas. In the Northern Rivers region, many of the rural areas in the lower floodplain have floodgates that protect agricultural areas, especially sugarcane farms, from estuarine waters but also help to remove water from areas post flood when water levels in the rivers drop sufficiently.

Detention Basins

These systems are designed to capture and store part of the flood runoff for release more slowly after the main flood peak has passed. They can range in size from several hundred square metres to several hectares in size. Their use needs to be carefully planned, as the outflows from a network of detention basins can either prolong inundation or result in flood impacts downstream.

Temporary Flood Barriers

Temporary systems are used in areas where flooding may be infrequent but relatively minor, or well understood. A number of systems exist such as inflatable weirs and barriers, temporary levees and sand bagging. These can also include property scale slot-in gates which can be quickly setup in advance of an event.

Landscape Management

Landscape management options considered cover a wide range of measures which aim to increase flood conveyance and storage in key areas where it may be constrained by natural or built features. Over the history of the study area measures like dredging had historically been widely adopted.

Other Infrastructure

From the options considered, the other infrastructure category has primarily captured pump augmentation projects and upgrades to town drains. Where pump projects have been suggested they have typically been to increase the reliability of systems, increase the capacity of the system (trigger levels and maximum flow rate) and in general to reduce the time taken to drain flooded areas.

4.2.2 Option type – Property modification measures

House Raising

For some types of properties, the habitable flood level can be raised to reduce the frequency of above floor flooding. This reduction in risk brings a reduction in the expected damage and losses from flooding.

House raising is most appropriate and is best suited to timber framed houses, typically ‘Queenslander’ style buildings which are already elevated to some extent. Raising of other house types may be cost prohibitive.

House Purchase

House purchasing schemes aim to buy properties which are most at risk of flooding in order to reduce the expected flood damages over time. This approach should be targeted to purchase and remove buildings from key flow paths or floodways, enable the construction of structural flood mitigation measures or to remove properties from areas where the risk to life of occupants or rescuers is elevated.

Land use planning / zoning

Where flood risk in unacceptably high and cannot be managed with mitigation works, re-zoning may help reduce flood risk and associated costs by reducing the development potential of flood liable land.

Flood proofing / building control

This involves the retrofitting of existing structures with flood resistant materials and building approaches with the aim of reducing the cost of damages and aid in the recovery speed and cost post-event.

House relocation

This approach could take a number of forms however typically involves physical relocation of a house to a plot of land with a lower risk of flooding. Typically the building types where this approach can be applied are similar to house raising with timber framed 'Queenslander' style properties bring common. House relocations typically come at a greater cost than house raising but may realise a much larger reduction in flood risk and expected damages.

4.2.3 Option type – Response modification measures

Technical Study

Technical studies have been included on the project list where the specific study provides a base of evidence to enable decisions to be made. These studies will often refine previously assessed options or fill gaps in previous assessments to allow for cost-benefit and other metrics to be assessed.

Flood prediction and warning

Providing robust flood prediction and warning services are critical to giving communities the maximum amount of time to respond to an incoming flood event. In some areas, existing gauge infrastructure was damaged by the 2022 flood event and other floods in the recent past. As well as gauge infrastructure, the quality of flood warnings are also dependant on gauge ratings and any relationships which describe the passage of the flood through the systems.

Other non-infrastructure

This category captured some options which proposed the formation of committees which contribute to a number of the option types considered in this study. Also included here were some policy recommendations for councils in relation to climate change adaptation.

Flood access and evacuation

Options here focussed on evacuation planning not just for people but also for stock. Options also considered evacuation route raising aiming to provide a community with increased access out of flood impacted areas in the time leading up to a flood event. Route raising will be above a defined level of flood risk and is typically constrained by the waterway crossings on the existing evacuation route. While primarily providing access with higher flood immunity, evacuation routes play a key role in the post-event flood recovery works which often require vehicles and labour from outside the impacted towns.

The raising of evacuation routes will often have a detrimental impact of the flood levels and extents upstream of the raised route. The flood impacts of raised routes should be balanced against the benefits they bring.

Flood-awareness, education and readiness

Flood education and awareness campaigns have a significant role to play in educating the community about the risks flooding poses to their communities as well as what to do in the event of a flood. This is particularly important in the growing coastal communities with significant numbers of new residents from outside the area for whom an understanding of the underlying risk may be missing.

Flood-readiness programs will also assist in the management and maintenance of private property and infrastructure which may impact the passage of a flood (bunds on private land, bails/water tanks and other property which can block waterways).

Emergency response

Emergency response options aim to improve community access to key services and information during and after the flood event. This may include access to evacuation centres, medical care, fuel, food and communications.

5 Engagement

5.1 Approach

To ensure relevant potential projects were identified and prioritised correctly in the MCA, stakeholder engagement was undertaken with the main aim of validating the MCA results and achieving stakeholder buy-in and endorsement. This allowed stakeholders to see how option recommendations were formulated and prioritised and express their views on the relative importance of criteria and objectives, in addition to providing project ideas and formal project submissions. This approach enabled stakeholder participation in decision-making that is not possible in pure quantitative analysis without stakeholder engagement.

The engagement approach was designed to be consistent with research ethics requirements and formal ethics approval was sought and obtained for the project. This included ensuring all participants registered and were provided with details of the study and how their information would be used and stored.

In addition to broader community involvement through a series of drop-in sessions for registered participants, key stakeholder groups were also invited to participate in these consultation activities where we had identified them through the stakeholder engagement planning process. Council staff and community members from the seven LGAs and Rous County Council that are responsible for, or impacted by, flooding in the study area were the primary direct and indirect mechanism for engagement activities, which included:

1. Council meetings - targeted meetings were held with key council staff (technical and managerial) from the seven LGAs in the study area and from Rous County Council. These meetings were used to review the overall project list for the LGA, the sources of information used, the NRRI MCA analysis and draft ranking of flood mitigation projects. In addition, a meeting with NSW State Government Agencies was held online to brief them on progress with prioritisation.
2. Meetings with people from key stakeholder groups and the broader community - briefing sessions were held with registered participants including members of the public, organised community groups and traditional owners. A series of social media and email posts raised awareness of these sessions and each were held in local venues (nominally two per local government area) selected by the project team in consultation with the LGA and NEMA.

Stakeholder groups were identified through a regional stakeholder mapping exercise, reviewed by relevant staff from NEMA, Local and State agencies and other engagement practitioners. LGA staff and regional NEMA officers reviewed the stakeholder mapping undertaken by NRRI project team to identify any missing stakeholders.

The briefing sessions with stakeholders provided an overview of the project, the objectives and outputs of Part 1, an overview of the assessment criteria for the MCA, the list of projects identified through the review step relevant to that LGA, and the subset of projects identified.

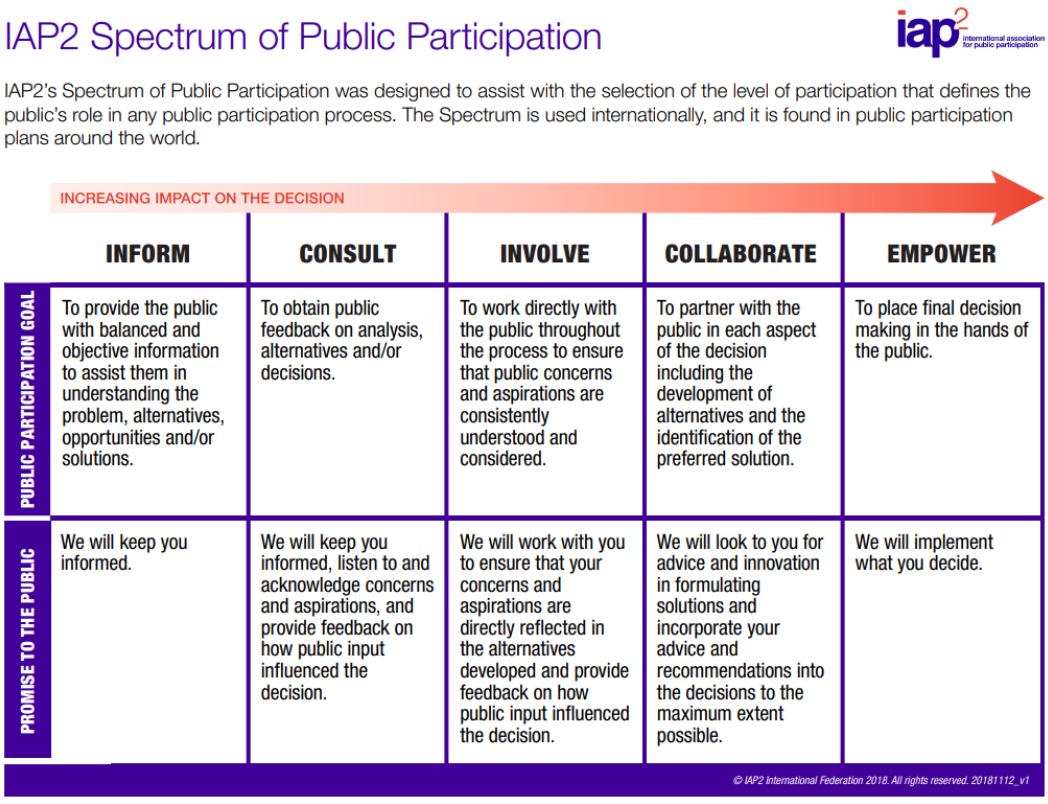
Discussion with the key stakeholder groups were facilitated by the project team and focused on (1) feedback on the criteria for assessment (what is missing, what is more/less important), (2) if there are projects missing from the list, and (3) is the information associated with projects represented correctly.

The high-level objective for communication and engagement for Phase 1 Rapid review and assessment, was to:

- Empower key stakeholders and the local community to contribute to identifying and prioritising on-ground initiatives to support flood recovery efforts and build resilience to future flood related natural disasters and extreme events.

5.2 Method of delivery

The method of delivery aimed to demonstrate a transparent and consistent approach in relation to stakeholder communication and engagement and have been developed using the principles of the International Association for Public Participation (IAP2) model and the IAP2 Guide to Engaging in Disaster Recovery, as well as principles identified by the project team for the purpose of this project.



IAP2 Spectrum of Public Participation

IAP2's Spectrum of Public Participation was designed to assist with the selection of the level of participation that defines the public's role in any public participation process. The Spectrum is used internationally, and it is found in public participation plans around the world.

INCREASING IMPACT ON THE DECISION

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

Figure 10. IAP2 spectrum of public participation (https://iap2.org.au/resources/spectrum/)

This specifically focused on being:

Appropriate

- Ensure all cultural protocols are strictly adhered to
- Build on known successful engagement approaches

- Use local and respected individuals to co-facilitate and host local engagement initiatives.

Collaborative

- Be active partners with stakeholders - engage early, listen and aim to have a comprehensive understanding of stakeholders needs and aspirations.

Purposeful

- Communicate the objectives of engagement clearly
- Seek to understand stakeholder participation objectives
- Commit to action to deliver on identified issues
- Maintain open dialogue.

Inclusive

- Engage early and ask stakeholders how they want to be engaged in order to achieve mutually beneficial outcomes
- Identify and enable the participation of all key stakeholders
- Provide feedback to stakeholders with information on the actions taken wherever possible.

Transparent

- Communicate in an open, honest, timely, and authentic manner that instils confidence and trust
- Ensure technical expertise is available to address questions or issues raised during engagement activities

Timely

- Provide sufficient time for meaningful consultation Communicate and adhere to time allocated for engagement and be efficient
- Implement efficiencies such as providing information prior to meetings where possible

Respectful and responsive

- Acknowledge, appreciate and respect the needs, experience, perspectives, values and expertise of the stakeholders
- Show how stakeholder input will be, or has been used
- Document outcomes, provide updates and close the loop by acting upon commitments
- Proactively seek information and input. Ask questions and respond through actions.

Consistent and coordinated

- Be consistent with messages when communicating to all stakeholders
- Ensure a coordinated engagement approach that builds on existing information and avoids repetitive information requests or unproductive engagement.

Clear, informed communication

- Communications are clear, concise, free of jargon and do not assume knowledge
- Communications are targeted to different demographics and stakeholder groups
- Engagement and communications informed by undertaking qualitative and quantitative research (where possible).

Build on previous experiences and lessons

- Understand what engagement and conversations have been had in relation to disaster recovery and building flood resilience.

Build on the inherent skills and knowledge (i.e. capacity) that already exists in the region and in relation to flood resilience.

Manage expectations

- Be mindful of over promising and raising expectations.

Have a holistic view of progress

- Ensure communication is put in context of other activities and/or phases of the project such that it is clear how smaller parts fit into the bigger picture.

5.3 Engagement Survey

In addition to the ability to meet and discuss the project aims, objectives, criteria and outcomes, a structured survey was designed to enable consistent input into the MCA criteria assessment process. The survey was developed to ask specific, multiple-choice questions for each criteria theme and individual criterion under each theme with the purpose of obtaining input into the weightings to be used for both the themes and criteria. The survey was also published online so that those unable to attend face to face sessions were still able to provide input.

Overall, 345 surveys were completed. The survey itself was completed by participants with initial guidance from engagement staff, though it was completed largely by attendees based on their own experience. We did find that the use of some of the terms in the MCA criteria were not well understood by some community members and assistance was provided to help them understand what was required for some questions, but overall, the survey results provides a useful guidance around what the criterion of highest importance were. It also provided us with important data around spatial variance across different local government areas and also the variance for individual criterion. This has been used in a sensitivity analysis to evaluate changes in ranking for projects based on upper and lower weightings which is detailed further below.

5.4 High level summary of stakeholders

Figure 11 below highlights the key stakeholder groups targeted through the consultation.

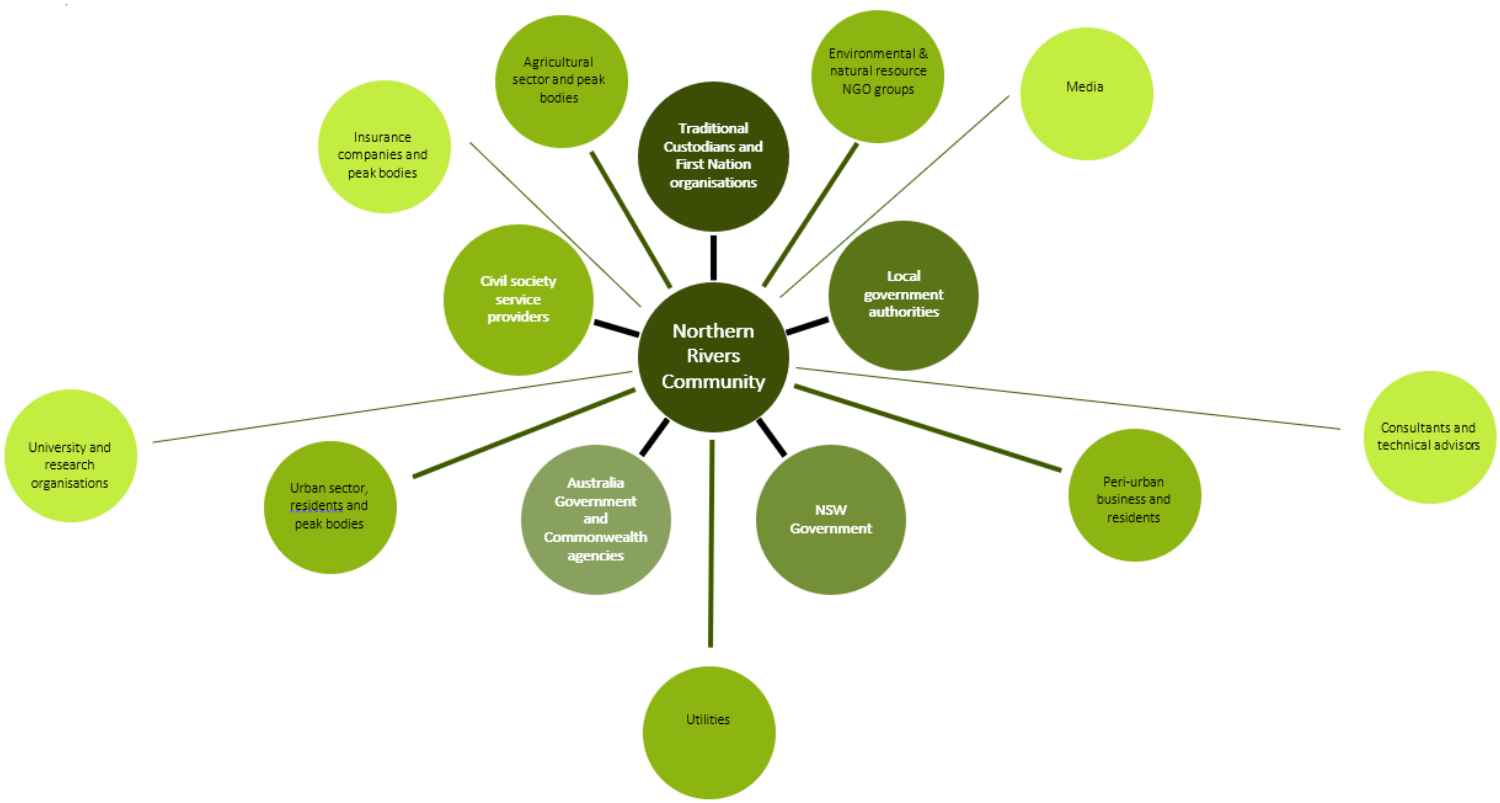


Figure 11. High level stakeholder analysis

These stakeholder groups were either specifically invited to community engagement sessions, or in the case of local government and state government agencies, specific information sessions were held both face to face (for local government) and online (state agencies). Some organised community groups also had detailed discussions with technical staff at specific sessions, usually associated with providing a formal submission to the NRRI project team.

We also provided separate invitations to traditional owner groups to meet with us and several groups did take up this opportunity, though we recognised that the informal “drop-in” sessions may not have been culturally appropriate in some circumstances. We had hoped to have direct meetings with specific traditional owner groups if this was required, but overall this offer was not taken up during the engagement period, possibly because of the limited time period that the engagement was undertaken.

5.5 Outcomes

5.5.1 Engagement activities

A total of 15 engagement sessions with the community were held over a three week period from 17 October to 3 November resulting in more than 400 attendees. Sessions were held at the locations outlined in Table 4 and shown on Figure 12. In addition to the community sessions (Figure 13), eight face to face sessions were held with local government staff from the seven LGAs and Rous County Council, in addition to an online session with state agency staff from a range of departments.

Table 4. Engagement session locations

Date	Location	Venue
Mon 17th October	Lismore	Lismore Workers Sports Club
Tuesday 18th October	Goonellabah	Goonellabah Community Centre
Wednesday 19th October	Wardell	St Patrick Church Hall
Thursday 20th October	Ballina	Ballina Jockey Club
Monday 24th October	Casino	Casino Community & Cultural Centre
Monday 24th October	Woodburn	Woodburn Memorial Hall
Tuesday 25th October	Coraki	Coraki Golf Club
Wednesday 26th October	Maclean	Maclean Bowls Club
Thursday 27th October	Grafton	Grafton Regional Gallery
Monday 31st October	Kyogle	Kyogle Showgrounds
Tuesday 1st November	Murwillumbah	Murwillumbah Civic Centre
Tuesday 1st November	Bonalbo	Bonalbo Community Hall
Wednesday 2nd November	Ocean Shores	Ocean Shores Country Club
Wednesday 2nd November	South Tweed	South Tweed Sports
Thursday 3rd November	Mullumbimby	Mullumbimby Ex-Services club

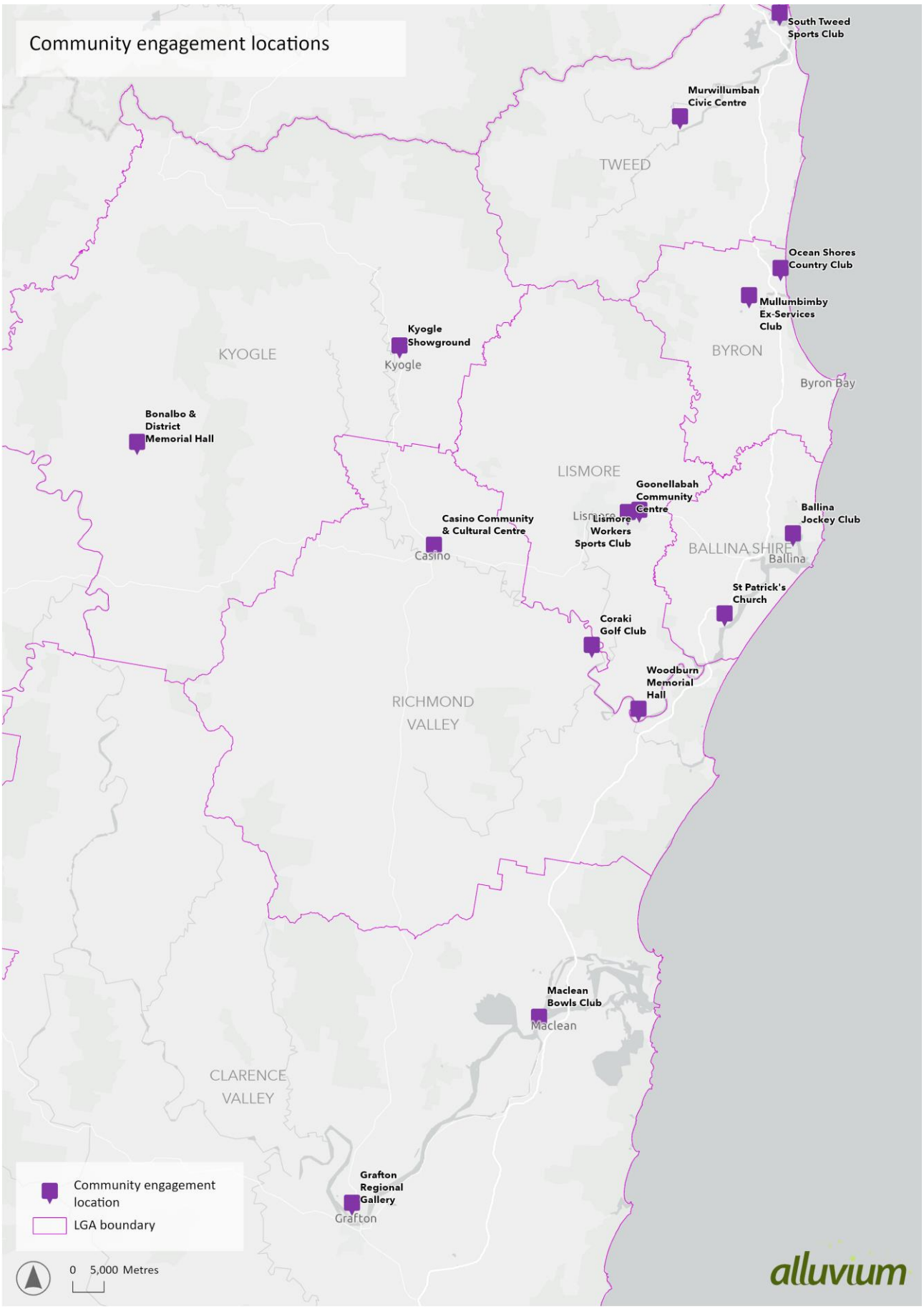


Figure 12. Engagement session locations

Figure 13. Community engagement session

Overarching information of the engagement results is provided in Table 5 below showing the locations and number of attendees and responses obtained. In addition to this information, detailed engagement reports for each of the LGAs is presented in Appendix C.

Table 5. Engagement results

LGA	Date	Location	Pre-registered	Attended	Questionnaires completed	Submissions and/or supplementary information provided
Lismore City Council			**123**	**102**	**89**	**18**
	17-October-2022	Goonelabah	53	40		
	18-October-2022	Lismore	70	62		
Ballina Shire Council			**57**	**75**	**66**	**8**
	19-October-2022	Wardell	27	45		
	20-October-2022	Ballina	30	30		
Richmond Valley Shire Council			**63**	**76**	**43**	**10**
	24-October-2022	Woodburn	38	50		
	24-October-2022	Casino	13	11		
	25-October-2022	Coraki	12	15		
Clarence Valley Shire Council			**66**	**57**	**78**	**12**
	26-October-2022	MacLean	33	33		
	27-October-2022	Grafton	33	24		
Kyogle Council			**10**	**20**	**12**	**1**
	31-October-2022	Kyogle	9	8		
	01-November-2022	Bonalbo	1	12		
Tweed Shire Council			**60**	**40**	**41**	**7**
	01-November-2022	Murwillumbah	36	24		
	02-November-2022	South Tweed	24	16		
Byron Shire Council			**30**	**46**	**16**	**3**
	02-November-2022	Ocean Shores	14	34		
	03-November-2022	Mullumbimby	16	12		
		Total	409	**416**	**345**	**59**

6 Multi-Criteria Assessment (MCA) Overview

6.1 Overview

In order to undertake a consistent and transparent analysis of project proposals, we have developed an approach that relies on a detailed Multi Criteria Assessment (MCA). An MCA provides a systematic approach to support evaluating different options through the use of criteria and weightings. It is normally used to identify and compare different options by assessing their effects, performance, impacts, and trade-offs in a consistent manner when the level, veracity and robustness of the underlying evidence varies. The MCA approach adopted in this project provides a systematic approach for supporting complex decisions according to pre-determined criteria and objectives. MCA is particularly suitable for complex decision problems that involve multiple and conflicting objectives and criteria. It allows identifying a single preferred alternative, or to rank or short-list possible alternatives. MCA provides a framework to explore trade-offs between different options.

Other techniques such as those based on the direct outputs of biophysical and economic numerical modelling were considered but given that there was insufficient coverage of the whole of the Northern Rivers region and that in the timeframes available, such detailed modelling would not have been possible. In addition, the MCA process allowed us to consider a range of other criteria such as those around social and environmental impacts, which may not have been possible with a purely numerical approach.

The MCA process we have adopted in this project has considered a range of criteria, including guidance provided by NEMA, which covers the funding requirements of the $150M fund. The MCA criteria also includes socio-cultural factors (7 of 34 total criteria) along with economic (5 of 34) and environment (3 of 34) criteria in the assessment process. A spatial mapping process is used to identify areas of potential interdependency between projects and investigation of these interactions to avoid/ minimise any unanticipated/ unintended consequences that may arise from the implementation of selected projects. More than 300 potential flood mitigation projects and activities were identified for prioritisation prior to undertaking broader stakeholder engagement, based on the desktop review.

The outcome of the prioritisation is contained in the ranked project lists in Appendix B. The projects identified and prioritised in this component of the project are subject to Commonwealth government and State government review before finalisation of the funding allocations which will occur beyond this project's completion.

6.2 Design

The MCA was developed based on previous MCA frameworks that the project teams have used successfully in a range of projects. Initial design was developed considering the MCA processes suggested in NSW Flood Risk Management Plan Guidelines, however our recent experience in

developing similar processes for the Queensland Reconstruction Authority indicated that the MCA could be expanded and the method of weightings changed.

This is outlined in the sections below.

6.3 Criteria Development

Criteria development initially focused on deriving broad themes to use in order to cover the range of areas requiring assessment through the process. These theme categories included:

- **Flood risk mitigation** – this covers criteria that can be used to assess whether the project reduces or increases flood risk, not only for the area covered by the project itself, but potential upstream and downstream impacts.
- **Flood resilience** – in this theme, criteria that cover how projects may improve the ability to recover from a flood and be better prepared for subsequent floods were identified.
- **Environment** – these criteria are to assess whether the project may have a beneficial or negative impact on environmental conditions, both on the land (terrestrial) and in the waterways.
- **Social-cultural** – within this theme, we have identified a number of criteria related to both social and cultural elements, including traditional owners, but also more broadly to consider mental health (perceptions of safety), underlying disaster resilience and overall community well-being.
- **Economic –** this theme is to evaluate the economic benefits and constraints of the project, including the overall cost (capital and operating), cost-benefit and the impacts on local business (both agricultural and commercial/industrial).
- **Feasibility** – the criteria in this theme are focused on the ability to deliver a robust project outcome, and includes assessment of the underlying evidence supporting the project and the ability for it to be delivered successfully.

Within each of these categories, individual criteria were developed, based on initial discussions with local and state agencies, assessment of existing guidelines and literature and with reference to other MCA processes we have undertaken. They were then further refined through the community engagement process to the final criteria list as presented below, grouped under the relevant theme categories.

Overall, from the engagement, participants indicated that the criteria themselves were generally to be representative, but in some cases were not specific enough or needed changes to wording. Examples of this included the need to add livestock into the ability to evacuate (Flood resilience criterion 4), changing the impacts on amenity to be broader to consider impacts on social capital (Socio-cultural criterion 6) and to include agriculture in economic impact (Economic criterion 5). While further criteria were suggested, such as the need to include adaptation in flood resilience, we felt that these were either discrete project actions, or could be included in other criteria. The adopted list is provided in Table 6 below.

Table 6. MCA Criteria

Flood Risk Mitigation	
1	Impact on the magnitude of flood risk locally (frequency, depth and/or duration)
2	Impact on the extent of inundation
3	Impact upstream
4	Impact downstream
Flood resilience	
1	Impact on preparedness
2	Impact on warning time
3	Impact on the ability to deal with the emergency (infrastructure and resources)
4	Impact on the ability to evacuate (people and/or stock)
5	Impact on access (for supply of goods and services, for emergency vehicles etc.)
6	Impact on robustness of infrastructure (e.g. roads, STPs etc)
7	Impact on robustness of property (commercial and residential)
Environmental	
1	Impact on terrestrial ecology
2	Impact on aquatic ecology (incl. water quality, habitat)
3	Impact on physical stream processes (flow, sediment transport, erosion)
Socio-cultural	
1	Impact on peoples' perception of safety
2	Impact on health and education services
3	Targets a community that is more vulnerable[1]
4	Extent of population at risk
5	Population growth rate of targeted community
6	Impact on social capital (on community facilities/spaces, also social cohesion and amenity)
7	Impact on cultural sites of significance/cultural heritage
Economic	
1	Capital cost
2	Operating cost
3	Cost-benefit Analysis (CBA)
4	CBA uncertainty
5	Impact on local business and agriculture (economic activity, investment, jobs, incomes or innovation)
Feasibility	
1	Longevity/resistance to climate change
2	Extent of evidence to support the option
3	Robustness of evidence to support option
4	Age of evidence to support option
5	Certain and well-established outcomes/tried and tested method
6	Constructability/deliverability
7	Capacity to deliver/maintain
8	Implementation timeframe

[1] Community vulnerability was assessed using the Australian Disaster Resilience Index

6.4 Scoring Process

The ultimate task of the MCA was to assign an overall score to each management option. To calculate an overall score, each criterion was scored by the project team over a five-point rating from -2 through 0 to +2. This score was assigned based on the following interpretation:

2 - Strongly positive: The management option will likely achieve an improvement to the highest level of the criterion.

1 - Positive: The management option will achieve some improvement of the criterion.

0 - Neither positive nor negative: The management option will result in no change to the criteria.

-1 - Negative: The management option will achieve some degradation of the criterion.

-2 - Strongly negative: The management option will likely achieve degradation to the lowest level of the criterion.

Where possible, scoring was automated or uses established bands to ensure overall consistency and reduce the subjectivity of scoring, though this is usually for direct numerical estimates, such as impact on the magnitude of the flood risk (where determined), costs, population at risk, vulnerability and age of evidence. More details on the economic assessment undertaken is presented in Appendix D.

6.5 Weightings

Initial weightings were selected for MCA criteria based on previous assessments and identified priorities from NEMA and local and state government consultation. Each category was assigned a weighting out of 100%, then within each category, the criteria within the category were also given a weighting out of 100%. The final weighting shows how much each criteria contributes to the overall score.

These initial weightings were discussed in detail through the community engagement process using a structured survey to identify which criteria were of higher importance to stakeholders. This process is discussed further in Section 5.

From the results of the community engagement including discussion of the criteria themselves and the outputs of the surveys, the criteria weightings were adopted as the mean values from all LGAs. The overall theme scores (out of 10) are shown in Figure 14 below.

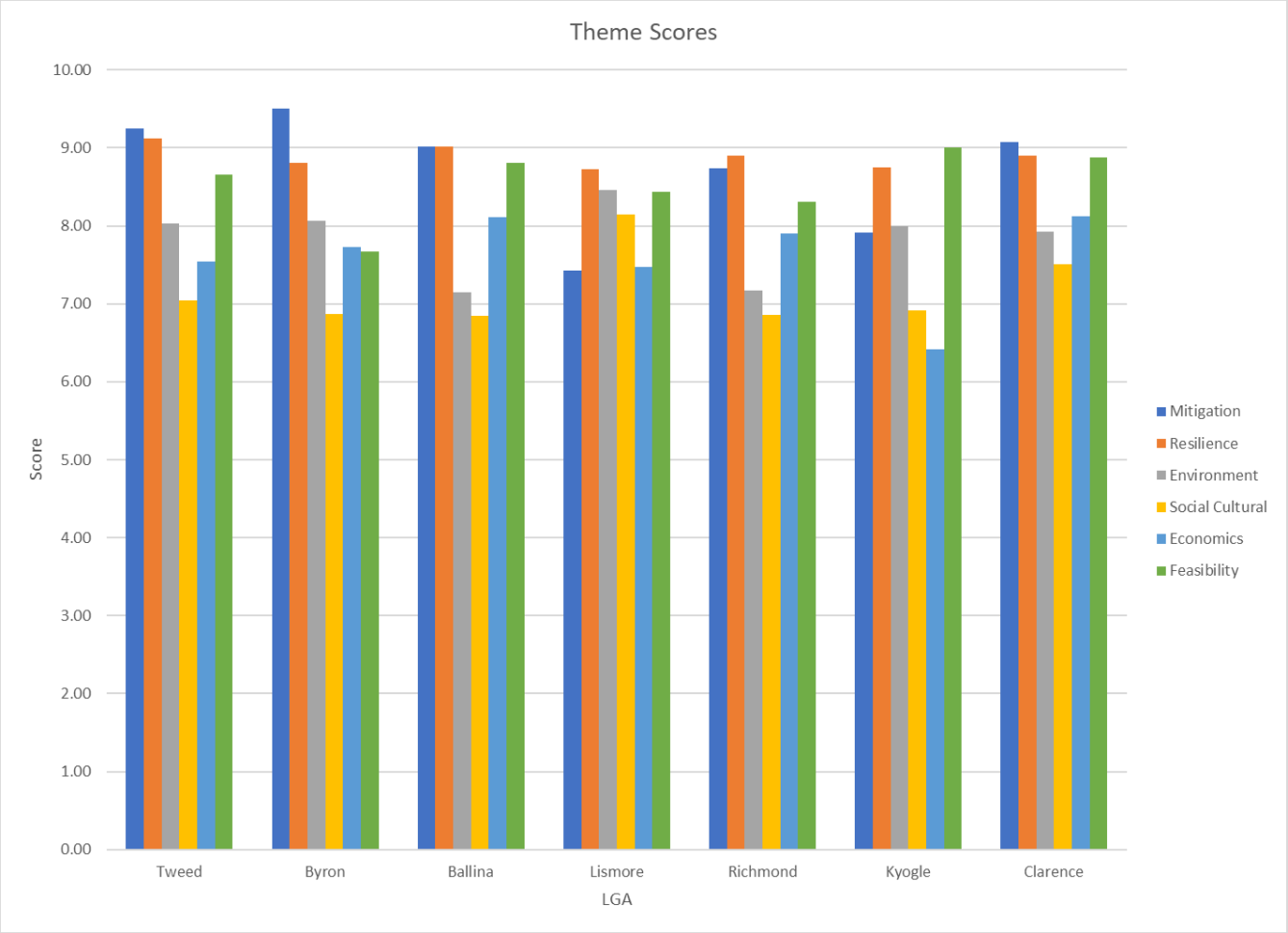


Figure 14. Theme scores from engagement survey results

Across the LGAs, the themes were ranked relatively consistently with the exceptions of Lismore and Kyogle. For most LGAs, flood mitigation scored highest or equally as high as flood resilience, with feasibility also being highly scored. With Lismore and Kyogle, flood resilience weighted more strongly, though the exact reasons why this is the case were not clear, except perhaps that the realisation that floods of the magnitude of February/March 2022 were unlikely to be effectively mitigated and more importance was placed on the ability to recover and be more resilient to the frequency of flooding.

The final weightings were derived by proportioning the individual scores across the total of the scores for both the themes and the criteria within the themes, such that all themes summed to 100% and the criteria within themes also totalled to 100%. This is presented in Table 7 below.

Table 7. Criteria weightings

Themes	Criteria	Theme Weighting	Criteria Weighting	Final Weighting	Theme Weighting	Criteria Weighting	Final Weighting	Theme Weighting	Criteria Weighting	Final Weighting
		Using Mean Scores			Using Maximum Scores			Using Minimum Scores		
Flood risk mitigation		17.9%			18.1%			16.8%		
1	Impact on the magnitude of flood risk locally (depth and/or duration)		26.4%	4.7%		26.4%	4.8%		26.0%	4.4%
2	Impact on the extent of inundation		25.3%	4.5%		24.9%	4.5%		24.4%	4.1%
3	Impact upstream		23.5%	4.2%		24.1%	4.4%		23.8%	4.0%
4	Impact downstream		24.7%	4.4%		24.5%	4.5%		25.8%	4.3%
Flood resilience		18.2%			17.4%			19.7%		
1	Impact on preparedness		14.6%	2.7%		14.6%	2.5%		14.3%	2.8%
2	Impact on warning time		14.7%	2.7%		14.5%	2.5%		14.9%	2.9%
3	Impact on the ability to deal with the emergency (infrastructure and resources)		14.7%	2.7%		14.5%	2.5%		14.9%	2.9%
4	Impact on the ability to evacuate (people and/or stock)		13.9%	2.5%		14.1%	2.5%		13.2%	2.6%
5	Impact on access (for supply of goods and services, for emergency vehicles etc.)		14.1%	2.6%		14.1%	2.5%		14.1%	2.8%
6	Impact on robustness of infrastructure (e.g. roads, STPs etc)		14.3%	2.6%		14.3%	2.5%		14.7%	2.9%
7	Impact on robustness of property (commercial and residential)		13.8%	2.5%		13.9%	2.4%		14.0%	2.8%
Environment		16.1%			16.2%			16.2%		
1	Impact on terrestrial ecology		31.3%	5.0%		31.8%	5.1%		31.1%	5.0%
2	Impact on aquatic ecology (incl. water quality, habitat)		32.9%	5.3%		32.8%	5.3%		32.8%	5.3%
3	Impact on physical stream processes (flow, sediment transport, erosion)		35.8%	5.7%		35.4%	5.7%		36.1%	5.8%

Themes	Criteria	Theme Weighting	Criteria Weighting	Final Weighting	Theme Weighting	Criteria Weighting	Final Weighting	Theme Weighting	Criteria Weighting	Final Weighting
		Using Mean Scores			Using Maximum Scores			Using Minimum Scores		
Socio-cultural		14.7%			15.6%			15.5%		
1	Impact on peoples' perception of safety		14.4%	2.1%		14.7%	2.3%		13.7%	2.1%
2	Impact on health and education services		14.9%	2.2%		14.4%	2.2%		15.6%	2.4%
3	Targets a community that is more vulnerable		15.7%	2.3%		15.2%	2.4%		16.3%	2.5%
4	Extent of population at risk		15.1%	2.2%		14.9%	2.3%		15.3%	2.4%
5	Population growth rate of targeted community		12.9%	1.9%		13.1%	2.0%		12.5%	1.9%
6	Impact on social capital (on community facilities/spaces, also social cohesion and amenity)		13.9%	2.0%		14.2%	2.2%		13.8%	2.1%
7	Impact on cultural sites of significance/cultural heritage		13.1%	1.9%		13.5%	2.1%		12.8%	2.0%
Economic		15.6%			15.5%			14.5%		
1	Capital cost		18.0%	2.8%		18.4%	2.9%		18.1%	2.6%
2	Operating cost		19.4%	3.0%		19.7%	3.1%		19.4%	2.8%
3	Cost-benefit Analysis (CBA)		20.9%	3.3%		21.3%	3.3%		21.3%	3.1%
4	CBA uncertainty		20.5%	3.2%		19.7%	3.1%		20.0%	2.9%
5	Impact on local business and agriculture (economic activity, investment, jobs, incomes or innovation)		21.2%	3.3%		20.9%	3.2%		21.2%	3.1%
Feasibility		17.5%			17.2%			17.3%		
1	Longevity/resistance to climate change		12.7%	2.2%		12.7%	2.2%		13.2%	2.3%
2	Extent of evidence to support the option		12.7%	2.2%		12.4%	2.1%		12.9%	2.2%
3	Robustness of evidence to support option		12.7%	2.2%		12.6%	2.2%		13.2%	2.3%
4	Age of evidence to support option		11.3%	2.0%		11.7%	2.0%		10.5%	1.8%
5	Certain and well-established outcomes/tried and tested method		11.6%	2.0%		12.1%	2.1%		11.3%	2.0%
6	Constructability/deliverability		13.0%	2.3%		12.7%	2.2%		13.3%	2.3%
7	Capacity to deliver/maintain		13.3%	2.3%		13.3%	2.3%		12.9%	2.2%
8	Implementation timeframe		12.5%	2.2%		13.0%	2.3%		11.7%	2.0%

7 Economic analysis of flood risk

7.1 Purpose

The economic analysis of flood risk for the Northern Rivers region has been undertaken to provide a robust understanding of the economic damages and losses and their distribution across the region, across different types of assets and values, and across stakeholder groups. This can be used to inform the prioritisation of funding for adaptation.

This section provides a summary of the economic analysis; however, further details can be found in Appendix D.

7.2 Approach

The initial aim of this analysis has been to develop the economic base case for assessment of economic improvement by a project. The base case is the potential economic costs (damages/losses) associated with flooding (and no adaptation – i.e., 'do nothing different') (Figure 15). The base case also becomes the reference condition to estimate the effectiveness of any adaptation options, assessing the suitability of potential investment.

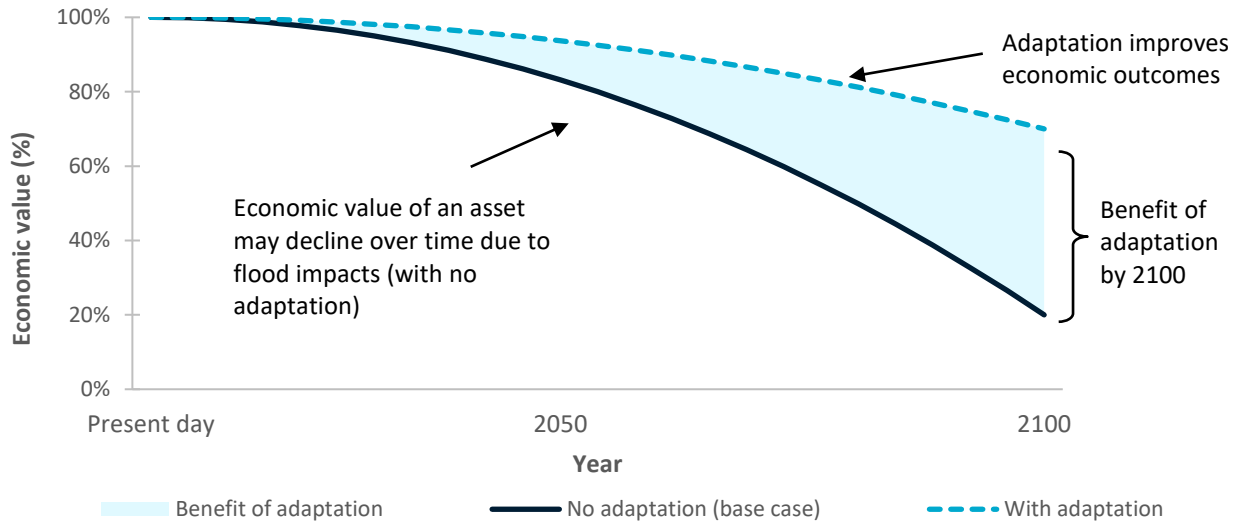


Figure 15. Conceptual diagram - Decline in economic value due to flooding: economic base case (no adaptation) compared to the scenario with adaptation

Economic costs are considered in terms of 'damages' (i.e. asset damage) and 'losses' (i.e. profit or value foregone). The base case is focused on direct damages to key infrastructure assets (buildings and facilities, and transport), as well as consideration of potential damages to some key land uses (e.g. agricultural land use). Furthermore, indirect and intangible damages have been considered in the base case.

Damages have been estimated as average annual damages (AAD) based on flood modelling of the extent of the flood zone. This was performed by JBPacific to estimate the magnitudes of six design floods. The AAD is the best practice approach for understanding potential economic impacts of

flood hazards and for economic analysis of flood adaptation options and is consistent with the approach used by the insurance sector to price flood risk. AAD has been estimated based on the six modelled Annual Equivalent Probability (AEP) events of 5%, 2%, 1%, 0.5%, 0.2% and 0.067% at relevant locations. Table 8 presents a summary of the key assets exposed to the 0.067% flood event (the most extreme flood event assessed) to provide an indication of the scale of the economic assessment.

Table 8. Summary of 0.067% flood event exposed assets

Asset category	Exposed assets
Buildings	73,266 buildings
Roads	7,498 km of roads
Agricultural land	275,886 ha of agricultural land

Economic input data has been drawn from a range of sources; however, the two primary data sources for the economic inputs are Rawlinsons Construction Cost Handbook (2022) and NSW Government's (2022) Flood Risk Management Guide to support flood damage assessments (see Section D.5 for table of input parameters). Ranges were also established for all of the economic inputs (over 60 different input variables), noting that there is considerable risk and uncertainty involved in an economic assessment of this kind as detailed information relating to specific assets is not available. These ranges for inputs to the economic model were then used as inputs to Monte Carlo simulations which were run to provide a probabilistic assessment of the base case results (20,000 iterations run for each of the model outputs).

7.3 Economic base case

The base case for the Northern Rivers region has been determined by examining the likelihood and consequence ($ damage) of flood hazard impacts on assets. This takes account of asset footprint, asset types, estimated floor levels (for depth), and other key variables (all outlined in Appendix D). The region as a whole is estimated to experience average annual damages of between $1.0 and $1.8 billion.[1] These damages are not spread evenly across Local Government Areas (LGAs) or asset categories.

Figure 16 presents the damage curves for the 7 LGAs included in the assessment. It should also be noted that the damage curves have varying slopes. This means that for some areas the risk is relatively more concentrated in extreme infrequent flood events (e.g. Tweed Shire Council), while in others it is relatively more concentrated in less extreme but more frequent flood events (e.g. Ballina Shire Council). However, the curves show that, regardless of location, the majority of the economic value of risk is from relatively frequent events. This may have implications for the type of adaptations that may be economically viable.

[1] This estimate represents a 90% confidence interval derived from Monte Carlo simulation using 20,000 iterations.

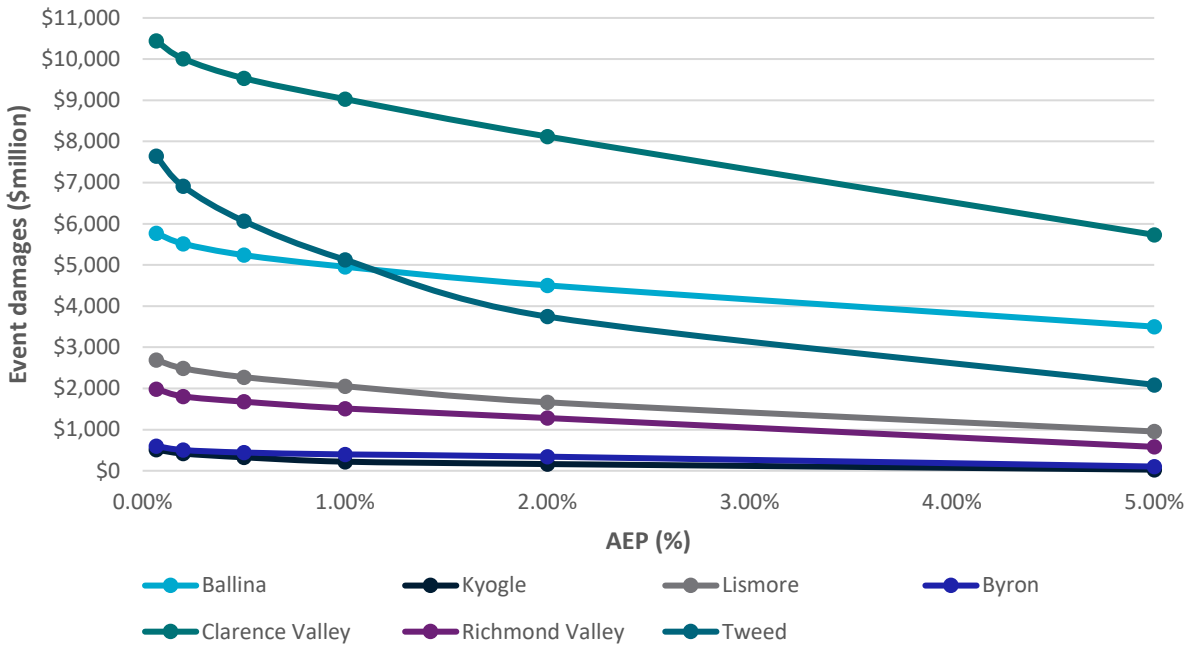


Figure 16. Local government area damage curves (all assets)

Figure 17 presents the average annual damages for each LGA by asset type. These results indicate that Clarence Valley, Ballina, and Tweed LGAs have the greatest flood risk in the region – largely a function of the number and type of assets within the flood exposure under different AEPs. Furthermore, the majority of the risk in almost all LGAs comes from risks to buildings and associated contents and vehicles (particularly residential buildings). Other key categories include roads (particularly for the Richmond Valley LGA), and indirect damages (i.e. clean up costs, relocation costs, and trading losses). It should be noted that the losses associated with loss of access (i.e. major roads cut off) were not able to be incorporated into this region-wide assessment as they require much more fine scale analysis; however, these losses could be significant.

The error bars (reflecting the range from the Monte Carlo simulations) also show that there is considerable uncertainty involved in the estimates, where the major driver of the uncertainty (and the skewness of the estimates) is the intangible damages (i.e. injuries, fatalities, and social and wellbeing impacts). The uncertainty is also not equal across LGAs. For example, Byron has the greatest uncertainty (in proportional terms) due the higher proportion of AADs coming from roads (52% compared to the region wide contribution of 12%) and intangible damages (7% compared to the region wide contribution of 5%). Both roads and intangible damages have high levels of uncertainty compared to other damage categories. Ballina, Lismore, and Clarence Valley have relatively low levels of uncertainty (in proportional terms) due to higher contributions from damages to buildings and associated assets.

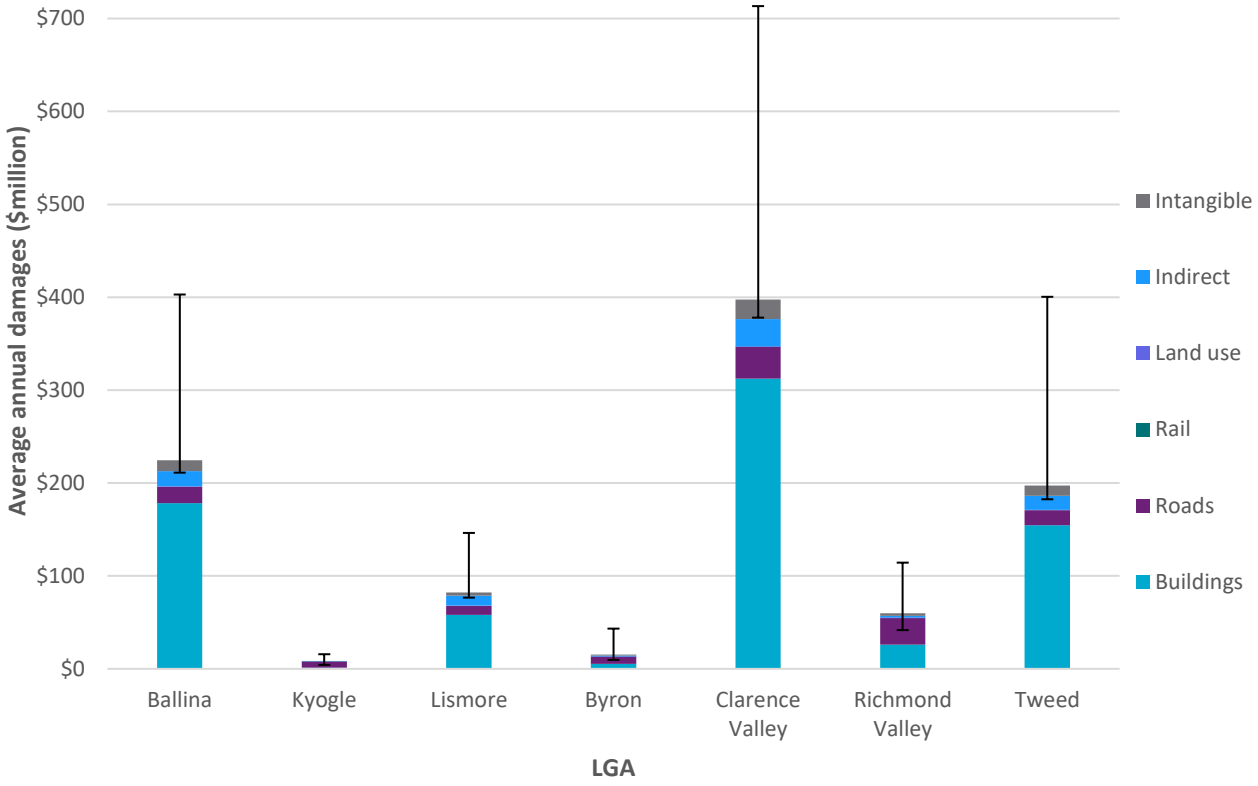


Figure 17. Local government area average annual damages by asset category (90% C.I. represented in error bars)

Figure 18 presents the share of region-wide AADs for each asset category, including a more detailed breakdown of the buildings category. As at the LGA level, residential buildings are the greatest contributor to the total AADs.

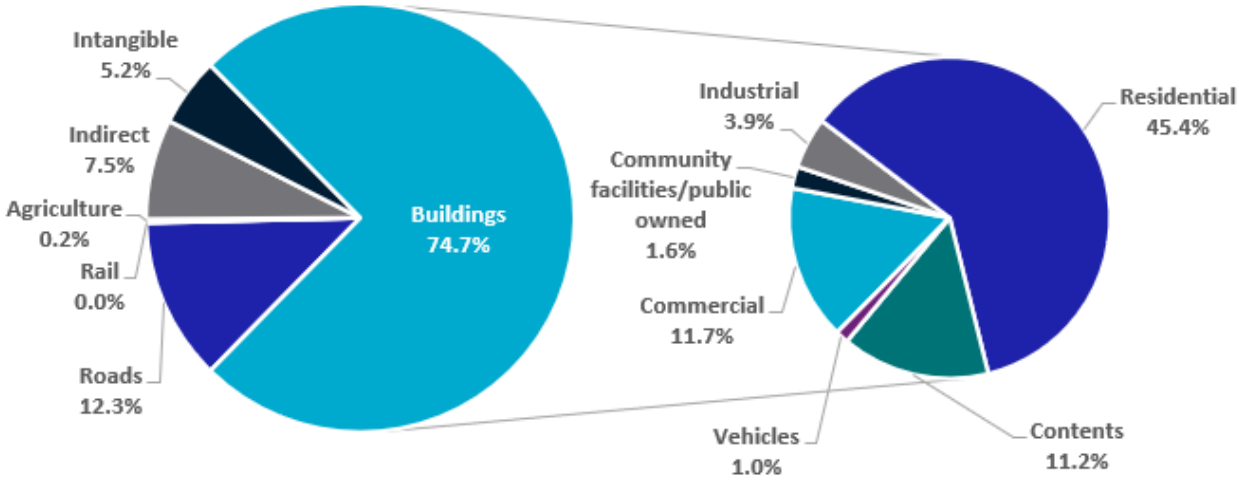


Figure 18. Region wide average annual damages share by asset category

Another key consideration of the economic base case is the asset ownership, or which stakeholder groups the damages accrue to. In particular, it is useful to understand the risk to publicly owned assets compared to privately owned assets, as this can help to inform adaptation and provide opportunities for cost sharing and co-investment. Risks to public assets (i.e. roads, rail, community facilities/publicly owned buildings) only make up approximately 14% of the total AADs.

8 Project Prioritisation

8.1 Emerging Themes

During the consultation with local government and community stakeholders, several themes were continually raised. These were typically included as individual projects over a number of localities, or as generally consistent messages provided through the engagement. It was difficult therefore to include these in project prioritisation as they either needed to be considered as an overall project for all LGAs, or more details were needed to include and assess them.

These themes include:

- Improved dynamic understanding of the system for all stakeholders – this includes:
  - Increasing the number of flood (rain and river) gauges across the region
  - Provide more robustness for the existing gauge network by improving maintenance and developing strategies for back up when critical gauges are compromised
  - Centralising the data from the flood gauges into a single point of access for all
  - Allow for citizen science to be included in flood information, especially in the lead up and during flood emergencies
  - Converting the data into information that is easy to interpret for a range of stakeholders
  - Communicating the information in ways that provide awareness, warning and emergency response advice to all stakeholders
  - Providing ongoing awareness of flooding, flood impacts and approaches to build resilience
- Improved static understanding of the system – this includes:
  - Developing an understanding of the whole of the system including differences between whole of catchment and local scale flooding and a whole of catchment scale mitigation strategy for the Richmond River catchment
  - Improve governance systems for providing improved flood mitigation
  - Improve legislation to assist in maintenance of flood mitigation structures
  - Allocate more funding for maintenance of existing and future flood infrastructure (drains, floodgates, etc)
  - Manage development on floodplains to ensure existing flooding is not exacerbated
  - Building community resilience via community led projects
  - Improved robustness and resilience of communications infrastructure
  - Assess the impacts of landslips across the region and identify other at-risk areas
- Assess the role of nature-based solutions for flood management – this includes:
  - Evaluate the effectiveness of nature-based solutions at a whole of catchment scale including a catchment wide assessment of the suitability of nature-based solutions in the Richmond River catchment

  - Undertake fundamental research in the roles of vegetation in flood mitigation and resilience
- Evaluate the economic resilience and strategic direction for the region
  - There does not appear to be a long-term strategy for ensuring the economic resilience and future directions for many of the larger communities in the Northern Rivers region, or for the region as a whole. This needs to identify critical infrastructure necessary for ongoing economic sustainability of the region, such as large-scale industries (e.g. sugar mills and refineries, dairy processers, manufacturers etc), large scale employers (e.g. tourism, education, health, local government), commercial centres (CBDs, retail hubs, industrial centres) and evaluate the ongoing susceptibility of these economic assets to future large scale disruption and perturbing events such as flooding, bushfire, pandemics and drought.

We strongly recommend these themes for consideration into more detailed project scopes that either can be funded within the existing $150M allocation, or as part of separate funding for the scoping phase at least.

These themes are not unique to the Northern Rivers region and would be suitable for flood resilience across all parts of Australia. The methodologies developed to both scope and implement these would therefore have a wide range of applicability to flood prone areas across the country.

8.2 Overall Results

8.2.1 Project eligibility and short listing

From our initial list of projects, we developed a 'short-list' of projects eligible for NEMA funding by assessing each project against a range of eligibility criteria. The following criteria were used to assess if a project was not eligible to be considered further:

- Insufficient information for scoring – where there was a lack of evidence (e.g. relevant evidence included either a published report, relevant research literature or another quantitative assessment) which did not allow the MCA scoring process to be undertaken consistent with other identified projects.
- Further assessment likely – where a project had been proposed that may have significant impacts to upstream or downstream landholders, the environment or cultural assets and this had not been previously assessed.
- Complete – project has already been completed since being proposed.
- Superseded – project has been replaced by an alternative option or is now redundant (usually applies to older project suggestions).
- Incorporated – project has been incorporated into another project e.g. where several projects have been consolidated into the one proposal.
- On hold – project status is on hold e.g. due to land tenure uncertainty.
- Not recommended – project is actively not recommended by Council staff due to evidence-based reasoning.

- Funding secured – funding has been secured through alternative sources e.g. Public Works or voluntary home buy-back or house raising scheme.
- Plan or strategy – project is a plan or strategy with no direct flood improvement outcome (identified as ineligible according to NEMA funding principles).
- Maintenance of existing assets – project relates to ongoing maintenance of existing assets (identified as ineligible according to NEMA funding principles).
- Emergency services – project relates to improvements in emergency services (e.g. SES, RFS, Police), which are likely to be internally processed by those agencies.

8.2.2 Final ranked lists

From the consideration of the criteria above, the more than 330 project proposals were reviewed and an initial project list of 113 separate eligible projects were identified for scoring and ranking. Further refinement of projects based on updated eligibility assessments regarding planning type projects, confirmation of alternative funding sources secured for some of the projects and combining of projects into region-wide projects (e.g. community awareness type proposals) has led to a final list of 62 distinct projects now considered for prioritisation.

Combining the results of the project lists with the MCA scoring process has resulted in weighted scores for all projects. These have then been ranked across all Northern Rivers region LGAs regardless of location.

It should be noted that some projects that have ranked in the final list do not have definitive costs associated with them. These are mostly associated with the need to finalise the specific flood immunity that the project may be related to. For example, a number of the evacuation route projects do not have a final cost as they relate to the overall evacuation route which may require different levels of investment dependent on what final flood immunity is required. They are therefore able to be scaled dependent on the amount of available funding. As no definitive costs were provided for those types of projects, we have included them in the list but noting that further definition will be required. This may mean that the final list of projects selected for the $150M of available funding may vary as refinement of costs and effectiveness are confirmed.

8.3 Investment Scenarios

There are many ways to consider investment to ensure that the impacts of future flooding are reduced over time. These can include focusing on projects that may aim to mitigate the level, extent or frequency of the flood, those that may build resilience for future flooding and those which maximise the results for all of the assessed criteria. The MCA allows us to switch between rankings for different themes, but also to look at individual criteria rankings if required.

For this prioritisation, we have adopted three investment scenarios for possible funding allocation including that being based on ranking:

a) The total overall ranked MCA score for all criteria

b) The ranked scores for the flood risk mitigation theme

c) The ranked scores for the flood resilience theme.

The top 20 results are presented in the following tables to illustrate how the project lists change for each investment scenario. This illustrates that when the overall score is considered, a range of projects of varying sizes and across different option types are ranked high on the list, including community awareness type projects (highlighted in orange). With flood risk mitigation as being the theme to prioritise investment, larger scale projects become dominant, with the Leycester Creek Bypass Channel causing the full amount of funding to be exceeded after the 12th ranked project. It also shows that projects beyond the likely limit of funding from the ranked list using the overall score now are higher in priority. Using flood resilience as the theme for prioritisation sees both larger scale projects and proposals around flood warning and evacuation approaches being higher on the list.

This shows the versatility of the MCA process in that the prioritisation of projects identified can be refocused if community needs or agency requirements change in the future and also indicates the legacy of this prioritisation process in that it can provide a useful approach for future project assessment if required.

For the results presented in Appendix B, we have used the total overall ranked MCA score for all criteria as the basis for prioritisation. Where projects have been combined, they have been considered as combined projects and not individually.

Table 9. Top 20 Projects by Total Weighted MCA Score (all projects considered individually)

Row colours: Orange = flood awareness (can be combined across multiple LGAs)

*Project is also included into another combined option (e.g. NP39 is a combination of 7 related projects (NP32 to NP38))

Option Name	LGA	Option Heading	Flood Risk Mitigation	Flood resilience	Environmental	Socio-cultural	Economic	Feasibility	TOTAL
NP35	Lismore	Raise pump control rooms/towers in all pump stations*	**0.22**	**0.26**	**0.00**	**0.01**	**-0.02**	**0.26**	**0.73**
PP2	Various	Public Proposal - Riparian revegetation and reforestation for flood resilience in the Clarence, Richmond, Tweed and Brunswick Catchments	**0.00**	**0.10**	**0.27**	**0.02**	**0.06**	**0.26**	**0.72**
PP3	Various	Public Proposal - Heal the Rivers Flood Recovery and Landscape Restoration Proposal	**0.09**	**0.16**	**0.15**	**0.00**	**0.03**	**0.28**	**0.71**
NP39	Lismore	Combined upgrades to pumps and pump stations (7 projects)	**0.22**	**0.26**	**0.00**	**0.03**	**-0.05**	**0.24**	**0.70**
NP34	Lismore	Power supply backups for all pump stations (levee/sewer)*	**0.22**	**0.18**	**0.00**	**0.03**	**-0.02**	**0.26**	**0.67**
NP42	Lismore	Electrify/install SCADA to replace tractor pump*	**0.22**	**0.18**	**0.00**	**0.03**	**-0.02**	**0.26**	**0.67**
NP43	Lismore	Fibre connect all flood pump stations*	**0.13**	**0.26**	**0.00**	**0.01**	**0.01**	**0.24**	**0.65**
RI27	Richmond Valley	Prepare and implement a long-term management plan for the Tuckombil Canal and Rocky Mouth Ck floodgates	**0.13**	**0.16**	**0.00**	**0.06**	**0.00**	**0.26**	**0.61**
NP9	Byron	SGB Flood Pump Generator	**0.13**	**0.16**	**0.00**	**0.02**	**0.03**	**0.26**	**0.60**
CL84	Clarence Valley	Helicopter landing pad (Glenreagh) for East Bank Rd resdients and other areas	**0.00**	**0.16**	**0.00**	**0.07**	**0.06**	**0.29**	**0.58**
NP38	Lismore	New electric submersible pump stations (x2) at levee near Snow St and Three Chain Rd*	**0.13**	**0.16**	**0.00**	**0.01**	**0.01**	**0.26**	**0.57**
CL6	Clarence Valley	Emergency Management	**0.00**	**0.08**	**0.00**	**0.03**	**0.12**	**0.33**	**0.56**
CL90	Clarence Valley	Flood Information Update for LEP and DCP	**0.00**	**0.00**	**0.00**	**0.07**	**0.15**	**0.33**	**0.54**
CL51	Clarence Valley	Develop practical method of evacuation	**0.00**	**0.08**	**0.00**	**0.11**	**0.09**	**0.26**	**0.54**
NP15	Richmond Valley	Dairy Flat road improvements	**0.00**	**0.19**	**0.00**	**0.09**	**-0.02**	**0.28**	**0.53**
PP8	Richmond Valley	Public Proposal - Bungawalbyn resident buy-out (to be considered in conjunction with Bungawalbyn levee repair)	**0.18**	**0.05**	**0.00**	**0.02**	**-0.05**	**0.33**	**0.53**
CL98	Clarence Valley	Community Awareness - additional strategic signage	0.00	0.03	0.00	0.04	0.15	0.31	0.53
CL92	Clarence Valley	Raise public awareness and compile floodsafe brochure	0.00	0.03	0.00	0.07	0.15	0.28	0.53
BA28	Ballina Shire	Further consideration of recommended option from 'Ross Lane Upgrade Options Assessment' for upgrading Ross Lane at Deadmans Creek and North Creek crossings	**0.00**	**0.16**	**0.00**	**0.06**	**-0.02**	**0.33**	**0.52**
NP16	Richmond Valley	Thearles Canal culvert upgrade	**0.00**	**0.16**	**0.00**	**0.06**	**0.01**	**0.28**	**0.51**

Table 10. Top 20 Projects by Flood Risk Mitigation Weighted MCA Score (all projects considered individually)

Row colours: Orange = flood awareness (can be combined across multiple LGAs) ; Yellow = anticipated to be beyond limit of funding when ranked on TOTAL

* Project is also included into another combined option (e.g. NP39 is a combination of 7 related projects (NP32 to NP38))

Option Name	LGA	Option Heading	Flood Risk Mitigation	Flood resilience	Environmental	Socio-cultural	Economic	Feasibility	TOTAL
LI6	Lismore	Combined option LI1 to LI5	**0.31**	**0.11**	**-0.11**	**-0.04**	**-0.08**	**0.26**	**0.44**
BY29	Byron	Preferred Byron Drainage Strategy Construction	**0.23**	**0.13**	**0.05**	**0.06**	**-0.08**	**0.08**	**0.46**
TW48	Tweed	Alma St modification	**0.23**	**0.06**	**-0.11**	**0.04**	**0.03**	**0.16**	**0.40**
BY31	Byron	North Coast Railway Bridge Widening	0.22	0.00	-0.05	0.02	-0.03	0.03	0.19
NP34	Lismore	Power supply backups for all pump stations (levee/sewer)*	**0.22**	**0.18**	**0.00**	**0.03**	**-0.02**	**0.26**	**0.67**
NP35	Lismore	Raise pump control rooms/towers in all pump stations*	**0.22**	**0.26**	**0.00**	**0.01**	**-0.02**	**0.26**	**0.73**
NP39	Lismore	Combined upgrades to pumps and pump stations (7 projects)	**0.22**	**0.26**	**0.00**	**0.03**	**-0.05**	**0.24**	**0.70**
NP42	Lismore	Electrify/install SCADA to replace tractor pump*	**0.22**	**0.18**	**0.00**	**0.03**	**-0.02**	**0.26**	**0.67**
BY5	Byron	Implement debris control measures for Federation Bridge and Billinudgel Railway Bridge	**0.18**	**0.05**	**-0.06**	**0.02**	**0.00**	**0.26**	**0.46**
PP8	Richmond Valley	Public Proposal - Bungawalbyn resident buy-out (to be considered in conjunction with Bungawalbyn levee repair)	**0.18**	**0.05**	**0.00**	**0.02**	**-0.05**	**0.33**	**0.53**
BY40	Byron	Upgrade Coogera Circuit Detention	0.18	0.05	-0.11	0.01	-0.03	0.20	0.31
NP21	Lismore	Leycester Creek Bypass Channel	0.18	0.13	-0.27	0.05	-0.05	0.03	0.07
NP32	Lismore	Extra pump Lower Hollingworth pump station*	**0.13**	**0.16**	**0.00**	**0.01**	**-0.05**	**0.26**	**0.50**
NP33	Lismore	Increase capacity in Browns Creek pump station*	**0.13**	**0.16**	**0.00**	**0.01**	**-0.05**	**0.26**	**0.50**
NP38	Lismore	New electric submersible pump stations (x2) at levee near Snow St and Three Chain Rd*	**0.13**	**0.16**	**0.00**	**0.01**	**0.01**	**0.26**	**0.57**
NP43	Lismore	Fibre connect all flood pump stations*	**0.13**	**0.26**	**0.00**	**0.01**	**0.01**	**0.24**	**0.65**
NP9	Byron	SGB Flood Pump Generator	**0.13**	**0.16**	**0.00**	**0.02**	**0.03**	**0.26**	**0.60**
RI27	Richmond Valley	Prepare and implement a long-term management plan for the Tuckombil Canal and Rocky Mouth Ck floodgates	**0.13**	**0.16**	**0.00**	**0.06**	**0.00**	**0.26**	**0.61**
PP9	Tweed	Public Proposal - Cudgen Lake Flood Mitigation Options Assessment	0.13	0.05	0.00	0.02	-0.05	0.33	0.48
BY39	Byron	Upgrade Broken Head Road Crossing of South Tallow Creek „	0.10	0.08	-0.06	-0.01	0.01	0.17	0.29

Table 11. Top 20 Projects by Flood Resilience Weighted MCA Score (all projects considered individually)

- Project is also included into another combined option (e.g. NP39 is a combination of 7 related projects (NP32 to NP38))

Option Name	LGA	Option Heading	Flood Risk Mitigation	Flood resilience	Environmental	Socio-cultural	Economic	Feasibility	TOTAL
NP35	Lismore	Raise pump control rooms/towers in all pump stations*	0.22	0.26	0.00	0.01	-0.02	0.26	0.73
NP39	Lismore	Combined upgrades to pumps and pump stations (7 projects)	0.22	0.26	0.00	0.03	-0.05	0.24	0.70
NP43	Lismore	Fibre connect all flood pump stations*	0.13	0.26	0.00	0.01	0.01	0.24	0.65
NP14	Richmond Valley	Tatham Bridge Raising	-0.04	0.21	-0.06	0.03	-0.02	0.26	0.38
NP15	Richmond Valley	Dairy Flat road improvements	0.00	0.19	0.00	0.09	-0.02	0.28	0.53
KY23	Kyogle	Raise Reynolds Bridge between Casino and Kyogle	0.00	0.18	0.00	-0.02	-0.05	0.19	0.31
RI9	Richmond Valley	Flood warning and emergency planning	0.00	0.18	0.16	0.00	-0.06	0.15	0.43
NP42	Lismore	Electrify/install SCADA to replace tractor pump*	0.22	0.18	0.00	0.03	-0.02	0.26	0.67
NP34	Lismore	Power supply backups for all pump stations (levee/sewer)*	0.22	0.18	0.00	0.03	-0.02	0.26	0.67
NP29	Lismore	Mechanical trash racks at all 3 major pump station inlets	-0.04	0.18	0.00	0.01	-0.05	0.29	0.38
CL84	Clarence Valley	Helicopter landing pad (Glenreagh) for East Bank Rd resdients and other areas	0.00	0.16	0.00	0.07	0.06	0.29	0.58
BA18	Ballina Shire	Evacuation Route Raising - Comprises Ballina Island and west Ballina only and EXCLUDES bridge duplication at River St and Tamarind Dve (including bridge duplication) to Cumbalum.	-0.14	0.16	-0.06	0.09	-0.02	0.33	0.36
NP38	Lismore	New electric submersible pump stations (x2) at levee near Snow St and Three Chain Rd*	0.13	0.16	0.00	0.01	0.01	0.26	0.57
NP16	Richmond Valley	Thearles Canal culvert upgrade	0.00	0.16	0.00	0.06	0.01	0.28	0.51
BA28	Ballina Shire	Further consideration of recommended option from 'Ross Lane Upgrade Options Assessment' for upgrading Ross Lane at Deadmans Creek and North Creek crossings	0.00	0.16	0.00	0.06	-0.02	0.33	0.52
NP45	Lismore	Combined upgraded flood telemetry, technology and community warning systems	0.00	0.16	0.00	0.07	-0.05	0.26	0.43
NP9	Byron	SGB Flood Pump Generator	0.13	0.16	0.00	0.02	0.03	0.26	0.60
NP32	Lismore	Extra pump Lower Hollingworth pump station*	0.13	0.16	0.00	0.01	-0.05	0.26	0.50
NP33	Lismore	Increase capacity in Browns Creek pump station*	0.13	0.16	0.00	0.01	-0.05	0.26	0.50
RI27	Richmond Valley	Prepare and implement a long-term management plan for the Tuckombil Canal and Rocky Mouth Ck floodgates	0.13	0.16	0.00	0.06	0.00	0.26	0.61
BA14	Ballina Shire	Raise Low Points on Evacuation Routes	-0.09	0.16	0.00	0.07	0.03	0.33	0.49

8.4 Funding distribution

During the stakeholder engagements, we heard many suggestions around funding allocation for the proposed $150M. This included even distribution across all LGAs, proportioned according to population density, proportioned according to flooding history, proportioned according to overall impact of February/March 2022 flood and several others.

In order to provide some guidance on this, we have derived a table (Table 12) which identifies the amount of Annual Average Damage (AAD) incurred due to flooding, as well as population distribution. We have then evaluated that damage based on proportion of the population (AAD per capita) and on an areal basis given the size of the LGA. This helps to show where future damage from flooding is most likely to cause impact based on historic flooding (not included February/March 2022).

Table 12. Distributions of Average Annual Damages (AAD)

LGA name	AAD	Area (km^2)	Population	AAD per capita	AAD per km^2	Proportion of population	Proportion of damage (total AAD)	Proportion AAD/km^2
Ballina	$224,371,491	484	45,607	$4,920	$463,577	15%	23%	61%
Byron	$15,384,026	567	35,993	$427	$27,132	12%	2%	4%
Clarence Valley	$397,335,817	10,441	51,846	$7,664	$38,055	17%	40%	5%
Kyogle	$8,272,740	3,589	8,681	$953	$2,305	3%	1%	0%
Lismore	$82,369,372	1,290	43,420	$1,897	$63,852	14%	8%	8%
Richmond Valley	$59,858,574	3,051	23,548	$2,542	$19,619	8%	6%	3%
Tweed	$197,316,391	1,321	98,954	$1,994	$149,369	32%	20%	20%

The Clarence Valley LGA is by far the largest of all local government areas and therefore has a large area that is susceptible to flooding. On this basis, Clarence Valley would be the largest beneficiary of funding if it was distributed on this basis. If funding distribution was considered on the basis of population, then the Tweed LGA would benefit most. Considering the proportion of damages per person, Clarence Valley would again see the majority of funding if this was the only consideration for funding distribution, with Ballina second.

Given the uniqueness of the February/March 2022 event, we also considered the damage to properties that occurred during the event as shown in Table 12. Whilst total damage costs were not yet available, we were provided with results that indicated severe, moderate or minor damage to properties from the event.

Table 13. Distributions based on February/March 2022

LGA name	Number of Residences (Severe Damage / Destroyed)	Number of Residences (Moderate Damage)	Number of Residences (Minor Damage)	Population in flood footprint (no.)	Proportion by total damaged properties	Proportion by severe damage	Proportion of population in flood footprint (%)
Ballina	77	194	377	7,033	10%	6%	16%
Byron	60	448	603	6,116	18%	4%	17%
Clarence Valley	10	25	65	4,276	1.6%	0.7%	8%
Kyogle	6	7	26	239	0.6%	0.4%	3%
Lismore	602	955	247	7,269	29%	45%	17%
Richmond Valley	332	214	287	5,085	13%	25%	22%
Tweed	250	566	858	14,488	27%	19%	15%

It would appear that of all likely funding distribution approaches, a distribution which considered population per LGA (Proportion of population column in Table 12 above), or population in the flood footprint (Proportion of population in the flood footprint column in Table 13 above) would appear to provide distributions that are consistent with building longer term flooding resilience across the region. If the focus was only on the recovery from the February/March 2022 event, then the distribution according to the total damaged properties (Proportion by total damaged properties column in Table 13 above) provides a useful proportional breakdown. Given that every future flood event is likely to have different characteristics, it is suggested that the proportion of population in the flood footprint is the most suitable for consideration and this would help to ensure that those likely to have been impacted from the February/March 2022 event, wherever that occurred (urban or rural) receive relatively equitable access to funding.

9 Caveats and assumptions

This prioritisation process was undertaken based on the information available and able to be analysed within the timeframes available. There were a number of caveats and assumptions identified as the project progressed and during finalisation. These are set out below.

9.1 Technical assessment

The following caveats relate to the technical assessment, including the project identification, MCA process and finalisation of project prioritisation. These include:

- The scoring methods used are subject to subjectivity for some criteria, where there is a bias based on available knowledge and evidence. To mitigate this, the scoring approach was cross-scored between different staff and reviewed overall as a project team to ensure consistency and removal of bias.
- Some proposals had limited information across the evaluation criteria and needed to be populated to ensure equitable scoring. To mitigate this, content from other proposals was used for scoring (i.e. regionally consistent context)
- No uncertainty or sensitivity analysis has been undertaken to evaluate confidence in assessment priorities. To mitigate this, we used maximum and minimum scores to explore the bounds of the overall results, and we found little variance such that we have confidence that while individual rankings may vary slightly, the list of highest ranked projects would not change significantly.
- Projects were scored in isolation, not in combination, noting that some projects may have dependencies or cause impacts to other projects. To mitigate this, we included a qualitative assessment of upstream and downstream dependencies and impacts in the assessment.
- The scoring method used scores ranging from -2 to +2. Given the size of the ranges in some values (e.g. project costs), some granularity in the data will be lost when “banded” into one of five scores (-2, -1, 0, +1, +2). We used this approach to reflect the coarseness of information from many of the proposals. To mitigate this, the weightings provided by the community engagement process was used to determine those criteria which were more important to the community.
- The economic assessment was limited by availability of damage assessments across the whole of the region, for a range of flood heights. We were unable to mitigate this fully, but used as many lines of evidence that were available across the region.
- Damage assessments are based on a range of probabilistic design flood events and not based on what transpired in the 2022 event. As each flood event is likely to be different, to mitigate this, we used long-term historical data, built up across both historical and probabilistic events.

9.2 Engagement

The caveats set out below relate to the community engagement component of the project. These include:

- The timeframe for notification of the community for upcoming engagement was limited. We mitigated this by ensuring engagement days and locations were shared through multiple local channels. We established an online survey for those who were unable to be physically present.
- First Nations engagement was limited. This reflects the quick pace of the project, where First Nations engagement needs time to build trust. Mitigation was limited, we used culturally appropriate engagement methods and First Nations facilitators. Further time would have been needed to fully mitigate this risk.
- The region was experiencing consultation fatigue. We mitigated this by having engagement move through many towns in the region, with drop-ins and less formal processes (we listened).
- The engagement needs to respect the contributions from the 400 people who engaged with the project, and needs to reciprocate back to the community in sharing outcomes. We partially mitigated this by conveying clearly to participants during consultation that this is the only round of community engagements, and their inputs will be used in generating the prioritised list which will be submitted to NEMA. Further mitigation for this needs agreement for information sharing, in partnership with NEMA.

10 Key Opportunities and Conclusions

10.1 Key Opportunities

Under Section 8.1, a series of emerging themes were identified throughout the project both through the various engagement activities and through the analysis undertaken for prioritisation. Given the importance of these themes, we see that continued focus on them is critical for improved resilience in the Northern Rivers region and this leads to the first key opportunity.

Key opportunity 1 – Develop the emerging themes into detailed project scopes suitable for inclusion in this funding round or future funding.

We also considered how funding might be distributed given that there are a number of different methods that may be considered. This is outlined in Section 8.4 and led to the following key opportunity:

Key opportunity 2 – Consideration be given to allocation of funding according to proportion of population in the flood footprint. This would help to ensure that those likely to have been impacted from the February/March 2022 event, wherever that occurred (urban or rural) receive relatively equitable access to funding.

As also noted in the emerging themes section, insufficient emergency warning and flood awareness was a recurring issue across all local government areas. An accurate and comprehensive emergency warning system is reliant on a robust and suitably extensive flood gauging and rainfall station network. According to both what we heard during the engagement process and an independent analysis of the gauges (Lerat et al., 2022), the network failed on many occasions and is insufficient in its extent (e.g. Bungawalbin catchment is a major catchment yet only has two water level gauges and no rainfall gauges). In addition to the above, many people expressed concern around the lack of clarity with which flood information is communicated. During the February/March flood event, engagement participants told us that there were many issues with warnings being delayed and 'out of date'. With no centralised point to access the raw data, it was difficult to cross-check the warnings people were receiving. Others expressed difficulty in interpreting the information, which was exacerbated in the state of emergency. These three factors – gauge network issues, accessibility of information and clarity of information – suggests that a combined approach to improving emergency warnings and flood awareness is necessary. A suitable project would generate and integrate the following:

- A robust river and rainfall gauge network covering the entire Northern Rivers region – managed by a single entity
- Provision of information from that network in a timely and centralised manner
- Communication of that information in a way that enables members of the community to understand and contextualise the information so that they can respond appropriately.

We have developed an initial scope for the project in Appendix E but recommend that it is collaboratively developed with associated agencies.

Key Opportunity 3 – Development of a comprehensive flood gauging, information and communication network that centralises information and makes it readily accessible to all stakeholders.

We have reviewed numerous large-scale infrastructure proposals such as levees, drainage channels, diversions, outlets and other similar options. Whilst their function is likely to be very suitable for minimising local flood risk, there is insufficient evidence to indicate how they might impact the whole-of-catchment system (i.e. how they might impact upstream and downstream areas). This strengthens the need for a whole-of-catchment model. Without this whole-of-catchment model available yet, caution should be exercised when considering the implementation of any large-scale infrastructure-based projects, especially where the information used to assess their efficacy is limited to a small area or out-of-date.

Key Opportunity 4 – Caution must be exercised when considering the implementation of any large-scale infrastructure projects until a whole-of-catchment assessment is undertaken to ensure that they will provide an overall net benefit to the region.

There is real tension between rural and urban flood response. We have observed the need to take a balanced view as many of the flood mitigation structures benefit both areas and ensure that both areas are considered. At present many agricultural areas are not included within any flood modelling. A typical example might be the need to ensure adequate drainage in agricultural areas such that the restoration of land for agriculture can be established soon after the flood event. We heard of many situations where water remained on paddocks for considerable periods, drowning out crops and pasture, and preventing restoration of the businesses which relied on productive land. This was considerably less obvious than property damage in residential and commercial areas, but no doubt as damaging in the long term.

It is also difficult to separate the function of levees in rural areas in terms of protecting both rural and urban areas nearby. We suggest that levee function be considered as related to the overall area that it benefits, not considered rural or urban.

Key Opportunity 5 – Further consideration of the needs of rural landholders and the role of infrastructure in rural areas is needed in flood mitigation.

Many of the local governments we talked to note the lack of capacity and funding to maintain existing infrastructure, let alone dealing with new infrastructure that may arise out of this project. It was stressed often to us that the amount of funding for maintaining flood infrastructure had not increased in nearly 25 years. Lack of maintenance of drains, flood gates and other infrastructure was also regularly raised as a cause of flooding in most of the engagement sessions. A focus on both funding of capital and operational funding is therefore needed.

Key Opportunity 6 – As a matter of urgency, funding of maintenance of flood management and mitigation structures/infrastructure needs to be significantly improved

Many of the projects identified are not well scoped or truly “shovel ready”. Most, if not all, will need further assessment to ensure they can be properly delivered (e.g. detailed design, refined cost estimates, survey, approvals processes etc).

Key Opportunity 7 – Projects identified for funding will likely need further detailed scoping and design. It is likely that this will change costs and priorities. Care needs to be taken around the allocation of funds to ensure that flexibility is provided where these costs may vary.

Economic resilience is essential to the ongoing survival and sustainability of these regional communities. Key economic assets, such as small and large employers, commercial areas and associated supporting services, need to be considered as essential for the recovery of the region. What appears to be missing is clear guidance on what are the critical economic assets, and what does the future economic pathway look like for the region and key centres. This has been highlighted in the key themes of the previous section, but is reiterated here.

Key Opportunity 8 – Economic resilience needs to be considered for regional centres and the entire Northern Rivers region to identify critical infrastructure and services that are essential for flood resilience and recovery.

10.2 Conclusions

This project has identified a large number of projects that may be suitable for funding under the Emergency Response Fund allocation. Even so, the ability of these projects to reduce flood impacts for an event of the size of the February/March 2022 flood events is unlikely to be well understood until they can be assessed in a whole of catchment model such as that being developed through the longer two year project being implemented under the NRRI. What these projects will deliver is an improvement in the ability to manage smaller floods and improve the recovery and resilience of the region. The challenge in delivering such a wide range of projects like those identified is that they are largely evaluated in isolation and without a catchment scale model to understand the combined effects of the projects.

Overall, however, this rapid prioritisation project has been implemented with considerable community input into project identification, key criteria that are important to them and most importantly, a chance to have their concerns documented and put forward to relevant authorities.

In the timeframes available, we have not been able to completely verify all of the projects as to their suitability at this point in time, given that many were identified prior to the February/March 2022 event. There are many studies and assessments currently underway to evaluate further projects and mitigation approaches that may be more beneficial than those identified here, but what has been identified is those that are most suitable at the time of writing.

It is hoped that the lists and methods identified, and the information gathered, will further inform flood management for the Northern Rivers region, and that this should be seen as an ongoing need. Managing flooding in this region is highly complex, technically, socially, culturally and economically. It will not be solved by injections of funding if they are not supported by ongoing assessments of all of the aspects identified in our multi-criteria assessment.

Appendix A Full Project List

Note this is those projects identified through the document analysis process and local government proposals. Public submissions were also received after this full list was finalised and are contained in Appendix F.

Table 14. Full Project list (not including public submissions – see Appendix F)

ID	LGA	Source Study	Year report published	Location	Confidence	Watercourse 1	Option	Description	OPTION TYPE Flood Modification	OPTION TYPE Property Mod	OPTION TYPE Response Modification	Source report Priority	Council recommendations in source report
BY1	Byron	North Byron FPRMS 2020	2020	Mullumbimby	High		Avocado Court drainage modification consideration	Increase network capacity along Avocado Court, Grevillea Avenue and Pine Avenue (600mm pipe increased to 900mm, 750mm to 1200mm and 9000mm to 1200mm). Installation of three (3) additional inlets. Benefits: Reduction in above floor inundation and in number of properties affected by flood. In the 1% AEP event, flood levels are reduced significantly in Avocado Court and Grevillea Avenue, up to 0.25m and 0.7m.	Floodways			MODERATE	
BY2	Byron	North Byron FPRMS 2020	2020	Billinudgel	High	Marshalls Ck	Billinudgel infrastructure improvements	Bank lowering and widening to reduce peak levels	Landscape Management			LOW	
BY3	Byron	North Byron FPRMS 2020	2020		High	Saltwater Ck	Saltwater Ck upgrade assessment	Investigate various options for embankment removal and culvert capacity	Floodways			MODERATE	
BY4	Byron	North Byron FPRMS 2020	2020		High		Develop guidance on the design and installation of fencing traversing waterways and channels.	Ensuring fence design does not obstruct flood flow	Landscape Management			LOW	
BY5	Byron	North Byron FPRMS 2020	2020		High	Brunswick River	Implement debris control measures for Federation Bridge and Billinudgel Railway Bridge		Landscape Management			HIGH	
BY6	Byron	North Byron FPRMS 2020	2020	North Byron	High		Development of a whole of catchment drainage model and overland flow path investigation	Development of a whole catchment drainage model including formal pipe network. The overland flow paths study scope also includes: - BY15: Undertaking a more detailed assessment of properties which may benefit from property level protection - BY3: Further detailed assessment of Saltwater Creek upgrade assessment and mitigation options for Mullumbimby. (incl. influence of structures) - BY23: More detailed assessment of potential raising of River Street to provide improved flood immunity and evacuation. - BY9: Consider viable options to implement the recommendations of the New City Road drainage assessment (assessment recommends culvert outlet construction and channel maintenance). - BY2: Further consideration of Billinudgel infrastructure improvements including the possiblity of bank lowering and widening to reduce peak levels - BY1: Further consideration of Avocado Court drainage modification			Technical Study	HIGH	
BY7	Byron	North Byron FPRMS 2020	2020	North Byron	High	Brunswick Estuary	Develop a sediment transport model to investigate modification to the rock walls, as part of the Coastal Management Program for the Brunswick Estuary.	A detailed sediment transport model to investigate modification to the rock walls for the purpose of improved sediment transport, as part of the Coastal Management Program Scoping Study for Cape Byron to South Golden Beach. Will provide an understanding of sediment transport processes due to the rock walls and will investigation options for improving sediment transport in Readings Bay. Limited concerns with this option. Costs associated with development of this model however funding options are available.			Technical Study	MODERATE	
BY8	Byron	North Byron FPRMS 2020	2020		High	Capricornica Canal	Implement recommendations from South Golden Beach levee audit	Audit includes a number of recommendations, predominantly regarding the clearing of vegetation and ongoing maintenance of the levee. Provide benefits to the South Golden Beach community as a method for providing ongoing maintenance of the levee. Some costs associated with maintenance of levee. Levee audit notes there may be limitations as the inspection was visual only.	Levees			LOW	
BY9	Byron	North Byron FPRMS 2020	2020	Mullumbimby	High	Brunswick River	Options to implement New City Rd drainage assessment	Assessment recommends culvert outlet construction and channel maintenance			Technical Study	LOW	
BY10	Byron	North Byron FPRMS 2020	2020		High		House raising scheme investigation	Consideration for 11 properties		House Raising		MODERATE	
BY11	Byron	North Byron FPRMS 2020	2020		High		Formalise house purchase scheme	Consider VHP for 15 eligible properties		House Purchase		LOW	
BY12	Byron	North Byron FPRMS 2020	2020		High		Amend land use zoning	Update land use zoning to include flood hazard in Mullumbimby, South Golden Beach and New Brighton		Land use planning / zoning		HIGH	
BY13	Byron	North Byron FPRMS 2020	2020		High		Revise flood planning levels	Adopt flood planning levels determined in FRMS&P, include sea level rise		Land use planning / zoning		HIGH	
BY14	Byron	North Byron FPRMS 2020	2020		High		Revise flood planning area	Adopt flood planning areas determined in FRMS&P, include sea level rise		Land use planning / zoning		MODERATE	
BY15	Byron	North Byron FPRMS 2020	2020		High		Undertake a more detailed assessment of properties which may benefit from property level protection	Undertake more detailed assessment of properties which may benefit from property level protection - measures include sandbags, plastic sheeting, barriers		Flood proofing / building control		HIGH	
BY16	Byron	North Byron FPRMS 2020	2020		High		Providing property level flood info via GIS portal	Informing homeowners of thier flood risk		Flood proofing / building control		HIGH	
BY17	Byron	North Byron FPRMS 2020	2020		High		Council consider updating the DCP to incorporate the recommendations detailed in the FRMS; Provide more detailed guidance on the principles of wet proofing, appropriate design and materials, with direct reference to available guideliness; include a requirement for an assessment of property level protection as part of the DCP2014 planning matrix criteria FL4; Implement the recommendations regarding appropriate fill areas in the DCP2014			Land use planning / zoning		HIGH	
										Land use planning / zoning		HIGH	
										Land use planning / zoning		HIGH	
BY20	Byron	North Byron FPRMS 2020	2020	Ocean Shores	High	Marshalls Ck	Byron Shire Council compliance team investigate illegal builds south of North Heads Road.	Area has been identified as incompatible with development, builds are a risk to life			Flood prediction and warning	MODERATE	
BY21	Byron	North Byron FPRMS 2020	2020	Byron	High		Form committee of council, state, emergency services and community	Ensure implementation of FRMP			Other non-infrastructure	MODERATE	
BY22	Byron	North Byron FPRMS 2020	2020	North Byron	High		Flood warning system for North Byron	Improve communication, accuracy and prediction			Flood prediction and warning	HIGH	
BY23	Byron	North Byron FPRMS 2020	2020	New Brighton	High	Marshalls Ck	Assessment of raising River St	To provde improved immunity and evacuation routes			Flood access and evacuation	LOW	
BY24	Byron	North Byron FPRMS 2020	2020		High		Identify key roads and implement automatic warning signs and depth indicators	Consider investigating automatic warning signs and depth indicators for the Pocket Road and Sherry's Bridge on Main Arm Road.			Flood-awareness, education and readiness	HIGH	
BY25	Byron	North Byron FPRMS 2020	2020		High		Engage with the community to prepare an ongoing flood education program,	This will limit complacency and improve awareness			Flood-awareness,	MODERATE	

ID	LGA	Source Study	Year report published	Location	Confidence	Watercourse 1	Option	Description	OPTION TYPE Flood Modification	OPTION TYPE Property Mod	OPTION TYPE Response Modification	Source report Priority	Council recommendations in source report
							with appropriate evaluation by Council and SES following implementation.				education and readiness		
BY26	Byron	North Byron FPRMS 2020	2020	Mullumbimby	High	Brunswick River	Evacuation Assessment for Mullumbimby	Identify evacuation centre and improve capability			Flood access and evacuation	HIGH	
BY27	Byron	Belongil Ck FRMS&P 2015	2015	Byron Bay	High	Belongil Creek	Permanent Belongil Ck Entrance Opening	Install permanent opening to allow catchment to better flow to ocean	Floodgates			No	
BY28	Byron	Belongil Ck FRMS&P 2015	2015	Byron Bay	High	Belongil Creek	Byron Drainage Strategy	Reduces flooding and improves immunity, through a series of pumps	Floodways			Pending	
BY29	Byron	Belongil Ck FRMS&P 2015	2015	Byron Bay	High		Preferred Byron Drainage Strategy Construction	Improved drainage and wetland creation. Reduction in current flood risk from Belongil Creek and Storm Tide, reduction of risk to people, risk to property. Ecological improvement.	Detention Basins			Pending	
BY30	Byron	Belongil Ck FRMS&P 2015	2015	Byron Bay	High		Drainage Infrastructure Maintenance	Council identified 5 major drainage lines that require maintenance. Reduction in current flood risk from Belongil Creek and Storm Tide, reduction of risk to people, risk to property. Ecological improvement.	Landscape Management			Yes	
BY31	Byron	Belongil Ck FRMS&P 2015	2015	Byron Bay	High	Belongil Creek	North Coast Railway Bridge Widening	Double width to 80m	Floodways			No	
BY32	Byron	Belongil Ck FRMS&P 2015	2015	Byron Bay	High	Belongil Creek	Belongil Creek Entrance Strategy	Long term plan for creek entrance structure	Floodgates			Yes	
BY33	Byron	Belongil Ck FRMS&P 2015	2015	Byron Bay	High		Community Awareness	Multi-faceted community awareness campaign Reduction of residual flood risk from Belongil Creek. Reduction of risk to people, risk to property. Ecological improvement.			Flood-awareness, education and readiness	Yes	
BY34	Byron	Belongil Ck FRMS&P 2015	2015	Byron Bay	High		Flood Warning: Gauge at Ewingsdale Road Bridge and St Helena	Gauge at Ewingsdale Road Bridge and St Helena			Flood prediction and warning	Yes	
BY35	Byron	Belongil Ck FRMS&P 2015	2015	Byron Bay	High		Flood information: Develop info data set, review emergency procedures	Develop info data set, review emergency procedures			Flood-awareness, education and readiness	Yes	
BY36	Byron	Belongil Ck FRMS&P 2015	2015	Byron Bay	High		Emergency planning	SMS warning, evacuation routes for Johnson St, prioritise evacuation for Belongil Spit, education			Flood access and evacuation	Yes	
BY37	Byron	Belongil Ck FRMS&P 2015	2015	Byron Bay	High		Voluntary house raising per/property	Engage owners regarding possible raising		House Raising		Yes	
BY38	Byron	Belongil Ck FRMS&P 2015	2015	Byron Bay	High		Adoption of the Flood Planning Matrix	Aims to provide an assessment framework which prevents inappropriate development within the floodplain.		Land use planning / zoning		Yes	
TW1	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Plan for pedestrian and local evacuation	Identify suitable evacuation points; Update residents			Flood access and evacuation	HIGH	
TW2	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Install flash flood warning system	Install audible flood sirens linked to river gauges; managed by SES			Flood prediction and warning	HIGH	
TW3	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Establish flood watch network	SES to promote the concept particularly in high risk locations				HIGH	
TW4	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Voluntary House Purchase	Recommended to extend current VHP scheme		House Purchase		MEDIUM	
TW5	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Voluntary House Raising	Recommended to extend current VHR scheme		House Raising		MEDIUM	
TW6	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Inform high risk residents	Recommended to contact all properties identified under VHP & VHR schemes as being high risk			Flood-awareness, education and readiness	HIGH	
TW7	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Manage strategic development	Manage hydraulic impacts associated with future development		Land use planning / zoning		HIGH	
TW8	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Manage future development flood risk	Council to update relevant development controls and policies to incorporate recommendations made in study		Land use planning / zoning		HIGH	
TW9	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Implement climate change adaption plan	Recommended that Council implement Climate Change Adaption using flood study info			Other non-infrastructure	MEDIUM	
TW10	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Update local flood plan	SES to update plan to include info derived from flood studies		Land use planning / zoning		HIGH	
TW11	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Plan for different types of flood risk	Using map of hydraulic risk map, SES will update their emergency planning			Technical Study	HIGH	
TW12	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Plan for flash flooding	Recommended that SES use a triage approach with thier flash flood planning			Technical Study	HIGH	
TW13	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Promote general flood awareness	SES and Council to promote tailored messages throughout area			Flood-awareness, education and readiness	HIGH	
TW14	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Target education campaigns based on flood risk	Generate specific flood awareness material for each flood risk type			Flood-awareness, education and readiness	HIGH	
TW15	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Provide flood information	Online interactive mapping for the public			Flood-awareness, education and readiness	MEDIUM	
TW16	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Provide info to assist with personal flood plans	SES door knocking and letterbox drop for residents most at risk			Flood-awareness, education and readiness	HIGH	
TW17	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Target new residents and tourists with flood info	Target awareness material at new residents and tourists, consider novel distribution channels			Flood-awareness, education	HIGH	

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TW18	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Use social media	Estabish a Facebook page dedicated to flooding			and readiness Flood-awareness, education and readiness Flood-awareness, education and readiness	MEDIUM	
TW19	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Undertake disaster resilence workshops	Council to provide support to SES through planning and leading workshop			**Flood prediction and warning**	HIGH	
TW20	**Tweed**	**Tweed Coastal Creeks FRMP**	**2015**	**Tweed**	**N/A**		**Enhance gauge network**	**5 additional stream gauges and two more rain gauges in Burringbar, Mooball and Crabbes Ck area**			Flood prediction and warning	**HIGH**	
TW21	Tweed	Tweed Coastal Creeks FRMP	2015	Tweed	N/A		Develop gauge triggers	Perform flood modelling to determine gauge triggers				HIGH	
TW22	**Tweed**	**Tweed Valley FRMP**	**2014**	**Murwillumbah**	**Medium**		**Local drainage study (Murwillumbah)**	**Local drainage issues, such as blocked and / or overflowing drains, were identified by the SES and Floodplain Management Committee (FMC) as key impediments to evacuation in the past. Local drainage studies would provide more information about flooding from this source. A local drainage study for Murwillumbah town is also needed for the purposes of quantifying and mitigating stormwater risks behind the town levee, to optimise the operation of the Lavender Creek pump station, and development planning purposes.**			**Technical Study**	**HIGH**	
TW23	Tweed	Tweed Valley FRMP	2014	Lower Tweed, Chinderah	Medium		Local drainage study (Lower Tweed and Chinderah)	Based on anecdotal evidence from past flooding events (particularly 2005), local drainage studies are recommended for the lower Tweed area (including Tweed Heads, Tweed Heads South and Banora Point) and Chinderah. Improve evacuation cabability through better route immunity; Quantify risk and identify mitigation			**Technical Study**	**HIGH**	
TW24	Tweed	Tweed Valley FRMP	2014	Lower Tweed	Medium		Raise Tweed Heads Sth levee to 100 ARI levels	Provides additional evacuation time; 190 additional protected dwellings; 200k annual maintence	**Levees**			**MODERATE**	
TW25	Tweed	Tweed Valley FRMP	2014	Lower Tweed	Medium		Tweed Heads Sth levee overtopping study	Inform future decisions. $30,000 each			Technical Study	MODERATE	
TW26	Tweed	Tweed Valley FRMP	2014	Lower Tweed	Medium		Extend Tweed Heads Sth Levee - 100 ARI protection	Provides additional evacuation time for Phillip Parade; 60 additional protected dwellings; 100k annual maintence	**Levees**			**MODERATE**	
TW27	Tweed	Tweed Valley FRMP	2014	Murwillumbah	Medium		Enhance Sth Murwillimbah-Condong flowpath	It was identified that the hydraulic connection between the South Murwillumbah and Condong basins at Lot 4 Quarry Road is a critical flowpath that should be preserved to ensure no worsening of flooding in South Murwillumbah. Mechanisms for achieving this via either acquisition or planning controls have been identified as part of the review of planning considerations. There is also potential to alleviate flooding in the South Murwillumbah basin by improving this flowpath. Initial assessment indicated that lowering Lot 4 Quarry Road to the levels of the upstream airstrip could reduce 100 year ARI flood levels in the South Murwillumbah basin by approximately 50 mm.	**Floodways**			**HIGH**	
TW28	Tweed	Tweed Valley FRMP	2014	Murwillumbah	Medium		Murwillimbah Levee Overtopping Study	Inform future decisions; Improve hydraulic behaviour understanding			Technical Study	MODERATE	
TW29	Tweed	Tweed Valley FRMP	2014	Murwillumbah	Medium		Voluntary House Purchase			**House purchase**		**MODERATE**	
TW30	Tweed	Tweed Valley FRMP	2014	Murwillumbah, Tweed Heads	Medium		Voluntary House Raising			House raising		MODERATE	
TW31	Tweed	Tweed Valley FRMP	2014		Medium		Strategic Planning	Ensure future development of study area manages flood risk		Land use planning / zoning			
TW32	Tweed	Tweed Valley FRMP	2014		Medium		Method of flood warning	Review and update flood warning plans			Flood prediction and warning	HIGH	
TW33	Tweed	Tweed Valley FRMP	2014		Medium		Detailed evacuation planning study	Commission detailed evacuation planning study			Technical Study	HIGH	
TW34	Tweed	Tweed Valley FRMP	2014		Medium		Community FloodSafe program	Update with strategies from study, include evacuation plan			Flood-awareness, education and readiness	HIGH	
TW35	Tweed	Tweed Valley FRMP	2014		Medium		Provide personal flood risk info	Modelling based info, comission model to link gauge height to floor level			Flood-awareness, education and readiness	HIGH	
TW36	Tweed	Tweed Valley FRMP	2014		Medium		Educate high risk residents	Part of FloodSafe			Flood-awareness, education and readiness	MEDIUM	
TW37	Tweed	Tweed Valley FRMP	2014		Medium		Develop flood safe website	Upgrade council website, ensure can handle high traffic			**Flood-awareness, education and readiness**	**HIGH**	
TW38	Tweed	Tweed Valley FRMP	2014		Medium		Continue Flood Watch Network	Educate, identify and recruit members			Flood prediction and warning	MEDIUM	
TW39	Tweed	Tweed Valley FRMP	2014	Tabulum	Medium		Include Tumbulgum gauge in warning system	Recommend to NSW Flood Warning Committee			**Flood prediction and warning**	**MEDIUM**	
TW40	Tweed	Tweed Valley FRMP	2014		Medium		Improve storm surge prediction capabilities	Advise local SES			Flood prediction and warning	MEDIUM	
TW41	Tweed	Tweed Valley FRMP	2014		Medium		Review plans for areas with insufficient warning	Educate residents			Flood prediction and warning	HIGH	
TW42	Tweed	Tweed Valley FRMP	2014		Medium		Include pedestrian evacuation in planning	Educate residents, identfy routes			Flood access and evacuation	MEDIUM	
TW43	Tweed	Tweed Valley FRMP	2014		Medium		Develop rural evacuation plans	Educate residents, identfy routes			Flood access and evacuation	MEDIUM	
TW44	Tweed	Tweed Valley FRMP	2014		Medium		Review evacuation centres	Review capabilities and planning, review communications between departments			Flood access and evacuation	MEDIUM	
TW45	Tweed	Tweed Valley FRMP	2014	Tweed Heads	Medium		Identify alternative to Tweed Civic Centre	alternative to function as evacuation centre. Check capability			Flood access and evacuation	MEDIUM	

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TW46	Tweed	South Murwillumbah FRMS&P	2019	Murwillumbah	High	Tweed River	Earthworks across Lot 4 on Quarry Rd	Preserves the South Murwillumbah Condong Flowpath, provides protection for 1% AEP floods	**Floodways**			**HIGH**	
TW47	Tweed	South Murwillumbah FRMS&P	2019	Murwillumbah	High	Tweed River	Raise Sth Murwillumbah Levee to 20% AEP, raise CBD Levee	Raise embankment by 0.4 to 0.8m between Colin and Alma St as well as new spillway and extention to the south	**Levees**			**LOW**	
TW48	Tweed	South Murwillumbah FRMS&P	2019	Murwillumbah	High	Tweed River	Alma St modification	Involves elevation of Alma Street. Goal of this option is to provide additional time for people from South Murwillumbah to evacuate into the Murwillumbah CBD andWill occur if levee raising or in conjunction with future works		Flood proofing / building control		LOW	
TW49	Tweed	South Murwillumbah FRMS&P	2019	Murwillumbah	High	Tweed River	Modify Condong CK Channel	Council to initiate discussions with stakeholders	**Floodways**			**MEDIUM**	
TW50	Tweed	South Murwillumbah FRMS&P	2019	Murwillumbah	High	Tweed River	Voluntary House Purchase	The proposed scheme is suitable and should continue to be implemented		House purchase		MEDIUM	
TW51	Tweed	South Murwillumbah FRMS&P	2019	Murwillumbah	High	Tweed River	Temporary flood barriers (Commercial properties)	Property owners resposnsible for implementation costs	Temporary Flood Barriers			MEDIUM	
TW52	Tweed	South Murwillumbah FRMS&P	2019	Murwillumbah	High	Tweed River	Land Swap Options	Earthworks could also be considered across these properties, Subject to availability. Second higher cost option available if properties are unwilling to participate		House Purchase		HIGH	
TW53	Tweed	South Murwillumbah FRMS&P	2019	Murwillumbah	High	Tweed River	Consolidate (i.e. combine) residential lots to prevent intensification of development.	This option would look to consolidate (i.e., combine) these lots to prevent intensification in development. In general, two residential allotments that contain a single residential building would be consolidated into a single residential lot. This option would not alter existing flood behaviour or reduce the existing risk. However, it will help to ensure that the existing flood risk is not increased in the future and may provide an opportunity to reduce the future flood risk if redevelopment of these lots occurs and more flood resilient buildings take their place.		Land use planning / zoning		MEDIUM	
TW54	Tweed	South Murwillumbah FRMS&P	2019	Murwillumbah	High	Tweed River	Residential Flood Plan	Promote flood plan preparation		Land use planning / zoning		HIGH	
TW55	Tweed	South Murwillumbah FRMS&P	2019	Murwillumbah	High	Tweed River	Business Flood Plan	Promote flood plan preparation		Land use planning / zoning		HIGH	
TW56	Tweed	South Murwillumbah FRMS&P	2019	Murwillumbah	High	Tweed River	Flood Warning System Upgrades	Revise river level triggers to include evacuation route cut off and levee overtopping; Investigate use of SMS warning			Flood prediction and warning	MEDIUM	
TW57	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		Increasing height of East Murwillumbah & Commercial Rd levees	Includes provision of dedicated spillway; Reduce overtopping frequency; Protection above 1% AEP	**Levees**			**N/A**	
TW58	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		New low flow pump Lavender St	Some flood reductions south of creek, neglibigle when overtopping occurs	Levees			N/A	
TW59	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		Additional Wharf St Pump Capacity	Requires an independent pump system rather than upgrade	Levees			N/A	
TW60	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		New pump systems behind Dorothy St & East Murwillimbah levees	Significant Reductions during 1% AEP	**Levees**			**Recommended**	
TW61	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		Additional Proudfoots Lane pump to convey runoff	Flood level reduction for 20% AEP (0.5m) and 1% AEP (<0.05m); Innundation time reduction	**Levees**			**N/A**	
TW62	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		Regrading William St & Wharf St	Some significant reductions		Flood proofing / building control		N/A	
TW63	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		Drainage Upgrades in Proudfoots Ln, Nullum Ln & William St	0.5m reductions for 20% AEP on William St; Increased flow across playing fields; Small reductions in Proudfoot lane	Landscape Management			N/A	
TW64	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		Redesign of Commercial Rd levee gates	Minimal hydraulic impacts; Some inudation time reductions during larger floods (0.2 AEP)	Floodgates			N/A	
TW65	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		Planning Recommendations	Suggested that council have a more sensitive flood model perspecitve suring future development		Land use planning / zoning		N/A	
TW66	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		Temporary flood barriers (Commercial properties)	Provides benefits when depths are less than 0.9m, typically up to 1% AEP; Purchased at cost of owner	Temporary Flood Barriers			Recommended	
TW67	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		Local Flood Plan updates	Update to include learnings from ex-tropical cyclone Debbie and more detailed flood modelling			Flood prediction and warning	Recommended	
TW68	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		Flood Warning System	Develop SMS warning system, provide resources and develop community education program			Flood prediction and warning		
TW69	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		Community education	Install 'totem pole'near Wharf st and Commercial Rd intersection, provide education messages, basic website and property specific flood info			Flood-awareness, education and readiness		
TW70	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		River Dredging	No information provided	Landscape Management				
TW71	Tweed	Murwillumbah Levee & Drainage Study	2018	Murwillumbah	High		Knox Park duck pond excavation	Provide additional flood capacity storage	**Detention basins**				
KY1	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High	Timbarra River	1% AEP - Flood Levee	Increased upstream flood levels by 0.14m, construction and land aquisition constraints	Levees				
KY2	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High	Timbarra River	2% AEP - Flood Levee	Increased upstream flood levels by 0.14m, construction and land aquisition constraints	Levees				
KY3	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High	Timbarra River	Floodway - Location 1 Excavation	Excavate 600,000m3 of material east of racecource, erosion, downstream flood level increase	Floodways				
KY4	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High	Timbarra River	Floodway - Location 2 Excavation	Excavate 2,000,000m3 of material downstream of racecource, impacts wetland, downstream flood level increase	Floodways				
KY5	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High	Timbarra River	Improve Bruxner Highway evacuation route	Ensures evacuation route up to 1% AEP			Flood access and evacuation		
KY6	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High		Voluntary House Purchase	Reduces population at risk to high hazard flooding and property damage		House purchase		MEDIUM	
KY7	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High		Voluntary House Raising	15 potential properties; Aims to reduce over floor flooding		House raising		LOW	
KY8	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High		Review of LEP land zoning measures	Enables gradual migration out of floodplain		Land use planning / zoning		HIGH	
KY9	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High		Amend LEP	Amend Kyogle LEP to include Tabulam in flood mapping		Land use planning / zoning		HIGH	
KY10	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High		Amend DCP	Provide flood standard for non-residential planning		Land use planning / zoning		HIGH	

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KY11	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High		Develop/Upgrade flood warning system	Allow real time monitoring, refine forecasting features			Flood prediction and warning	HIGH	
KY12	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High		Flood education and awareness program	Signposting and messaging by council or SES			Flood-awareness, education and readiness	HIGH	
KY13	Kyogle	Tabulam Floodplain Risk Management Plan	2019	Tabulam	High		Update local flood plan	Formalise procedures, identify evacuation centres, outline updates			Flood prediction and warning	HIGH	
KY14	Kyogle	Kyogle Floodplain Risk Management Plan	2009	Kyogle	High	Richmond River	10% AEP Partial Ring Levee + Additional Fawcetts Ck Floodway	Improves structural stability; Provides protection to 'the flats''; Gives evacuation warning	Levees			HIGH	
KY15	Kyogle	Kyogle Floodplain Risk Management Plan	2009	Kyogle	High	Richmond River	Voluntary House Purchase	Reduction in house and property damage		House purchase		MEDIUM	
KY16	Kyogle	Kyogle Floodplain Risk Management Plan	2009	Kyogle	High	Richmond River	Voluntary House Raising	Reduction in house damage. Voluntary house raising of those houses inundated above floor level in the 5% AEP event.		House raising		HIGH	
KY17	Kyogle	Kyogle Floodplain Risk Management Plan	2009	Kyogle	High	Richmond River	Development Controls	High intangible benefit, control development on floodplain thereby minimising risk		Land use planning / zoning		HIGH	
KY18	Kyogle	Kyogle Floodplain Risk Management Plan	2009	Kyogle	High	Richmond River	Improve flood awareness	The following actions are proposed to increase flood awareness in Kyogle: - Dissemination of flood related brochures and booklets to the entire township. The brochures should be distributed annually at the beginning of the wet season (October). Any new residents should receive the brochure irrespective of the time of year. Within the content of the flyer should be contact details and helpful tips on what to do in a flood situation. - Permanent marking of historic flood levels (e.g. 2008, 1999, 1989, 1954) in numerous highly visible locations around Kyogle. Locations such as power poles adjacent to Fawcetts Creek on the Summerland Way near the town centre of Kyogle or signage on the Anzac Park toilet block are ideal for this purpose. - Construction of a permanent flood education billboard in the Visitor Information Center and Amphitheatre site documenting the flood history of Kyogle. Adjacent to the billboard, a flood totem marking historic flood levels will be erected. Additionally, the specific flood awareness strategies outlined in the Kyogle Local Flood Plan (SES, 2003) should be continued. The flood awareness strategies listed in the document include: - Talks and displays orientated to community organisations and schools; and - Publicity given to the Kyogle Local Flood Plan and to flood-orientated SES activities through local media outlets, including articles in local newspapers about the flood threat and appropriate response.			Flood-awareness, education and readiness	HIGH	
LI1	Lismore	Lismore Floodplain Risk Management Study	2020	Lismore CBD	HIGH	Wilsons River	CBD Levee Raising to 5% AEP flood immunity	200-400mm raising of levee to provide protection to 5% AEP event up from approx 10% AEP	Levees			N/A	
LI2	Lismore	Lismore Floodplain Risk Management Study	2020	Lismore South	HIGH	Leycester Creek	South Lismore Levee Raise to 5% AEP	raise to the existing South Lismore levee along the current alignment, to achieve 5% AEP immunity. 11 protected in 1% AEP, 14 protected in 5% AEP (of 353)	Levees			N/A	
LI3	Lismore	Lismore Floodplain Risk Management Study	2020	Lismore South	HIGH	Wilsons River	Excavation of Wilsons River Bend	Excavating the land located at 387 Keen Street which is on the eastern bank of Wilsons River by 1-3 m . 42 protected in 1% AEP, 14 protected in 5% AEP (of 353)	Landscape Management			N/A	
LI4	Lismore	Lismore Floodplain Risk Management Study	2020	Lismore	HIGH	Wilsons River	Removal of Kyogle Road Railway Embankment	8 protected in 1% AEP, 0 protected in 5% AEP (of 353)	Landscape Management			N/A	
LI5	Lismore	Lismore Floodplain Risk Management Study	2020	Lismore	HIGH	Wilsons River	Increased Conveyance at Hydraulic Controls	upgrades to key hydraulic controls downstream of Lismore to increase conveyance through South Lismore	Landscape Management			N/A	
LI6	Lismore	Lismore Floodplain Risk Management Study	2020	Lismore	HIGH	Wilsons River	Combined option LI1 to LI5	-	Landscape Management			N/A	
LI7	Lismore	Lismore Floodplain Risk Management Study	2020	Lismore	MEDIUM	Wilsons River	Zoning and Development Control	It is recommended that development controls in the Lismore LEP 2012 and Lismore DCP are reviewed and updated to align with the latest flood risk information from this study as well as consideration for the Lismore Floodplain Risk Management Plan (2014).		Land use planning / zoning		N/A	
LI8	Lismore	Lismore Floodplain Risk Management Study	2020	Lismore	MEDIUM	Wilsons River	Voluntary House Purchase	It is recommended that LCC review the current VHP scheme. It is also recommended that the list of eligible houses be reviewed with consideration for the hydraulic results from this Study.		House purchase			
LI9	Lismore	Lismore Floodplain Risk Management Study	2020	Lismore	MEDIUM	Wilsons River	Voluntary House Raising	It is recommended that LCC review the eligibility criteria to provide greater flexibility where warranted. Also recommended that list of eligible houses is reviewed with consideration for the results from this Study.		House raising			
LI11	Lismore	Lismore Floodplain Risk Management Study	2020	Lismore	MEDIUM	Wilsons River	Community Flood Awareness and Readiness	It is recommended that LCC ... develop a community awareness strategy to disseminate the latest flood information as part of the Lismore FRMP implementation.			Flood-awareness, education and readiness		
LI12	Lismore	Lismore Floodplain Risk Management Study	2020	Lismore	MEDIUM	Wilsons River	Flood Prediction & Warning: provide URBS model to BoM for review and NSW SES, BoM and LCC review flood warning systems	It is recommended that the URBS model from this Study be provided to BoM for review and consideration for flood prediction purposes. Additionally, it is recommended that the NSW SES, BoM and LCC review the flood warning systems in place for Lismore.			Flood prediction and warning		
LI13	Lismore	Lismore Floodplain Risk Management Study	2020	Lismore	MEDIUM	Wilsons River	Emergency Response for Floods	It is recommended that the NSW SES in conjunction with LCC review the Lismore City Local Flood Plan in light of the updated flood modelling results from this Study and consider any lessons learnt from the 2017 event.			Flood-awareness, education and readiness	Recommended	
BA1	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina		Richmond River	Implement Gallans Rd Cycleway Floodway	Gallans Rd Cycleway Floodway lies to the south of Cumbalum Ridge between Emigrant Creek and North Creek floodplains. Minimal cross drainage infrastructure has been provided to allow flow between Emigrant Creek and North Creek. The proposed flood modification measure involves removal of the southern 100m of the embankment and incorporates clearing of drains and Roberts Creek. A cost-benefit analysis undertaken in the BFRMS indicated that the scheme has a cost-benefit ratio of 2.8 (or 5.6 when accounting for intangible damages). It is recommended that a preliminary design, which includes a more detailed feasibility assessment and environmental impact assessment, is undertaken.	Floodways			Recommended	
BA2	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina		Richmond River	Removal/Lowering of Deadmans Ck Road	Deadmans Creek Road, which services development on the Cumbalum Ridge, is located along an embankment across the Emigrant Creek floodplain in Cumbalum. This embankment acts like a weir, raising upstream flood levels. A new road (Ballina Heights Drive) providing a similar service is located approximately 1km north of Deadmans Creek Road. Therefore, there may be an opportunity to remove or lower Deadmans Creek Road.	Landscape Management			Recommended	
BA3	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Cabbage Tree Island		Richmond River	Cabbage Tree Island Low Level Deflector Levee	Construction of a low level deflector levee with a nominal crest elevation of 2.6 mAHD (10 year ARI flood level plus a freeboard of 300mm) extending around the southern end of Cabbage Tree Island. The levee would be elevated up to 2 metres above the island. It would 'deflect' flood flows around the southern end of Cabbage Tree Island and prevent floodwaters from discharging in a northerly direction across the habited areas during floods up to and including the 10 year ARI flood. The levee would also serve to slow the progression of floodwaters during	Levees			Recommended	

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								larger floods. Flood modelling for the levee has shown that the 100 year ARI flood level would be decreased by 100mm at the island and flow velocities are expected to decrease by up to 0.4 m/s behind the levee. The imposition of development controls can be an effective means of managing flood risks associated with future development (including redevelopment). The Ballina Development Control Plan, 2012, Chapter 26 – Floodplain Management was adopted by Council on 2 December 2012. While these controls will manage future flood risk, a more flexible approach to managing future flood risk could be considered. A draft DCP has been developed by Bewsher Consulting in close collaboration with Council's planners during the Ballina Floodplain Risk Management Study. In addition, the draft Wardell and Cabbage Tree Island Floodplain Risk Management Plans provide specific advice as follows: - Council develop policy to limit residential dwellings on Cabbage Tree Island to maintenance or replacement of existing premises. It is recommended that community related buildings be allowed, provided they are constructed with flood compatible materials and meet other general requirements for development on flood prone land (Worley Parsons, 2009).					
BA4	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina; Cabbage Tree Island; Wardell		Richmond River	Update Development Controls	- Provisions are made in Council's DCP that give suitable consideration to flood risk, flood hazard, flood warning and evacuation for proposed development and the impact on these facets to neighbouring development. More detail is provided in the draft Wardell Floodplain Risk Management Plan (Worley Parsons, 2009).		Land use planning / zoning		Recommended	
BA5	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina		Richmond River	Develop agricultural levee guidance	Levees are used by farmers in the study area to protect arable land from flooding. Particularly flooding associated with high tides where salt intrusion may degrade the quality of the soil. Currently there are no formal controls on this form of development. In some areas these levees impact on flood levels to neighbouring properties. Thus, it is recommended that some limitations are developed. This issue is common to the Richmond River County Council (RRCC). Thus, it is recommended that this is done in collaboration with RRCC.	Levees			Recommended	
BA6	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina		Richmond River	Develop voluntary house raising scheme	In the BFRMS, 49 properties within the 20 year ARI flood event were selected for consideration in a voluntary house raising scheme. Also, consideration should be given to voluntary house raising for existing dwellings at East Wardell (upstream from the Pacific Highway Bridge) that are expected to experience over floor flooding during the 100 year ARI flood, and existing dwellings at Wardell Village (near the intersection of Richmond and Wilson Streets) that are affected by over floor flooding during the 20 year ARI event. It is recommended that a voluntary house raising scheme is investigated. Floor levels should be limited to 3.5m above ground level due to practicality and aesthetic reasons. The onus will be on the owner to engage a contractor and undertake the works. It is recommended that the voluntary house raising grant is capped at $40,000, and increased each year to account for market trends. The grant will be provided following completion of the works and Council inspection.		House raising		Recommended	
BA7	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina		Richmond River	Finalise Selection of Evacuation Centres	A key aspect of the evacuation process is to have adequate facilities at the evacuation centres that house the evacuees. At the inception of the BFRMS there was no formal plan on where evacuation centres would be located and what the limitations at those centres may be. The BFRMS identified a number of potential evacuation centres. Council attempted to contact the NSW Department of Community Services (DoCS) to discuss the proposed evacuation centres further, but were unsuccessful in getting a response from DoCS at the time. It is recommended that DoCS are engaged to discuss the feasibility of using the proposed evacuation centres. If inadequacies are identified it may be necessary to seek alternative evacuation centres			Flood access and evacuation	Recommended	
BA8	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina		Richmond River	Update Evacuation Planning	Evacuation planning in the Shire in specific high risk areas (such as Cabbage Tree Island and Teven Valley), have been thought-out and documented in the existing Local Flood Plan. Additional evacuation procedures have been proposed in the draft Cabbage Tree Island and Wardell Floodplain Risk Management Plans (Worley Parsons, 2009a, 2009b). It is recommended that these proposed plans are appended to the Local Flood Plan. There is little structure to the evacuation procedure within the BFRMS area. Preliminary evacuation routes and zones have been proposed in the BFRMS. It is recommended that these are included in the Local Flood Plan along with the proposed evacuation centres. Once the Local Flood Plan has been updated, it is recommended that a street signage strategy is devised and implemented. The community needs to know how to react when receiving a flood warning or evacuation order. It is recommended that an ongoing flood education programme is implemented, as the community is dynamic and may constantly change. It is recommended that a community engagement strategy is developed. For example:			Flood access and evacuation Flood-awareness, education and	Recommended	
BA9	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina		Richmond River	Develop Community Engagement Strategy	- Lismore City Council runs a successful programme through one of its committees. - Richmond Valley Council is currently developing a flood information website in collaboration with the SES and OEH.			readiness	Recommended	
BA10	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina		Richmond River	Extend Gauge Network	Rain and stream gauges provide essential flood intelligence during a flood event. It is recommended that a minimum of three additional rain gauges (Newrybar Swamp, Brooklet and Cumbalum Ridge) and two river gauges (Emigrant Creek and North Creek) are installed. More appropriate locations may be determined during discussions with Council, the SES and OEH.			Flood prediction and warning	Recommended	
BA11	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina		Richmond River	Develop Flood Intelligence Cards	The use of reliable flood intelligence to base decisions upon can improve the human response to a flood emergency. The quicker the potential implications of a flood can be understood, the more time is available to act on the appropriate response. One method used by the SES for managing flood intelligence is the use of flood intelligence cards. It is recommended that SES flood intelligence cards are developed for each of the gauges surrounding the catchment (including gauges proposed under measure R4). Whereby, the implications on flooding in Ballina for prescribed gauge recordings are defined. It is recommended that this measure is supported by additional flood modelling covering a wider range of potential flooding scenarios.			Flood prediction and warning	Recommended	
BA12	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina		Richmond River	Assess Alternative Evacuation Order Methods	The traditional method used by the SES for issuing evacuation orders is door knocking. Significant time-savings could be made by opting for a fast dissemination method such as broadcast radio and television, mass telephone dialling, SMS or sirens warning. Increasing use of social media by society may also provide an opportunity for enhancing flood warning and dissemination of evacuation orders. Use of a website such as 'Twitter' may provide a fast means of sharing flood information between emergency services and the public. It is understood that the SES has already begun looking at alternative dissemination methods. It is recommended that several dissemination methods are used simultaneously to improve the time of response.			Flood access and evacuation	Recommended	
BA13	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina		Richmond River	Investigate Flood Warning and Prediction System Options	It is recommended that the BoM are engaged to extend their flood forecasting to Ballina. It is recommended that the feasibility of developing flood predictive tools is investigated in more detail. Consideration should be given to doing this at a catchment scale, encompassing other local councils in the Richmond River catchment.			Flood prediction and warning	Recommended	
BA14	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	Ballina		Richmond River	Raise Low Points on Evacuation Routes	Various evacuation routes have been identified in the study area in the BFRMS. An assessment of the closure of these routes was undertaken. It was found that the route closure can be delayed through raising the low points along some routes. It is recommended that the potential to delay evacuation route closure by raising low points on Moon Street, Kerr Street and River Drive (see Figures D-1 and D-6 in Appendix D in the BFRMS) is investigated further. In addition, consideration should be given to raising sections of Tamarind Drive and River Street. Benefits include increasing the time available for evacuation, thus reducing the risk to life and welfare of the community and SES.			Flood access and evacuation	Recommended	
BA15	Ballina Shire	Ballina Island and West Ballina Floodplain Risk Management Study and Plan DRAFT (GHD)	2021	Ballina Island and West Ballina		Richmond River	Levee Ballina Island and West Ballina	The concept of building a levee around Ballina Island and West Ballina to protect these areas from existing and future riverine, creek and ocean flooding sources has been previously raised by others as a potential flood mitigation measure: The Ballina Floodplain Risk Management Study (BMTWBM, 2012) considered the option of building a system of levees and pumps. However, it was determined that "*levees introduce risk of breach, overtopping and an increased maintenance burden on the community*" and a land use planning based approach was adopted as a "*gradual and adaptive floodplain management option*" that was "*well suited to dealing with the impacts of climate change*". In contrast, the Ballina Floodplain Risk Management Plan (BMTWBM, 2015) included a recommendation (ID F8) to	Levees			Not Recommended	

ID	LGA	Source Study	Year report published	Location	Confidence	Watercourse 1	Option	Description	OPTION TYPE Flood Modification	OPTION TYPE Property Mod	OPTION TYPE Response Modification	Source report Priority	Council recommendations in source report
BA16	Ballina Shire	Ballina Island and West Ballina Floodplain Risk Management Study and Plan DRAFT (GHD)	2021	Ballina Island and West Ballina		Richmond River	Filling of Private Properties and Raising Roads	"*Investigate the feasibility of alternative systems of flood structural measures that may include a combination of levees, pump and floodgates to provide protection for the Ballina Island precinct*". It is recommended that a review of Council's existing fill policy be undertaken in conjunction with Flood Management Measure P1 during the detailed options assessment phase of the project with consideration given to protecting public infrastructure. Raising of all roads to a minimum level of 1.8m AHD is considered to be cost prohibitive and is consequently not recommended.	Landscape Management			Not Recommended	
BA17	Ballina Shire	Ballina Island and West Ballina Floodplain Risk Management Study and Plan DRAFT (GHD)	2021	Ballina Island and West Ballina		Richmond River	Overland flood mitigation measures	It is recommended that proof of concept hydraulic modelling of the mitigation measures proposed at each of the five (5) priority 'hot spots' be undertaken during the detailed options assessment phase of this project for the following design events: - 1% AEP design rainfall with mean highwater spring tide (current climate) - 1% AEP design rainfall with mean highwater spring tide (Year 2100 climate) Additionally, it is recommended that a comprehensive Local Drainage Management Plan be developed by BSC as a separate project. This should consider other lower priority hotspots, known issues and constructability constraints. See Section 4 of Plan for details and locations of hotspots (p. 53-55).			Technical Study	Recommended	
BA18	Ballina Shire	Ballina Island and West Ballina Floodplain Risk Management Study and Plan DRAFT (GHD)	2021	Ballina Island and West Ballina		Richmond River	Evacuation Route Raising - Comprises Ballina Island and west Ballina only and EXCLUDES bridge duplication at River St and Tamarind Dve (including bridge duplication) to Cumbalum.	In order to improve evacuation potential during flood conditions under existing and future climate scenarios, the following road raising options were identified for consideration in consultation with Council: *Case 1*: Raise existing evacuation routes to above 1.8m AHD3. *Case 2:* Raise existing evacuation routes to elevations consistent with Councils existing fill policy (approximately 1.9m AHD to 2.2m AHD across study area) as defined by Map 1A in the Ballina Shire Development Control Plan 2012, Chapter 2b – Floodplain Management (BSC, 2012). *Case 3*: Raise existing evacuation routes to be above the 100 year ARI Year 2050 design flood (riverine, creek, ocean) level (approximately 2.1m AHD to 2.3m AHD across study area). *Case 4*: Raise existing evacuation routes to be above the 100 year ARI Year 2100 design flood (riverine, creek, ocean) level (approximately 2.4m AHD to 2.7m AHD across study area).	Flood access and evacuation			Recommended	
BA19	Ballina Shire	Ballina Island and West Ballina Floodplain Risk Management Study and Plan DRAFT (GHD)	2021	Ballina Island and West Ballina		Richmond River	Land use planning	It is recommended that land use planning management measures be further considered including: - Updating the LEP and DCP to reflect the new DPIE Floodprone Land Package. - Alternative solutions to Council's current fill policy including phased retreat, adoption of building envelopes, innovative building design, on-site detention, provision of safe evacuationroutes, and early warning systems. - Limitations on sensitive uses like seniors living, boarding houses, nursing homes, residential aged care facilities etc in flood affected areas (partially addressed in current DCP). - Apply additional controls requiring flood investigations/ filling to demonstrate appropriate evacuation routes in the DCP. - Consideration of overland flooding issues and in particular the outputs of the Ballina Island and West Ballina Overland Flood Study (GHD, 2020). - Preparation of more detailed flood inundation mapping delineating type of flood hazard and commensurate risk (i.e. riverine, creek, oceanic and overland flow paths). - Year 2050 and 2100 future climate conditions.	Land use planning / zoning			Recommended	
BA20	Ballina Shire	Ballina Island and West Ballina Floodplain Risk Management Study and Plan DRAFT (GHD)	2021	Ballina Island and West Ballina		Richmond River	Voluntary house purchase	To avoid the economic and social expenses of flooding in high hazard areas, it may be viable for Council to purchase flood affected properties at an equitable price, where voluntarily offered. The property should then be rezoned to a flood compatible use, such as open space. It is important to note, that this option is 'voluntary' and the implementation strategy could be long-term. Voluntary purchase at times attracts two-thirds funding from State Government, with the balance of funding provided by Council. The property value would be based on a determination by the State Valuer. Voluntary purchase will likely impact the Councils rates base.		House purchase		Recommended	
BA21	Ballina Shire	Ballina Island and West Ballina Floodplain Risk Management Study and Plan DRAFT (GHD)	2021	Ballina Island and West Ballina		Richmond River	Flood Proofing of Buildings	Flood proofing of buildings involves designing and constructing buildings with appropriate water resistant building materials to reduce flood damage. This solution reduces damage to the building structure but in most cases does not protect building contents. For existing structures, flood proofing would need to be retro-fitted to existing buildings or included as a development control to building extensions. Given the age and state of many of the buildings in Ballina Island and West Ballina, and that the Ballina Development Control Plan 2012 would provide for future development, flood proofing through retrofitting is not considered viable as a broad flood risk management option. Amongst other NSW guidelines, the Hawkesbury-Nepean Floodplain Management Steering Committee provides advice on building in flood prone areas entitled "Reducing Vulnerability of Buildings to Flood Damage (2007)". This provides general guidance on building in flood-prone areas. Flood proofing of buildings not considered viable as a broad floodplain risk management option on its own. However, innovative building design should be considered as part of the development controls associated with P1-Land Use Planning measures.		Flood proofing / building control		Recommended	
BA22	Ballina Shire	Ballina Island and West Ballina Floodplain Risk Management Study and Plan DRAFT (GHD)	2021	Ballina Island and West Ballina		Richmond River	Voluntary house raising	Voluntary house raising has the potential to reduce the damage cost to individual dwellings, however, this measure needs to be coupled with an effective evacuation plan.		House raising		Recommended	
BA23	Ballina Shire	Ballina Island and West Ballina Floodplain Risk Management Study and Plan DRAFT (GHD)	2021	Ballina Island and West Ballina		Richmond River	Improve Flood warning system and evac management	It is recommended that Council review the status of Items R1 to R8 of the Ballina Floodplain Risk Management Plan (WBMBMT, 2015) and the recommendations of the Richmond River Flood Warning and Evacuation Management Review (WBMBMT,2016), and determine if any outstanding items can be actioned. In 2016, the Richmond River Flood Warning and Evacuation Management Review (WBMBMT,2016) was prepared for Richmond River County Council (now Rous County Council (RCC). The document included a number of recommendations that broadly comprised: - Improved flood monitoring (implementation by: Bureau of Meteorology (BoM), NSW Office of Environment and Heritage (OEH) now known as NSW Department of Planning, Industry and Environment (DPIE) and RCC). - Improvements to flood forecasting and warning (implementation by: BoM). -Improved flood response (implementation by: State Emergency Service (SES), RCC and Councils). - Community education and flood information (implementation by: SES, RCC and Councils).	Flood prediction and warning			Recommended	
BA24	Ballina Shire	Wardell Floodplain Risk Management Plan	2009	Wardell		Richmond River	Consider voluntary house raising in East Wardell	Consider voluntary house raising for existing dwellings at East Wardell (upstream from the Pacific Highway Bridge) that are expected to experience over floor flooding during the 100 year recurrence flood, and existing dwellings at Wardell Village (near the intersection of Richmond and Wilson Streets) that are affected by over floor flooding during the 20 year recurrence event. 1. Consult with property owners to determine support for house raising proposal. 2. Consult with DECCW regarding the likelihood of gaining funding for works. 3. Undertake a detailed assessment of the costs, benefits and flood impacts associated with the proposed house raising works. 4. Seek funding for works. 5. Subject to funding approval and technical assessment, undertake voluntary house raising. Further revision of Policy Statement No.11 (Flood Levels) within Council's Combined Development Control Plan Chapter 1 – Urban Land to incorporate additional requirements for Wardell Village and general flood-related requirements for development across the Ballina Shire LGA.		House raising			
BA25	Ballina Shire	Wardell Floodplain Risk Management Plan	2009	Wardell		Richmond River	Revise planning policy statement	1. Rename Policy Statement No.11 to 'Flood Policy'. 2. Incorporate additional clauses into Section 4.4 of the Policy for Wardell Village to include the requirements outlined in Section 3.3.2 of this Plan 3. Incorporate additional clause into Section 4.4 for Wardell Village that specifies that development is prohibted within 50 metres of the shoreline at East Wardell, downstream from the Pacific Highway Bridge. For development immediately south of this zone, it needs to be shown that substantial flood damages will be avoided and the impact on flooding will be minimal. Update the Ballina Local Flood Plan 2000 to incorporate flood warning protocols for Wardell and alternative options for flood evacuation and refuge.	Land use planning / zoning				
BA26	Ballina Shire	Wardell Floodplain Risk Management Plan	2009	Wardell		Richmond River	Update local flood plan	1. Consult with Local and Regional SES officers to modify the Local Flood Plan. 2. Update the Flood Plan to incorporate the dissemination of flood warnings to residents at Wardell and East Wardell based on flood levels recorded at Coraki (and Woodburn). Monitoring of flood levels at Coraki will provide approximately 10 hours warning time. 3. Warnings should be broadcasted by the local media to assist in reducing the burden of SES in relation to door knocking and ensuring all residents are evacuated. 4. Update the Flood Plan to incorporate the relocation of flood affected residents at Wardell and East Wardell to the Wardell Sports and			Flood prediction and warning		

ID	LGA	Source Study	Year report published	Location	Confidence	Watercourse 1	Option	Description	OPTION TYPE Flood Modification	OPTION TYPE Property Mod	OPTION TYPE Response Modification	Source report Priority	Council recommendations in source report
								Recreation Ground for temporary refuge during relatively short episodes of flooding. 5. Update the Flood Plan to incorporate the relocation of flood affected residents to the entertainment centre at Alstonville if the duration of flooding is expected to be more than one or two days.					
RI1	Richmond Valley	Casino Floodplain Risk Management Plan	2002	Casino		Richmond River	Floodgating	Floodgating of outlets to the river (and associated levee works): - on the Main Drain on the north bank of the river; and - between the Railway Bridge and Irving Bridge on the south bank of the river.	Floodgates				
RI2	Richmond Valley	Casino Floodplain Risk Management Plan	2002	Casino		Richmond River	Canterbury Street Levee	Levee works along the riverbank to the west of the Railway Bridge in the vicinity of Canterbury Street. Two (2) possible orientations of the Canterbury Street Levee were investigated.	Levees				
RI3	Richmond Valley	Casino Floodplain Risk Management Plan	2002	Casino		Richmond River	CBD levee	Levee works along the riverbank to the east of the Railway Bridge in order to protect the CBD. Five (5) possible orientations of the CBD Levee were investigated.	Levees				
RI4	Richmond Valley	Casino Floodplain Risk Management Plan	2002	Casino		Richmond River	Lowering Bruxner Hwy	Lowering the section of the Bruxner Highway located to the southwest of the town.	Landscape Management				
RI5	Richmond Valley	Casino Floodplain Risk Management Plan	2002	Casino		Richmond River	Removing the railway viaduct and embankment	Removing the railway viaduct and embankment that is located to the south of the town adjacent to Summerland Way.	Landscape Management				
RI6	Richmond Valley	Casino Floodplain Risk Management Plan	2002	Casino		Richmond River	Voluntary house purchase	Purchasing houses that are inundated by a specified design flood event. For example, if the 20 year design flood level were chosen as the criteria, Council's long-term objective would be to purchase houses that are prone to inundation (above floor) in a 20 year flood event.		House purchase		MEDIUM	
RI7	Richmond Valley	Casino Floodplain Risk Management Plan	2002	Casino		Richmond River	Voluntary house raising	Raising the floor level of individual houses to a specified level. Thus, the number of houses that are inundated during flood events may be reduced. Criteria are defined (e.g. buildings that are inundated in the 50 year design flood) for selecting those buildings to be considered for house raising.		House raising		MEDIUM	
RI8	Richmond Valley	Casino Floodplain Risk Management Plan	2002	Casino		Richmond River	Development Control Plan	The imposition of controls on property and infrastructure development. For example, setting the minimum habitable floor level for new houses based on the design flood levels.		Land use planning / zoning		HIGH	
RI9	Richmond Valley	Casino Floodplain Risk Management Plan	2002	Casino		Richmond River	Flood warning and emergency planning	Enhance and improve flood warning and emergency planning in the Casino area.			Flood prediction and warning	HIGH	
RI10	Richmond Valley	Casino Floodplain Risk Management Plan	2002	Casino		Richmond River	Raising community awareness	Increase knowledge of flooding and the level of preparedness amongst the Casino community.			Flood-awareness, education and readiness	HIGH	
RI11	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	All areas		Richmond River	Development Control Plan	**See Section 6 of Plan**		Land use planning / zoning		Immediate	
RI12	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	All areas		Richmond River	Flood warning and emergency planning	See Section 4 of Plan The initiatives to be implemented as part of this measure are described below: · Coloured Flood Band Classification System (based on coloured flood totem) – the current SES flood classification system is replaced by the coloured flood band classification system; · Inundation Plans & Evacuation Shelter Diagrams – the SES is to benefit from the use of these plans and diagrams for flood response and emergency planning purposes; and · Flood Height Prediction – the system for predicting flood heights is to be reviewed by the SES, BoM and DLWC. · SES Flood Intelligence Card – The Flood Intelligence Card system is based on estimates of flood behaviour and possible effects at different flood levels. Estimates may potentially be improved using results of the flood study. · Other tools for improving assessment of, and response to, flood events – these tools may include an automated telephone warning system and community radio station alerts.			Emergency response	Immediate	
RI13	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	All areas		Richmond River	Raising community awareness	These are recommendations and may be implemented according to SES strategies. **See Section 5 of Plan**			Flood-awareness, education and readiness	Immediate	
RI14	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	All areas		Richmond River	Continual liaison with RTA	The Pacific Highway provides varied flood protection to communities living in its proximity. The RTA have verbally advised that their current aim is to achieve at least a 5 year flood immunity for the Pacific Highway in the study area. It is recommended that Council liaise on a regular and continual basis with the RTA throughout the life of the Floodplain Management Plan with the aim of achieving mutual benefits from a flooding perspective. In the short term this may involve advising RTA of highway low points within the Mid-Richmond area based on surveyed road levels and predicted 5 year flood levels. In the longer term it will involve assessments of potential benefits and impacts of increasing road levels in specific areas.			Flood-awareness, education and readiness	Ongoing	
RI15	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	All areas		Richmond River	Floodgating and maintenance of drainage works	Richmond Valley Council are currently committed to floodgating all stormwater pipes within the three main urban Mid-Richmond townships. Council has advised that new drainage works are to be floodgated as a matter of Council policy and a regular floodgate maintenance program is developed. Maintenance of canals will also be included in this program. It is recommended that Council and RRCC develop a floodgate maintenance and operation program for all floodgates and canals under their control as soon as possible. Maintenance and operation programs will address environmental issues such as acid sulphate soils and fish passage when and where the opportunity arises and the program will be consistent with other environmental plans and strategies. All new stormwater drainage works will be floodgated and included in the maintenance and operation program.	Floodgates			Ongoing	
RI16	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	Coraki		Richmond River	Voluntary house raising (outside levee area)	Council initiates a program aimed at offering funding for house raising in accorda nce with that determined in the Study for Scheme B. Other eligible houses in rural areas and those that may have been missed during the survey would be assessed on a case-by-case basis. The owners of the houses are offered a subsidy towards the cost of raising the floor level of their house to the flood planning level. The funding available to each party is determined by referring to the proposed funding scheme outlined in Table 9-1 and Table 9-2. The eligible houses are listed in Appendix G.		House raising		Ongoing	
RI17	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	Coraki		Richmond River	Ring levee to 1 in 20 year flood level	A ring levee around Coraki is considered as a means for protecting the main urban area of Coraki from floodwaters. Two locations for the Coraki Ring Levee were considered in the Study, with the location of the levee adopted by the Committee presented in Figure 10.1. Several levee heights were assessed to determine the costs and benefits associated with each. The selected levee height provides a 20 year flood immunity (Option 1.2b in the Study). This prevents the above floor inundation of 24 residential and 11 commercial or industrial buildings. Fine-tuning of the levee location and specific locations of overflow points would be determined during the Concept Design and EIS stage. The Coraki Ring Levee has negligible impact on peak flood levels with the maximum impact predicted being 0.01m (1cm). Such a small impact is due to the ability of the large expanse of floodplain to absorb the small loss of storage and conveyance of floodwaters associated with construction of the levee.	Levees			Low	
RI18	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	Woodburn		Richmond River	Voluntary house raising	Council initiates a program aimed at offering funding for house raising in accorda nce with that determined in the Study for Scheme B. Other eligible houses in rural areas and those that may have been missed during the survey would be assessed on a case-by-case basis. The owners of the houses are offered a subsidy towards the cost of raising the floor level of their house to the flood planning level. The funding available to each party is determined by referring to the proposed funding scheme outlined in Table 9-1 and Table 9-2. **The eligible houses are listed in Appendix G.**		House Raising		Ongoing	

ID	LGA	Source Study	Year report published	Location	Confidence	Watercourse 1	Option	Description	OPTION TYPE Flood Modification	OPTION TYPE Property Mod	OPTION TYPE Response Modification	Source report Priority	Council recommendations in source report
RI19	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	Woodburn		Richmond River	Low level levee	Woodburn currently receives some flood protection from existing levees. Low points in these levees were identified to determine the locations at which floodwaters initially break through. The low level Woodburn levee proposed is shown in Figure 11.1, and links the following levees: · Golf Links Road – road forms a levee to the south-east of Woodburn. · Levee along Tuckombil Canal and Evans River – this levee joins Golf Links Road thus forming a continuous protection from the south-east direction. · Pacific Highway and River St – in some places the road forms the levee while in others an earth mound levee exists between the road and the river. · Levee between the Pacific Highway and Water Tank Hill – this levee prevents water flowing from the north-east between the Pacific Highway and the Water Tank Hill. The portion of the levee formed by Golf Links Road and the Tuckombil Canal Levee is at a level above or equal to the 20 year event in the Richmond River. Low points that exist along the Pacific Highway and River Street would preferably be filled such that the level of protection offered by the levee was as uniform as possible. The recommended levee heights detailed in the Study provide at least 5 year immunity. The levee prevents the above floor inundation of 5 residential buildings. The Woodburn low level levee has negligible impact on peak flood levels.	Levees			Low	
RI20	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	Woodburn		Richmond River	Short St/Cooper St protection	Short Street and Cooper Street in Woodburn are located at the southern and northern end of Creek St respectively. Local residents have identified low points in the small natural levee alongside Rocky Mouth Creek at the end of both of these streets. Survey data along this levee verifies the existence of the low points. Carrying out necessary work will reduce nuisance and early flooding through the low point along Short St and Cooper St.	Other Infrastructure			High	
RI21	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	Woodburn		Richmond River	Clearing Woodburn town canal SUPERCEDED BY ROUS COUNTY COUNCIL PROPOSAL	The Woodburn Town Canal drains the entire region at the back of Woodburn into the Tuckombil Canal / Evans River. It runs alongside Norman Street and is fed by drains along Duke Street and Watson Street. Clearing on an as-need-basis of overgrown vegetation in the canal is suggested to help reduce Woodburn drainage problems.	Landscape Management			Ongoing	
RI23	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	Broadwater		Richmond River	Pacific Hwy sth of Eversons Ck protection	Local residents identify a low region in the Pacific Highway as one of the initial points that allows water to flow over the Pacific Highway into the back of Broadwater. Current survey information indicates that this low point is the only point on the Pacific Highway that provides less than 10 year flood protection to the township of Broadwater. The lowest road level in this section of the road is about 2.2m AHD. This provides full protection in the 5 year flood and allows a maximum depth of water of about 0.1m over the road in a 10 year flood event.	Other Infrastructure			High	
RI24	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	Broadwater		Richmond River	Rattle Creek flood mitigation works	Residents have noted that a point along Rattle Creek near the Mill Manager's house is the second point to be broken by floodwaters should they continue to rise after breaking through south of Eversons Creek. Flood waters appear unable to drain from the region following a flood and pond to shallow depths behind the levee.	Levees			Low	
RI25	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	Rural		Richmond River	Swan Bay levee ponding	Discussions with local landholders indicate that the problem is the local surface water around Reardons Lane Canal and Thearles Canal. In one spot, water that is caught between the road, river levee and Thearles Canal levee follows the open drains, which takes it away from the river, under the road, then parallel to the river down Thearles Canal. A more direct route for the water would be via a pipe with flood gate through the river levee, taking ponding water directly to the river. Council should request RRCC to design and construct a pipe or equivalent drainage structure as part of RRCC's annual operations. The Swan Bay New Italy Road area (west of Rosolen's Canal) is identified as requiring an increase in drainage through the road in the form of culverts. At present, the only culverts through the road are small culverts designed to carry local flow.	Levees			High	
RI26	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	Rural		Richmond River	Increase drainage through swan bay New Italy road	The Committee selected the drainage improvement option of a shallow drain and culverts under the southern section of Swan Bay New Italy Rd (see Figure 17.1). This consists of a flat, shallow drain over 1km in length running in a north-south direction at 1m AHD with culverts equivalent to 4m2 in flow area. Details of the change in flood drainage behaviour and of the assessments into other options are presented in the Study. Some further investigation will be needed to determine if acid-sulphate soils are a problem in this area and the potential implications for construction of the drain. Further detailed survey work is also required to determine the best location for the drain and associated culverts.	Other Infrastructure			Medium	
RI27	Richmond Valley	Mid-Richmond Floodplain Risk Management Plan	2002	Rural		Richmond River	Prepare and implement a long-term management plan for the Tuckombil Canal and Rocky Mouth Ck floodgates	The original Tuckombil Canal was excavated at the turn of the 20th century by horse drawn means. It was constructed to help mitigate flooding in Rocky Mouth Creek and the Mid-Richmond by diverting floodwater down the Evans River. Following a series of large flood events in the 1940s and 1950s the canal was enlarged in 1965 and an inflatable rubber dam (fabridam) installed. The fabridam collapsed in 1985 and a temporary weir constructed. A replacement fabridam was installed in 1994 and in 1996 an operational protocol for the fabridam and Rocky Mouth Creek Floodgates was formulated. The fabridam failed in January 1999 and was repaired and operational again in November 1999. In July 2001 the fabridam again failed and a temporary concrete weir was constructed in December 2001 and this is the current status of canal. The repeated failure and susceptibility to vandalism of the fabridam have rendered it inoperable for lengthy periods. The length of time inoperable has been exacerbated by warranty disputes. This has placed the structures viability, both economically and environmentally, in question. Thus a long-term management plan for the canal and associated structures is required.	Floodgates			High	
CL1	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	All areas	Medium	Clarence River	Voluntary House Purchase	Complete Palmers Island VP Scheme and conduct a review for an additional VP scheme		**House purchase**		**Medium**	
CL2	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	All areas	Medium	Clarence River	Voluntary House Raising	Compile list of eligible properties, develop guidelines, develop administrative procedures and progressivley implement scheme. COST TO IMPLEMENT WHOLE SCHEME		House raising		Medium	
CL3	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	All areas	Medium	Clarence River	Surveys and Database	Conduct a property survey, assemble GIS database, evaluate VP and VHR schemes			Technical Study	Medium	
CL4	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	All areas	Medium	Clarence River	Emergency Management Planning	Conduct emergency management planning			**Emergency response**	**Medium**	
CL5	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	All areas	Medium	Clarence River	Planning Considerations	Endorse planning approach outlined in plan, endorse inclusions in Council's LEP, endorse adoption of flood management areas, endorse development controls, finalise flood management maps, review current policy and review settlement strategy		**Land use planning / zoning**		**High**	
CL6	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	All areas	Medium	Clarence River	Emergency Management	In addition to istalling additional rain gauges above Copanhurst, review Grafton Rating Curve in flood predictions, incorporate tidal anomalies in flood predictions, train SES for levee overtopping scenarios, form standard warning templates for all major urban areas, develop integrated flood warning website, consider merging 4 local plans into 1, update flood plans/intelligence with new flood data and update evacuation plans for levee overtopping events Restore damaged levees following overtopping, ensure that undermining, slumping, erosion, settlement or other potential weaknesses don't jeapardise levee integrity			**Emergency response**	**Medium/High**	
CL7	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Grafton	Medium	Clarence River	Regular maintenance of existing levee (Grafton)		Levees				
CL8	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Grafton	Medium	Clarence River	Complete outstanding items from 2004 levee audit	Westlawn Levee had minor stability issues, two outlet pipes had missing flap gates. One each at Dobie St on the Grafton levee and one on Westlawn Levee	Levees				

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CL9	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Grafton	Medium	Clarence River	Up-to-date survey of complete levee system (Grafton)	Survey includes natural high ground, railway embankment and other structures part of the system. Compare to original design drawings			Technical Study		
CL10	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Grafton	Medium	Clarence River	Review potential levee deficiencies (Grafton)	Verify representation of levees in the flood model and further review potential levee augmentation options	Levees				
CL11	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Grafton	Medium	Clarence River	Prepare flood evacuation capability assessment (Grafton)	Determine requirements and capability of the SES to safely evacuate residents, given the affected population, warning times, flood behaviour, available routes and potential for catastrophic levee failure			**Flood access and evacuation**		
CL12	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Grafton	Medium	Clarence River	Improved emergency management operations (Grafton)	Including flood intelligence cards and SES local flood plan with info from latest study			Emergency response		
CL13	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Grafton	Medium	Clarence River	Investigate flood free access to Junction Hill (Grafton)	Either by road raising measures or through modifications to the Westlawn levee. These options are preferred to levee raising			Technical Study		
CL14	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Grafton	Medium	Clarence River	Improved community awareness of overtopping risk (Grafton)	Ensure residents are aware of the possibility of levee overtopping			Flood-awareness, education and readiness		
CL15	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Grafton	Medium	Clarence River	Install box culverts through levee near North Street (Grafton)	Design and install twin 2.1x2.1 box culverts thorugh river bank levee near North St to imprie local drainage prior to floodgates closing, and to speed up the removal of impounded stormwater east of Alumy Creek once river levels subside, or following events that overtop the levees	**Other Infrastructure**				
CL16	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	South Grafton	Medium	Clarence River	Regular maintenance of existing levee system (Sth Grafton)	Ensure there is sufficent vegetation cover on the embankments and a suitable slope in order to limit scouring. Manage levees to account for damage or settlement	Levees				
CL17	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	South Grafton	Medium	Clarence River	Complete outstanding items from 2004 levee audit (Sth Grafton)	Repair vertical crack in low concrete wall at the end of Riverside St. Repair localised erosion, slips, slumping, scouring and cracking. Replace outlet pipe gate on the Urban levee	Levees				
CL18	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	South Grafton	Medium	Clarence River	Up-to-date survey of complete levee system (Sth Grafton)	The 2004 levee audit indicated possible modifications to the levees to ensure futher protection. A survey has been recommended in order to begin the investigation. The recommendations were height increases to the South Grafton Rural levee and the Waterview levee by about 0.4m, rasing of the south Grafton levee to protect against 100yr floods			Technical Study		
CL19	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	South Grafton	Medium	Clarence River	Review potential levee deficiencies (Sth Grafton)	Given the levee raises on both sides of the river, the flood levels have been predicted to rise up to 0.28m. As such further levee raises have been suggested however, this increases the risk of catastrophic failure as stability issues can become critical. As such alternate measures such as management and awareness have been suggested.			Technical Study		
CL20	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	South Grafton	Medium	Clarence River	Improved emergency management operations (Sth Grafton)	It is preferable that instead of levee raising that South Grafton residents be educated on the flooding risks and the need to evacuate			Emergency response		
CL21	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	South Grafton	Medium	Clarence River	Improved community awareness of overtopping risk (Sth Grafton)	It is preferable that instead of levee raising that South Grafton residents be aware of the risk of overtopping as stability issues have been identified with continued levee raising			Flood-awareness, education and readiness		
CL22	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Maclean	Medium	Clarence River	Survey complete levee system and identify deficiencies (Maclean)	A detailed survey has been suggested as there are many factors influencing the proposal to raise the levee by 0.3m. Including cost, limited benefit, social issues, levee has never been overtopped before and it does not eliminate the risk of overtopping. Non-structural solutions are preferred for Maclean.			Technical Study		
CL23	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Maclean	Medium	Clarence River	Review internal drainage strategy (Maclean)	Further review of the internal drainage strategy including capacity and maintenance of existing levee pumps			Technical Study		
CL24	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Maclean	Medium	Clarence River	Apply appropriate development controls (Maclean)	Application of appropriate development controls for new development and redevelopment as this occurs. The primary control for residential development is the use of minimum floor levels based on the 100 year flood level (WBM, 2004) in the river with 0.5m freeboard. Other flood-proofing initiatives are recommended for commercial development.		Land use planning / zoning			
CL25	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Maclean	Medium	Clarence River	Improved emergency management operations (Maclean)	Improved emergency management planning, including the development of a standard flood warning template for Maclean, updating flood intelligence cards and the Local Flood Plan, based on the latest flood results			Emergency response		
CL26	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Maclean	Medium	Clarence River	Improved community awareness of overtopping risk (Maclean)	Implementation of a measured education campaign to dispel the perception that the town enjoys full protection from flooding as a result of the levee. Residents and owners need to be reminded of the risk of levee overtopping and the consequent flood behaviour			Flood-awareness, education and readiness		
CL27	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2014	Brushgrove	Low	Clarence River	Volunary house raising (Bushgrove)	Voluntary house raising or house reconstruction for 8 houses currently below the 20 year flood level. Given the flood-prone nature of this area, and the frequency of nuisance flooding, a full cost subsidy (up to say $50,000) may be appropriate.		house raising			
CL28	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2014	Brushgrove	Low	Clarence River	Improved emergency planning (Bushgrove)	Improved emergency management planning, including evacuation planning, providing flood warnings specific to Brushgrove, updating the Local Flood Plan with new flood intelligence data, public awareness of the flood risk and further consideration of evacuation procedures.			Emergency response		
CL29	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2014	Brushgrove	Low	Clarence River	Development Controls (Bushgrove)	For future development and redevelopment		Land use planning / zoning			
CL30	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2014	Brushgrove	Low	Clarence River	Feasibility Study for improved flood access (Bushgrove)	Providing improved flood access between the Highway and the Brushgrove Bridge.			**Flood access and evacuation**		
CL31	Clarence Valley	Grafton and Lower Clarence Floodplain	2007	Chatsworth	Medium	Clarence River	Evacuation Planning	There is a relatively high flood risk at Chatsworth. Much of the island will be inundated in a 5 year flood, and floodwater will surround the majority of dwellings in the 20 year flood. Access to the island will be cut an early stage, leaving the village isolated and subject to flooding in major events. Early evacuation of all residents should be sought. Any intensification of Grafton and Lower Clarence FRMP Bewsher Consulting			**Flood access and evacuation**		

ID	LGA	Source Study	Year report published	Location	Confidence	Watercourse 1	Option	Description	OPTION TYPE Flood Modification	OPTION TYPE Property Mod	OPTION TYPE Response Modification	Source report Priority	Council recommendations in source report
		Risk Management Plan						Pty Ltd June 2007 J1276_Plan_V2.doc -83- existing development through future subdivision or rezoning should be avoided. Some existing dwellings may qualify for the valley-wide house raising scheme.					
CL32	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Cowper	Medium	Clarence River	Evacuation Planning	It is considered that there is a moderate to high flood risk for Cowper. Evacuation requirements will be an important consideration for the town. Any intensification of existing development through future subdivision or rezoning should be avoided. Some existing dwellings may qualify for inclusion in the valley-wide house raising scheme.			**Flood access and evacuation**		
CL33	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Harwood	Medium	Clarence River	Evacuation Planning	There is a relatively high flood risk associated with Harwood village due to the number of buildings that are affected and possible isolation problems if early evacuation is not achieved			Flood access and evacuation		
CL34	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Palmers Island	Medium	Clarence River	Evacuation Planning	Palmers Island is considered to represent a high flood risk, due to the number of buildings potentially affected by flooding and likely isolation problems if early evacuation is not achieved. Any intensification of existing development through future subdivision or rezoning should be avoided.			Flood access and evacuation		
CL35	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Other towns and rural areas	Medium	Clarence River	Development Controls	No intensification of development through subdivision or rezoning should be permitted at Chatsworth, Cowper, Harwood, Palmers Island and Southgate. Care also needs to be exercised in siting areas of future development along Brooms Head Road, Lawrence, Townsend, Tucabia and Waterview Heights.		Land use planning / zoning			
CL36	Clarence Valley	Grafton and Lower Clarence Floodplain Risk Management Plan	2007	Other towns and rural areas	Medium	Clarence River	Evacuation Planning - For flood prone caravan parks	recommended that Council in liaison with the SES conduct an investigation of flood risk on a site-specific basis. Should include warning times, resources and degree of hazard			Flood access and evacuation		
CL37	Clarence Valley	Wooli River Floodplain Risk Management Plan	1999	Wooli	Low	Wooli Wooli River	Wooli River Entrance Works	Including construction of flood overflow across Jones Beach, removal of monument area, removal of low wall at entrance, changing direction of flow mouth	**Landscape Management**				
CL38	Clarence Valley	Wooli River Floodplain Risk Management Plan	1999	Wooli	Low	Wooli Wooli River	Dredging	By dredging from entrance to the bowling club river conveyance would be improved and flood levels lowered, consider dreding in the estuary study as a component for rehabilitation NO LONGER PROPOSED IN DRAFT WOOLI FLOOD STUDY AND MANAGEMENT PLAN	Landscape Management				
CL39	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		West Yamba Levee feasibility study	Initially a more detailed levee feasibility study should be undertaken which would investigate a possible levee alignment as well as undertake further public consultation. Previous studies have rejected a levee as it was considered that it would not be supported by the community.			Technical Study	HIGH	
CL40	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		Implement and maintain drainage database	In order to limit ponding, inadequate drainage and drain blockage			**Technical Study**	**HIGH**	
CL41	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		Wave runup study	This study would investigate the magnitude, likelihood and damage potential of wave runup at Yamba as well as possible mitigation measures			Technical Study	MEDIUM	
CL42	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		Update flood warning program	Providing advice on the deadline when Yamba residents need to evacuate to high ground and ensuring best practice is employed on providing advice on ocean storm surge and wave runup activity			Flood prediction and warning	HIGH	
CL43	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		Prepare evacuation plan for Yamba	Ensure Yamba residents can be safley moved to high ground during a flood event			**Flood access and evacuation**	**HIGH**	
CL44	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		Implement a flood awareness plan	A high level of flood awareness will ensure that damage to goods and the risk to life is minimised			Flood-awareness, education and readiness	HIGH	
CL45	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		Update development controls	The strategic assessment and management of flood risk can prevent development occurring in unsuitable areas and will ensure that the potential damage to new developments		Land use planning / zoning		HIGH	
CL46	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		Introduce controls for caravan parks on the floodplain	This issue should be investigated further through a detailed inspection by the park manager and the SES to accurately assess the hazard		Land use planning / zoning		MEDIUM	
CL47	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		Implement a house raising scheme	If levee not constructed a VHR scheme would provide a viable means of flood protection for the 14 “suitable” buildings		House raising		LOW	
CL48	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		Flood related climate change policy	This would include the potential impacts of increased human activity - nutrients, sedimentation, runoff - on the nearby exclusion zones during a flood or ocean event when WSUD capacities are exceeded			Flood-awareness, education and readiness	HIGH	
CL49	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		Review Evacuation Routes	Review exacuation routes in light of population growth and climate change impacts on flooding			Flood access and evacuation	HIGH	
CL50	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		Hydraulic Modelling to assess potential floodway.IS THIS EVEN POSSIBLE ANYMORE?? HOUSES HAVE NOW BEEN BUILT THERE	between Golding and Freeburn streets	**Floodways**			**HIGH**	
CL51	Clarence Valley	Yamba Floodplain Risk Management Plan	2009	Yamba	Medium		Develop practical method of evacuation	Evacuation to high ground in Yamba is the preferred strategy. The provision of a designated flood refuge, on artificially high land within the development area, is an option for consideration, however, acknowledging that it will not have the range of other infrastructure available on Yamba Hill which can service the population during a major flood event			Flood access and evacuation	HIGH	
CL52	Clarence Valley	Alipou Creek Floodplain Risk Management Plan	2006	Grafton	Medium	Alipou Creek	Improve drainage from the Pacific Highway to Clarenza levee	Divert culverts to Clarence river and stream clearing			**Technical Study**	**HIGH**	
CL53	Clarence Valley	Alipou Creek Floodplain Risk Management Plan	2006	Grafton	Medium	Alipou Creek	Culvert cleaning under Pacific highway	Removal of any significant debris (branches, trees) from culverts	Floodways			LOW	
CL54	Clarence Valley	Alipou Creek Floodplain Risk Management Plan	2006	Grafton	Medium	Alipou Creek	Additional openings in ''the Block''	Further hydraulic modelling is required to quantify the impacts of any additional openings in “the Block”.			Technical Study	HIGH	
CL55	Clarence Valley	Alipou Creek Floodplain Risk Management Plan	2006	Grafton	Medium	Alipou Creek	Construct stock mounds	Stock mounds are one means of limiting the potential for stock losses during a flood and are an alternative to evacuation	Landscape Management			LOW	
CL56	Clarence Valley	Alipou Creek Floodplain Risk Management Plan	2006	Grafton	Medium	Alipou Creek	Establish Voluntary House Purchase Scheme	Cannot be economically or socially justified but this strategy can be considered as a long term measure to reduce the number of flood liable buildings.		House purchase		LOW	
CL57	Clarence Valley	Alipou Creek Floodplain Risk Management Plan	2006	Grafton	Medium	Alipou Creek	Voluntary House Raising	The house floors is likely to be inundated in a major Alipou Creek flood and there is limited safe refuge within the buildings as it is single storey		House raising		HIGH	
CL58	Clarence Valley	Alipou Creek Floodplain Risk Management Plan	2006	Grafton	Medium	Alipou Creek	Update Planning Policy	Was not undertaken as part of this plan however, is noted as important		Land use planning / zoning		MEDIUM	
CL59	Clarence Valley	Alipou Creek Floodplain Risk Management Plan	2006	Grafton	Medium	Alipou Creek	Install community based warning system	would greatly assist in reducing flood damages for landowners by providing more time to move their stock.			Flood prediction and warning	LOW	
CL60	Clarence Valley	Alipou Creek Floodplain Risk Management Plan	2006	Grafton	Medium	Alipou Creek	Implement a flood awareness plan	This measure will ensure that residents are aware of the flood problem and the means available to help reduce flood damages.			Flood-awareness, education	HIGH	

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											and readiness		
CL61	Clarence Valley	Alipou Creek Floodplain Risk Management Plan	2006	Grafton	Medium	Alipou Creek	Install max height recorders	Maximum height recorders will assist in providing more accurate records of peak levels in future floods			Flood prediction and warning	HIGH	
CL62	Clarence Valley	Alipou Creek Floodplain Risk Management Plan	2006	Grafton	Medium	Alipou Creek	Audit of levee structures along creek	ensure that the levee system surrounding Alipou Creek is maintained at design conditions.	Levees			MEDIUM	
											Flood-awareness, education and		
CL63	Clarence Valley	Iluka Floodplain Risk Management Plan	2007	Iluka	Medium	North Arm	Formailse local drainage issues	Issue of runoff ponding in low lying areas or flowing at shallow depths. Residents should document these issues			readiness	HIGH	
CL64	Clarence Valley	Iluka Floodplain Risk Management Plan	2007	Iluka	Medium	North Arm	Undertake levee scenario 1	Filling the low spots to 2.4 mAHD would provide the same level of protection as the existing Marandowie Drive concrete levee	Levees			HIGH	
CL65	Clarence Valley	Iluka Floodplain Risk Management Plan	2007	Iluka	Medium	North Arm	Develop flood evacuation plan	There is no current plan and residents have been badly cut off before			**Flood access and evacuation**	**HIGH**	
CL66	Clarence Valley	Iluka Floodplain Risk Management Plan	2007	Iluka	Medium	North Arm	Update flood warning system	Possible improvements include providing advice on the evacuation deadline for residents and ensuring best practice for ocean storm surge and wave runup activity.			Flood prediction and warning	HIGH	
CL67	Clarence Valley	Iluka Floodplain Risk Management Plan	2007	Iluka	Medium	North Arm	Prepare evacuation plan for Anchorage Caravan Park	An evacuation plan should be put in place			Flood access and evacuation	HIGH	
CL68	Clarence Valley	Iluka Floodplain Risk Management Plan	2007	Iluka	Medium	North Arm	Implement a flood awareness plan	Awareness of evacuation, potential for the levee system to fail and what to do during a flood.			Flood-awareness, education and readiness	MEDIUM	
CL69	Clarence Valley	Iluka Floodplain Risk Management Plan	2007	Iluka	Medium	North Arm	Undertake levee scenario 2	Determine how the Duke Street mounds would be tied into the high ground behind properties on Gundaroo Court	Levees			MEDIUM	
CL70	Clarence Valley	Iluka Floodplain Risk Management Plan	2007	Iluka	Medium	North Arm	Prepare development control plan for Iluka	Should consider flood access, structural soundess, fencing, public assets and flood planning levels		Land use planning / zoning		MEDIUM	
CL71	Clarence Valley	Iluka Floodplain Risk Management Plan	2007	Iluka	Medium	North Arm	Undertake study to quantify effects of wave runup	Wave runup can produce flooding on the western foreshore of Iluka as well as foreshore erosion. There is no current info about the affects of wave runup			Technical Study	LOW	
CL72	Clarence Valley	Iluka Floodplain Risk Management Plan	2007	Iluka	Medium	North Arm	Undertake levee scenario 3	Raising the Marandowie Drive and Caravan Park levees would provide protection greater than the 500y ARI event	Levees			LOW	
CL73	Clarence Valley	Iluka Floodplain Risk Management Plan	2007	Iluka	Medium	North Arm	Voluntary House Raising	Three properties on Marandowie Drive could potentially be raised although further investigations are required.		House raising		LOW	
BA27	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015	West Ballina		Richmond River	Design and construct West Ballina flood relief culverts	The majority of inundated dwellings during moderate to large floods are in West Ballina and Ballina Island (86%).					
BA28	Ballina Shire	Ross Lane Upgrade Options Assessment (BMT 2021)	2021	Lennox Head		Richmond River	Options assessment for upgrading Ross Lane at Deadmans Creek and North Creek crossings			Evacuation Route Raising			
BA29	Ballina Shire	Cumbalum Area Flood study (WMAwater 2022)	2022	Ballina		Richmond River	Initial study at Cumbalum to determine existing conditions case - extend through to Ballina due to 2022 event			Evacuation Route Raising			
NP7	Ballina Shire	2022 flood event (Long list Ballina Council edits)	2022	Wardell		Richmond River	Raising of Wardell Road approx 1 km north of Wardell required due to isolation of Wardell and inability to evacuate to Alstonville			Evacuation Route Raising			
NP8	Ballina Shire	2022 flood event (Long list Ballina Council edits)	2022	Uralba		Richmond River	Raising of Bruxner Highway			Evacuation Route Raising			
BA32	Ballina Shire	Ballina Floodplain Risk Management Plan (BMT)	2015			Richmond River	Consider recommendations from the Newrybar Swamp Flood and Drainage Assessment (ref: R.B17689.001.00.docx)	Recommendations for clearing and enlargement of drains, culvert installation and part levee removal across private land and Ballina Nature Reserve (ex Drainage Union drains)					
NP1	Ballina Shire	Rous County Council Flood Mitigation Projects	2022			Emigrant Creek	Improve condition of Lower Emigrant Creek levee network	The lower Emigrant Creek floodplain is protected by a series of levees, including Emigrant Creek levee and Chilcotts levee. These levees service 5km2 of predominantly agricultural land used for growing sugar cane and macadamias and grazing cattle. These lower estuary levees are historic and require revitalisation to continue to protect this land from minor and moderate floods. The levees reduce damage to agricultural land which has economic and social benfits for the area.					
NP2	Richmond Valley	Rous County Council Flood Mitigation Projects	2022	Bungawalbyn			East Bungawalbyn levee - investigation, design and potential reconstruction works	The East Bungawalbyn levee is a major structural flood mitigation asset that reduces the impact of flooding across a wide area of the mid-Richmond floodplain. The levee services roughly 23km2 of land, which is used agriculturally for sugar cane, tea tree and to graze cattle. The levee directly protects 15 residential dwellings and access for a further 89 households. Important access routes for the broader, rural communities of Swan Bay and Bungawalbyn are also protected by the levee, including Bungawalbyn-Whiporie Road, Reardons Lane and Swan Bay New Italy Road. The levee is historic and may be up to 100 years old. Following three overtopping events since 2017 and significant damage in all events, the levee requires investigations, design and reconstruction work to improve its resilience to future floods and over-topping events. Levee repairs for the three recent events have cost around $200,000 each event, funded through disaster recovery funding arrangements. It requires extensive work to continue to provide adequate levels of service to the community. The levee provides protection against the frequent minor and moderate floods in this area and reduces damage to agriculture and the risk to people and dwellings. Works on the levee will provide economic and social benefits to the area.					
NP3	Richmond Valley	Rous County Council Flood Mitigation Projects	2022	Swan Bay			Swan Bay levee and canal works	The risk of flooding and inundation across the Swan Bay floodplain is reduced through a network of levees and canals. This existing mitigation infrastructure is historic and needs improvements. The Swan Bay levee along with Reardons, Thearles and Campbells canals service roughly 20km2 of land that is used agriculturally to grow sugar cane, tea tree, pecans and graze cattle. The infrastructure services around 10 residential dwellings and protects vehicle access to the Swan Bay residential estate which has more than 40 residential dwellings. The network of infrastructure protects major transport and evacuation routes of Reardons Lane, Swan-Bay New Italy Road and Coraki-Woodburn Road. The Swan Bay levee and canals protect the area from minor and moderate flooding and reduces the length of inundation after flooding. The infrastructure delivers both economic and social benefits by minimising damage to agriculture and increasing the safety of people living in the area.					
NP4	Richmond Valley	Rous County Council Flood Mitigation Projects	2022	Coraki and Woodburn			Improve condition of Coraki and Woodburn town drains	The rural villages of Coraki and Woodburn are serviced by main town drains that reduce inundation times after flooding. The existing Coraki Town drain and Woodburn Town drain are historic and need their condition improved and preserved. The Coraki Town drain services around 1.5km2 of land within the village which includes residential dwellings, the main access routes of Queen Elizabeth Drive and access in and out of aged care and health facilities. The Woodburn Town drain services around 3km2 of land and is one of the main pathways that floodwaters drain from the village. Both Town drains reduce the length of inundation after flooding and are important during major events. Reducing the length of inundation within the villages delivers human and social outcomes, benefits dwellings and infrastructure and the local economy by minimising damage to property and allowing for quicker recovery after flood events.					
NP5	Lismore	Rous County Council Flood Mitigation Projects	2022	Lismore		Wilsons River	Revilitise South and East Lismore Town Drains	South and East Lismore are serviced by two main drains that reduce inundation after flooding. The existing South Lismore drain and Gundurimba Creek drain are historic and need their condition revitalised and preserved. The South Lismore drain services around 6km2 of land that houses an industrial estate and the Lismore airport and is one of the main pathways that floodwaters drain from the area. Gundurimba Creek drain services around 4km2 of land which includes the main route of Wyrallah Road, the East Lismore Sewage Treatment Plant, Lismore Waste Facility, around 5 residential dwellings and is the main pathway for floodwaters to drain from East Lismore. Both Town drains reduce the length of inundation after flooding and are important during major events. Reducing the length of inundation within these areas delivers	Landscape Management			Recommended	

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								human and social outcomes, benefits dwellings and infrastructure and the local economy by minimising damage to property and allowing for quicker recovery after flood events.					
NP6	Ballina Shire	Rous County Council Flood Mitigation Projects	2022				Revitalise condition of Lower Newrybar drain to improve immunity of Ross Lane	The area immediately south of Ross Lane, Newrybar is serviced by a drain that runs west to east into the main Newrybar drain and North Creek. This drain services a known problematic area, where inundation after even small rain events can close the major route of Ross Lane, as well as 5 residential dwellings. The area receives runoff from land upstream and to the west. The drain is historic and needs its condition to be revitalised in order to continue to provide the expected level of service. Work on the drain would improve the immunity of Ross Lane, enabling more secure road and transport access, as well as reduce the risk of flooding on the residential dwellings.					
BA35	Ballina Shire	Ballina Island and West Ballina Floodplain Risk Management Study and Plan DRAFT / Council meeting and engagement workshops	2021		Richmond River	Develop a Local Drainage Management Plan	Additionally, it is recommended that a comprehensive Local Drainage Management Plan be developed by BSC as a separate project. This should consider other lower priority hotspots, known issues and constructability constraints. This would involve commissioning a study to determine the drainage network (currently unknown due to historic fire)						
	Clarence Valley	Council meeting notes regarding Category D Local Government Recovery Grant	2022				Bacon Street, Grafton pump upgrade						
	Clarence Valley	Council meeting notes regarding Category D Local Government Recovery Grant	2022				Ardent Street, South Grafton pump upgrade						
CL65	Clarence Valley	Council meeting notes regarding Category D Local Government Recovery Grant	2022				Investigate and design an evacuation plan for Iluka Road	3rd priority for CVC: Review and implement actions reported in the Flood Risk Management Plan (2007) including an investigation to increase the flood immunity of Iluka Road in the vicinity of the Esk River crossing. ALSO Submitted for DPE funding (5th time it has been submitted for a grant)					
CL	Clarence Valley	Council meeting notes regarding Category D Local Government Recovery Grant	2022				Yamba Road investigation and options paper and business case, including project costs, to increase flood immunity						
CL	Clarence Valley	Council meeting notes regarding Category D Local Government Recovery Grant	2022				Consolidate & update the Flood Risk Management Plans						
CL74	Clarence Valley	Council's floodplain prioritisation list, adopted in August 2020	2020				Maclean levee rehabilitation	Approximately 600m of riverbank works for levee protection Population 1000 - 5000 people (2775)					
	Clarence Valley	Council's floodplain prioritisation list, adopted in August 2020	2020				House Raising	Re-introduce at Council policy on House Raising, but limiting the grant amount to that as provided by the State Government. Population 1000 - 5000 Council included in VHR program; property owner contributes 33%					
CL75	Clarence Valley	Council's floodplain prioritisation list, adopted in August 2020	2020				Iluka levee strengthening	Levee wall was constructed of mass concrete in 8m sections that are not connected by dowells and some sections have moved (rotated and sunk) since construction. The levee wall also has no cutoff wall. Structural works would stabilise and strengthen the Iluka levee. Population 1000 - 5000					
	Clarence Valley	Council's floodplain prioritisation list, adopted in August 2020	2020				Major upgrades to flood pumps including telemetry	Currently not all pumps have telemetry installed and requre inspection by staff to ensure they are operating as programmed. Telemetry will allow the remote monitoring and recording of flood pump for operational and potential legal purposes. Alarm system will advise relevant staff when pumps do not operate as programmed for immediate attention. Population 1000 - 5000 GRANT RECIEVED UNDER NSW DISASTER RISK REDUCTION FUND					
CL76	Clarence Valley	Council's floodplain prioritisation list, adopted in August 2020	2020				Interconnection of pump stations	Interconnect flood pumps in River Street (Maclean) and interconnect Pound, Bacon and Fry Streets (Grafton) with underground drainage lines. Population >5000 COUNCIL NOTE: COUNCIL HAS ALLOCATED $1.5m FROM NDRA PART D FUNDING FOR DRAINAGE WORKS AND INTERCONNECTION OF MACLEAN WORKS MAY BE INCLUDED					
CL77	Clarence Valley	Council's floodplain prioritisation list, adopted in August 2020 / Glenreagh Floodplain Risk Plan (2018)	2020				Helicopter landing pad (Glenreagh) for East Bank Rd resdients and other areas	Helicopter landing areas for East Bank residents and other areas Population 100-999					
CL78	Clarence Valley	Council's floodplain prioritisation list, adopted in August 2020 / Glenreagh Floodplain Risk Plan (2018)	2020				Automatic gauge at Orara River (Glenreagh) at location of manual gauage to inform BOM, SES and residents	New automatic gauage at location of manual gauge to inform BOM and SES and residents. Population 100-999			HIGH		
CL79	Clarence Valley	FPRMP/Council's floodplain prioritisation list, adopted in August 2020	2020				Install rainfall gauges in Alipou Creek (South Grafton)	Installation of four (or more) rainfall gauges linked to a central system that can be accessed by local landowners Population < 10					
	Clarence Valley	Council's floodplain prioritisation list, adopted in August 2020	2020				Drainage improvements for Taloumbi ring drain area	As per recommendation in flood study that is currently being prepared for that area Population <10 COUNCIL NOTE: COUNCIL HAS SEPARATELY RESOLVED FOLLOWING PROPERTY OWNER REPRESENTATION TO SEEK FUNDING FOR THESE WORKS. PROJECT HAS BEEN PUT FORWARD FOR POSSIBLE FUNDING UNDER RURAL DRAINAGE PROGRAM.					
CL80	Clarence Valley	Assessment Report North St Pump Station (SMEC) / Tony's Council meeting	2022				North St Pump Station needs to be relocated	NDRA funding will only cover replacing the pump station in-situ.					
CL81	Clarence Valley	Glenreagh Floodplain Risk Plan	2018				Land Use and Flood Planning					HIGH	
CL82	Clarence Valley	Glenreagh Floodplain Risk Plan	2018				Flood Information Update for LEP and DCP. Where resources allow updates using the latest Australian Rainfall and Runoff should be completed					MEDIUM	
CL83	Clarence Valley	Glenreagh Floodplain Risk Plan	2018				Flood Plan and SES Flood Action Card Update.					HIGH	
CL84	Clarence Valley	Glenreagh Floodplain Risk Plan	2018				Public Awareness and Evacuation Planning, and flood information/signage. Publish flood mapping on Councils website					MEDIUM	

ID	LGA	Source Study	Year report published	Location	Confidence	Watercourse 1	Option	Description	OPTION TYPE Flood Modification	OPTION TYPE Property Mod	OPTION TYPE Response Modification	Source report Priority	Council recommendations in source report
CL85	Clarence Valley	Glenreagh Floodplain Risk Plan	2018				Remote alert or webcam information on Bluff Bridge (Haywards Bridge)				MEDIUM		
CL86	Clarence Valley	Glenreagh Floodplain Risk Plan	2018				Investigate flood immunity along Evacuation Route to north of Glenreagh					LOW	
CL87	Clarence Valley	Glenreagh Floodplain Risk Plan	2018				Approved subdivision off Tallawudjah Creek Road - more detailed simulations to determine impacts					LOW	
CL88	Clarence Valley	Glenreagh Floodplain Risk Plan	2018				Flood conveyance Improvements - Regular maintenance of creeks and culverts					HIGH	
BY39	Byron	Tallow Creek FRMS&P 2009	2009				Upgrade Broken Head Road Crossing of South Tallow Creek „	Broken Head Road is a key access and egress road for the study area, acting as the primary link to the South of Byron Bay. Flood modelling identified that the Broken Head Road crossing of Tallow Creek will be impassable in a flood event less than the 1 in 5 year ARI flood event. Given the importance of Broken Head Road for egress and emergency services access during a flood event, a higher flood immunity is recommended. To achieve this, increasing the capacity of the creek crossing of Broken Head road is required. Preliminary calculations have been performed to establish the upgrade required to achieve flood immunity up to and including the 1 in 10 year ARI flood event. The existing detention basin situated to the South of Coogera Circuit was identified as an ineffective drainage element of the Tallow Creek catchment. The existing spillway is poorly configured, with the following deficiencies: - The spillway has insufficient capacity given the basin catchment size; - The bunding surrounding the detention basin is too low, with the basin frequently overtopping to the North-East. As a result of the basin configuration, nuisance flooding has been recently reported for the properties to the North-East of the existing detention basin. To reduce the instances of nuisance flooding, an auxiliary flood overflow is proposed for the Coogera Circuit detention basin. Existing development greatly reduces the options for storm water relief structures from the detention basin. A combination of pipe and open channel drainage links are proposed to convey additional flood flows from the existing detention basin to link in with an existing flood flow path.					
BY40	Byron	Tallow Creek FRMS&P 2009	2009				Upgrade Coogera Circuit Detention	See pg 74-76 of report					
NP9	Byron	Council Staff recommendation - not supported by a Plan	2022	South Golden Beach			SGB Flood Pump Generator	Protection from power failures.					
NP10	Byron	Council Staff recommendation - not supported by a Plan		South Golden Beach			Investigate Options for SGB Flood Gate Upgrades	Alternate solutions - flood gates with automated knife valves for full closure as an example					
NP11	Byron	Council Staff recommendation - not supported by a Plan		South Golden Beach			Design SGB and Fern Beach Flood Levy Upgrades	Levy over topped in 2022. Propose to raise Levy. Public Works now investigating.					
NP12	Byron	Council Staff recommendation - not supported by a Plan		South Golden Beach			Investigate Flood Levy for Western SGB	Post 2022 flood, investigate the benefits of a levy for west of Capricornia Canal. Propose to request Public Works investigate as part of Levy program					
NP13	Byron	Council Staff recommendation - not supported by a Plan		Shire wide			Post Event Shire-wide Flood Planning Level Review	Proposed action following post event report					
CL89	Clarence Valley	Council's floodplain prioritisation list, adopted in August 2020 / Glenreagh Floodplain Risk Plan (2018)	2020	South Grafton		Musk Valley Creek	Flood studies to determine design flood levels for Musk Valley Creek and Alipou Creeks upstream of the Pacific Highway crossings should be undertaken						
CL	Clarence Valley	Council's floodplain prioritisation list, adopted in August 2020 / Glenreagh Floodplain Risk Plan (2018)	2020				Supplement the recent installation of flood signs on telegraph poles with further strategic signage to warn of the potential risks of levee overtopping and/or failure during floods						
KY19	Kyogle	Council email		Bonalbo			*Woodenbong Road/Sandilands floodway upgrade*						
KY20	Kyogle	Council email		Bonalbo			*Capeen Street floodway upgrade*						
KY21	Kyogle	Council email		Kyogle			Kyogle Accelerated Voluntary House Purchase Scheme	Initially targeted towards those homes in the floodplain that have been damaged and in need of repairs, and where the owners would prefer to sell off the property rather than undertake the repairs. This is of particular concern where this investment is eventually wasted when the property is purchased and demolished some years later under the slow moving regular voluntary house purchase scheme. This would need to be funded by the State and Federal Governments, as the requirement for a Council contribution is what slows this program down so much during normal times, as this is difficult for Council to raise with its competing responsibilities. We have at least three of these in Kyogle, but would likely attract others, so suggest a budget of around $2 million. We have identified a longer term housing proposal that we would like considered. This would see the flood prone properties in the Kyogle township relocated to a flood free housing estate, which is already approved. We have in principle support from the developer, and are looking at a variation on the voluntary house purchase scheme that would see units built for temporary accommodation while the existing houses are relocated to new flood free land, provided with new floor coverings and painting. Then the families can move back in to their own home now located on flood free land, and at the end of the process the temporary accommodation can be transferred to North Coast Community Housing to be used for social and affordable housing needs. This is expected to cost around $30 million dollars for approximately 70 homes, which works out cheaper and faster than the longer term costs of the existing voluntary house purchase scheme under current guidelines, and also retains the existing housing stock so as to not further add to the housing shortage already being experienced.					
KY22	Kyogle	Council email		Kyogle			Kyogle Voluntary House Flood Free Relocation						
KY23	Kyogle	Council email					Raise Reynolds Bridge between Casino and Kyogle	Priority 1 for Build back better: Raise Reynolds Bridge (Summerland Way (State Road)) between Casino and Kyogle to increase flood immunity and avoid current high frequency isolation of the road between the two communities					
KY24	Kyogle	Council email					Clarence Way – Tunglebung Creek and Culmaran Creek	Priority 2 for Build back better: Lifting road approaches to two existing bridges, and extended floodways on approaches. Improved flood immunity from Q2 to Q20 for this major regional road. Strategic alignment with regional state and local road network priorities, improved disaster reliability, adaptability and recovery speed.					
KY25	Kyogle	Council email					Gradys Creek Road Bridge improvements	Priority 3 for Build back better: Greives Crossing and Lamonds Bridge - both bridges are funded under FCB, additional funding for flood immunity raised from Q5 to Q50 at Greives Crossing and from Q5 to Q20 at Lamonds. Will offer improved flood immunity, improved disaster reliability, adaptability and recovery speed.					
KY26	Kyogle	Council email					Causeways improvement program	Priority 4 for Build back better: Improvements to approaches, improved low flow provisions (limited to the damaged structures from 2022 event). Will offer improved flood immunity, improved disaster reliability, adaptability and recovery speed. The two bridges at Tatham (between Casino and Coraki) are relatively low set. Larger flood events overtop the bridges and cut access between Casino and Coraki. Council is currently investigating options to replace these bridges and proposes to raise the level of the bridges to improve access during larger flood events. Coraki's population of 1373 would directly benefit from this proposal, as well as residents in surrounding rural areas. Better connecting Coraki to the main service centre of Casino strengthens options to provide emergency evacuation, emergency housing and supplies for the village. In the 2022, Casino's main commercial precinct experienced only minor impacts and was able to reopen services within 48 hours					
NP14	Richmond Valley	Council's NRRI project list					Tatham Bridge Raising	Improving the flood resilience of this road will provide a better evacuation pathway from Coraki to Casino.					

ID	LGA	Source Study	Year report published	Location	Confidence	Watercourse 1	Option	Description	OPTION TYPE Flood Modification	OPTION TYPE Property Mod	OPTION TYPE Response Modification	Source report Priority	Council recommendations in source report
NP15	Richmond Valley	Council's NRRI project list					Dairy Flat road improvements	Soft soils under MR145 at Dairy Flat, Bungawalbin have created a dip in the road which causes this section of main road to be the last to reopen between Coraki and Woodburn (often taking weeks to open after the peak of a flood). Historic attempts to stabilise this short section of road have failed to prevent subsidence. It is proposed to bridge the soft soils with a series of culverts to improve road access between Coraki and Woodburn during and post floods. Coraki's population of 1373 would directly benefit from this proposal, as well as residents in surrounding rural areas. The village of Woodburn (population 740) would also directly benefit from improved access. MR145 provides a direct link between Casino (population 11,000) and the Pacific Motorway (M1) at Woodburn. This road also connects the major freight route of the Summerland Way with the M1 motorway. Improving its flood resilience is essential for public safety and economic sustainability in the region. Thearles Canal drains significant areas of agricultural land in Swan Bay. The canal has a single culvert beneath MR145 which has been identified by residents as a choke point for drainage. Council will be upgrading sections of MR145 damaged by heavy haulage during the construction of the Woodburn to Ballina Pacific Motorway upgrade, with assistance from Federal Government Funding. However, this funding does not include resources for construction of additional culverts. Improving drainage at this point would help to improve the flood resilience of MR145 and provide better access for surrounding rural communities.					
NP16	Richmond Valley	Council's NRRI project list					Thearles Canal culvert upgrade	The Swan Bay area has a population of 357, including 121 homes. The project would help to improve access and flood resilience for this community Most river height gauges in the Richmond River have datums other than AHD. Council flood studies and information supplied to the community is all referenced to AHD. However, river gauges, which provide essential information about projected flood peaks, can be AHD, LWOST or individual gauge datums. This creates confusion during natural disasters. As an example, Casino River Gauge datum is 5.01m below the AHD datum. To further confuse things, the Irving Bridge (Casino) visual gauge has a different datum to the Casino river gauge which is 7.87m higher than the bridge gauge. Ensuring all Richmond River gauges are calibrated to AHD datum would provide consistency and help community members to better understand impending flood risks. However, public education would be required to support the change, due to historic reliance on the old measures.					
NP17	Richmond Valley	Council's NRRI project list					Richmond River gauges calibration to AHD datum	Casino's population of 11,000 would directly benefit from improved information on expected river heights. Some 300 properties in Casino were inundated in the 2022 floods. Communities down river of Casino, such as Coraki (1372) Woodburn (740) Broadwater (650) and surrounding districts would also benefit from improved information on river heights. Installation of additional automated river height gauges at the following locations would assist in providing essential information for residents to inform their flood response plans. Preferred locations include: Whiporie, Elliots Road (@Myall Creek Gibberagee), Neilly's Lagoon Road (@Bungawalbin Creek Bungawalbin), Broadwater (Pacific Highway bridge crossing and/or SES shed), Evans River @ bridge, Fairy Hill (Kyogle/RV LGA boundary @Baraimal Lane), Stratheden Road Stratheden (@Waldrons Bridge).					
NP18	Richmond Valley	Council's NRRI project list					Additional River Height gauges	The entire Richmond Valley LGA would benefit from additional information on river heights, to assist in flood response planning. Concern with lack of reliable information on river heights was raised in particular by residents of Bungawalbin (population 120), who were isolated for extended periods following the 2022 flood. Additional gauges are proposed for this area. Council has 4762 floor level records which assist in flood planning for the LGA. However, there are still up to 1000 dwellings without floor level records, especially in the Bentley area and the upper parts of the Bungawalbin Creek catchment, including Rappville. Filling these data gaps would improve Council's capacity for flood risk planning.					
NP19	Richmond Valley	Council's NRRI project list					Addressing data gaps	This project would benefit some 2500 residents directly by improving available flood records. It would also assist in building a more reliable data base for future flood planning for the Richmond Valley. Council is nearing completion of its new flood study and is ready to prepare a new Floodplain Risk Management Plan to identify and evaluate flood mitigation/preparedness projects, evaluate flood planning controls and whether these should be changed in light of the 2022 flood event. While RVC has received funding support from the NSW Government to prepare its flood study, it currently does not have funding available for the associated Floodplain Risk Management Plan. This is a critical piece of planning to improve community flood resilience in the future.					
NP20	Richmond Valley	Council's NRRI project list					New Floodplain Risk Management Plan	All residents of the Richmond Valley Local Government Area – 23,500 population – would benefit from this project.					

Appendix B Final ranked project lists

Table 15. Final overall ranked eligible project list

Option Name	LGA	Option Heading	Description	Flood Risk Mitigation	Flood resilience	Environmental	Socio-cultural	Economic	Feasibility	TOTAL
PP2	Various	Public Proposal - Riparian revegetation and reforestation for flood resilience in the Clarence, Richmond, Tweed and Brunswick Catchments	Biodiverse revegetation of riparian zones and reforestation of marginal grazing country to achieve benefits of slowing overland and stream water flows, retaining additional water until saturation and full runoff occurs, stabilising erodible soils including on streambanks and reducing stream and estuarine siltation and turbidity. Needs to be large-scale to have an impact and therefore needs a commercial driver (with targeted subsidy from governments where required) - carbon markets. A pilot project is suggested, which can be upscaled as outlined in the proposal. For the pilot project, it is proposed that 240 hectares of riparian vegetation would be established over two years, covering around 8 kilometres of cleared river and streambank. - Complementary to and guided by Local Land Services. - Provides income to landowners from carbon sequestration - Generates a Green Employment program and skills development opportunity	**0.00**	**0.10**	**0.27**	**0.02**	**0.06**	**0.26**	**0.72**
PP3	Various	Public Proposal - Heal the Rivers Flood Recovery and Landscape Restoration Proposal	The project will run a series of community workshops to bring together community members, stakeholders and government agencies to identify and prioritise restoration work for natural and cultural values in the floodplain and wetland areas of the Northern Rivers catchments. The workshops will develop an Indigenous led integrated knowledge system combining knowledge of first nations communities with other cultural and environmental data. This integrated knowledge system will combine this spatial data and values in the landscape to inform and plan local strategies and activities including revegetation, erosion control and wetland restoration along with cultural site protection. The work program will also include hands on demonstrations of planning and implementing restoration activities at local demonstration sites in each river catchment at two sites in each river catchment each year. This will include the identification and protection of local natural and cultural values in the landscape with local First Nations community members along with private landholders, NGO's such as Landcare as well as government agencies and other relevant stakeholders. This project would develop a First Nations-led strategy for Bundjalung Country in the Northern Rivers to deliver cultural landscape restoration and Country and nature-based flood mitigation and adaptation. This would: - Establish a First Nations River Custodians team to deliver nature-based solutions, resilience building, emergency preparedness, response and recovery, monitoring, knowledge and data sharing on Country, including in priority areas of land use change such as Tuckean Swamp restoration - Develop a platform to cohere and integrate data from multiple sources and systems, and make it available to stakeholders as appropriate, to empower decision-making for Country restoration and flood mitigation and adaptation - Link with partners across the region to connect existing efforts, knowledge and data, link in and fill gaps in monitoring programs for biodiversity and Country, and design and conduct additional surveys as needed, including working with and skilling up with other groups in the region - Work with local universities and training facilities to support First Nations students and connect with their skills and networks - Undertake community resilience and engagement activities including for social development - Deliver cross-sector workshops to share knowledge and identify and prioritise actions, opportunities and strategies for recovery and resilience, including in response to positive land-use-change drivers, important habitat areas, culturally-significant places and species - Support vital research and knowledge-sharing into the effectiveness of cultural landscape restoration and Country and nature-based flood mitigation and adaptation strategies - Develop adaptive management and integrated approaches to delivery of project elements and strategies	**0.09**	**0.16**	**0.15**	**0.00**	**0.03**	**0.28**	**0.71**
NP39	Lismore	Combined upgrades to pumps and pump stations (7 projects)	Combination of 7 related options NP32 to NP38.	**0.22**	**0.26**	**0.00**	**0.03**	**-0.05**	**0.24**	**0.70**
NP9	Byron	SGB Flood Pump Generator	Protection from power failures.	**0.13**	**0.16**	**0.00**	**0.02**	**0.03**	**0.26**	**0.60**
CL84	Clarence Valley	Helicopter landing pad (Glenreagh) for East Bank Rd resdients and other areas	Helicopter landing areas for East Bank residents and other areas Population 100-999	**0.00**	**0.16**	**0.00**	**0.07**	**0.06**	**0.29**	**0.58**
CL6	Clarence Valley	Emergency Management	Review Grafton Rating Curve in flood predictions, incorporate tidal anomalies in flood predictions, train SES for levee overtopping scenarios, form standard warning templates for all major urban areas, develop integrated flood warning website, consider merging 4 local plans into 1, update flood plans/intelligence with new flood data and update evacuation plans for levee overtopping events.	**0.00**	**0.08**	**0.00**	**0.03**	**0.12**	**0.33**	**0.56**
CL51	Clarence Valley	Develop practical method of evacuation	Evacuation to high ground in Yamba is the preferred strategy. The provision of a designated flood refuge, on artificially high land within the development area, is an option for consideration, however, acknowledging that it will not have the range of other infrastructure available on Yamba Hill which can service the population during a major flood event	**0.00**	**0.08**	**0.00**	**0.11**	**0.09**	**0.26**	**0.54**
NP15	Richmond Valley	Dairy Flat road improvements	Soft soils under MR145 at Dairy Flat, Bungawalbin have created a dip in the road which causes this section of main road to be the last to reopen between Coraki and Woodburn (often taking weeks to open after the peak of a flood). Historic attempts to stabilise this short section of road have failed to prevent subsidence. It is proposed to bridge the soft soils with a series of culverts to improve road	**0.00**	**0.19**	**0.00**	**0.09**	**-0.02**	**0.28**	**0.53**

Option Name	LGA	Option Heading	Description	Flood Risk Mitigation	Flood resilience	Environmental	Socio-cultural	Economic	Feasibility	TOTAL
			access between Coraki and Woodburn during and post floods. Coraki's population of 1373 would directly benefit from this proposal, as well as residents in surrounding rural areas. The village of Woodburn (population 740) would also directly benefit from improved access. MR145 provides a direct link between Casino (population 11,000) and the Pacific Motorway (M1) at Woodburn. This road also connects the major freight route of the Summerland Way with the M1 motorway. Improving its flood resilience is essential for public safety and economic sustainability in the region.							
Combined Project	All	Undertake whole of region community flood awareness and education campaign	Combines 15 projects across all LGAs and uses the highest score for community awareness projects as the indicator of priority							**0.53**
BA28	Ballina Shire	Further consideration of recommended option from 'Ross Lane Upgrade Options Assessment' for upgrading Ross Lane at Deadmans Creek and North Creek crossings	Ross Lane is located at the southern end of the Newrybar Swamp and crosses the North Creek floodplain. The road has a history of frequent flooding at the Deadmans Creek crossing and presents safety risks when it occurs. Ross Lane closes on average 1-2 times per year for approximately 1-3 days per event. The best option from a hydraulic perspective is Option 2 which provides a 20% AEP road formation level. Option 2 provides increased road formation level with minimal impacts. As there is a section of Ross Lane to the east of North Creek which is also inundated in a 20% AEP flood event, the upgrade at Deadmans Creek alone cannot achieve 20% AEP flood immunity for Ross Lane. However, as the depth of inundation east of Ross Lane is minimal in the 20% AEP event, it is expected that it would be possible to achieve this immunity in the future with minimal additional works.	**0.00**	**0.16**	**0.00**	**0.06**	**-0.02**	**0.33**	**0.52**
NP16	Richmond Valley	Thearles Canal culvert upgrade	Thearles Canal drains significant areas of agricultural land in Swan Bay. The canal has a single culvert beneath MR145 which has been identified by residents as a choke point for drainage. Council will be upgrading sections of MR145 damaged by heavy haulage during the construction of the Woodburn to Ballina Pacific Motorway upgrade, with assistance from Federal Government Funding. However, this funding does not include resources for construction of additional culverts. Improving drainage at this point would help to improve the flood resilience of MR145 and provide better access for surrounding rural communities. The Swan Bay area has a population of 357, including 121 homes. The project would help to improve access and flood resilience for this community	**0.00**	**0.16**	**0.00**	**0.06**	**0.01**	**0.28**	**0.51**
BA14	Ballina Shire	Raise Low Points on Evacuation Routes	Various evacuation routes have been identified in the study area in the BFRMS. An assessment of the closure of these routes was undertaken. It was found that the route closure can be delayed through raising the low points along some routes. It is recommended that the potential to delay evacuation route closure by raising low points on Moon Street, Kerr Street and River Drive (see Figures D-1 and D-6 in Appendix D in the BFRMS) is investigated further. In addition, consideration should be given to raising sections of Tamarind Drive and River Street. Benefits include increasing the time available for evacuation, thus reducing the risk to life and welfare of the community and SES.	**-0.09**	**0.16**	**0.00**	**0.07**	**0.03**	**0.33**	**0.49**
CL15	Clarence Valley	Install box culverts through levee near North Street (Grafton)	Design and install twin 2.1x2.1 box culverts thorugh river bank levee near North St to improve local drainage prior to floodgates closing, and to speed up the removal of impounded stormwater east of Alumy Creek once river levels subside, or following events that overtop the levees	**0.09**	**0.08**	**0.00**	**0.07**	**0.00**	**0.24**	**0.48**
BY29	Byron	Preferred Byron Drainage Strategy Construction	Improved drainage and wetland creation. Reduction in current flood risk from Belongil Creek and Storm Tide, reduction of risk to people, risk to property. Ecological improvement.	**0.23**	**0.13**	**0.05**	**0.06**	**-0.08**	**0.08**	**0.46**
TW46	Tweed	Earthworks across Lot 4 on Quarry Rd	Preserves the South Murwillumbah Condong Flowpath, provides protection for 1% AEP floods	**0.09**	**0.11**	**0.00**	**0.04**	**0.00**	**0.22**	**0.46**
CL55	Clarence Valley	Construct stock mounds	Stock mounds are one means of limiting the potential for stock losses during a flood and are an alternative to evacuation	**-0.05**	**0.10**	**0.00**	**0.04**	**0.07**	**0.29**	**0.45**
TW59	Tweed	Additional Wharf St Pump Capacity	Requires an independent pump system rather than upgrade	**0.00**	**0.05**	**0.00**	**0.05**	**0.06**	**0.28**	**0.45**
LI6	Lismore	Combined option LI1 to LI5	This option reflects implementation of the five flood modification measures discussed (LI1 to LI1) into a single option. It includes Raise of CBD Levee to Provide 5% AEP Immunity, Raise of South Lismore Levee to provide 5% AEP Flood Immunity, Excavation of Wilsons River Bends at 387 Keen Street, Removal of Kyogle Road Railway Embankment and Increase Conveyance at Key Hydraulic Controls at Bruxner Highway, Caniaba Road and Krauss Avenue. The hydraulic modelling results from simulation of this mitigation option are summarised below: • Areas negatively impacted in the 5% AEP flood event included North Lismore (70 mm), a significant portion of South Lismore (30-70 mm), Lismore airport buildings (40 mm) and the development located south of Lismore Lake (50 mm). • Areas negatively impacted in the 1% AEP flood event generally included uninhabited areas upstream of the South Lismore levee. • Areas where flood levels are expected to reduce in the 5% AEP flood event include South Lismore (15-400 mm) and the area west of the Bruxner Highway and south of the airport (40-110 mm). Most of the CBD is flood free in the 5% AEP flood event and there are properties along Caniaba Street downstream of the South Lismore levee that are	**0.31**	**0.11**	**-0.11**	**-0.04**	**-0.08**	**0.26**	**0.44**

Option Name	LGA	Option Heading	Description	Flood Risk Mitigation	Flood resilience	Environmental	Socio-cultural	Economic	Feasibility	TOTAL
			also flood free. • In the 1% AEP flood event, reductions in flood levels are expected throughout the floodplain, except the previously identified uninhabited areas upstream of the South Lismore Levee within the Leycester Creek floodplain.							
BA5	Ballina Shire	Develop agricultural levee guidance	Levees are used by farmers in the study area to protect arable land from flooding. Particularly flooding associated with high tides where salt intrusion may degrade the quality of the soil. Currently there are no formal controls on this form of development. In some areas these levees impact on flood levels to neighbouring properties. Thus, it is recommended that some limitations are developed. This issue is common to the Richmond River County Council (RRCC). Thus, it is recommended that this is done in collaboration with RRCC.	**0.00**	**0.08**	**0.00**	**0.04**	**0.12**	**0.20**	**0.44**
TW72	Tweed	New Pump System within East Murwillumbah Levee	A new pump system near George Street (just east of York Street) to assist in draining East Murwillumbah. It was assumed that the pump system would provide a peak flow capacity of 2 m 3 /s and would start to operate once the water depth upstream of George Street exceeds 1 metre.	**0.00**	**0.00**	**0.00**	**0.10**	**0.03**	**0.31**	**0.44**
BY24	Byron	Identify key roads and implement automatic warning signs and depth indicators	Consider investigating automatic warning signs and depth indicators for the Pocket Road and Sherry's Bridge on Main Arm Road.	**0.00**	**0.00**	**0.00**	**0.04**	**0.09**	**0.31**	**0.44**
CL3	Clarence Valley	Flood-affected property survey and database	Conduct a property survey to determine which properties are affected by various floods and assemble a GIS database to present the information, including floor levels, flood levels, building type and location. This will enable the identification of problem areas in the catchment, help evaluate economic benefits of flood mitigation works, help identify properties for flood notification or other flood awareness activities, assist SES evacuation planning and evaluate a property's qualification for VP and VHR schemes.	**0.00**	**0.05**	**0.00**	**0.07**	**0.03**	**0.29**	**0.43**
NP45	Lismore	Combined upgraded flood telemetry, technology and community warning systems	Combination of 5 related options NP40 to NP44	**0.00**	**0.16**	**0.00**	**0.07**	**-0.05**	**0.26**	**0.43**
NP30	Lismore	Widen Browns Creek flood channel, culvert and re-route services currently restricting flow at Brewster Street	The existing open channel narrows where it crosses Brewster Street causing a restriction in flows which then breaks the channel and spills across parks and roads at Brewster St and Uralba. Would improve evacuation routes and extend evacuation timeframes.	**0.09**	**0.13**	**0.00**	**0.01**	**-0.03**	**0.22**	**0.42**
BA2	Ballina Shire	Removal/Lowering of Deadmans Ck Road	Deadmans Creek Road, which services development on the Cumbalum Ridge, is located along an embankment across the Emigrant Creek floodplain in Cumbalum. This embankment acts like a weir, raising upstream flood levels. A new road (Ballina Heights Drive) providing a similar service is located approximately 1km north of Deadmans Creek Road. Therefore, there may be an opportunity to remove or lower Deadmans Creek Road.	**0.09**	**0.00**	**0.00**	**0.07**	**0.00**	**0.26**	**0.42**
PP4	Various	Public Proposal - Community-led Resilience Teams (facilitated by the Red Cross)	With a changing climate increasing the number and intensity of disasters across the country, communities identifying their risks and the capacities they have at hand to manage them is going to become a critical tool in helping them adapt. Community-led Resilience Program was piloted in 2017-18, borne out of the disastrous impacts of 2017 Tropical Cyclone Debbie. It has been further developed and extended in response to the 2019-2020 Black Summer bushfires and COVID, it takes an all hazards, strength-based approach ensuring that community is central. Community-led Resilience Teams (CRTs) provide a formal structure, direction and guidance which complement community resources, people, and capacity. CRTs enable the collective community voice to be channelled externally benefiting emergency management organisations such as SES, RFS, and Councils. Local communities know their history, risks, people, resources, capacities, and geographical location better than anyone from outside their community. The CRT program helps to tap into that vital information and into the very heart of the community itself bringing transparency to communities' culture and idiosyncrasies for external stakeholders, it assists communities to identify their own strengths, capacities, and vulnerabilities, and developing a plan to strengthen their resilience. The proposal is for a two-year funded project delivered across 7 LGA in Northern Rivers area, reaching approximately a total of 70 communities and providing a minimum of 4 engagement opportunities in establishing a CRT.	**0.00**	**0.11**	**0.00**	**0.02**	**-0.03**	**0.31**	**0.40**
TW48	Tweed	Alma St modification	Involves elevation of Alma Street. Goal of this option is to provide additional time for people from South Murwillumbah to evacuate into the Murwillumbah CBD and will occur if levee raising or in conjunction with future works	**0.23**	**0.06**	**-0.11**	**0.04**	**0.03**	**0.16**	**0.40**
PP7	Clarence Valley	Public Proposal - Sugar Mill Protection	Protection of three major sugar mills - Condong Sugar Mill and Cape Byron Power Cogeneration Facility (Tweed River), Broadwater Sugar Mill and Cape Byron Power Cogeneration Facility, and Harwood Sugar Mill and Refinery (Clarence River), by way of flood walls and specially designed flood gates. See proposal (pg. 4) for addressing of criteria. Cost estimate is based on other similar projects.	**0.09**	**0.03**	**0.00**	**0.00**	**-0.05**	**0.33**	**0.39**
TW58	Tweed	New low flow pump Lavender Creek and CBD	Some flood reductions south of creek, negligible when overtopping occurs	**0.00**	**0.00**	**0.00**	**0.13**	**0.03**	**0.22**	**0.38**
NP8	Ballina Shire	Revitalise condition of Lower Newrybar drain to improve immunity of Ross Lane	The area immediately south of Ross Lane, Newrybar is serviced by a drain that runs west to east into the main Newrybar drain and North Creek. This drain services a known problematic area, where inundation after even small rain events can close the major route of Ross Lane, as well as 5 residential dwellings. The area receives runoff from land upstream and to the west. The drain is historic and needs its condition to be revitalised in order to continue to provide the expected level of service. Work on the drain would improve the immunity of Ross Lane, enabling more secure road and transport access, as well as reduce the risk of flooding on the residential dwellings.	**0.00**	**0.11**	**-0.05**	**0.07**	**0.00**	**0.26**	**0.38**

Option Name	LGA	Option Heading	Description	Flood Risk Mitigation	Flood resilience	Environmental	Socio-cultural	Economic	Feasibility	TOTAL
NP14	Richmond Valley	Tatham Bridge Raising	The two bridges at Tatham (between Casino and Coraki) are relatively low set. Larger flood events overtop the bridges and cut access between Casino and Coraki. Council is currently investigating options to replace these bridges and proposes to raise the level of the bridges to improve access during larger flood events. Coraki's population of 1373 would directly benefit from this proposal, as well as residents in surrounding rural areas. Better connecting Coraki to the main service centre of Casino strengthens options to provide emergency evacuation, emergency housing and supplies for the village. In the 2022, Casino's main commercial precinct experienced only minor impacts and was able to reopen services within 48 hours Improving the flood resilience of this road will provide a better evacuation pathway from Coraki to Casino.	**-0.04**	**0.21**	**-0.06**	**0.03**	**-0.02**	**0.26**	**0.38**
TW1	Tweed	Procedure for pedestrian and local evacuation	Identify suitable evacuation points; Update residents	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.35**	**0.38**
NP29	Lismore	Mechanical trash racks at all 3 major pump station inlets	Trash racks will reduce the risk of rubbish and debris being washed/sucked into pump intakes and causing damage to pumps. During flood events there can often be large items such as shopping trolleys washed down drainage channels which are a significant risk to the pump infrastructure. Providing this infrastructure would lead to improved resilience outcomes of pumps and improve ability to mitigate flood impacts	**-0.04**	**0.18**	**0.00**	**0.01**	**-0.05**	**0.29**	**0.38**
BA18	Ballina Shire	Evacuation Route Raising - Comprises Ballina Island and west Ballina only and EXCLUDES bridge duplication at River St and Tamarind Dve (including bridge duplication) to Cumbalum.	In order to improve evacuation potential during flood conditions under existing and future climate scenarios, the following road raising options were identified for consideration in consultation with Council: Case 1: Raise existing evacuation routes to above 1.8m AHD3. Case 2: Raise existing evacuation routes to elevations consistent with Councils existing fill policy (approximately 1.9m AHD to 2.2m AHD across study area) as defined by Map 1A in the Ballina Shire Development Control Plan 2012, Chapter 2b – Floodplain Management (BSC, 2012). Case 3: Raise existing evacuation routes to be above the 100 year ARI Year 2050 design flood (riverine, creek, ocean) level (approximately 2.1m AHD to 2.3m AHD across study area). Case 4: Raise existing evacuation routes to be above the 100 year ARI Year 2100 design flood (riverine, creek, ocean) level (approximately 2.4m AHD to 2.7m AHD across study area).	**-0.14**	**0.16**	**-0.06**	**0.09**	**-0.02**	**0.33**	**0.36**
NP7	Lismore	Revilitise South and East Lismore Town Drains	South and East Lismore are serviced by two main drains that reduce inundation after flooding. The existing South Lismore drain and Gundurimba Creek drain are historic and need their condition revitalised and preserved. The South Lismore drain services around 6km2 of land that houses an industrial estate and the Lismore airport and is one of the main pathways that floodwaters drain from the area. Gundurimba Creek drain services around 4km2 of land which includes the main route of Wyrallah Road, the East Lismore Sewage Treatment Plant, Lismore Waste Facility, around 5 residential dwellings and is the main pathway for floodwaters to drain from East Lismore. Both Town drains reduce the length of inundation after flooding and are important during major events. Reducing the length of inundation within these areas delivers human and social outcomes, benefits dwellings and infrastructure and the local economy by minimising damage to property and allowing for quicker recovery after flood events.	**0.00**	**0.11**	**-0.05**	**0.01**	**0.03**	**0.26**	**0.35**
CL13	Clarence Valley	Investigate flood free access to Junction Hill (Grafton) via The Summerland Way	Junction Hill is a larger town which is located upstream of Grafton, on high ground which is mostly above the PMF flood. All of the dwellings within the town boundaries appear to be above the 100 year flood level, with the majority of dwellings also located above the PMF flood. Access south of Junction Hill to Grafton will be cut by floodwater; however, flood free access will be available to the north of town via the Summerland Way. Access will investigate road raising measures and/or modifications to the Westlawn levee. These options are preferred to levee raising.	**0.00**	**0.03**	**0.00**	**0.07**	**0.06**	**0.20**	**0.35**
NP19	Richmond Valley	Addressing data gaps in Floor Level recording	Council has 4762 floor level records which assist in flood planning for the LGA. However, there are still up to 1000 dwellings without floor level records, especially in the Bentley area and the upper parts of the Bungawalbin Creek catchment, including Rappville. Filling these data gaps would improve Council's capacity for flood risk planning. This project would benefit some 2500 residents directly by improving available flood records. It would also assist in building a more reliable data base for future flood planning for the Richmond Valley.	**0.00**	**0.00**	**0.00**	**-0.02**	**0.06**	**0.31**	**0.35**
LI4	Lismore	Removal of Kyogle Road Railway Embankment	8 protected in 1% AEP, 0 protected in 5% AEP (of 353)	**0.09**	**0.00**	**0.00**	**-0.02**	**-0.06**	**0.33**	**0.35**
PP6	Lismore	Public Proposal - Application for Emergency Funding re Lismore Flood Mitigation, Northern Rivers Resilience Initiative(CSIRO ProjectGroup).	Undertake an urgent drain clearance operation across the identified areas (60 streets). Given the third La Nina, residents believe this is an emergency that requires action to be conducted as soon as possible. Assuming a cost of approximately $7000-10,000 (some may be more, some may be less) to clear each street, we estimate the total sum required to be in the region of$500,000. Note: Although this funding application is seeking urgent action to clear the drains, we acknowledge that some of the problems will require more infrastructural planning and development because, due to poor design, or changing conditions, some of the drains do not drain anywhere. However, acknowledgement of this does not negate the need to clear the drains as soon as possible. Indeed, a significant effort to clear the drains should have been undertaken after the initial clean-up. However,	**0.01**	**0.03**	**0.00**	**0.00**	**-0.03**	**0.33**	**0.33**

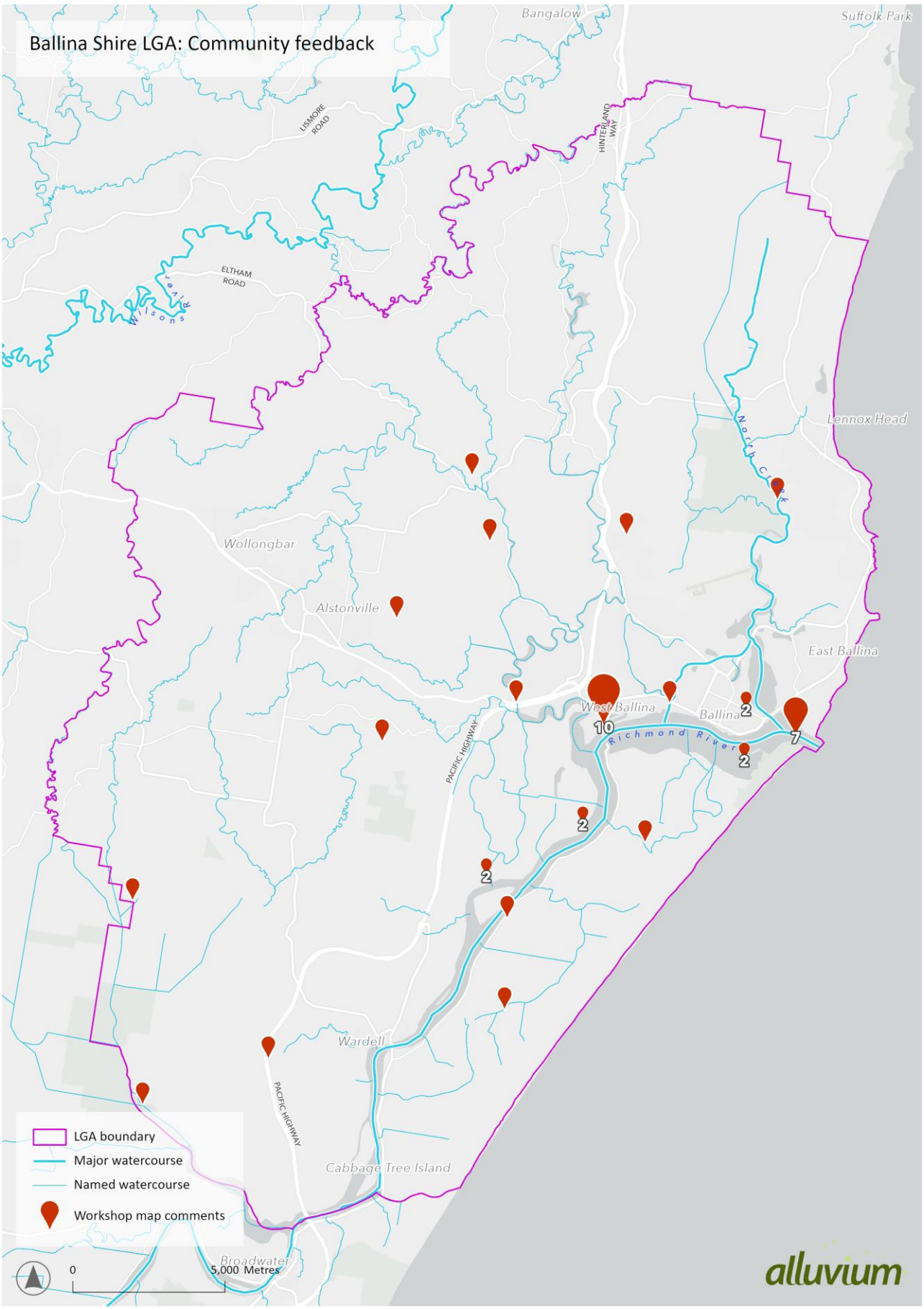
Option Name	LGA	Option Heading	Description	Flood Risk Mitigation	Flood resilience	Environmental	Socio-cultural	Economic	Feasibility	TOTAL
			this did not happen, and some stormwater drains damaged during theclean-up operation have not been repaired.							
TW33	Tweed	Detailed evacuation procedures	A more detailed evacuation planning study is required to investigate trouble spots more closely and plan strategies for reducing evacuation risk in those areas. This study is taking broad recommendations fro the FRMS and applying them at a local level. Outcomes will improve the safety of residents and reduce SES resourcing requirements.	**0.00**	**0.10**	**0.00**	**0.06**	**0.00**	**0.18**	**0.34**
NP6	Richmond Valley	Improve condition of Coraki and Woodburn town drains	The rural villages of Coraki and Woodburn are serviced by main town drains that reduce inundation times after flooding. The existing Coraki Town drain and Woodburn Town drain are historic and need their condition improved and preserved. The Coraki Town drain services around 1.5km2 of land within the village which includes residential dwellings, the main access routes of Queen Elizabeth Drive and access in and out of aged care and health facilities. The Woodburn Town drain services around 3km2 of land and is one of the main pathways that floodwaters drain from the village. Both Town drains reduce the length of inundation after flooding and are important during major events. Reducing the length of inundation within the villages delivers human and social outcomes, benefits dwellings and infrastructure and the local economy by minimising damage to property and allowing for quicker recovery after flood events.	**0.00**	**0.11**	**-0.05**	**-0.02**	**0.03**	**0.26**	**0.33**
NP10	Byron	Investigate Options for South Golden Beach Flood Gate Upgrades	Alternate solutions - flood gates with automated knife valves for full closure as an example	**0.00**	**0.00**	**0.00**	**0.02**	**0.06**	**0.26**	**0.34**
TW60	Tweed	New pump systems behind Dorothy St	Installation of a new pump system for the area behind the Dorothy Street levee to assist in reducing flood levels behind the levee and allowing water to drain from behind the levee following the flood. Significant Reductions during 1% AEP	**0.00**	**0.00**	**0.00**	**0.06**	**0.00**	**0.26**	**0.32**
CL83	Clarence Valley	Interconnection of pump stations	Interconnect flood pumps in River Street (Maclean) and interconnect Pound, Bacon and Fry Streets (Grafton) with underground drainage lines. Population >5000	**0.00**	**0.05**	**0.00**	**0.05**	**-0.03**	**0.24**	**0.32**
NP1	Ballina Shire	Investigate the raising of Wardell Road approx 1 km north of Wardell	Required due to isolation of Wardell and inability to evacuate to Alstonville	**0.00**	**0.00**	**0.00**	**0.04**	**-0.06**	**0.33**	**0.32**
KY23	Kyogle	Raise Reynolds Bridge between Casino and Kyogle	Priority 1 for Build back better: Raise Reynolds Bridge (Summerland Way (State Road)) between Casino and Kyogle to increase flood immunity and avoid current high frequency isolation of the road between the two communities	**0.00**	**0.18**	**0.00**	**-0.02**	**-0.05**	**0.19**	**0.31**
BY40	Byron	Upgrade Coogera Circuit Detention	The existing detention basin situated to the South of Coogera Circuit was identified as an ineffective drainage element of the Tallow Creek catchment. The existing spillway is poorly configured, with the following deficiencies: - The spillway has insufficient capacity given the basin catchment size; - The bunding surrounding the detention basin is too low, with the basin frequently overtopping to the North-East. As a result of the basin configuration, nuisance flooding has been recently reported for the properties to the North-East of the existing detention basin. To reduce the instances of nuisance flooding, an auxiliary flood overflow is proposed for the Coogera Circuit detention basin. Existing development greatly reduces the options for storm water relief structures from the detention basin. A combination of pipe and open channel drainage links are proposed to convey additional flood flows from the existing detention basin to link in with an existing flood flow path.	**0.18**	**0.05**	**-0.11**	**0.01**	**-0.03**	**0.20**	**0.31**
KY24	Kyogle	Clarence Way – Tunglebung Creek and Culmaran Creek	Priority 2 for Build back better: Lifting road approaches to two existing bridges, and extended floodways on approaches. Improved flood immunity from Q2 to Q20 for this major regional road. Strategic alignment with regional state and local road network priorities, improved disaster reliability, adaptability and recovery speed.	**0.00**	**0.11**	**0.00**	**0.01**	**-0.05**	**0.24**	**0.30**
KY25	Kyogle	Gradys Creek Road Bridge improvements	Priority 3 for Build back better: Greives Crossing and Lamonds Bridge - both bridges are funded under FCB, additional funding for flood immunity raised from Q5 to Q50 at Greives Crossing and from Q5 to Q20 at Lamonds. Will offer improved flood immunity, improved disaster reliability, adaptability and recovery speed.	**0.00**	**0.11**	**0.00**	**0.01**	**-0.05**	**0.24**	**0.30**
BY39	Byron	Upgrade Broken Head Road Crossing of South Tallow Creek „	Broken Head Road is a key access and egress road for the study area, acting as the primary link to the South of Byron Bay. Flood modelling identified that the Broken Head Road crossing of Tallow Creek will be impassable in a flood event less than the 1 in 5 year ARI flood event. Given the importance of Broken Head Road for egress and emergency services access during a flood event, a higher flood immunity is recommended. To achieve this, increasing the capacity of the creek crossing of Broken Head road is required. Preliminary calculations have been performed to establish the upgrade required to achieve flood immunity up to and including the 1 in 10 year ARI flood event.	**0.10**	**0.08**	**-0.06**	**-0.01**	**0.01**	**0.17**	**0.29**
KY5	Kyogle	Improve Bruxner Highway evacuation route	Ensures evacuation route up to 1% AEP	**0.00**	**0.05**	**0.00**	**-0.02**	**-0.08**	**0.33**	**0.28**
PP1	Various	Public Proposal - Expansion and improvements to the river and rain gauge network	There is an urgent need for more rainfall and river height data to feed BOM's predictive models and enable SES to disseminate appropriate warnings. More accurate warnings enable communities to make well-informed decisions, which ultimately reduces the extent of damage and trauma experienced. Some people also rely on the raw gauge data to inform their response, separate from official warnings. Over time, gauges generate useful data which may inform future decision-making. Gauges record peak levels of floods and provide information about the rate of rise and recession of floodwaters, which may be useful for assessing flood mitigation options and providing data for future flood studies.	**0.00**	**0.10**	**0.00**	**0.04**	**-0.06**	**0.20**	**0.28**

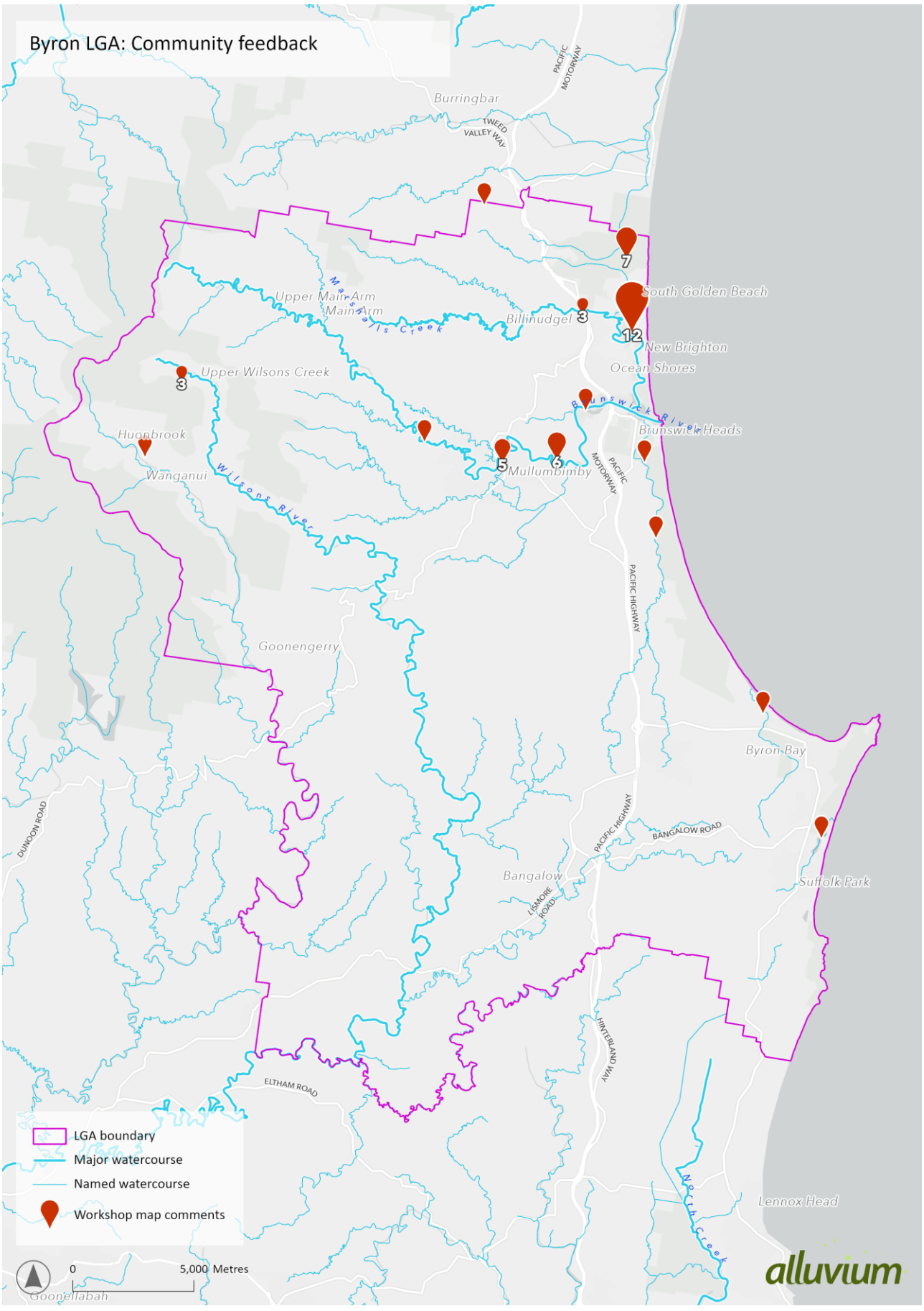
Option Name	LGA	Option Heading	Description	Flood Risk Mitigation	Flood resilience	Environmental	Socio-cultural	Economic	Feasibility	TOTAL
			21 specific new gauge locations have been suggested from a variety of sources recorded in the proposal. We are proposing combined rainfall/river height gauges, costed at $30,000 each + $3,000/year for maintenance. Please see the proposal for recommendations to further improve the gauge network regarding governance, maintenance, standardisation, dissemination of gauge data and incorporation of private gauge data.							
PP5	Lismore	Public Proposal - Feasibility study of Richmond/Wilsons River catchment for climate resilience and adaption planning	The proposal is a comprehensive Climate Resilience and Adaptation Feasibility Study for the Richmond/Wilsons River Catchment. The study results will inform a business case involving economic resilience and water management recommendations for both flood and drought including: • estimated costs associated with implementation of the proposed projects; • benefit/cost analyses associated with the proposed resilience projects • timelines and conceptual scope of work for the projects • an outline of social and economic benefits See proposal for details on how the study addresses all criteria. Estimated feasibility study costs: Research for a Climate Resilience and Adaptation Plan - $2 million Feasibility Study of total mitigation Options B-R - Later stage (accurate damages data not yet available)	**0.00**	**0.10**	**0.00**	**0.02**	**-0.06**	**0.22**	**0.29**
LI5	Lismore	Increased Conveyance at Hydraulic Controls	upgrades to key hydraulic controls downstream of Lismore to increase conveyance through South Lismore	**0.09**	**0.05**	**-0.06**	**-0.04**	**-0.09**	**0.26**	**0.23**
RI26	Richmond Valley	Increase drainage through swan bay New Italy road	The Swan Bay New Italy Road area (west of Rosolen's Canal) is identified as requiring an increase in drainage through the road in the form of culverts. At present, the only culverts through the road are small culverts designed to carry local flow. The Committee selected the drainage improvement option of a shallow drain and culverts under the southern section of Swan Bay New Italy Rd (see Figure 17.1). This consists of a flat, shallow drain over 1km in length running in a north-south direction at 1m AHD with culverts equivalent to 4m2 in flow area. Details of the change in flood drainage behaviour and of the assessments into other options are presented in the Study. Some further investigation will be needed to determine if acid-sulphate soils are a problem in this area and the potential implications for construction of the drain. Further detailed survey work is also required to determine the best location for the drain and associated culverts.	**0.00**	**0.00**	**0.00**	**0.02**	**-0.06**	**0.26**	**0.22**
BY7	Byron	Develop a sediment transport model to investigate modification to the rock walls, as part of the Coastal Management Program for the Brunswick Estuary.	High order flood events result in significant scour around the entrance. There are possible impacts of the Readings Bay training walls on flooding behaviour, particularly adjacent to Marshalls Creek. There is also some concern about flooding and its impact on the estuarine environment. A detailed sediment transport model to investigate modification to the rock walls for the purpose of improved sediment transport, as part of the Coastal Management Program Scoping Study for Cape Byron to South Golden Beach. Will provide an understanding of sediment transport processes due to the rock walls and will investigation options for improving sediment transport in Readings Bay. Limited concerns with this option. Costs associated with development of this model however funding options are available.	**0.00**	**0.03**	**0.05**	**0.02**	**0.00**	**0.17**	**0.27**
LI3	Lismore	Excavation of Wilsons River Bend	Excavating the land located at 387 Keen Street which is on the eastern bank of Wilsons River by 1-3 m . 42 protected in 1% AEP, 14 protected in 5% AEP (of 353)	**0.05**	**0.00**	**-0.11**	**-0.02**	**-0.05**	**0.24**	**0.10**
NP21	Lismore	Leycester Creek Bypass Channel	Bypass channel from Tuncester to South Gundurimba to improve conveyance of flood waters from Leycester Creek from flood events starting from 20-50%AEP flood event. Design elements include: base width of 250m, average depth of 3m, batter slopes 1:6; estimated channel capacity of 1400m3/s Reductions of up to 940 mm in the CBD are observed in the 5% AEP event, and up to 470mm in the 1% AEP event. Reductions of up to 420 mm in North Lismore are observed in the 5% AEP event, and up to 440 mm in the 1% AEP event. Reductions of up to 700 mm in South Lismore are observed in the 5% AEP event, and introduction of flood free areas. Reductions of up to 600 mm in the 1% AEP event. Conveyance of flows through to Wilsons River from Leycester Creek causes flood impacts in the 5% AEP flood event in the order of 80 mm downstream. Minimal impacts are observed in the 1% AEP flood event.	**0.18**	**0.13**	**-0.27**	**0.05**	**-0.05**	**0.03**	**0.07**
NP27	Lismore	Concrete line Browns Creek from Uralba Street to bat cave between Dawson and Keen Streets	The section of the channel from Uralba Street to the bat cave tunnel at Dawson and Keen Streets is currently grass lined and very difficult to properly maintain because of the steep embankments on the channel. Lining the channel with concrete will improve water flows and reduce ongoing maintenance costs.	**0.09**	**-0.03**	**-0.17**	**-0.04**	**-0.09**	**0.22**	**-0.01**
KY3	Kyogle	Floodway - Location 1 Excavation	Excavate 600,000m3 of material east of racecource, erosion, downstream flood level increase	**0.00**	**0.03**	**-0.22**	**-0.04**	**-0.09**	**0.08**	**-0.23**
KY4	Kyogle	Floodway - Location 2 Excavation	Excavate 2,000,000m3 of material downstream of racecourse, impacts wetland, downstream flood level increase	**0.00**	**0.00**	**-0.27**	**-0.04**	**-0.09**	**0.06**	**-0.33**
BA33	Ballina Shire	Option S2 - Dredging of the Richmond River channel extending from Little Pimlico Island upstream to Meaneys Lane	The dredging will involve deepening the river channel by up to 5 metres and the removal of about 1.2M m 3 of material from the river bed. The dredging will aim to increase the flow carrying capacity of the Richmond River channel. This will potentially allow a greater proportion of flood flows to be contained to the river channel, thereby, reducing the proportion	**0.05**	**-0.05**	**-0.22**	**0.04**	**-0.12**	**-0.05**	**-0.36**

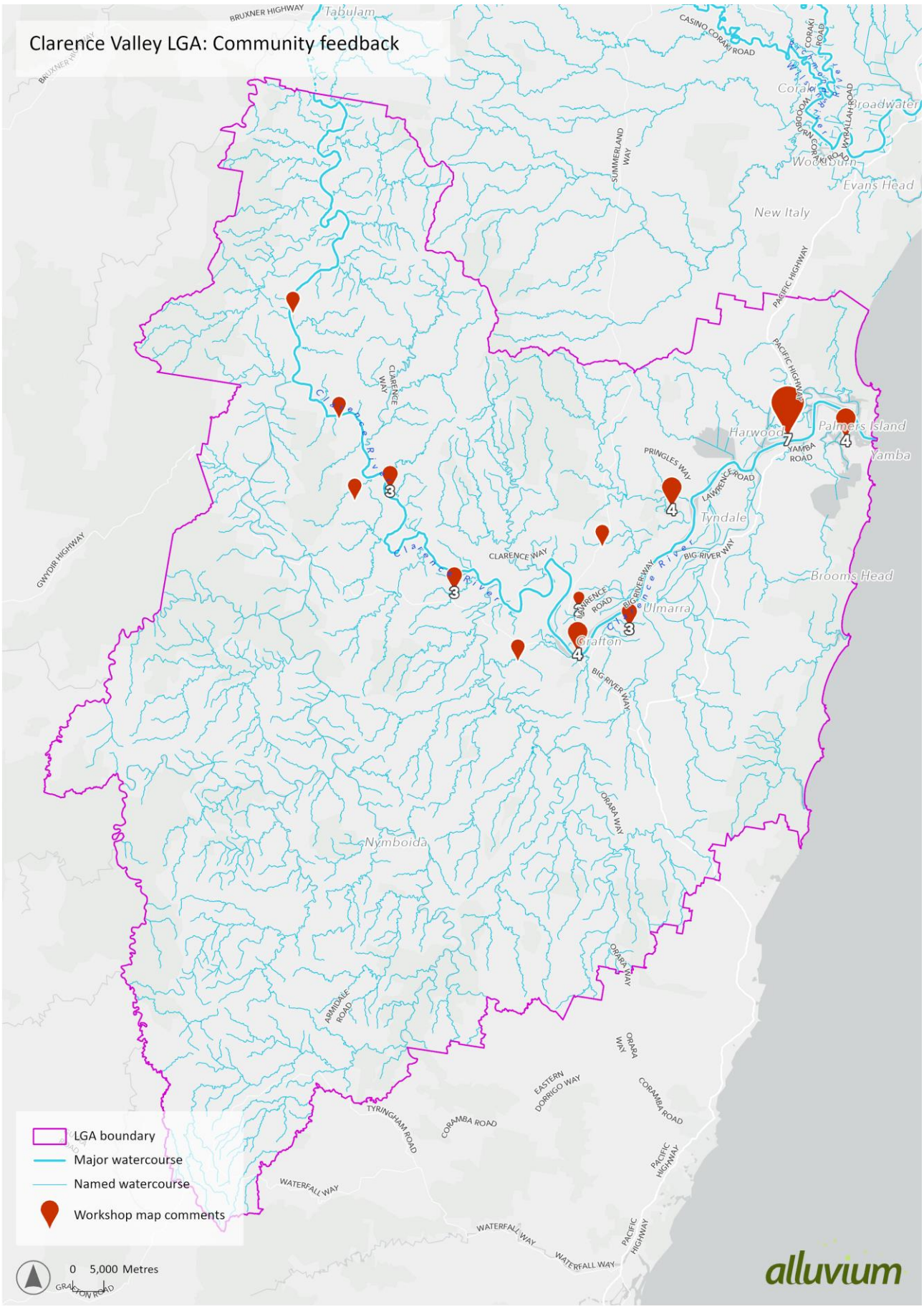
Option Name	LGA	Option Heading	Description	Flood Risk Mitigation	Flood resilience	Environmental	Socio-cultural	Economic	Feasibility	TOTAL
			of flows discharged across the floodplain in the vicinity of Wardell and East Wardell. Hydraulic assessment of the dredging option shows that flood levels upstream from Wardell may be reduced by up to 0.08 metres.							

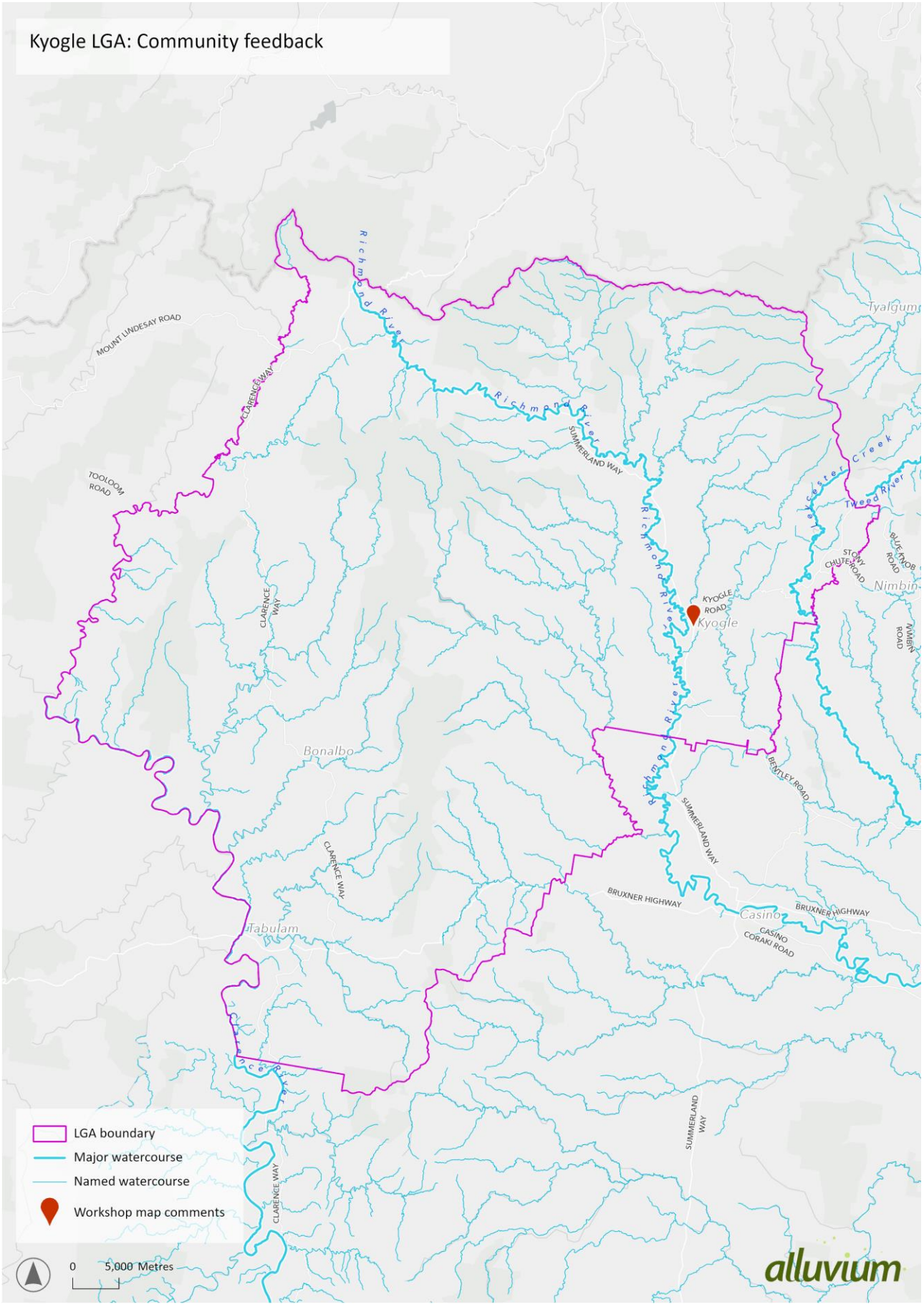
Appendix C Engagement reports & maps

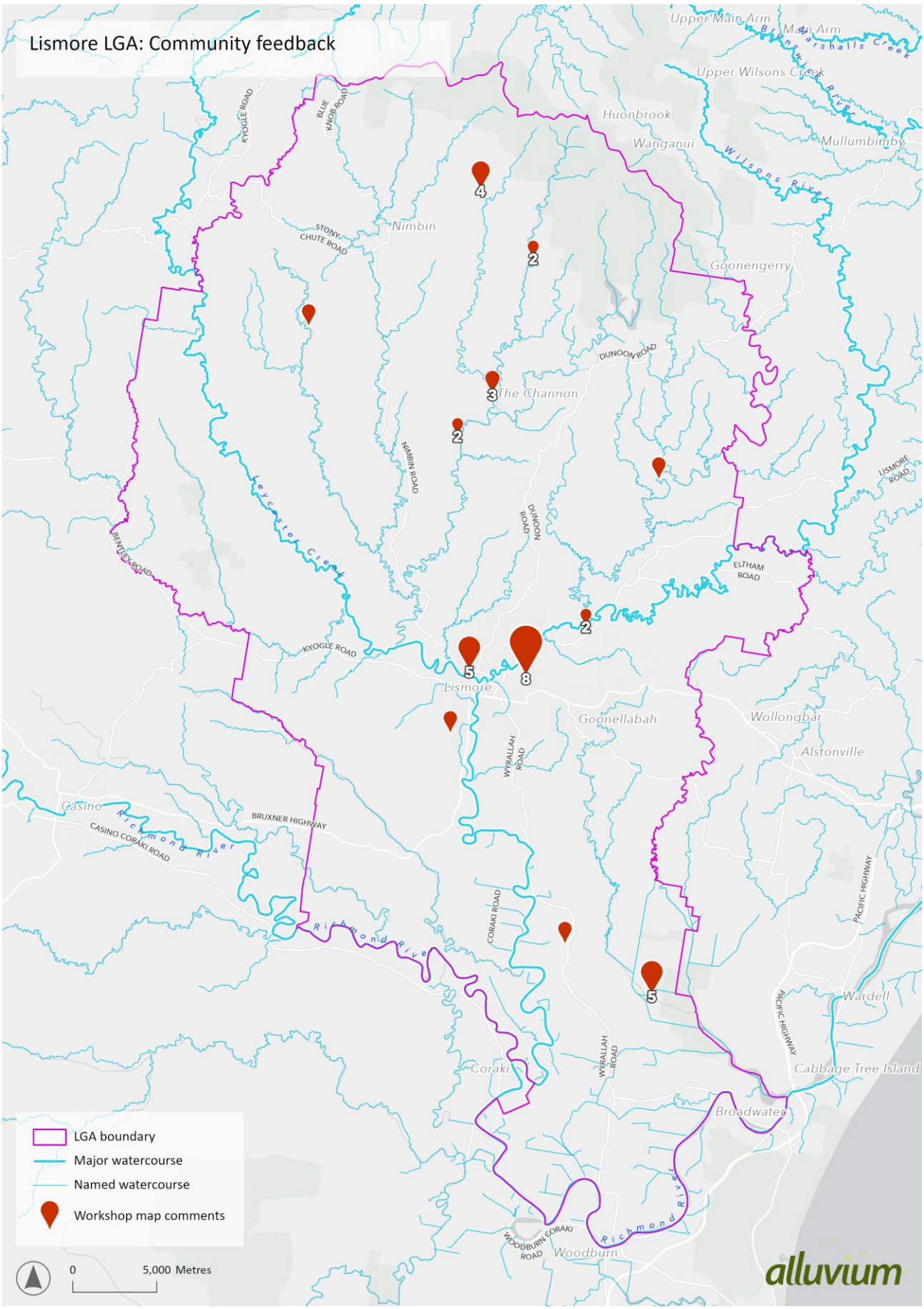
Individual engagement reports are attached to this report and form Appendix C. In addition, the maps on the following pages relate to locations referred to in comments received during engagements in each of the local government areas. The size of the icon refers to the number of comments received (the larger the icon, the more comments received).

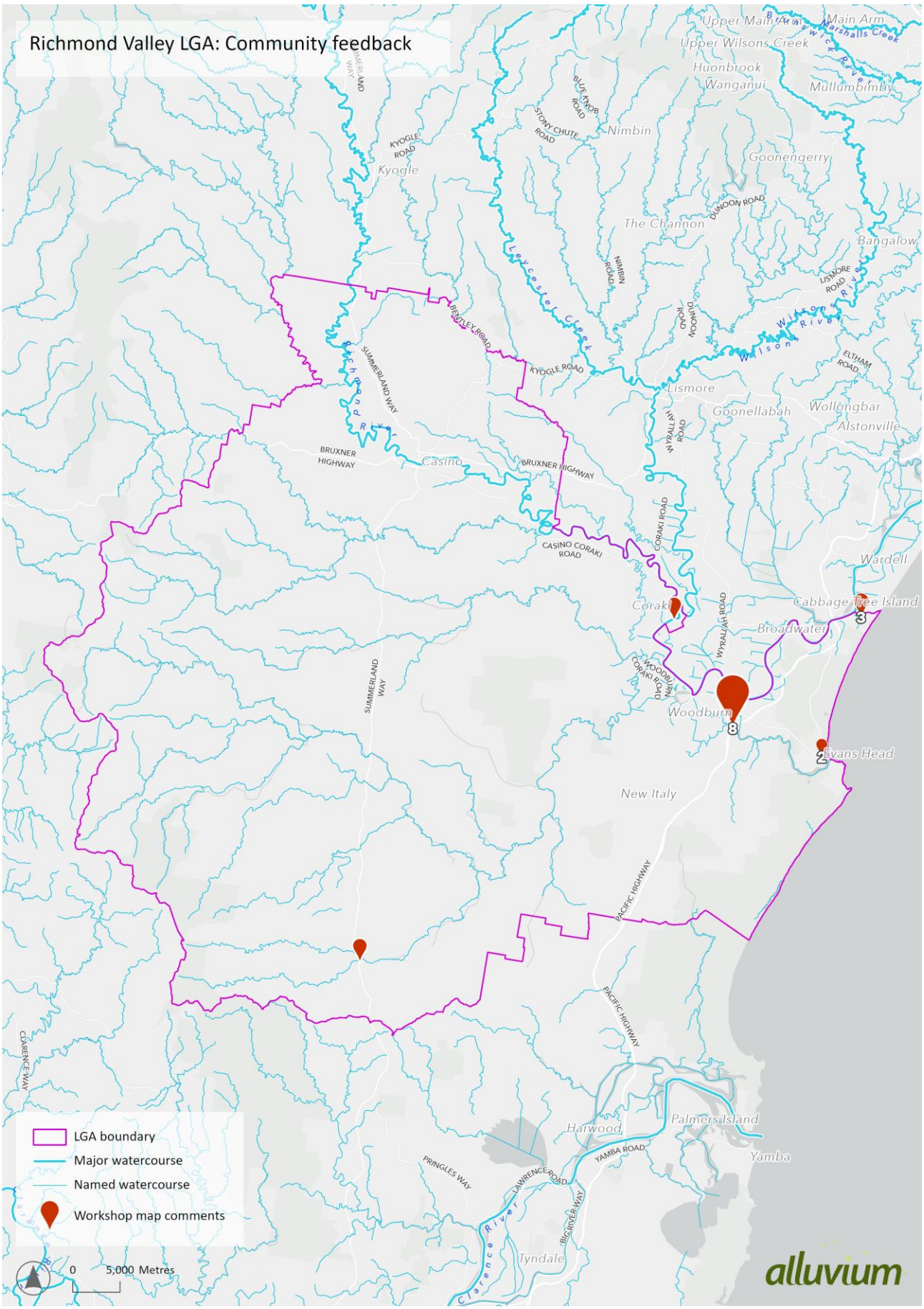

Ballina Shire LGA: Community feedback
Bangalow
Suffolk Park
LISMORE ROAD
HINTERLAND WAY
ELTHAM ROAD
Wilsons River
Lennox Head
North Creek
Wollongbar
Alstonville
East Ballina
West Ballina
Ballina
Richmond River
PACIFIC HIGHWAY
Wardell
Cabbage Tree Island
Broadwater
10
2
7
2
2
2
LGA boundary
Major watercourse
Named watercourse
Workshop map comments
0
5,000 Metres
alluvium

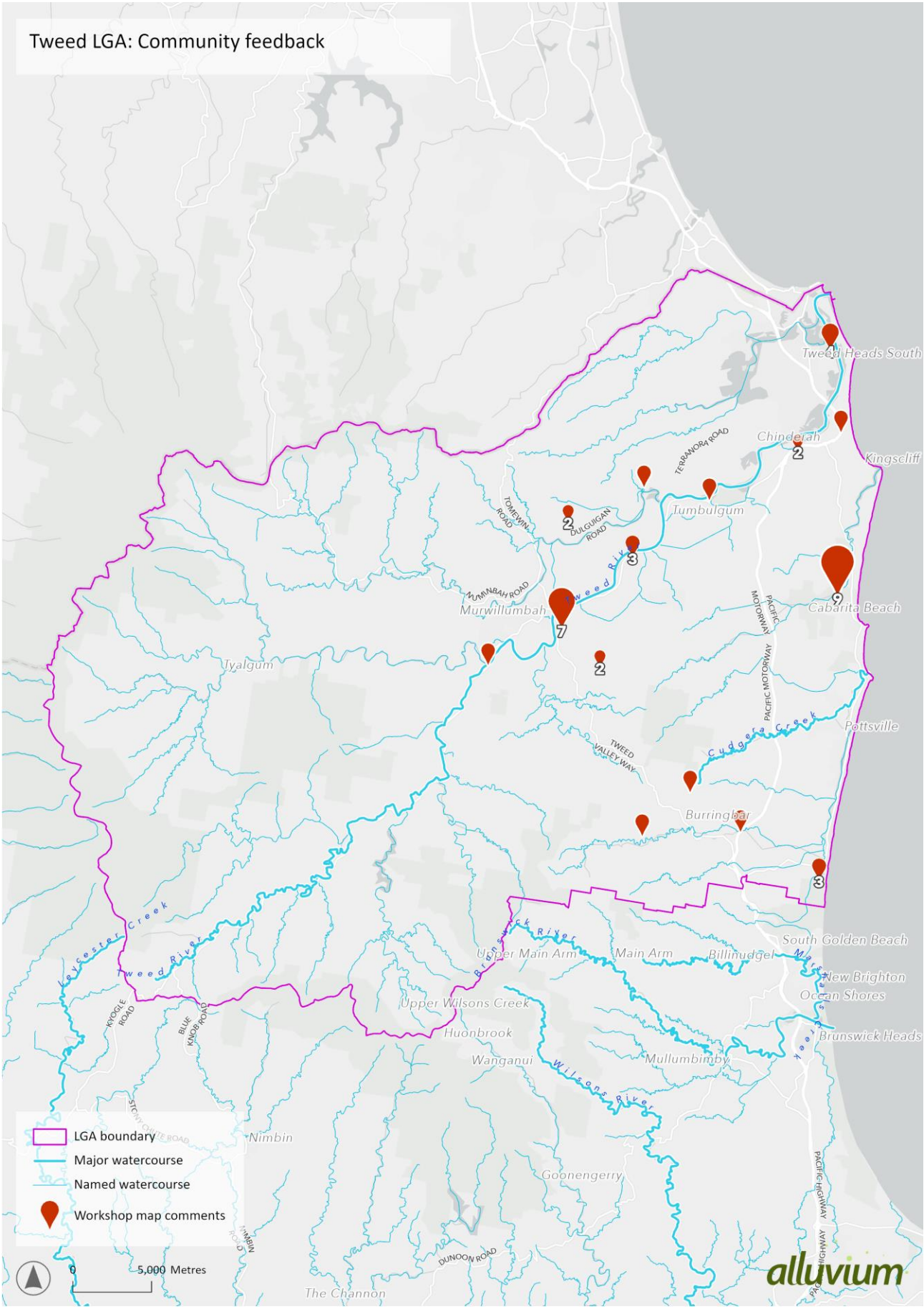

Byron LGA: Community feedback
Burringbar
PACIFIC MOTORWAY
TWEED VALLEY WAY
Upper Main Arm
Main Arm
Mallanganee Creek
Billinudgel
South Golden Beach
New Brighton
Ocean Shores
Upper Wilsons Creek
Brunswick River
Brunswick Heads
Huonbrook
Wanganui
Wilsons River
Mullumbimby
PACIFIC MOTORWAY
PACIFIC HIGHWAY
Goonengerry
Byron Bay
DUNOON ROAD
PACIFIC HIGHWAY
BANGALOW ROAD
Bangalow
Suffolk Park
LISMORE ROAD
HINTERLAND WAY
ELTHAM ROAD
North Creek
Lennox Head
Goonellabah
LGA boundary
Major watercourse
Named watercourse
Workshop map comments
0
5,000 Metres
alluvium


Clarence Valley LGA: Community feedback
LGA boundary
Major watercourse
Named watercourse
Workshop map comments
0 5,000 Metres
alluvium
Tabulam
Coraki
Broadwater
Woodburn
Evans Head
New Italy
Harwood
Palmers Island
Yamba
Tyndale
Brooms Head
Ulmarra
Grafton
Nymboida
BRUXNER HIGHWAY
CASINO CORAKI ROAD
CORAKI ROAD
WOODBURN CORAKI ROAD
WOODBURN EVANS HEAD ROAD
WYRALLAH ROAD
SUMMERLAND WAY
PACIFIC HIGHWAY
CLARENCE WAY
YAMBA ROAD
PRINGLES WAY
LAWRENCE ROAD
BIG RIVER WAY
GWYDIR HIGHWAY
ORARA WAY
ARMIDALE ROAD
EASTERN DORRIGO WAY
CORAMBA ROAD
TYRINGHAM ROAD
WATERFALL WAY
GRAFTON ROAD


Kyogle LGA: Community feedback
MOUNT LINDESAY ROAD
CLARENCE WAY
TOOLOOM ROAD
Richmond River
SUMMERLAND WAY
Tyalgum
Leycester Creek
Tweed River
BLUE KNOB ROAD
STONY CHUTE ROAD
Nimbin
NIMBIN ROAD
KYOGLE ROAD
Kyogle
Bonalbo
BENTLEY ROAD
BRUXNER HIGHWAY
Casino
CASINO CORAKI ROAD
Tabulam
Clarence River
LGA boundary
Major watercourse
Named watercourse
Workshop map comments
0
5,000 Metres
alluvium


Lismore LGA: Community feedback
Upper Main Arm
Main Arm
Upper Wilsons Creek
Huonbrook
Wanganui
Mullumbimby
Nimbin
Goonengerry
The Channon
Leycester Creek
Lismore
Goonellabah
Wollongbar
Alstonville
Casino
Richmond River
Coraki
Wardell
Cabbage Tree Island
Broadwater
Woodburn
KYOGLE ROAD
BLUE KNOB ROAD
STONY CHUTE ROAD
NIMBIN ROAD
DUNOON ROAD
BENTLEK ROAD
ELTHAM ROAD
LISMORE ROAD
WYRALLAH ROAD
BRUXNER HIGHWAY
CASINO CORAKI ROAD
CORAKI ROAD
PACIFIC HIGHWAY
WOODBURN CORAKI ROAD
LGA boundary
Major watercourse
Named watercourse
Workshop map comments
0
5,000 Metres
alluvium


Richmond Valley LGA: Community feedback
Upper Main Arm
Upper Wilsons Creek
Huonbrook
Wanganui
Main Arm
Marshalls Creek
Mullumbimby
Nimbin
Goonengerry
The Channon
Bangalow
Kyogle
Lismore
Goonellabah
Wollongbar
Alstonville
Casino
Wardell
Broadwater
Cabbage Tree Island
Woodburn
Evans Head
New Italy
Harwood
Palmers Island
Yamba
Tyndale
KYOGLE ROAD
BLUE KNOB ROAD
STONY CHUTE ROAD
DUNOON ROAD
NIMBIN ROAD
LISMORE ROAD
ELTHAM ROAD
BENTLEY ROAD
SUMMERLAND WAY
BRUXNER HIGHWAY
CASINO CORAKI ROAD
CORAKI ROAD
WYRALLAH ROAD
WOODBURN CORAKI ROAD
PACIFIC HIGHWAY
YAMBA ROAD
PRINGLES WAY
LAWRENCE ROAD
BIG RIVER WAY
CLARENCE WAY
Leycester Creek
Richmond River
Wilsons River
Clarence River
LGA boundary
Major watercourse
Named watercourse
Workshop map comments
0
5,000 Metres
alluvium


Tweed LGA: Community feedback
Tweed Heads South
Chinderah
Kingscliff
Tumbulgum
Cabarita Beach
Murwillumbah
Tyalgum
Pottsville
Burringbar
South Golden Beach
New Brighton
Ocean Shores
Brunswick Heads
Billinudgel
Main Arm
Upper Main Arm
Upper Wilsons Creek
Huonbrook
Wanganui
Mullumbimby
Goonengerry
Nimbin
The Channon
Tweed River
Leisure Creek
Brunswick River
Wilsons River
Cudgera Creek
Marshalls Creek
TERRANORA ROAD
TOMEWIN ROAD
DULGUIGAN ROAD
NUMINBAH ROAD
PACIFIC MOTORWAY
TWEED VALLEY WAY
KYOGLE ROAD
BLUE KNOB ROAD
DUNOON ROAD
PACIFIC HIGHWAY
LGA boundary
Major watercourse
Named watercourse
Workshop map comments
0
5,000 Metres
alluvium

Appendix D Detailed economic assessment

D.1 Purpose

The economic analysis of flood risk for the Northern Rivers region has been undertaken to provide a robust understanding of the economic damages and losses and their distribution across the region, across different types of assets and values, and across stakeholder groups. This can be used to inform the prioritisation of funding for adaptation.

The results of this analysis were used to assist in informing MCA economic criteria.

D.2 Approach

D.2.1 Context

The base case is the potential economic costs (damages/losses) associated with flooding (and no adaptation – i.e., 'do nothing different') (Figure 19). The base case also becomes the reference condition to estimate the effectiveness of each adaptation option, assessing the suitability of potential investment.

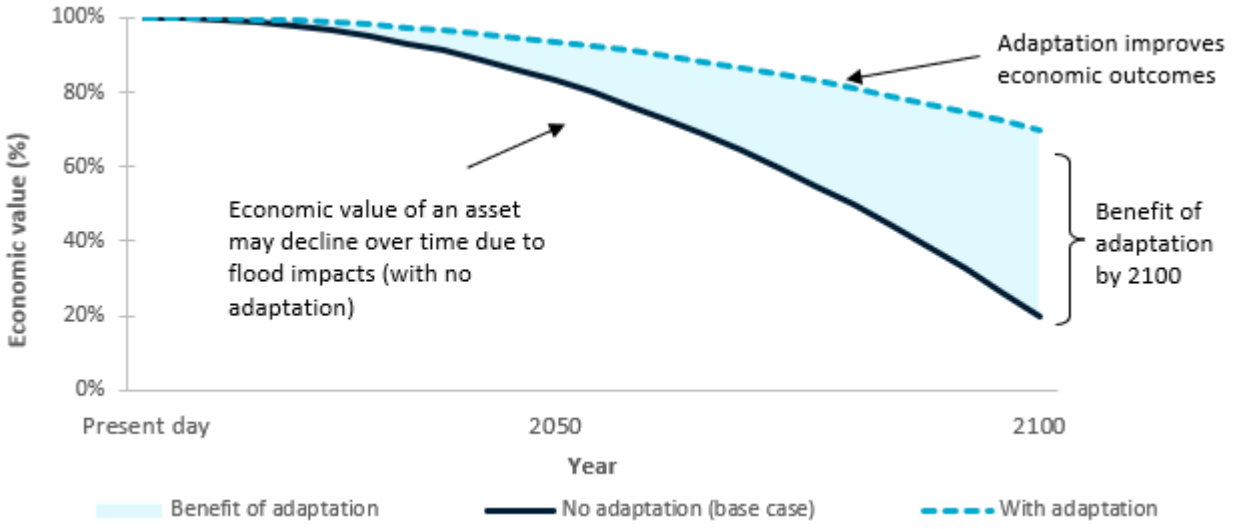


Figure 19. Conceptual diagram - Decline in economic value due to flooding: economic base case (no adaptation) compared to the scenario with adaptation

Economic costs are considered in terms of 'damages' (i.e., asset damage) and 'losses' (i.e., profit or value foregone). The base case is focused on direct damages to key infrastructure assets (buildings and facilities, and transport), as well as consideration of potential damages to some key land uses. Furthermore, indirect and intangible damages have been considered in the base case.

Indirect damages represent losses incurred as a consequence of flooding occurring, but not due to direct impact. Indirect damages include any tangible flow-on effects that are not directly caused by the hazard but arise as a result of the consequences of the damage and destruction. Intangible

damages represent losses incurred that can't be 'bought or sold'. Intangible damages arise from adverse social and environmental effects caused by flooding. Indirect damages are often calculated as a percentage of direct damages, while intangible damages are often calculated as a percentage of direct and indirect damages. In this analysis, indirect and intangible damages have been calculated using the methods outlined in the NSW Government's (2022) Flood Risk Management Guide to support flood damage assessments.

The base case is determined by examining the likelihood and consequence ($ damage) of flood impacts on assets across the Northern Rivers region, for a range of different flooding events. Incorporating event likelihoods into an assessment of the value of risk accounts for the uncertainty associated with knowing the exact nature (e.g., size, severity) of the flood events that will occur in any one year. The consequence is assessed as the total cost of fixing or replacing damaged assets. Damage and loss are estimated using available unit rates (provided directly, inferred or transferred).

Flood events and their corresponding annual exceedance probability (AEP) are defined in Table 16.[2]

Table 16. Flood events

Annual Exceedance Probability (AEP)	Annual Recurrence Interval (ARI)
0.067%	1 in 1,500
0.2%	1 in 500
0.5%	1 in 200
1%	1 in 100
2%	1 in 50
5%	1 in 20

Table 17 presents a summary of the key assets exposed to the 0.067% flood event (the most extreme flood event assessed) to provide an indication of the scale of the economic assessment.

Table 17. Summary of 0.067% flood event exposed assets

Asset category	Exposed assets
Buildings	73,266 buildings
Roads	7,498 km of roads
Agricultural land	275,886 ha of agricultural land

D.2.2 Hazards and assets

Five key components of damages have been considered for the base case:

[2] The Annual Exceedance Probability is the probability of occurrence of an event in a given year. It is analogous to an Annual Recurrence Interval which is the average period between the recurrence of a given event. E.g., A 1% AEP is equivalent to a 1 in 100-year ARI.

- **Damage to buildings** – Building assets include public and private buildings, building contents, and motor vehicles. This is the financial cost of repairing or replacing these assets.
- **Damage to transport infrastructure** – Transport assets include roads and railway infrastructure. This is the financial cost of repairing or replacing the aforementioned assets and can also trigger other economic losses where access to key sites is lost.
- **Agricultural damages** – Agricultural assets represent broadacre and horticulture farming areas, and livestock grazing areas. This is the lost production value and/or the cost of replacing farm infrastructure.
- **Indirect damages** – Indirect damages include factors such as residential and non-residential clean-up costs, relocation (alternative accommodation) costs, and commercial trading losses that occur as a result of direct damages to buildings.
- **Intangible damages** – Intangible damages include factors such as social and wellbeing impacts (i.e., stress and anxiety), injury, and loss of life that occur as a result of flooding.

D.2.3 Estimating damages

Damages have been estimated as average annual damages (AAD) based on flood modelling performed by JBPacific to forecast the occurrence and magnitudes of floods.

$$Average\ annual\ damages\ = \int_0^1 D(p).dp$$

Where:

D (p) = the expected damage for a flood event with probability p

The AAD is the best practice approach for understanding potential economic impacts of flood hazards and for economic analysis of flood adaptation options.[3] AAD has been estimated based on the six modelled AEPs of 5%, 2%, 1%, 0.5%, 0.2% and 0.067% at relevant locations.

D.2.4 Considerations and assumptions

The following considerations and assumptions are relevant to the base case and subsequent economic analysis:

- Estimates of potential economic losses are based on available data.
- Estimates of losses are indicative only and have been assessed to inform a high-level understanding of the significance of flooding for the Northern Rivers region.

[3] This is effectively the same procedure used by the insurance industry to work out the economic value of risk.

- Unit cost rates (Section D.5) are estimates only based on past experience and values from other comparable locations. These estimates should only be used as a guide and rates can vary significantly from region to region, and over time.
- A low, more likely and high estimate of unit cost rates and associated economic damage has been provided for each event in each modelled year, to reflect uncertainty / variability in pricing of assets. The low and high values are based on a 20% - 50% variance of the price estimates used in analysis, where data was not available to determine high and low estimates.
- Where there were large buildings at the edge of a given hazard area, an assessment of the likely resilience of these buildings was undertaken and building size was either reduced or the building was removed entirely from calculations where necessary.
- There were a number of assets that were assumed to be resilient to selected flood events. These were largely infrastructure assets that have been built to withstand flood events of certain magnitudes (e.g. roads, rail, bridges are likely to some level of resilience to the more frequent flooding events).

D.3 Base case results

The base case for the Northern Rivers region has been determined by examining the likelihood and consequence ($ damage) of flood hazard impacts on assets. The region is estimated to experience average annual damages of between $1.0 and $1.8 billion. A summary of the base case results is provided below. Additional detail on the base case results is provided in Section D.6 (including a table of damages split by SA2 area and asset category).

Figure 20 presents the damage curves for the 7 LGAs included in the assessment. It shows that the impacts of flooding are not spread evenly across the region, with Clarence Valley, Ballina, and Tweed being the LGAs most affected. It should also be noted that the damage curves have varying slopes. This means that for some areas the risk is relatively more concentrated in extreme infrequent flood events (e.g. Tweed Shire Council), while in others it is relatively more concentrated in less extreme but more frequent flood events (e.g. Ballina Shire Council). This may have implications for the type of adaptations that may be economically viable in a given location.

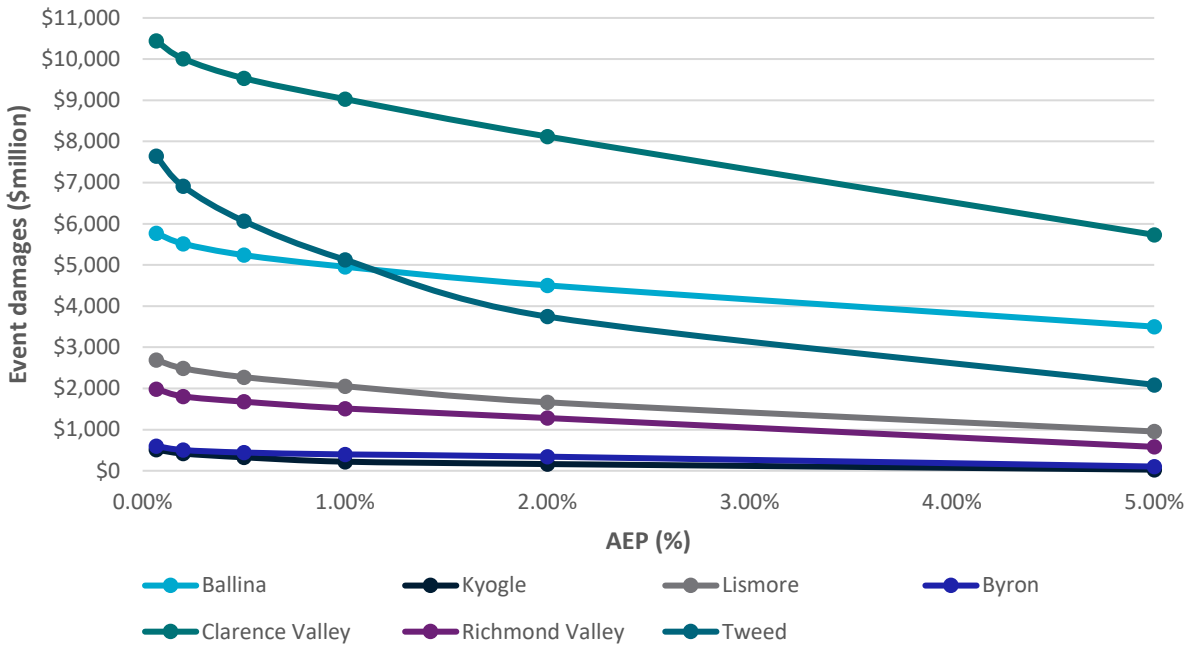


Figure 20. Local government area damage curves (all assets)

The damage curves were used to determine the AADs for each LGA. The results of this analysis are presented in Figure 21. These results indicate the majority of the risk in almost all LGAs comes from risks to buildings and associated contents and vehicles (particularly residential buildings). Other key categories include roads (particularly for the Richmond Valley LGA), and indirect damages (i.e. clean up costs, relocation costs, and trading losses). It should be noted that the losses associated with loss of access (i.e. major roads cut off) were not able to be incorporated into this region-wide assessment as they require much more fine scale analysis; however, these losses could be significant.

The error bars also show that there is considerable uncertainty involved in the estimates, where the major driver of the uncertainty (and the skewness of the estimates) is the intangible damages (i.e. injuries, fatalities, and social and wellbeing impacts). The uncertainty is also not equal across LGAs. For example, Byron has the greatest uncertainty (in proportional terms) due the higher proportion of AADs coming from roads (52% compared to the region wide contribution of 12%) and intangible damages (7% compared to the region wide contribution of 5%). Both roads and intangible damages have high levels of uncertainty compared to other damage categories. Ballina, Lismore, and Clarence Valley have relatively low levels of uncertainty (in proportional terms) due to higher contributions from damages to buildings and associated assets.

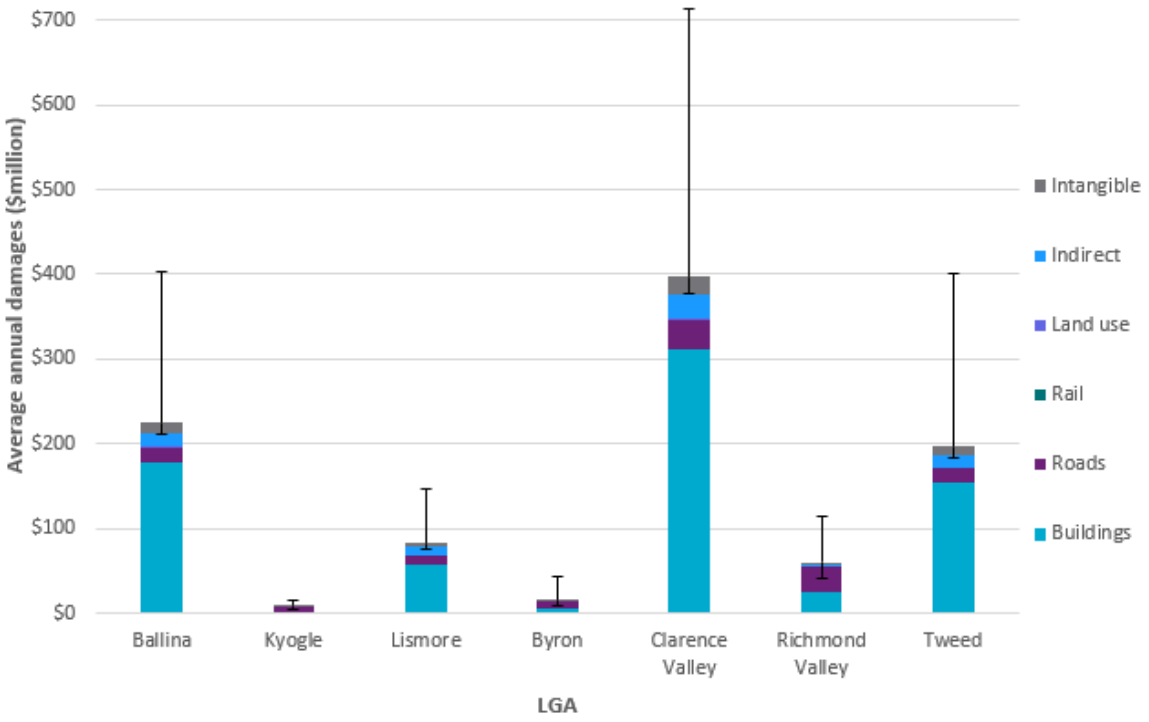


Figure 21. Local government area average annual damages by asset category (90% C.I. represented in error bars)

Figure 22 presents the share of region wide AADs for each asset category, including a more detailed breakdown of the buildings category. As at the LGA level, residential buildings are the greatest contributor to the total AADs.

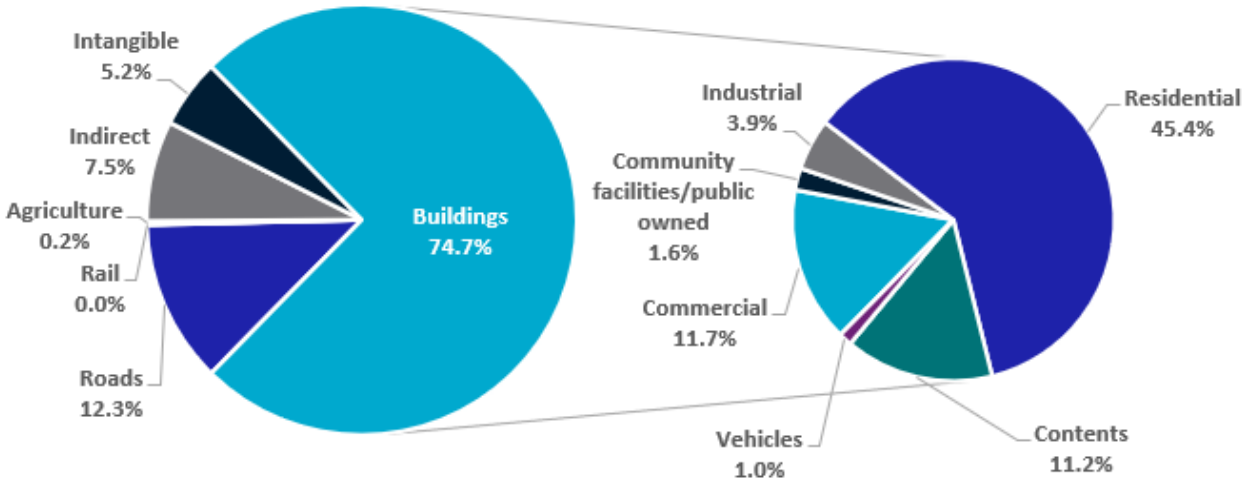


Figure 22. Region wide average annual damages share by asset category

Another key consideration of the economic base case is the asset ownership, or which stakeholder groups the damages accrue to. In particular, it is useful to understand the risk to publicly owned assets compared to privately owned assets, as this can help to inform adaptation and provide opportunities for cost sharing and co-investment. Risks to public assets (i.e. roads, rail, community facilities/publicly owned buildings) only make up approximately 14% of the total AADs.

D.3.1 Other considerations

Changing risk

Climate change provides a great deal of uncertainty and risk around the future severity of flooding in the Northern Rivers region. JBPacific have acknowledged that climate change could increase the quantity of flooded houses in the Northern Rivers region by 85% to 114% under various IPCC (emission) pathways.[4]

Vulnerability

A useful indicator for understanding the vulnerability to natural hazards of the Northern Rivers region based on its socio-demographic makeup is the Bushfire & Natural Hazards Cooperative Research Centre's Australian Disaster Resilience Index (ADRI) rather than just considering overall socio-economic vulnerabity. For all SA2 (Statistical Area Level 2) areas in Australia, the index aims to capture and quantify coping and adaptive capacities, based on the SA2's ability to withstand and adjust/change to natural hazard events. Derived from a wide range of social, economic, and institutional indicators, measures of coping capacity and adaptive capacity are developed, which combine to provide an indication of overall disaster resilience (and therefore vulnerability). Each SA2 is provided with a nationally standardised value between 0 and 1, with closer to 1 indicating greater resilience to natural disasters (Parsons et al., 2020). There are 8 different disaster resilience factors assessed which are presented in Figure 21 below.

[4] See JBPacific Northern NSW 5m flood mapping for further details: https://jbpacific.com.au/projects/floods-and-catchments/northern-nsw-5m-flood-mapping/

Figure 23. Disaster Resilience Index

Source: Parsons et al. (2020)

Due to the spatial granularity of the dataset, AADs were also able to be calculated at the SA2 level. This enabled a comparison of the AADs of an SA2 to be made with its Disaster Resilience Index, with the aim of gaining a better understanding of where there is intersection of high community vulnerability and high flood risk. Subsequently, Table 18 outlines AADs and Disaster Resilience Indexes for the relevant Northern Rivers SA2s. Rows shaded in red indicate an SA2 with above average AADs and a below average Disaster Resilience Index.

Table 18. Vulnerable SA2s

SA2 name	AAD ($million)	Disaster Resilience Index	Risk and vulnerability hotspot? *
Northern Rivers average	$39	0.54	n/a
Ballina	$180	0.53	Yes
Ballina Surrounds	$42	0.57	No
Bangalow	$2	0.59	No
Banora Point	$14	0.54	No
Brunswick Heads - Ocean Shores	$9	0.58	No
Byron Bay	$2	0.56	No
Casino	$5	0.42	No
Casino Surrounds	$25	0.44	No

SA2 name	AAD ($million)	Disaster Resilience Index	Risk and vulnerability hotspot? *
Evans Head	$32	0.43	No
Goonellabah	$0	0.75	No
Grafton	$182	0.48	Yes
Grafton Surrounds	$70	0.49	Yes
Kingscliff - Fingal Head	$30	0.62	No
Kyogle	$6	0.43	No
Lennox Head - Skennars Head	$2	0.63	No
Lismore	$68	0.64	No
Lismore Surrounds	$14	0.67	No
Maclean - Yamba - Iluka	$145	0.50	Yes
Mullumbimby	$3	0.52	No
Murwillumbah	$5	0.56	No
Murwillumbah Surrounds	$7	0.58	No
Pottsville	$9	0.53	No
Terranora - North Tumbulgum	$0	0.54	No
Tweed Heads	$65	0.48	Yes
Tweed Heads South	$66	0.54	Yes

*SA2 areas were labelled as risk and vulnerability hotspots where they had both above average AAD, and below average resilience compared to the wider Northern Rivers region.

Table 18 shows that the SA2's of Ballina, Grafton, Grafton Surrounds, Maclean – Yamba – Iluka, Tweed Heads and Tweed Heads South possess above average AADs and a below average Disaster Resilience Index and are likely to represent areas with high community vulnerability to natural disasters with a high level of flood risk. Grafton is of particular note, as it represents the SA2 with the highest estimated AADs, and also possesses a relatively low Disaster Resilience Index of 0.48. This assessment of vulnerability should also be considered for the prioritisation of funding for adaptation.

D.4 Property level adaptation

One way to manage flood risk and minimise the associated building damages, is to invest in upgrading existing structures to increase building resilience. Resilient housing is an approach where modifications are made to flood-prone structures that result in less damage and disruption from a flood event.

The two most common examples of building modifications to increase building resilience to flooding include:

- Raising floor levels (freeboard), where investments are made to modify flood-prone properties by raising them, resulting in less damage and disruption from a flood event. The costs of this program are the cost of raising the property. The benefits are the reduction of future flood damage for the property.

- A ‘resilient rebuild’, where investments are made to modify flood-prone properties (such as raising internal wiring to be higher than flood levels or the installation of water-resistant flooring materials that won’t require replacement after a flood event), resulting in less damage and disruption from future flood events. The costs of this program are the capital costs of the modifications. The benefits are a reduction of future flood damage for the property.

There are also a range of land use planning approaches and instruments that can be considered for facilitating short – or longer-term transitions in land use. A ‘property buy-back’ program is one of the more common of these instruments, where a property is purchased, the building demolished, and land rehabilitated in which the property was once situated on. The costs of this program include the price of acquiring the property from its current owner, as well as the costs of demolishing the home and rehabilitating the land. The benefits are the elimination of all future flood damage for the property.

The base case results, efficacies, and costs of property level adaptations have been brought together in a typical CBA process involving the discounting of costs and benefits with a discount rate of 7% (4% to 10% range tested in the sensitivity analysis) over a 30-year period.[5] Capital expenditures were assumed to be incurred in year 0 with limited additional operating and maintenance costs associated with these measures, and the benefits (avoided damages) starting from year one. No data was available to inform whether it is actually possible to raise properties (i.e. they are of the appropriate construction type), so the results represent an upper bound estimate of the total number of viable properties.

Table 19 presents the results of this analysis, including the confidence intervals derived from the Monte Carlo simulations.

Table 19. Cost-benefit analysis results for property level adaptation

LGA	Option	Count of economically viable properties (no., 90% C.I. in parentheses)	Investment required ($million, 90% C.I. in parentheses)	Benefit-cost ratio (90% C.I. in parentheses)
Ballina	Resilient housing	2,988 (34 to 5,324)	$120.4 ($1.2 to $225.8)	1.06 (1.03 to 1.45)
	Raising	6,506 (6,356 to 6,652)	$603.4 ($579.0 to $618.9)	2.08 (1.83 to 2.75)
	Buybacks	62 (0 to 3,682)	$38.9 ($0 to $1,403.4)	1.06 (1.05 to 1.32)
Byron	Resilient housing	5 (0 to 78)	$0.2 ($0 to $2.2)	1.12 (1.06 to 1.24)
	Raising	196 (134 to 475)	$12.7 ($8.3 to $30.2)	1.48 (1.41 to 1.71)
	Buybacks	1 (0 to 26)	$0.6 ($0 to $10.0)	1.15 (1.07 to 1.43)
Clarence Valley	Resilient housing	5,771 (1,341 to 9,938)	$213.8 ($44.4 to $368.2)	1.13 (1.04 to 1.45)
	Raising	12,157 (11,783 to 12,639)	$1,053.3 ($1,000.4 to $1,098.1)	2.02 (1.80 to 2.65)
	Buybacks	68 (0 to 5,936)	$42.6 ($0 to $2,254.9)	1.08 (1.03 to 1.36)
Kyogle	Resilient housing	7 (3 to 25)	$0.2 ($0.1 to $0.6)	1.15 (1.06 to 1.32)
	Raising	48 (38 to 84)	$3.0 ($2.2 to $5.3)	1.58 (1.47 to 1.86)

[5] These discount rates align with NSW Government’s guidelines. For further details see NSW Government (2017). Guide to Cost Benefit Analysis, Policy and Guidelines Paper. Available: https://arp.nsw.gov.au/assets/ars/393b65f5e9/TPP17-03_NSW_Government_Guide_to_Cost-Benefit_Analysis_0.pdf

LGA	Option	Count of economically viable properties (no., 90% C.I. in parentheses)	Investment required ($million, 90% C.I. in parentheses)	Benefit-cost ratio (90% C.I. in parentheses)
	Buybacks	0 (0 to 6)	$0 ($0 to $2.3)	n/a (1.04 to 1.34)
Lismore	Resilient housing	251 (44 to 713)	$7.2 ($1.2 to $21.1)	1.10 (1.05 to 1.37)
	Raising	1,607 (1,408 to 1,985)	$110.6 ($95.8 to $135.9)	1.64 (1.49 to 2.03)
	Buybacks	2 (0 to 262)	$1.3 ($0 to $104.2)	1.05 (1.05 to 1.25)
Richmond Valley	Resilient housing	429 (55 to 939)	$15.2 ($2.0 to $30.8)	1.11 (1.04 to 1.43)
	Raising	1,316 (1,204 to 1,512)	$100.7 ($90.2 to $115.8)	1.89 (1.71 to 2.43)
	Buybacks	4 (0 to 434)	$2.5 ($0 to $172.4)	1.06 (1.05 to 1.32)
Tweed	Resilient housing	991 (16 to 2,701)	$39.6 ($0.4 to $116.9)	1.07 (1.02 to 1.38)
	Raising	4,317 (3,871 to 5,321)	$433.3 ($381.2 to $545.0)	1.77 (1.62 to 2.19)
	Buybacks	14 (0 to 2,217)	$8.8 ($0 to $871.8)	1.07 (1.04 to 1.37)

The results of the cost-benefit analysis displayed in Table 19 suggest that it is economically viable for a considerably greater quantity of properties to be raised in comparison to having resilient building modifications performed or to be purchased through a buyback program. This can be observed for all of the LGA's that have been analysed within the Northern Rivers region. Furthermore, across all LGA's, less than 200 properties were found to be economically viable to be bought back.

Ballina and Clarence Valley represent the LGA's with the largest count of properties where the resilient housing and raising options are observed to be economically viable. On the contrary, the LGA's of Byron and Kyogle were found to possess a limited number of properties where the resilient housing and raising options are observed to be economically viable.

For all LGA's, the raising option provides the highest benefit-cost ratio when compared to the resilient housing option. Consequently, across all regions, the raising option represents the adaptation option that should be prioritised for funding.

D.5 Economic analysis input parameters

Table 20. Stage damage curves

		Height over floor (m)																	
Damage type	**Typology**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**	**5.5**	**6.0**	**6.5**	**7.0**
Building	**FDSS-SOG**	$473	$758	$976	$1,126	$1,297	$1,481	$1,604	$1,726	$1,905	$1,918	$1,918	$1,918	$1,918	$1,918	$1,918	$1,918	$1,918	$1,918
Building	**FDSS-Stumps**	$512	$808	$1,035	$1,193	$1,350	$1,549	$1,666	$1,782	$1,889	$1,945	$1,945	$1,945	$1,945	$1,945	$1,945	$1,945	$1,945	$1,945
Building	**FDHS**	$725	$1,044	$1,300	$1,491	$1,682	$1,958	$2,085	$2,212	$2,326	$2,389	$2,392	$2,392	$2,392	$2,392	$2,392	$2,392	$2,392	$2,392
Building	**FDDS**	$210	$342	$466	$581	$696	$808	$861	$914	$986	$1,178	$1,656	$1,744	$1,799	$1,846	$1,885	$1,911	$1,920	$1,921
Building	**MUSS**	$386	$647	$838	$959	$1,079	$1,204	$1,299	$1,393	$1,477	$1,487	$1,487	$1,487	$1,487	$1,487	$1,487	$1,487	$1,487	$1,487
Building	**MUDS**	$185	$257	$341	$437	$533	$574	$607	$640	$705	$1,082	$1,184	$1,231	$1,264	$1,328	$1,356	$1,361	$1,361	$1,362
Building	**Community facilities / public owned**	$61	$122	$169	$204	$239	$543	$1,032	$1,520	$1,629	$1,737	$1,792	$1,846	$1,846	$1,846	$1,846	$1,846	$1,846	$1,846
Building	**Commercial**	$87	$174	$242	$292	$341	$776	$1,474	$2,172	$2,327	$2,482	$2,560	$2,637	$2,637	$2,637	$2,637	$2,637	$2,637	$2,637
Building	**Industrial**	$111	$167	$222	$278	$334	$667	$1,084	$1,084	$1,084	$1,084	$1,084	$1,084	$1,084	$1,084	$1,084	$1,084	$1,084	$1,084
Contents	**Single storey**	$84	$169	$226	$257	$287	$402	$441	$466	$479	$479	$479	$479	$479	$479	$479	$479	$479	$479
Contents	**Double storey**	$38	$77	$104	$122	$139	$187	$196	$204	$216	$273	$398	$446	$446	$446	$446	$446	$446	$446
Relocation	**Ballina**	$4,875	$6,825	$7,638	$8,613	$9,379	$18,850	$18,850	$18,850	$18,850	$18,850	$18,850	$18,850	$18,850	$18,850	$18,850	$18,850	$18,850	$18,850
Relocation	**Byron**	$7,350	$10,290	$11,515	$12,985	$14,140	$28,420	$28,420	$28,420	$28,420	$28,420	$28,420	$28,420	$28,420	$28,420	$28,420	$28,420	$28,420	$28,420
Relocation	**Kyogle**	$2,250	$3,150	$3,525	$3,975	$4,329	$8,700	$8,700	$8,700	$8,700	$8,700	$8,700	$8,700	$8,700	$8,700	$8,700	$8,700	$8,700	$8,700
Relocation	**Lismore**	$3,713	$5,198	$5,816	$6,559	$7,142	$14,355	$14,355	$14,355	$14,355	$14,355	$14,355	$14,355	$14,355	$14,355	$14,355	$14,355	$14,355	$14,355
Relocation	**Richmond Valley**	$3,150	$4,410	$4,935	$5,565	$6,060	$12,180	$12,180	$12,180	$12,180	$12,180	$12,180	$12,180	$12,180	$12,180	$12,180	$12,180	$12,180	$12,180
Relocation	**Clarence Valley**	$3,338	$4,673	$5,229	$5,896	$6,421	$12,905	$12,905	$12,905	$12,905	$12,905	$12,905	$12,905	$12,905	$12,905	$12,905	$12,905	$12,905	$12,905
Relocation	**Tweed**	$5,250	$7,350	$8,225	$9,275	$10,100	$20,300	$20,300	$20,300	$20,300	$20,300	$20,300	$20,300	$20,300	$20,300	$20,300	$20,300	$20,300	$20,300

Sources: BMT (2018) Brisbane River Strategic Floodplain Management Plan, NSW DPE (2022) Flood Risk Management Measures

Table 21. Economic analysis input parameters

Input type	Input	Low	More likely	High	Rationale
Direct damages associated with inundated residential buildings	**Floor level (metres above ground)**	0.0	0.3	0.5	Assumption to account for lack of data on floor levels (i.e. asset data contained ground levels only).
	Vehicle cost ($/property)	$4,888	$6,110	$7,332	More likely value aligns with NSW Government's (2022) Flood Risk Management Guide. Low and high values represent +- 20% of more likely value.
Direct damages to transport assets	**Local Government controlled road**	$-	$75,580	$132,265	BMT (2018) Brisbane River Strategic Floodplain Management Plan
	State/Federal Government controlled road <50 Year ARI ($/km)	$-	$237,538	$415,691	BMT (2018) Brisbane River Strategic Floodplain Management Plan
	State/Federal Government controlled road >=50 Year ARI ($/km)	$-	$8,484,011	$14,847,019	BMT (2018) Brisbane River Strategic Floodplain Management Plan
	Railway ($/km)	$-	$207,895	$1,628,073	High represents replacement cost sourced from Rawlinsons (2018). More likely represents repair cost sourced from Kellerman et al (2015), low represents negligible damage.
Agriculture	**Broadacre ($/ha)**	$135	$270	$405	Assumption that broadacre cropping production is lost for 12 months. Values based on operating margin estimates for sugarcane in NSW (the key broadacre crop in the region). High and low values represent +- 50% of more likely value. Valle, H & Martin, P 2015, Australian sugarcane farm businesses: financial performance, 2013–14, ABARES research report prepared for Sugar Research Australia and the Queensland Government Department of Agriculture and Fisheries, Canberra, December.
	Grazing ($/ha)	$67	$136	$205	Assumption that grazing production is lost for 12 months. Low and high values sourced from DPI (2019), representing 'Coastal weaners- unimproved pasture' and 'Coastal weaners- improved pasture', respectively. More likely represents the average of the high and low values.
	Horticulture ($/ha)	$3,064	$6,128	$9,192	Assumed macadamias (the dominant horticulture crop in the region). Values based on replacement of irrigation infrastructure (Rookwood Weir Macadamia Commodity Report (AEC Group, 2022)) and loss of one year's crop (Macadamia Benchmarking Report (2021)). Low and high calculated as +/- 50%.
Indirect damages	**Residential clean up cost ($/m2)**	$3,476	$4,345	$5,214	More likely value aligns with NSW Government's (2022) Flood Risk Management Guide. Low and high values represent +- 20% of more likely value.
	Commercial clean up (%)	8%	10%	12%	Based on NSW Government's (2022) Flood Risk Management Guide. +/- 20% used as range.
	Commercial industrial trading losses (%)	14%	18%	22%	Based on NSW Government's (2022) Flood Risk Management Guide. +/- 20% used as range.
Relocation	**Ballina ($/week)**	$497	$650	$765	Values sourced from Realestate.com (2022), where more likely represents the median rental price snapshot for 3-bedroom houses, the low represents 2-bedroom houses, and the high represents 4-bedroom houses for the months of October 2021 – September 2022.
	Byron ($/week)	$675	$980	$1,650	Values sourced from Realestate.com (2022), where more likely represents the median rental price snapshot for 3-bedroom houses, the low represents 2-

Input type	Input	Low	More likely	High	Rationale
					bedroom houses, and the high represents 4-bedroom houses for the months of October 2021 – September 2022.
	Kyogle ($/week)	$207	$300	$505	Values sourced from Realestate.com (2022), where more likely represents the median rental price snapshot for 3-bedroom houses, the low represents 2-bedroom houses, and the high represents 4-bedroom houses for the months of October 2021 – September 2022.
	Lismore ($/week)	$380	$495	$590	Values sourced from Realestate.com (2022), where more likely represents the median rental price snapshot for 3-bedroom houses, the low represents 2-bedroom houses, and the high represents 4-bedroom houses for the months of October 2021 – September 2022.
	Richmond Valley ($/week)	$289	$420	$500	Values sourced from Realestate.com (2022), where more likely represents the median rental price snapshot for 3-bedroom houses, the low represents 2-bedroom houses, and the high represents 4-bedroom houses for the months of October 2021 – September 2022.
	Clarence Valley ($/week)	$390	$445	$465	Values sourced from Realestate.com (2022), where more likely represents the median rental price snapshot for 3-bedroom houses, the low represents 2-bedroom houses, and the high represents 4-bedroom houses for the months of October 2021 – September 2022.
	Tweed ($/week)	$482	$700	$1,150	Values sourced from Realestate.com (2022), where more likely represents the median rental price snapshot for 3-bedroom houses, the low represents 2-bedroom houses, and the high represents 4-bedroom houses for the months of October 2021 – September 2022.
Intangible damages	**Social and wellbeing damages - AEP 0.0% ($/household/year)**	$-	$-	$-	More likely value aligns with NSW Government's (2022) Flood Risk Management Guide. Low and high values represent +- 50% of more likely value.
	Social and wellbeing damages - AEP 1.0% ($/household/year)	$27	$53	$80	More likely value aligns with NSW Government's (2022) Flood Risk Management Guide. Low and high values represent +- 50% of more likely value.
	Social and wellbeing damages - AEP 2.0% ($/household/year)	$212	$425	$637	More likely value aligns with NSW Government's (2022) Flood Risk Management Guide. Low and high values represent +- 50% of more likely value.
	Social and wellbeing damages - AEP 5.0% ($/household/year)	$301	$603	$904	More likely value aligns with NSW Government's (2022) Flood Risk Management Guide. Low and high values represent +- 50% of more likely value.
	Fatalities ($/property)	$-	$11,679	$505,738	Based on NSW Government's (2022) Flood Risk Management Guide ranges represent different sets of assumptions around the extremity of the flood.
	Injuries ($/property)	$-	$7,294	$63,172	Based on NSW Government's (2022) Flood Risk Management Guide ranges represent different sets of assumptions around the extremity of the flood.
Cost-benefit analysis inputs	**Appraisal period (years)**		30		Aligns with NSW Government's (2017) cost-benefit analysis guidelines.
	Discount rate (%)	3%	7%	10%	Aligns with NSW Government's (2017) cost-benefit analysis guidelines.

Input type	Input	Low	More likely	High	Rationale
Property buyback	**Buyback cost ($/m2)**	$188	$884	$2,018	Based on average urban land values for the LGAs in the study area from the NSW Valuer General, with the low representing the minimum, more likely representing the average, and high representing the maximum.
	Average property size – urban (m2)	666	708	784	Based on average urban land sizes for the LGAs in the study area from the NSW Valuer General, with the low representing the minimum, more likely representing the average, and high representing the maximum.
	Buyback efficacy (%)	n/a	100%	n/a	Assumption that after removing assets from the property and rehabilitating, the remaining risk is nil.
Resilient building	**Average property size – urban (m2)**	666	708	784	Based on average urban land sizes for the LGAs in the study area from the NSW Valuer General, with the low representing the minimum, more likely representing the average, and high representing the maximum.
	Raising cost ($/m2)	$433	$456	$468	High and low values sourced from Queensland Reconstruction Authority (QRA) (2021). Most likely value presents the average of high and low values.
	Raising efficacy (%)	70%	78%	85%	High and low values sourced from Queensland Reconstruction Authority (QRA) (2021). Most likely value presents the average of high and low values.
	Resilient housing cost ($/m2)	$148	$221	$294	High and low values sourced from Queensland Reconstruction Authority (QRA) (2021). Most likely value presents the average of high and low values.
	Resilient housing efficacy (%)	18%	22%	25%	High and low values sourced from Queensland Reconstruction Authority (QRA) (2021). Most likely value presents the average of high and low values.

D.6 Detailed base case results

Table 22. Base case results by SA2 area and asset category (more likely estimates presented)

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Ballina	Buildings	Residential	$1,722,244,452	$1,928,775,472	$2,080,312,645	$2,179,065,650	$2,272,345,515	$2,352,262,371	$96,787,549
Ballina	Buildings	Contents	$445,576,490	$509,358,752	$552,618,746	$577,796,286	$595,612,843	$602,220,007	$25,420,103
Ballina	Buildings	Vehicles	$37,272,816	$39,704,714	$40,957,325	$41,678,340	$42,429,907	$42,747,643	$1,976,008
Ballina	Buildings	Commercial	$236,318,566	$342,727,531	$423,112,940	$466,100,351	$509,519,512	$550,700,054	$17,275,303
Ballina	Buildings	Industrial	$114,607,938	$165,253,495	$205,835,142	$231,100,672	$252,342,592	$269,239,457	$8,398,083
Ballina	Buildings	Community facilities/public owned	$20,124,122	$30,785,929	$40,629,173	$46,228,609	$51,312,189	$55,309,090	$1,592,136
Ballina	Roads	Local	$13,982,408	$14,051,823	$14,120,350	$14,149,339	$14,171,148	$14,205,899	$702,918
Ballina	Roads	Major	$3,154,252	$112,658,766	$112,658,766	$112,658,766	$112,658,766	$112,658,766	$3,990,371
Ballina	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Ballina	Land use	Grazing	$88,750	$89,206	$89,370	$89,448	$89,548	$89,631	$4,457
Ballina	Land use	Broadacre	$45,169	$45,169	$45,169	$45,169	$45,169	$45,169	$2,258
Ballina	Land use	Horticulture	$-	$-	$-	$-	$-	$-	$-
Ballina	Indirect	Residential clean up	$28,412,613	$29,316,394	$30,068,096	$30,324,457	$30,467,845	$30,533,022	$1,466,050
Ballina	Indirect	Relocation	$86,691,312	$111,581,484	$120,369,432	$124,618,948	$127,287,016	$129,029,527	$5,381,074
Ballina	Indirect	Non-residential clean up	$37,105,063	$53,876,696	$66,957,725	$74,342,963	$81,317,429	$87,524,860	$2,726,552
Ballina	Indirect	Trading losses	$63,166,771	$91,436,585	$113,210,655	$125,496,184	$137,135,179	$147,589,112	$4,621,210
Ballina	Intangible	Fatalities	$76,367,648	$78,796,837	$80,817,269	$81,506,318	$81,891,718	$82,066,900	$3,940,461
Ballina	Intangible	Injuries	$47,695,390	$49,212,539	$50,474,399	$50,904,745	$51,145,446	$51,254,856	$2,461,014
Ballina	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$3,543,384
Ballina Surrounds	Buildings	Residential	$309,392,365	$335,711,881	$358,805,800	$375,461,198	$391,278,543	$407,089,879	$16,938,568
Ballina Surrounds	Buildings	Contents	$81,083,686	$89,320,465	$95,217,328	$98,867,897	$102,111,582	$105,206,551	$4,473,783
Ballina Surrounds	Buildings	Vehicles	$5,218,194	$5,548,150	$5,853,665	$6,085,856	$6,195,842	$6,269,165	$279,265
Ballina Surrounds	Buildings	Commercial	$6,326,416	$8,576,059	$10,461,298	$12,078,030	$13,928,810	$15,701,093	$444,303
Ballina Surrounds	Buildings	Industrial	$54,251,109	$64,086,030	$68,087,353	$70,179,598	$71,524,024	$73,644,470	$3,140,022
Ballina Surrounds	Buildings	Community facilities/public owned	$776,660	$1,058,999	$1,169,440	$1,262,963	$1,334,789	$1,382,437	$51,388
Ballina Surrounds	Roads	Local	$28,209,673	$32,105,382	$33,040,391	$33,903,681	$34,790,818	$36,163,412	$1,572,268
Ballina Surrounds	Roads	Major	$6,842,618	$308,420,912	$325,328,186	$341,777,699	$364,854,784	$387,892,064	$11,385,838
Ballina Surrounds	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Ballina Surrounds	Land use	Grazing	$344,556	$413,468	$440,183	$461,763	$485,319	$510,210	$20,318

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Ballina Surrounds	Land use	Broadacre	$1,738,420	$1,763,331	$1,778,092	$1,788,189	$1,798,743	$1,806,522	$88,137
Ballina Surrounds	Land use	Horticulture	$7,017,286	$7,443,829	$7,647,397	$7,814,732	$8,002,819	$8,185,397	$371,004
Ballina Surrounds	Indirect	Residential clean up	$3,984,457	$4,197,367	$4,449,383	$4,531,940	$4,631,877	$4,788,301	$211,632
Ballina Surrounds	Indirect	Relocation	$13,394,388	$15,836,600	$17,323,289	$18,048,504	$18,669,463	$19,210,936	$785,832
Ballina Surrounds	Indirect	Non-residential clean up	$6,135,419	$7,372,109	$7,971,809	$8,352,059	$8,678,762	$9,072,800	$363,571
Ballina Surrounds	Indirect	Trading losses	$10,903,955	$13,079,176	$14,138,757	$14,806,373	$15,381,510	$16,082,201	$645,179
Ballina Surrounds	Intangible	Fatalities	$10,709,456	$11,281,717	$11,959,087	$12,180,984	$12,449,597	$12,870,033	$568,827
Ballina Surrounds	Intangible	Injuries	$6,688,587	$7,045,993	$7,469,044	$7,607,630	$7,775,392	$8,037,975	$355,261
Ballina Surrounds	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$539,190
Bangalow	Buildings	Residential	$5,369,797	$7,877,958	$10,236,130	$12,577,137	$15,182,243	$18,395,839	$422,608
Bangalow	Buildings	Contents	$1,229,489	$1,821,520	$2,329,485	$2,901,352	$3,493,280	$4,360,300	$97,332
Bangalow	Buildings	Vehicles	$152,757	$195,530	$274,963	$372,728	$452,162	$525,486	$11,435
Bangalow	Buildings	Commercial	$657,698	$828,698	$1,018,459	$1,206,756	$1,516,411	$2,032,841	$44,901
Bangalow	Buildings	Industrial	$242,986	$375,269	$457,834	$584,694	$790,136	$1,110,661	$20,116
Bangalow	Buildings	Community facilities/public owned	$578,934	$654,373	$714,687	$774,286	$938,657	$1,216,364	$33,884
Bangalow	Roads	Local	$1,366,211	$1,598,035	$1,712,130	$1,969,486	$2,224,714	$2,656,536	$81,535
Bangalow	Roads	Major	$638,596	$25,226,568	$28,022,885	$30,441,053	$33,764,791	$40,690,902	$973,458
Bangalow	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Bangalow	Land use	Grazing	$147,107	$172,486	$183,996	$196,893	$211,385	$229,737	$8,588
Bangalow	Land use	Broadacre	$9,897	$10,075	$10,108	$10,119	$10,154	$10,170	$502
Bangalow	Land use	Horticulture	$38,856	$55,364	$65,745	$80,313	$99,410	$119,800	$2,880
Bangalow	Indirect	Residential clean up	$199,875	$291,122	$351,953	$373,679	$421,475	$499,687	$14,534
Bangalow	Indirect	Relocation	$610,400	$927,185	$1,199,800	$1,375,850	$1,599,115	$2,082,990	$48,444
Bangalow	Indirect	Non-residential clean up	$147,962	$185,834	$219,098	$256,574	$324,520	$435,987	$9,890
Bangalow	Indirect	Trading losses	$162,123	$216,714	$265,733	$322,461	$415,178	$565,830	$11,703
Bangalow	Intangible	Fatalities	$537,225	$782,479	$945,982	$1,004,376	$1,132,843	$1,343,062	$39,066
Bangalow	Intangible	Injuries	$335,523	$488,697	$590,813	$627,283	$707,517	$838,809	$24,398
Bangalow	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$37,397
Banora Point	Buildings	Residential	$10,824,926	$68,557,564	$389,453,507	$609,850,381	$747,651,174	$834,007,088	$9,625,748
Banora Point	Buildings	Contents	$2,508,585	$14,340,283	$90,266,091	$151,142,338	$197,237,693	$224,679,983	$2,332,921
Banora Point	Buildings	Vehicles	$207,750	$727,125	$4,955,451	$8,572,748	$10,106,432	$11,071,859	$125,775
Banora Point	Buildings	Commercial	$-	$-	$2,766,940	$6,354,495	$10,931,148	$16,764,763	$92,207
Banora Point	Buildings	Industrial	$130,474	$256,783	$748,624	$1,234,473	$1,749,393	$2,234,361	$24,415

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Banora Point	Buildings	Community facilities/public owned	$3,363,561	$8,333,683	$17,796,698	$25,792,072	$34,524,065	$42,757,274	$585,582
Banora Point	Roads	Local	$3,184,900	$3,714,948	$3,923,812	$4,079,927	$4,153,331	$4,276,468	$182,522
Banora Point	Roads	Major	$-	$-	$-	$-	$-	$-	$-
Banora Point	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Banora Point	Land use	Grazing	$3,499	$3,595	$3,667	$3,702	$3,737	$3,764	$180
Banora Point	Land use	Broadacre	$-	$-	$-	$-	$-	$-	$-
Banora Point	Land use	Horticulture	$-	$-	$-	$-	$-	$-	$-
Banora Point	Indirect	Residential clean up	$247,671	$1,729,350	$5,904,992	$7,178,106	$7,977,605	$8,225,275	$139,554
Banora Point	Indirect	Relocation	$543,250	$2,639,900	$11,951,975	$19,059,375	$28,968,750	$33,436,400	$334,172
Banora Point	Indirect	Non-residential clean up	$349,404	$859,047	$2,131,226	$3,338,104	$4,720,461	$6,175,640	$70,220
Banora Point	Indirect	Trading losses	$23,485	$46,221	$632,801	$1,366,014	$2,282,497	$3,419,842	$20,992
Banora Point	Intangible	Fatalities	$665,691	$4,648,161	$15,871,484	$19,293,371	$21,442,270	$22,107,961	$375,094
Banora Point	Intangible	Injuries	$415,757	$2,903,007	$9,912,530	$12,049,669	$13,391,763	$13,807,520	$234,265
Banora Point	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$230,350
Brunswick Heads - Ocean Shores	Buildings	Residential	$10,593,289	$24,311,058	$34,401,071	$41,659,803	$49,765,054	$58,500,296	$1,255,592
Brunswick Heads - Ocean Shores	Buildings	Contents	$2,134,875	$5,004,483	$7,235,020	$8,919,735	$10,668,241	$12,640,821	$262,023
Brunswick Heads - Ocean Shores	Buildings	Vehicles	$256,633	$727,125	$959,317	$1,185,398	$1,374,817	$1,680,332	$35,548
Brunswick Heads - Ocean Shores	Buildings	Commercial	$3,508,341	$7,153,654	$9,142,008	$10,605,695	$11,706,179	$12,667,444	$348,939
Brunswick Heads - Ocean Shores	Buildings	Industrial	$462,940	$860,206	$1,115,946	$1,375,780	$1,581,092	$1,836,327	$43,895
Brunswick Heads - Ocean Shores	Buildings	Community facilities/public owned	$190,718	$241,596	$331,224	$360,767	$400,700	$528,469	$13,193
Brunswick Heads - Ocean Shores	Roads	Local	$7,856,577	$8,441,856	$8,748,325	$9,091,584	$9,335,997	$10,245,031	$422,553
Brunswick Heads - Ocean Shores	Roads	Major	$4,208,827	$152,464,002	$155,718,079	$158,076,540	$161,390,325	$165,390,752	$5,482,804
Brunswick Heads - Ocean Shores	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Brunswick Heads - Ocean Shores	Land use	Grazing	$111,621	$112,698	$113,590	$114,309	$115,915	$124,370	$5,654
Brunswick Heads - Ocean Shores	Land use	Broadacre	$76,670	$77,285	$77,613	$78,121	$78,628	$78,884	$3,866
Brunswick Heads - Ocean Shores	Land use	Horticulture	$-	$-	$-	$-	$-	$-	$-
Brunswick Heads - Ocean Shores	Indirect	Residential clean up	$873,365	$1,655,483	$2,063,923	$2,320,284	$2,624,441	$2,911,217	$80,539
Brunswick Heads - Ocean Shores	Indirect	Relocation	$1,173,865	$3,253,810	$4,462,710	$5,368,230	$6,241,760	$7,111,405	$160,633
Brunswick Heads - Ocean Shores	Indirect	Non-residential clean up	$416,200	$825,546	$1,058,918	$1,234,224	$1,368,797	$1,503,224	$40,603
Brunswick Heads - Ocean Shores	Indirect	Trading losses	$714,831	$1,442,495	$1,846,432	$2,156,665	$2,391,709	$2,610,679	$70,710
Brunswick Heads - Ocean Shores	Intangible	Fatalities	$2,347,438	$4,449,621	$5,547,428	$6,236,477	$7,053,993	$7,824,793	$216,472
Brunswick Heads - Ocean Shores	Intangible	Injuries	$1,466,092	$2,779,010	$3,464,644	$3,894,990	$4,405,569	$4,886,972	$135,198

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Brunswick Heads - Ocean Shores	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$165,792
Byron Bay	Buildings	Residential	$9,072,155	$12,877,258	$16,486,157	$21,932,510	$28,959,950	$44,093,369	$726,541
Byron Bay	Buildings	Contents	$1,856,239	$2,680,142	$3,443,821	$4,565,508	$6,138,829	$9,387,710	$151,355
Byron Bay	Buildings	Vehicles	$232,191	$293,294	$391,059	$556,037	$727,125	$1,057,081	$17,491
Byron Bay	Buildings	Commercial	$4,882,055	$8,330,183	$10,224,412	$12,141,777	$14,306,734	$17,986,953	$420,065
Byron Bay	Buildings	Industrial	$811,993	$1,266,315	$1,911,032	$2,181,939	$2,963,091	$3,906,546	$72,195
Byron Bay	Buildings	Community facilities/public owned	$89,395	$192,748	$286,779	$366,850	$567,023	$835,859	$11,157
Byron Bay	Roads	Local	$2,358,755	$2,884,726	$3,348,994	$4,083,473	$4,398,010	$6,362,088	$152,539
Byron Bay	Roads	Major	$-	$-	$-	$-	$-	$-	$-
Byron Bay	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Byron Bay	Land use	Grazing	$29,364	$33,900	$37,419	$40,198	$45,759	$67,674	$1,749
Byron Bay	Land use	Broadacre	$21,366	$23,835	$25,195	$26,365	$27,958	$29,354	$1,191
Byron Bay	Land use	Horticulture	$539,539	$573,037	$594,195	$606,621	$646,073	$655,098	$28,710
Byron Bay	Indirect	Residential clean up	$556,173	$782,118	$995,028	$1,216,628	$1,499,060	$2,155,170	$42,436
Byron Bay	Indirect	Relocation	$868,369	$1,501,331	$1,956,852	$2,519,263	$3,223,554	$4,853,259	$81,261
Byron Bay	Indirect	Non-residential clean up	$578,344	$978,925	$1,242,222	$1,469,057	$1,783,685	$2,272,936	$50,342
Byron Bay	Indirect	Trading losses	$1,024,929	$1,727,370	$2,184,380	$2,578,269	$3,108,568	$3,940,830	$88,607
Byron Bay	Intangible	Fatalities	$1,494,886	$2,102,183	$2,674,444	$3,270,063	$4,029,185	$5,792,683	$114,059
Byron Bay	Intangible	Injuries	$933,631	$1,312,918	$1,670,323	$2,042,317	$2,516,426	$3,617,818	$71,236
Byron Bay	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$82,330
Casino	Buildings	Residential	$2,503,364	$6,491,993	$11,789,034	$47,633,568	$61,543,284	$86,705,365	$695,293
Casino	Buildings	Contents	$583,765	$1,523,404	$2,644,089	$10,739,486	$13,788,760	$19,300,832	$157,623
Casino	Buildings	Vehicles	$48,882	$152,757	$281,074	$837,111	$1,099,854	$1,417,589	$13,518
Casino	Buildings	Commercial	$-	$-	$-	$1,614,430	$1,879,665	$2,115,986	$13,352
Casino	Buildings	Industrial	$52,985	$183,057	$470,853	$1,902,622	$4,561,061	$9,154,225	$37,686
Casino	Buildings	Community facilities/public owned	$-	$1,114	$13,877	$732,769	$807,233	$901,199	$6,008
Casino	Roads	Local	$6,470,331	$6,983,802	$7,552,414	$8,973,234	$10,116,486	$11,418,159	$366,410
Casino	Roads	Major	$1,265,490	$67,430,068	$106,001,341	$112,011,931	$129,755,115	$151,508,676	$3,093,789
Casino	Rail	Rail	$723,684	$1,850,893	$1,922,617	$2,434,455	$2,482,479	$2,521,563	$80,771
Casino	Land use	Grazing	$530,286	$630,239	$674,469	$708,348	$788,855	$801,777	$31,229
Casino	Land use	Broadacre	$154,507	$161,014	$173,474	$202,325	$264,984	$272,363	$8,586
Casino	Land use	Horticulture	$-	$-	$-	$-	$-	$-	$-
Casino	Indirect	Residential clean up	$56,486	$165,114	$299,812	$1,333,946	$1,711,970	$2,628,786	$18,948

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Casino	Indirect	Relocation	$91,230	$256,170	$467,010	$1,602,180	$2,124,360	$2,928,630	$24,911
Casino	Indirect	Non-residential clean up	$5,299	$18,417	$48,473	$424,982	$724,796	$1,217,141	$5,705
Casino	Indirect	Trading losses	$9,537	$32,950	$84,754	$633,069	$1,159,331	$2,028,638	$9,187
Casino	Intangible	Fatalities	$151,824	$443,794	$805,837	$3,585,390	$4,601,446	$7,065,672	$50,929
Casino	Intangible	Injuries	$94,822	$277,172	$503,285	$2,239,254	$2,873,831	$4,412,863	$31,808
Casino	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$20,106
Casino Surrounds	Buildings	Residential	$81,967,807	$125,598,063	$156,086,258	$182,119,642	$208,615,133	$239,628,929	$6,412,109
Casino Surrounds	Buildings	Contents	$18,994,986	$29,999,643	$38,484,924	$45,736,186	$53,159,994	$60,578,075	$1,552,450
Casino Surrounds	Buildings	Vehicles	$2,034,729	$3,140,693	$3,806,715	$4,411,635	$5,016,554	$5,639,805	$157,921
Casino Surrounds	Buildings	Commercial	$1,974,039	$4,314,047	$7,229,181	$10,346,006	$13,961,093	$16,346,639	$263,539
Casino Surrounds	Buildings	Industrial	$3,835,106	$6,189,132	$7,867,823	$9,779,724	$11,837,514	$13,820,706	$323,512
Casino Surrounds	Buildings	Community facilities/public owned	$640,756	$884,095	$1,084,714	$1,343,544	$2,240,186	$3,640,971	$50,511
Casino Surrounds	Roads	Local	$75,789,825	$87,411,262	$93,605,709	$99,438,280	$105,351,967	$113,665,456	$4,364,685
Casino Surrounds	Roads	Major	$4,758,265	$231,646,565	$333,886,312	$374,806,093	$401,246,721	$419,875,571	$10,136,879
Casino Surrounds	Rail	Rail	$2,389,134	$3,662,286	$3,745,444	$4,372,248	$4,911,113	$4,990,322	$171,957
Casino Surrounds	Land use	Grazing	$4,629,199	$5,324,915	$5,775,857	$6,119,568	$6,469,953	$6,898,537	$266,950
Casino Surrounds	Land use	Broadacre	$1,212,521	$1,516,547	$1,576,228	$1,639,519	$1,662,895	$1,777,860	$72,872
Casino Surrounds	Land use	Horticulture	$156	$522	$968	$1,122	$3,163	$5,543	$39
Casino Surrounds	Indirect	Residential clean up	$2,246,417	$3,085,021	$3,541,257	$3,988,802	$4,392,897	$4,988,175	$154,080
Casino Surrounds	Indirect	Relocation	$3,047,143	$4,995,124	$6,367,491	$7,400,443	$8,498,556	$9,522,819	$254,078
Casino Surrounds	Indirect	Non-residential clean up	$644,990	$1,138,727	$1,618,172	$2,146,927	$2,803,879	$3,380,832	$63,756
Casino Surrounds	Indirect	Trading losses	$1,045,646	$1,890,572	$2,717,461	$3,622,631	$4,643,749	$5,430,122	$105,669
Casino Surrounds	Intangible	Fatalities	$6,037,938	$8,291,945	$9,518,219	$10,721,135	$11,807,263	$13,407,258	$414,138
Casino Surrounds	Intangible	Injuries	$3,770,992	$5,178,732	$5,944,600	$6,695,881	$7,374,222	$8,373,499	$258,650
Casino Surrounds	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$395,636
Evans Head	Buildings	Residential	$204,861,344	$230,288,792	$248,685,564	$262,984,297	$277,794,962	$291,596,739	$11,586,460
Evans Head	Buildings	Contents	$51,803,490	$58,313,942	$62,831,112	$65,825,507	$69,010,603	$71,209,359	$2,922,335
Evans Head	Buildings	Vehicles	$5,334,290	$5,988,092	$6,519,688	$6,874,085	$7,112,387	$7,362,909	$301,398
Evans Head	Buildings	Commercial	$2,997,348	$3,949,261	$4,541,547	$4,955,521	$5,296,610	$5,569,233	$196,731
Evans Head	Buildings	Industrial	$23,829,265	$34,452,040	$40,895,815	$43,409,612	$45,917,311	$47,791,677	$1,690,047
Evans Head	Buildings	Community facilities/public owned	$5,752,432	$6,696,585	$7,802,137	$8,594,740	$9,300,352	$9,975,588	$346,565
Evans Head	Roads	Local	$22,283,131	$23,724,518	$25,503,403	$26,742,487	$27,823,329	$29,866,661	$1,207,089

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Evans Head	Roads	Major	$8,047,090	$295,553,870	$300,041,910	$305,903,231	$316,401,862	$362,287,347	$10,674,298
Evans Head	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Evans Head	Land use	Grazing	$595,965	$621,076	$635,701	$651,485	$670,393	$708,230	$31,132
Evans Head	Land use	Broadacre	$1,081,579	$1,084,748	$1,086,672	$1,088,204	$1,089,658	$1,098,961	$54,248
Evans Head	Land use	Horticulture	$63,630	$63,720	$63,958	$64,105	$64,318	$64,533	$3,190
Evans Head	Indirect	Residential clean up	$4,883,893	$5,105,493	$5,301,023	$5,483,517	$5,618,215	$5,752,913	$256,903
Evans Head	Indirect	Relocation	$8,682,818	$11,243,819	$11,990,601	$12,549,258	$13,086,620	$13,526,099	$541,634
Evans Head	Indirect	Non-residential clean up	$3,257,905	$4,509,789	$5,323,950	$5,695,987	$6,051,427	$6,333,650	$223,334
Evans Head	Indirect	Trading losses	$4,828,790	$6,912,234	$8,178,725	$8,705,724	$9,218,506	$9,604,964	$339,620
Evans Head	Intangible	Fatalities	$13,126,967	$13,722,585	$14,248,131	$14,738,641	$15,100,683	$15,462,726	$690,507
Evans Head	Intangible	Injuries	$8,198,443	$8,570,436	$8,898,666	$9,205,013	$9,431,127	$9,657,241	$431,256
Evans Head	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$533,292
Goonellabah	Buildings	Residential	$61,879	$99,801	$104,717	$227,110	$929,576	$1,685,005	$8,879
Goonellabah	Buildings	Contents	$11,041	$21,336	$22,341	$37,993	$180,526	$361,750	$1,785
Goonellabah	Buildings	Vehicles	$-	$6,110	$6,110	$6,110	$6,110	$24,441	$238
Goonellabah	Buildings	Commercial	$-	$-	$-	$-	$-	$-	$-
Goonellabah	Buildings	Industrial	$-	$-	$-	$5,674	$31,781	$56,432	$167
Goonellabah	Buildings	Community facilities/public owned	$-	$-	$-	$-	$-	$-	$-
Goonellabah	Roads	Local	$104,964	$140,158	$173,491	$208,243	$277,923	$333,951	$7,559
Goonellabah	Roads	Major	$-	$-	$-	$-	$-	$-	$-
Goonellabah	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Goonellabah	Land use	Grazing	$6,323	$7,722	$8,679	$9,858	$11,289	$12,822	$395
Goonellabah	Land use	Broadacre	$-	$-	$-	$-	$-	$-	$-
Goonellabah	Land use	Horticulture	$2,722	$3,843	$5,329	$6,197	$7,147	$9,777	$211
Goonellabah	Indirect	Residential clean up	$8,690	$8,690	$13,035	$21,726	$56,486	$82,557	$721
Goonellabah	Indirect	Relocation	$7,425	$9,900	$10,271	$15,221	$49,677	$82,948	$666
Goonellabah	Indirect	Non-residential clean up	$-	$-	$-	$567	$3,178	$5,643	$17
Goonellabah	Indirect	Trading losses	$-	$-	$-	$1,021	$5,721	$10,158	$30
Goonellabah	Intangible	Fatalities	$23,358	$23,358	$35,036	$58,394	$151,824	$221,897	$1,939
Goonellabah	Intangible	Injuries	$14,588	$14,588	$21,882	$36,470	$94,822	$138,586	$1,211
Goonellabah	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$1,259
Grafton	Buildings	Residential	$1,249,690,488	$1,715,530,138	$1,972,819,905	$2,132,271,644	$2,257,191,120	$2,339,354,776	$84,390,916
Grafton	Buildings	Contents	$303,197,522	$415,126,900	$429,125,140	$351,663,257	$240,695,087	$136,678,163	$18,179,336

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Grafton	Buildings	Vehicles	$30,190,981	$36,282,948	$36,985,632	$37,193,382	$37,535,559	$37,865,515	$1,736,504
Grafton	Buildings	Commercial	$552,164,797	$717,706,460	$769,810,824	$787,127,420	$797,928,728	$806,343,342	$34,362,662
Grafton	Buildings	Industrial	$69,036,210	$119,762,073	$154,050,311	$173,138,122	$187,123,810	$201,837,067	$5,953,265
Grafton	Buildings	Community facilities/public owned	$74,187,571	$109,558,358	$135,248,890	$149,720,037	$166,405,282	$179,112,287	$5,516,589
Grafton	Roads	Local	$15,465,374	$15,804,023	$16,270,774	$16,533,981	$16,807,915	$17,047,895	$795,375
Grafton	Roads	Major	$3,949,711	$141,298,633	$141,408,097	$141,537,464	$141,816,101	$142,005,176	$5,008,537
Grafton	Rail	Rail	$1,782,079	$1,899,125	$1,943,614	$2,005,359	$2,089,557	$2,242,776	$94,830
Grafton	Land use	Grazing	$516,023	$525,418	$533,122	$539,415	$546,260	$553,338	$26,326
Grafton	Land use	Broadacre	$9,385	$9,385	$9,385	$9,385	$9,385	$9,385	$469
Grafton	Land use	Horticulture	$17,710	$17,710	$17,710	$17,710	$17,710	$17,710	$886
Grafton	Indirect	Residential clean up	$23,389,676	$26,174,886	$26,370,415	$26,548,565	$26,761,474	$27,022,180	$1,272,328
Grafton	Indirect	Relocation	$56,290,799	$73,609,405	$77,651,976	$78,432,426	$79,118,696	$79,832,174	$3,490,536
Grafton	Indirect	Non-residential clean up	$69,538,858	$94,702,689	$105,911,002	$110,998,558	$115,145,782	$118,729,270	$4,583,252
Grafton	Indirect	Trading losses	$111,816,181	$150,744,336	$166,295,004	$172,847,797	$177,309,457	$181,472,474	$7,256,867
Grafton	Intangible	Fatalities	$62,866,959	$70,353,068	$70,878,613	$71,357,444	$71,929,705	$72,630,433	$3,419,773
Grafton	Intangible	Injuries	$39,263,539	$43,938,986	$44,267,215	$44,566,269	$44,923,674	$45,361,313	$2,135,818
Grafton	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$3,373,701
Grafton Surrounds	Buildings	Residential	$515,159,049	$652,817,624	$754,130,857	$846,909,857	$961,725,735	$1,079,166,817	$33,349,987
Grafton Surrounds	Buildings	Contents	$132,476,557	$164,141,749	$182,435,377	$188,629,212	$187,480,157	$180,129,473	$8,039,145
Grafton Surrounds	Buildings	Vehicles	$11,609,566	$14,621,942	$16,296,164	$17,805,407	$19,772,923	$21,734,329	$731,846
Grafton Surrounds	Buildings	Commercial	$30,239,492	$38,206,198	$44,970,258	$51,404,507	$58,545,720	$63,707,216	$1,972,403
Grafton Surrounds	Buildings	Industrial	$37,295,521	$50,380,444	$61,311,378	$68,614,150	$78,104,163	$86,046,360	$2,585,288
Grafton Surrounds	Buildings	Community facilities/public owned	$7,943,683	$9,872,727	$11,419,022	$12,674,840	$15,973,958	$20,395,440	$514,756
Grafton Surrounds	Roads	Local	$80,750,773	$92,260,154	$100,781,619	$109,098,033	$120,122,578	$132,480,976	$4,685,626
Grafton Surrounds	Roads	Major	$6,917,566	$278,666,499	$301,912,756	$328,811,144	$373,621,887	$418,571,949	$10,624,294
Grafton Surrounds	Rail	Rail	$292,301	$346,977	$407,475	$571,089	$982,930	$1,556,305	$20,869
Grafton Surrounds	Land use	Grazing	$5,348,863	$6,141,056	$6,720,818	$7,273,733	$7,967,571	$8,775,451	$311,519
Grafton Surrounds	Land use	Broadacre	$1,632,815	$1,697,906	$1,741,145	$1,757,370	$1,772,987	$1,776,176	$84,748
Grafton Surrounds	Land use	Horticulture	$430,621	$496,632	$554,183	$608,482	$687,726	$782,322	$25,515
Grafton Surrounds	Indirect	Residential clean up	$9,559,221	$11,123,457	$12,396,572	$13,508,918	$14,929,766	$16,259,366	$566,894
Grafton Surrounds	Indirect	Relocation	$21,155,745	$28,683,079	$32,850,329	$36,264,576	$40,153,463	$44,198,437	$1,428,364
Grafton Surrounds	Indirect	Non-residential clean up	$7,547,870	$9,845,937	$11,770,066	$13,269,350	$15,262,384	$17,014,902	$507,245

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Grafton Surrounds	Indirect	Trading losses	$12,156,302	$15,945,596	$19,130,694	$21,603,358	$24,596,979	$26,955,644	$820,384
Grafton Surrounds	Intangible	Fatalities	$25,693,351	$29,897,718	$33,319,605	$36,309,377	$40,128,343	$43,702,055	$1,523,703
Grafton Surrounds	Intangible	Injuries	$16,046,774	$18,672,610	$20,809,749	$22,677,010	$25,062,144	$27,294,104	$951,628
Grafton Surrounds	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$1,358,208
Kingscliff - Fingal Head	Buildings	Residential	$205,283,610	$270,850,364	$316,993,573	$362,474,108	$441,675,813	$538,247,050	$13,998,237
Kingscliff - Fingal Head	Buildings	Contents	$50,201,923	$68,056,251	$80,138,937	$90,574,709	$109,008,458	$131,793,319	$3,489,404
Kingscliff - Fingal Head	Buildings	Vehicles	$6,984,070	$8,426,101	$9,141,005	$9,703,153	$10,503,602	$12,049,507	$419,477
Kingscliff - Fingal Head	Buildings	Commercial	$21,433,814	$37,013,092	$49,812,384	$59,506,902	$66,733,845	$71,216,722	$1,912,935
Kingscliff - Fingal Head	Buildings	Industrial	$14,602,347	$25,008,214	$34,590,814	$40,669,546	$47,566,390	$53,675,188	$1,315,936
Kingscliff - Fingal Head	Buildings	Community facilities/public owned	$544,608	$805,684	$1,280,274	$1,588,625	$1,902,013	$2,237,617	$47,344
Kingscliff - Fingal Head	Roads	Local	$7,213,144	$8,053,118	$8,277,141	$8,415,172	$8,552,404	$8,698,591	$395,127
Kingscliff - Fingal Head	Roads	Major	$3,334,797	$123,217,105	$130,939,321	$138,890,416	$143,219,236	$148,712,358	$4,560,562
Kingscliff - Fingal Head	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Kingscliff - Fingal Head	Land use	Grazing	$66,634	$72,176	$74,334	$76,871	$78,022	$79,305	$3,583
Kingscliff - Fingal Head	Land use	Broadacre	$190,590	$190,609	$190,613	$190,613	$190,617	$190,618	$9,530
Kingscliff - Fingal Head	Land use	Horticulture	$-	$-	$-	$-	$-	$-	$-
Kingscliff - Fingal Head	Indirect	Residential clean up	$5,687,737	$6,500,270	$7,021,683	$7,803,801	$9,133,401	$10,250,092	$332,655
Kingscliff - Fingal Head	Indirect	Relocation	$8,037,925	$25,113,881	$28,852,082	$30,992,052	$34,089,764	$37,750,264	$1,087,400
Kingscliff - Fingal Head	Indirect	Non-residential clean up	$3,658,077	$6,282,699	$8,568,347	$10,176,507	$11,620,225	$12,712,953	$327,622
Kingscliff - Fingal Head	Indirect	Trading losses	$6,486,509	$11,163,835	$15,192,576	$18,031,761	$20,574,042	$22,480,544	$581,197
Kingscliff - Fingal Head	Intangible	Fatalities	$15,287,544	$17,471,479	$18,872,934	$20,975,118	$24,548,829	$27,550,280	$894,113
Kingscliff - Fingal Head	Intangible	Injuries	$9,547,831	$10,911,807	$11,787,085	$13,100,003	$15,331,963	$17,206,518	$558,418
Kingscliff - Fingal Head	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$399,629
Kyogle	Buildings	Residential	$2,726,188	$8,686,455	$15,784,957	$24,599,037	$37,001,748	$54,680,848	$584,484
Kyogle	Buildings	Contents	$612,729	$1,972,837	$3,621,203	$5,603,198	$8,593,183	$12,929,826	$134,078
Kyogle	Buildings	Vehicles	$67,213	$232,191	$452,162	$629,361	$1,026,530	$1,393,148	$15,642
Kyogle	Buildings	Commercial	$152,785	$978,390	$2,308,406	$3,531,081	$4,885,889	$6,065,456	$71,970
Kyogle	Buildings	Industrial	$1,244,237	$2,046,545	$2,423,497	$3,281,049	$4,029,437	$5,042,038	$106,348
Kyogle	Buildings	Community facilities/public owned	$425,442	$720,654	$883,778	$1,069,641	$1,429,747	$1,850,914	$37,267
Kyogle	Roads	Local	$8,986,709	$13,134,632	$15,779,821	$18,708,252	$22,266,730	$25,163,956	$672,471
Kyogle	Roads	Major	$649,741	$95,552,467	$120,888,499	$185,661,568	$221,536,036	$250,026,633	$4,383,469
Kyogle	Rail	Rail	$420,988	$1,405,373	$1,771,685	$2,809,291	$3,553,556	$3,991,592	$71,969
Kyogle	Land use	Grazing	$855,360	$1,200,313	$1,449,210	$1,646,801	$1,821,995	$1,967,383	$60,864

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Kyogle	Land use	Broadacre	$171,625	$249,709	$292,137	$330,821	$369,635	$387,816	$12,401
Kyogle	Land use	Horticulture	$3,299	$3,720	$3,843	$4,274	$4,797	$5,245	$187
Kyogle	Indirect	Residential clean up	$126,008	$356,298	$577,898	$912,471	$1,303,530	$1,950,950	$22,426
Kyogle	Indirect	Relocation	$73,350	$291,921	$534,696	$835,350	$1,235,593	$1,808,079	$19,378
Kyogle	Indirect	Non-residential clean up	$182,246	$374,559	$561,568	$788,177	$1,034,507	$1,295,841	$21,559
Kyogle	Indirect	Trading losses	$251,464	$544,488	$851,743	$1,226,183	$1,604,759	$1,999,349	$32,097
Kyogle	Intangible	Fatalities	$338,685	$957,661	$1,553,280	$2,452,547	$3,503,639	$5,243,779	$60,276
Kyogle	Intangible	Injuries	$211,526	$598,107	$970,100	$1,531,738	$2,188,196	$3,275,001	$37,645
Kyogle	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$39,591
Lennox Head - Skennars Head	Buildings	Residential	$7,271,388	$18,516,454	$31,596,705	$42,058,286	$58,428,522	$82,105,576	$1,120,678
Lennox Head - Skennars Head	Buildings	Contents	$1,552,105	$4,120,386	$7,234,627	$9,865,505	$13,872,046	$19,885,351	$255,981
Lennox Head - Skennars Head	Buildings	Vehicles	$116,096	$452,162	$849,331	$1,167,067	$1,429,810	$1,900,303	$27,455
Lennox Head - Skennars Head	Buildings	Commercial	$-	$-	$68,408	$198,712	$327,776	$465,328	$2,639
Lennox Head - Skennars Head	Buildings	Industrial	$164,591	$453,723	$739,712	$956,192	$1,219,437	$1,681,943	$25,801
Lennox Head - Skennars Head	Buildings	Community facilities/public owned	$-	$-	$147,418	$181,113	$248,504	$366,142	$2,857
Lennox Head - Skennars Head	Roads	Local	$3,692,076	$4,064,325	$4,276,114	$4,424,782	$4,899,424	$5,388,249	$204,237
Lennox Head - Skennars Head	Roads	Major	$-	$-	$-	$-	$-	$-	$-
Lennox Head - Skennars Head	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Lennox Head - Skennars Head	Land use	Grazing	$65,395	$67,925	$69,923	$71,592	$76,044	$78,264	$3,419
Lennox Head - Skennars Head	Land use	Broadacre	$132,498	$133,191	$133,461	$133,636	$133,858	$133,920	$6,655
Lennox Head - Skennars Head	Land use	Horticulture	$462,661	$462,661	$462,661	$462,661	$462,661	$462,661	$23,133
Lennox Head - Skennars Head	Indirect	Residential clean up	$351,953	$673,491	$977,648	$1,199,248	$1,585,962	$2,159,515	$37,194
Lennox Head - Skennars Head	Indirect	Relocation	$181,141	$1,150,802	$1,895,586	$2,535,627	$3,630,157	$5,052,496	$64,695
Lennox Head - Skennars Head	Indirect	Non-residential clean up	$16,459	$45,372	$95,554	$133,602	$179,572	$251,341	$3,130
Lennox Head - Skennars Head	Indirect	Trading losses	$29,626	$81,670	$145,462	$207,883	$278,498	$386,509	$5,119
Lennox Head - Skennars Head	Intangible	Fatalities	$945,982	$1,810,213	$2,627,729	$3,223,348	$4,262,761	$5,804,362	$99,970
Lennox Head - Skennars Head	Intangible	Injuries	$590,813	$1,130,568	$1,641,147	$2,013,141	$2,662,306	$3,625,112	$62,437
Lennox Head - Skennars Head	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$21,226
Lismore	Buildings	Residential	$149,051,995	$248,125,534	$323,498,646	$366,569,006	$415,892,028	$469,420,170	$12,617,799
Lismore	Buildings	Contents	$33,643,942	$56,597,559	$74,595,025	$85,429,825	$96,034,279	$107,513,173	$2,889,217
Lismore	Buildings	Vehicles	$5,700,908	$9,342,645	$12,043,397	$12,966,052	$13,540,420	$14,340,869	$463,015
Lismore	Buildings	Commercial	$326,859,934	$534,836,160	$689,163,976	$766,191,921	$825,567,428	$876,438,581	$26,790,434

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Lismore	Buildings	Industrial	$38,130,199	$74,355,033	$107,242,949	$130,901,618	$156,969,327	$180,299,005	$3,967,481
Lismore	Buildings	Community facilities/public owned	$47,026,682	$63,980,074	$74,752,545	$82,047,357	$89,255,591	$96,646,966	$3,196,085
Lismore	Roads	Local	$9,535,640	$10,496,713	$10,967,985	$11,150,608	$11,362,929	$11,654,238	$519,990
Lismore	Roads	Major	$3,773,066	$138,173,922	$138,850,611	$139,258,615	$139,606,911	$140,174,135	$4,907,869
Lismore	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Lismore	Land use	Grazing	$200,812	$218,614	$227,171	$231,935	$235,709	$239,225	$10,846
Lismore	Land use	Broadacre	$6,987	$6,987	$6,987	$6,987	$6,987	$6,987	$349
Lismore	Land use	Horticulture	$663	$1,051	$1,379	$1,883	$2,100	$2,492	$57
Lismore	Indirect	Residential clean up	$5,778,984	$8,455,566	$9,454,939	$9,941,590	$10,480,383	$11,110,422	$403,996
Lismore	Indirect	Relocation	$11,081,777	$19,550,785	$24,813,236	$27,733,666	$30,661,484	$32,569,603	$964,136
Lismore	Indirect	Non-residential clean up	$41,201,682	$67,317,127	$87,115,947	$97,914,090	$107,179,235	$115,338,455	$3,395,400
Lismore	Indirect	Trading losses	$65,698,224	$109,654,415	$143,353,246	$161,476,837	$176,856,616	$190,212,766	$5,536,425
Lismore	Intangible	Fatalities	$15,532,799	$22,726,937	$25,413,060	$26,721,085	$28,169,256	$29,862,682	$1,085,863
Lismore	Intangible	Injuries	$9,701,004	$14,194,101	$15,871,719	$16,688,645	$17,593,100	$18,650,728	$678,176
Lismore	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$987,925
Lismore Surrounds	Buildings	Residential	$91,200,974	$110,223,971	$126,557,701	$139,168,933	$152,489,496	$166,872,734	$5,631,243
Lismore Surrounds	Buildings	Contents	$22,342,467	$27,276,731	$31,490,154	$34,758,628	$37,901,771	$41,600,531	$1,393,470
Lismore Surrounds	Buildings	Vehicles	$2,046,950	$2,474,671	$2,835,178	$3,036,818	$3,330,112	$3,531,752	$125,533
Lismore Surrounds	Buildings	Commercial	$1,277,417	$1,836,911	$2,226,257	$2,459,826	$2,772,871	$3,064,048	$92,529
Lismore Surrounds	Buildings	Industrial	$5,408,800	$7,408,533	$9,914,354	$12,017,354	$14,365,542	$17,082,896	$405,632
Lismore Surrounds	Buildings	Community facilities/public owned	$-	$-	$18,024	$24,204	$31,576	$39,543	$353
Lismore Surrounds	Roads	Local	$37,704,622	$40,102,649	$41,621,696	$42,987,818	$44,559,790	$46,309,951	$2,010,029
Lismore Surrounds	Roads	Major	$1,587,017	$62,046,410	$65,778,151	$67,131,529	$71,430,494	$72,146,989	$2,277,558
Lismore Surrounds	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Lismore Surrounds	Land use	Grazing	$2,027,438	$2,195,574	$2,302,720	$2,395,663	$2,487,013	$2,588,871	$110,016
Lismore Surrounds	Land use	Broadacre	$2,576,618	$2,584,318	$2,594,054	$2,599,171	$2,603,568	$2,611,522	$129,311
Lismore Surrounds	Land use	Horticulture	$2,168,899	$2,243,858	$2,294,645	$2,353,102	$2,422,337	$2,503,150	$112,619
Lismore Surrounds	Indirect	Residential clean up	$1,903,154	$2,220,346	$2,489,743	$2,654,856	$2,867,766	$3,024,190	$112,492
Lismore Surrounds	Indirect	Relocation	$3,896,469	$4,872,904	$5,720,379	$6,286,625	$6,897,867	$7,494,350	$248,892
Lismore Surrounds	Indirect	Non-residential clean up	$668,622	$924,544	$1,215,863	$1,450,138	$1,716,999	$2,018,649	$49,851
Lismore Surrounds	Indirect	Trading losses	$1,203,519	$1,664,180	$2,185,310	$2,605,892	$3,084,914	$3,626,450	$89,669
Lismore Surrounds	Intangible	Fatalities	$5,115,313	$5,967,865	$6,691,950	$7,135,744	$7,708,005	$8,128,442	$302,358
Lismore Surrounds	Intangible	Injuries	$3,194,767	$3,727,228	$4,179,455	$4,456,627	$4,814,032	$5,076,616	$188,838

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Lismore Surrounds	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$298,262
Maclean - Yamba - Iluka	Buildings	Residential	$1,225,230,149	$1,518,262,948	$1,684,083,528	$1,790,352,484	$1,905,464,009	$2,019,977,735	$75,357,557
Maclean - Yamba - Iluka	Buildings	Contents	$305,737,174	$386,336,545	$433,128,883	$458,265,766	$480,604,904	$498,129,606	$19,099,802
Maclean - Yamba - Iluka	Buildings	Vehicles	$27,704,090	$33,154,475	$35,097,550	$36,099,639	$37,022,294	$38,201,581	$1,617,431
Maclean - Yamba - Iluka	Buildings	Commercial	$152,770,456	$193,405,280	$223,643,302	$246,035,961	$268,918,256	$291,573,985	$9,792,553
Maclean - Yamba - Iluka	Buildings	Industrial	$111,449,711	$150,119,713	$168,806,163	$178,298,585	$185,876,575	$191,795,130	$7,311,840
Maclean - Yamba - Iluka	Buildings	Community facilities/public owned	$25,906,231	$35,384,147	$43,673,465	$50,596,344	$57,108,278	$62,286,645	$1,832,996
Maclean - Yamba - Iluka	Roads	Local	$36,730,074	$38,791,934	$40,970,815	$42,489,330	$43,960,416	$45,922,277	$1,960,505
Maclean - Yamba - Iluka	Roads	Major	$8,236,273	$300,420,060	$302,708,861	$306,341,089	$309,953,414	$322,730,894	$10,729,500
Maclean - Yamba - Iluka	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Maclean - Yamba - Iluka	Land use	Grazing	$635,064	$653,901	$666,529	$676,525	$688,617	$701,285	$32,736
Maclean - Yamba - Iluka	Land use	Broadacre	$1,861,883	$1,881,693	$1,886,912	$1,890,446	$1,893,998	$1,903,126	$93,917
Maclean - Yamba - Iluka	Land use	Horticulture	$2,638,950	$2,979,953	$3,018,506	$3,047,303	$3,085,649	$3,199,564	$144,963
Maclean - Yamba - Iluka	Indirect	Residential clean up	$23,046,413	$24,819,214	$25,692,580	$26,357,380	$27,200,330	$28,004,173	$1,236,477
Maclean - Yamba - Iluka	Indirect	Relocation	$42,870,092	$62,253,402	$68,921,521	$73,047,433	$76,535,884	$79,201,736	$2,968,651
Maclean - Yamba - Iluka	Indirect	Non-residential clean up	$29,012,640	$37,890,914	$43,612,293	$47,493,089	$51,190,311	$54,565,576	$1,893,739
Maclean - Yamba - Iluka	Indirect	Trading losses	$47,559,630	$61,834,499	$70,640,904	$76,380,218	$81,863,070	$87,006,441	$3,078,791
Maclean - Yamba - Iluka	Intangible	Fatalities	$61,944,334	$66,709,283	$69,056,721	$70,843,577	$73,109,263	$75,269,841	$3,323,414
Maclean - Yamba - Iluka	Intangible	Injuries	$38,687,314	$41,663,261	$43,129,353	$44,245,333	$45,660,367	$47,009,755	$2,075,637
Maclean - Yamba - Iluka	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$2,859,173
Mullumbimby	Buildings	Residential	$8,342,102	$15,605,594	$19,918,630	$24,779,745	$32,855,465	$47,332,520	$820,049
Mullumbimby	Buildings	Contents	$1,804,544	$3,396,973	$4,409,836	$5,519,026	$7,262,942	$10,436,508	$179,809
Mullumbimby	Buildings	Vehicles	$195,530	$293,294	$397,169	$470,493	$598,809	$855,442	$16,098
Mullumbimby	Buildings	Commercial	$1,732,580	$3,541,772	$4,132,778	$4,985,716	$6,066,239	$7,903,996	$171,445
Mullumbimby	Buildings	Industrial	$1,233,525	$1,964,572	$2,391,289	$2,857,680	$3,622,180	$5,167,938	$101,898
Mullumbimby	Buildings	Community facilities/public owned	$355,377	$540,010	$631,732	$730,063	$881,901	$1,062,290	$27,116
Mullumbimby	Roads	Local	$9,444,240	$10,512,316	$11,367,273	$12,011,504	$13,271,422	$14,229,126	$532,937
Mullumbimby	Roads	Major	$146,833	$6,130,006	$12,757,578	$13,643,244	$16,359,952	$17,295,375	$333,564
Mullumbimby	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Mullumbimby	Land use	Grazing	$278,765	$308,554	$326,796	$341,958	$365,958	$390,257	$15,485
Mullumbimby	Land use	Broadacre	$90,035	$93,967	$96,351	$98,684	$104,549	$117,310	$4,730
Mullumbimby	Land use	Horticulture	$59,377	$71,151	$77,266	$85,989	$93,534	$127,797	$3,610

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Mullumbimby	Indirect	Residential clean up	$399,749	$673,491	$808,189	$1,025,444	$1,346,981	$1,955,295	$35,155
Mullumbimby	Indirect	Relocation	$833,245	$1,492,785	$1,853,075	$2,318,155	$3,025,505	$4,338,670	$77,865
Mullumbimby	Indirect	Non-residential clean up	$332,148	$604,635	$715,580	$857,346	$1,057,032	$1,413,422	$30,046
Mullumbimby	Indirect	Trading losses	$533,899	$991,142	$1,174,332	$1,411,811	$1,743,915	$2,352,948	$49,202
Mullumbimby	Intangible	Fatalities	$1,074,449	$1,810,213	$2,172,256	$2,756,196	$3,620,427	$5,255,458	$94,489
Mullumbimby	Intangible	Injuries	$671,047	$1,130,568	$1,356,682	$1,721,381	$2,261,136	$3,282,295	$59,013
Mullumbimby	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$83,873
Murwillumbah	Buildings	Residential	$20,550,019	$37,625,094	$46,203,905	$52,576,625	$58,518,719	$66,869,944	$1,833,538
Murwillumbah	Buildings	Contents	$4,559,415	$8,552,654	$10,628,360	$12,154,339	$13,573,623	$15,421,266	$417,746
Murwillumbah	Buildings	Vehicles	$702,684	$1,289,273	$1,539,795	$1,698,663	$1,900,303	$2,181,376	$61,695
Murwillumbah	Buildings	Commercial	$5,237,209	$17,964,617	$28,422,594	$39,095,034	$56,831,529	$71,760,861	$1,026,216
Murwillumbah	Buildings	Industrial	$1,090,199	$1,773,769	$2,138,011	$2,391,973	$2,725,765	$3,423,671	$87,902
Murwillumbah	Buildings	Community facilities/public owned	$7,059,404	$11,677,376	$14,438,973	$16,846,456	$19,063,912	$20,687,419	$584,005
Murwillumbah	Roads	Local	$3,045,008	$3,688,619	$3,872,571	$4,055,548	$4,198,543	$4,371,414	$179,639
Murwillumbah	Roads	Major	$-	$-	$-	$-	$-	$-	$-
Murwillumbah	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Murwillumbah	Land use	Grazing	$24,222	$29,765	$33,264	$34,615	$35,232	$35,782	$1,471
Murwillumbah	Land use	Broadacre	$219,945	$231,277	$232,064	$232,852	$233,054	$233,212	$11,413
Murwillumbah	Land use	Horticulture	$-	$-	$-	$-	$-	$-	$-
Murwillumbah	Indirect	Residential clean up	$790,808	$1,181,867	$1,381,742	$1,612,032	$1,742,385	$2,033,507	$58,797
Murwillumbah	Indirect	Relocation	$1,846,225	$3,558,650	$4,404,550	$5,038,025	$5,636,600	$6,412,690	$172,815
Murwillumbah	Indirect	Non-residential clean up	$1,338,681	$3,141,576	$4,499,958	$5,833,346	$7,862,121	$9,587,195	$169,812
Murwillumbah	Indirect	Trading losses	$1,138,934	$3,552,909	$5,500,909	$7,467,661	$10,720,313	$13,533,216	$200,541
Murwillumbah	Intangible	Fatalities	$2,125,541	$3,176,633	$3,713,857	$4,332,833	$4,683,197	$5,465,677	$158,036
Murwillumbah	Intangible	Injuries	$1,327,506	$1,983,965	$2,319,488	$2,706,070	$2,924,889	$3,413,587	$98,701
Murwillumbah	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$150,399
Murwillumbah Surrounds	Buildings	Residential	$40,952,881	$59,402,373	$77,019,105	$93,750,983	$115,213,385	$143,123,625	$3,195,448
Murwillumbah Surrounds	Buildings	Contents	$9,252,382	$13,999,763	$18,529,303	$22,860,555	$28,421,677	$35,545,049	$758,167
Murwillumbah Surrounds	Buildings	Vehicles	$1,289,273	$1,741,435	$2,150,825	$2,590,766	$3,183,465	$3,788,385	$92,611
Murwillumbah Surrounds	Buildings	Commercial	$778,984	$1,004,174	$1,322,492	$1,630,584	$2,159,408	$2,783,150	$56,599
Murwillumbah Surrounds	Buildings	Industrial	$1,665,463	$3,384,105	$4,466,973	$7,199,370	$9,762,281	$12,791,155	$193,170
Murwillumbah Surrounds	Buildings	Community facilities/public owned	$156,422	$350,882	$517,139	$665,241	$885,236	$1,240,178	$19,475
Murwillumbah Surrounds	Roads	Local	$23,189,505	$25,845,953	$27,714,819	$29,418,172	$31,242,180	$32,900,765	$1,301,855

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Murwillumbah Surrounds	Roads	Major	$121,478	$4,358,673	$4,368,625	$4,358,673	$4,358,673	$4,378,576	$154,477
Murwillumbah Surrounds	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Murwillumbah Surrounds	Land use	Grazing	$536,129	$610,277	$656,918	$699,817	$747,071	$789,539	$30,645
Murwillumbah Surrounds	Land use	Broadacre	$1,445,777	$1,469,988	$1,478,595	$1,482,584	$1,486,347	$1,489,490	$73,313
Murwillumbah Surrounds	Land use	Horticulture	$191,504	$199,584	$205,899	$210,820	$214,751	$220,083	$10,010
Murwillumbah Surrounds	Indirect	Residential clean up	$1,373,052	$1,803,217	$2,276,833	$2,624,441	$3,006,810	$3,602,088	$95,552
Murwillumbah Surrounds	Indirect	Relocation	$2,999,600	$4,842,600	$6,330,200	$7,501,325	$9,005,200	$10,950,150	$253,439
Murwillumbah Surrounds	Indirect	Non-residential clean up	$260,087	$473,916	$630,660	$949,520	$1,280,692	$1,681,448	$26,924
Murwillumbah Surrounds	Indirect	Trading losses	$440,001	$789,890	$1,042,104	$1,589,392	$2,145,904	$2,803,375	$44,958
Murwillumbah Surrounds	Intangible	Fatalities	$3,690,500	$4,846,700	$6,119,689	$7,053,993	$8,081,727	$9,681,722	$256,825
Murwillumbah Surrounds	Intangible	Injuries	$2,304,900	$3,027,005	$3,822,050	$4,405,569	$5,047,440	$6,046,716	$160,400
Murwillumbah Surrounds	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$233,097
Pottsville	Buildings	Residential	$31,851,779	$52,417,715	$66,174,990	$78,098,474	$93,466,356	$110,189,122	$2,684,267
Pottsville	Buildings	Contents	$6,873,023	$11,422,017	$14,556,324	$17,562,071	$21,367,421	$25,568,704	$591,344
Pottsville	Buildings	Vehicles	$708,795	$1,545,905	$1,716,994	$2,022,509	$2,419,678	$2,761,855	$71,443
Pottsville	Buildings	Commercial	$933,958	$1,175,767	$1,445,256	$2,022,010	$2,747,345	$3,528,390	$67,109
Pottsville	Buildings	Industrial	$890,330	$1,287,412	$1,615,869	$1,892,197	$2,360,689	$3,096,976	$68,035
Pottsville	Buildings	Community facilities/public owned	$38,655	$53,153	$79,257	$88,911	$103,418	$122,149	$2,980
Pottsville	Roads	Local	$9,948,580	$12,276,218	$12,867,791	$13,666,188	$14,891,797	$15,754,644	$599,198
Pottsville	Roads	Major	$2,931,356	$112,648,815	$127,715,097	$132,969,388	$144,124,805	$171,072,949	$4,327,055
Pottsville	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Pottsville	Land use	Grazing	$174,115	$187,503	$197,676	$207,509	$220,985	$231,645	$9,462
Pottsville	Land use	Broadacre	$477,155	$500,358	$503,310	$505,499	$520,775	$523,676	$24,788
Pottsville	Land use	Horticulture	$1,689	$2,662	$3,505	$4,856	$6,313	$7,558	$148
Pottsville	Indirect	Residential clean up	$1,299,185	$1,837,978	$2,194,276	$2,411,531	$2,702,653	$3,071,986	$92,302
Pottsville	Indirect	Relocation	$1,055,025	$3,559,125	$4,451,525	$5,185,550	$6,105,825	$7,259,350	$164,045
Pottsville	Indirect	Non-residential clean up	$186,294	$251,633	$314,038	$400,312	$521,145	$674,752	$13,812
Pottsville	Indirect	Trading losses	$328,372	$443,372	$551,002	$704,557	$919,446	$1,192,566	$24,326
Pottsville	Intangible	Fatalities	$3,491,960	$4,940,131	$5,897,792	$6,481,732	$7,264,211	$8,256,909	$248,091
Pottsville	Intangible	Injuries	$2,180,903	$3,085,357	$3,683,464	$4,048,164	$4,536,861	$5,156,850	$154,945
Pottsville	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$104,763
Terranora - North Tumbulgum	Buildings	Residential	$3,184,821	$4,090,474	$4,955,778	$5,478,453	$7,252,601	$9,588,037	$217,162

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Terranora - North Tumbulgum	Buildings	Contents	$749,909	$975,257	$1,186,415	$1,319,446	$1,750,447	$2,306,452	$51,798
Terranora - North Tumbulgum	Buildings	Vehicles	$67,213	$79,434	$109,985	$122,206	$146,647	$171,088	$4,456
Terranora - North Tumbulgum	Buildings	Commercial	$-	$-	$-	$-	$-	$6,580	$9
Terranora - North Tumbulgum	Buildings	Industrial	$140,906	$230,198	$282,512	$308,408	$336,374	$379,807	$11,305
Terranora - North Tumbulgum	Buildings	Community facilities/public owned	$-	$-	$-	$-	$5,608	$9,756	$25
Terranora - North Tumbulgum	Roads	Local	$2,107,339	$2,219,483	$2,287,922	$2,355,120	$2,395,368	$2,457,602	$111,046
Terranora - North Tumbulgum	Roads	Major	$-	$-	$-	$-	$-	$-	$-
Terranora - North Tumbulgum	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Terranora - North Tumbulgum	Land use	Grazing	$25,212	$26,473	$27,420	$28,211	$29,031	$29,844	$1,329
Terranora - North Tumbulgum	Land use	Broadacre	$121,249	$121,634	$121,763	$121,856	$121,998	$122,280	$6,079
Terranora - North Tumbulgum	Land use	Horticulture	$30,555	$30,589	$30,638	$30,681	$30,761	$31,081	$1,531
Terranora - North Tumbulgum	Indirect	Residential clean up	$73,867	$82,557	$99,937	$104,282	$147,733	$186,839	$4,495
Terranora - North Tumbulgum	Indirect	Relocation	$188,150	$237,525	$300,750	$333,700	$433,200	$541,800	$12,824
Terranora - North Tumbulgum	Indirect	Non-residential clean up	$14,091	$23,020	$28,251	$30,841	$34,198	$39,614	$1,134
Terranora - North Tumbulgum	Indirect	Trading losses	$25,363	$41,436	$50,852	$55,513	$60,547	$69,550	$2,037
Terranora - North Tumbulgum	Intangible	Fatalities	$198,540	$221,897	$268,612	$280,291	$397,079	$502,188	$12,082
Terranora - North Tumbulgum	Intangible	Injuries	$123,998	$138,586	$167,762	$175,056	$247,996	$313,641	$7,546
Terranora - North Tumbulgum	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$11,311
Tweed Heads	Buildings	Residential	$509,669,458	$785,357,463	$980,540,356	$1,081,245,798	$1,166,501,660	$1,232,156,885	$39,201,523
Tweed Heads	Buildings	Contents	$121,692,590	$198,995,226	$253,676,021	$283,634,029	$306,486,378	$321,729,969	$9,935,427
Tweed Heads	Buildings	Vehicles	$9,281,542	$13,766,501	$17,921,503	$18,960,254	$19,528,511	$19,705,710	$693,391
Tweed Heads	Buildings	Commercial	$16,953,902	$54,886,161	$91,794,143	$126,310,492	$166,264,687	$206,405,016	$3,181,177
Tweed Heads	Buildings	Industrial	$9,046,427	$22,294,013	$35,878,302	$45,802,841	$54,945,413	$59,594,843	$1,232,383
Tweed Heads	Buildings	Community facilities/public owned	$4,187,448	$11,092,345	$16,861,545	$22,362,781	$27,187,307	$31,987,953	$602,128
Tweed Heads	Roads	Local	$7,042,400	$8,484,941	$9,047,701	$9,688,830	$10,122,603	$10,646,712	$418,076
Tweed Heads	Roads	Major	$1,468,882	$52,433,446	$52,443,397	$54,334,146	$58,891,845	$74,087,494	$1,907,747
Tweed Heads	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Tweed Heads	Land use	Grazing	$67,099	$73,149	$78,148	$83,206	$88,076	$94,482	$3,705
Tweed Heads	Land use	Broadacre	$-	$0	$1	$1	$3	$6	$0
Tweed Heads	Land use	Horticulture	$2,253	$2,230	$2,791	$3,845	$5,352	$6,221	$135
Tweed Heads	Indirect	Residential clean up	$8,568,538	$12,344,431	$13,513,263	$13,917,357	$14,043,365	$14,165,028	$581,750
Tweed Heads	Indirect	Relocation	$21,479,479	$39,855,789	$50,808,575	$57,877,110	$62,602,275	$64,620,450	$1,953,680
Tweed Heads	Indirect	Non-residential clean up	$3,018,778	$8,827,252	$14,453,399	$19,447,611	$24,839,741	$29,798,781	$501,569

SA2 name	Asset category	Asset subcategory	5% AEP damages	2% AEP damages	1% AEP damages	0.5% AEP damages	0.2% AEP damages	0.067% AEP damages	AAD
Tweed Heads	Indirect	Trading losses	$4,680,059	$13,892,431	$22,981,040	$30,980,400	$39,817,818	$47,879,975	$794,441
Tweed Heads	Intangible	Fatalities	$23,030,586	$33,179,460	$36,321,056	$37,407,184	$37,745,869	$38,072,875	$1,563,631
Tweed Heads	Intangible	Injuries	$14,383,745	$20,722,221	$22,684,304	$23,362,645	$23,574,170	$23,778,402	$976,565
Tweed Heads	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$1,370,111
Tweed Heads South	Buildings	Residential	$361,391,531	$557,408,990	$697,398,321	$777,551,703	$835,377,636	$876,979,225	$27,889,037
Tweed Heads South	Buildings	Contents	$88,897,157	$141,236,527	$179,249,105	$202,493,191	$220,297,294	$231,810,900	$7,098,921
Tweed Heads South	Buildings	Vehicles	$7,735,637	$12,128,941	$15,037,443	$16,033,421	$16,418,370	$16,540,576	$593,155
Tweed Heads South	Buildings	Commercial	$152,318,154	$312,909,068	$448,075,988	$541,219,898	$623,251,154	$680,455,958	$16,326,055
Tweed Heads South	Buildings	Industrial	$6,808,150	$13,804,646	$24,597,746	$33,008,024	$42,776,664	$48,978,082	$852,717
Tweed Heads South	Buildings	Community facilities/public owned	$10,840,867	$21,215,114	$28,307,052	$32,718,101	$35,937,029	$38,492,743	$1,059,278
Tweed Heads South	Roads	Local	$6,506,944	$6,557,653	$6,557,653	$6,557,653	$6,557,653	$6,557,653	$327,122
Tweed Heads South	Roads	Major	$1,368,579	$48,880,829	$48,880,829	$48,880,829	$48,880,829	$48,880,829	$1,731,358
Tweed Heads South	Rail	Rail	$-	$-	$-	$-	$-	$-	$-
Tweed Heads South	Land use	Grazing	$1,601	$1,601	$1,601	$1,601	$1,601	$1,601	$80
Tweed Heads South	Land use	Broadacre	$-	$-	$-	$-	$-	$-	$-
Tweed Heads South	Land use	Horticulture	$-	$-	$-	$-	$-	$-	$-
Tweed Heads South	Indirect	Residential clean up	$7,912,428	$10,410,861	$11,379,818	$11,679,630	$11,766,532	$11,844,744	$500,258
Tweed Heads South	Indirect	Relocation	$17,168,200	$34,531,625	$43,580,200	$48,585,600	$52,745,425	$54,303,775	$1,656,036
Tweed Heads South	Indirect	Non-residential clean up	$16,996,717	$34,792,883	$50,098,079	$60,694,602	$70,196,485	$76,792,678	$1,823,805
Tweed Heads South	Indirect	Trading losses	$28,642,735	$58,808,469	$85,081,272	$103,361,026	$119,885,007	$131,298,127	$3,092,179
Tweed Heads South	Intangible	Fatalities	$21,267,088	$27,982,395	$30,586,767	$31,392,604	$31,626,180	$31,836,398	$1,344,597
Tweed Heads South	Intangible	Injuries	$13,282,353	$17,476,396	$19,102,955	$19,606,241	$19,752,120	$19,883,412	$839,768
Tweed Heads South	Intangible	Social and wellbeing impacts	$-	$-	$-	$-	$-	$-	$835,845

Appendix E Theme project scopes

E.1 Development of a comprehensive flood gauging, information and communication network

As outlined in Key opportunity 3 in Section 10, the 2022 flood event revealed that the dynamic understanding of the river systems is limited.

A suitable project would generate and integrate the following:

- A robust river and rainfall gauge network covering the entire Northern Rivers region – managed by a single entity
- Provision of information from that network in a timely and centralised manner
- Communication of that information in a way that enables members of the community to understand and contextualise the information so that they can respond appropriately

Improvement to the rain and river gauge network is essential for developing our *dynamic* understanding of the hydrological system. This primarily requires:

- Expansion of the gauge network
- Transfer of ownership and overseeing of maintenance to a single entity (e.g. BOM)

Expansion of gauge network

To benefit short-term decision-making

There is an urgent need for more rainfall and river height data to feed BOM's predictive models and enable SES to disseminate appropriate warnings. More accurate warnings enable communities to make well-informed decisions, which ultimately reduces the extent of damage and trauma experienced. Some people also rely on the raw gauge data to inform their response, separate from official warnings.

Key examples where the lack of data had critical consequences:

- The lack of gauges in Bungawalbin catchment severely impacted warning times for towns downstream. BOM's limited understanding of the impact of Bungawalbin Creek on flooding at Woodburn and surrounding areas is demonstrated by the following series of events, articulated by an anonymous submission to NRRI:

  At 2.30am on Monday 28th February, BOM stated Woodburn may reach 5.3m on Tuesday. This forecast remained unchanged for ~24 hours. At 1.30am on Tuesday, BOM revised its warning for Woodburn (10.5 hours after Coraki surpassed its highest ever flood peak level and Bungawalbin junction had equalled its highest ever recorded flood), predicting a flood height of 6m at 4.30am on Tuesday morning. Flood levels reached 6.01m by 2.30am.

  Bungawalbin catchment is almost twice the size of the Wilsons River catchment area yet currently has only two auto rain gauges and three automatic river height gauges.

- Terania Creek catchment recorded some of the highest rainfall during the February 2022 flood event. The lack of gauges along Terania Creek, which feeds into Leycester Creek,

meant river heights for Leycester Creek were severely underestimated. This contributed to the underestimation of the flood peak at Lismore.

- Broadwater has no gauging and is not a formal forecasting location, so the town did not receive any warnings.

See Table 1 for a (non-exhaustive) list of suggested locations for additional gauges. It is recommended that BOM also reviews the locations of gauges and forecasting locations independently.

To benefit long-term decision-making

Over time, gauges generate useful data which may inform future decision-making. Gauges record peak levels of floods and provide information about the rate of rise and recession of floodwaters, which may be useful for assessing flood mitigation options and providing data for future flood studies.

Table 23. A selection of suggested additional gauge locations

Gauge	Catchment	Sub-catchment	Location	Source
Level	Richmond River	Bungawalbin Creek	Myall Creek at Whiporie	Richmond Valley Council submission
Level	Richmond River	Bungawalbin Creek	Myall Creek at Elliotts Road, Gibberagee	Richmond Valley Council submission
Level	Richmond River		Richmond River at Pacific Highway bridge and/or SES shed, Broadwater	Richmond Valley Council submission / NSW Flood Inquiry
Level	Richmond River	Evans River	Evans River	Richmond Valley Council submission
Level	Richmond River		Richmond River near Kyogle/Richmond Valley LGA boundary at Baraimal Ln, Fairy Hill	Richmond Valley Council submission
Level	Richmond River	Eden Creek	Eden Creek at Waldrons Bridge (Stratheden Road), Strathedon	Richmond Valley Council submission
Rain	Richmond River		Newrybar Swamp*	Ballina FRMP (2015)
Rain	Richmond River		Brooklet*	Ballina FRMP (2015)
Rain	Richmond River		Cumbalum Ridge*	Ballina FRMP (2015)
Level	Richmond River		Emigrant Creek*	Ballina FRMP (2015)
Level	Richmond River		North Creek*	Ballina FRMP (2015)
Rain	Clarence River	Alipou Creek	Alipou Creek (South Grafton) (1) Note: FRMP asked for "four (or more) gauges", but it is a relatively small system	Clarence Valley Council priority projects list (2022)/Alipou Creek FRMP (2006)
Rain	Clarence River		Additional (1-2) gauges upstream of Copmanhurst	Grafton and Lower Clarence FRMP (2007) / community consultation
Level and rain	Richmond River	Bungawalbin Creek	Additional gauges (1-2) Bungawalbin Creek catchment	Multiple submissions / NSW Flood Inquiry
Level and rain		Cudgen Creek	Cudgen Creek catchment (Clothiers Creek, Cudgen Lake, Reserve Creek) (2)	CBBRA submission
Level and rain	Richmond River	Terania Creek	Terania Creek catchment (1-2)	Community consultation
		TOTAL NO. GAUGES	**15**	

**Recently funded under Preparing Australian Communities (PAC) grant*

Estimated costings

Scoping refined gauge network, flood communication, information centralisation ~$500,000 +$30k/year for maintenance

Combined rain/river height gauge ~ $30,000 + $3,000/year for maintenance

Total cost of expanded gauge network = $450,000 + $45,000/year for maintenance

Further recommendations regarding improvements to the gauge network

Establish a single entity responsible for a gauge maintenance program

It is difficult to decipher who holds responsibility for gauges, which are currently owned by four entities – Water NSW, BOM, Councils and Manly Hydraulics (and not always maintained by the same entity). This creates issues around accountability for malfunctioning gauges.

The number or gauges that failed during the 2022 flood is significant, with 49 failed rainfall gauges (41 failures for the climate network and 8 failures for the flood network) and 4 failed water level stations (Lerat et al., 2022). Figure 4.a and Figure 4.b in CSIRO's Catchment Characterisation Report (Lerat et al., 2022) show the locations of the failed rain gauges, with addition details provided in Appendix A and B of the same report. The four water level stations that failed during the 2022 flood included Lismore (H058176), East Gundurimba (203427), Evans River at Fishing co-op (203462) and Rocky mouth Creek (203432) (Lerat et al., 2022).

In some instances, these gauge failures had critical consequences. It is recommended that the failures are investigated and equipment is strengthened for future flood events.

Key examples where malfunctioning gauges had critical consequences:

- The rainfall gauge at The Channon was recording a zero reading during the 2022 flood event (see Lismore engagement report). Even if it were functioning properly, it would have recorded an inaccurate reading as it is poorly placed under an overhanging tree.
- Many other critical gauges failed during the 2022 floods (Lerat et al., 2022). This has major consequences for providing early warnings during a large flood event.

Whilst the cause of each gauge failure is yet to be determined, consistent maintenance of rain and river height gauges is likely to reduce the risk of gauge failure in future flood events.

Standardise gauges to AHD and educate public where changes have been made

Most river height gauges in the Richmond River have datums other than AHD. Council flood studies and information supplied to the community is all referenced to AHD. However, river gauges, which provide essential information about projected flood peaks, can be AHD, LWOST or individual gauge datums. This creates confusion during flood events. As an example, Casino River gauge datum is 5.01 m below the AHD datum (Richmond Valley Council, 2022). To further confuse things, the Irving Bridge (Casino) visual gauge has a different datum to the Casino River gauge which is 7.87 m higher than the bridge gauge. Ensuring all Richmond River gauges are calibrated to AHD datum would provide consistency and help community members to better understand impending flood risks. Public education would be required to support the change, due to historic reliance on the old measures.

Improve dissemination/communication of gauge data

Issues:

- There were delays in dissemination of predicted flood levels
- There is no centralised platform to access gauge data

Potential solutions:

- Create a centralised platform to access real-time information e.g. river height and rainfall app
- Make the data easily interpretable e.g. by establishing Low, Moderate, High, Extreme flood level ratings, including graphs showing rise and fall to indicate river height trajectory etc.

Consider incorporating data from private gauges

There are many private gauges in region, particularly in the upper catchments. In the past, these private gauges were relied upon by landholders downstream and information was generally communicated by radio or telephone. Although these gauges are not standardised, they provide more data, which may further inform decision-making and/or be used to verify official gauges. There is currently no formal means of disseminating private gauge information to the community. During the NRRI engagement, it was suggested that a centralized platform be created to upload this information, with the caveat of it being unstandardised data.

Appendix F Public Submissions

Table 24. Summary of public submissions

LGA	Author	Submission title	Brief description
Ballina	Deborah Mills	Presented as Feedback on: Draft Ballina Flood and Protection Feasibility Plan	Author's home falls within the area Council have identified as being at greatest risk of flooding. Submission requests that *No.7 Commission a Local Stormwater Drainage Management Study and Plan* as a "*Strategic Action Plan to be completed within 3 years*" to be moved to highest priority and carried out urgently.
Ballina	Dennis Watling	Dredging of Ballina, Brunswick, Tweed Heads + Others	Dredge the mouth of the bar and up river to at least Burns Point Ferry. Most suitable vehicle is The Brisbane - a Hopper Dredger Trawling Suction Hopper. Provides contact details of the manager.
Ballina	Kevin Loughrey	Mitigation of future flooding of Ballina township and its surrounds	Suggests methods to alleviate flooding, including 1) building dams, 2) real time reporting of rainfall, 3) webpage for flood information, 4) diverting surplus water inland, 5) dredge mouth of the Richmond River, 6) open Tuckombil Canal, 7) construct "circuit breakers" - diverting floodwaters directly to the ocean
Ballina	Malcom Johnson	Submission	Raises concerns about impacts of deforestation, erosion and consequential siltation leading to smothering of seagrass beds and poor water quality. Also concerned about the loss of wetlands due to drainage infrastructure, necessary for as a natural detention basin. Accompanying paper "Effect of deforestation on watershed water balance: hydrological modelling-based approach" (Hlásny et al., 2015).
Ballina	Roderick Faye (West Ballina Canal Advisory Group)	Submission	Concerned with water quality issues in the Richmond River. The Coastal Zone Management Plan (Hydrosphere Consulting, 2011) addresses issues but no action yet taken. Suggests: a) managing water in one of the three main catchments affecting Lismore (e.g. Dunoon Dam), b) dredging mouth of river, c) Government buy the current farming leases where the 3 main wetlands (Tuckean, Bungawalbin and Newrybar) are located, return them to their original function and consequentially reduce black water events.
Ballina	Teresa Dodd	Submission	Ballina resident living on very flood-prone Burns Point Ferry Rd. Suggests 1) add West Ballina to critical hotspot list, 2) close the road and ferry during flood events 3) install second experimental plastic flap drain 4) remake sandbag/earth wall at ferry end 5) urgent study of pipe network and locations 6) investigate accurate flood tide heights 7) halt development on flood-prone lands 8) hire an engineer from the Netherlands
Ballina	Anonymous	Flood Control System Diagram	Diagram showing proposal for a Flood Control System near Coraki and Tide Control System near Broadwater
Ballina	Dennis Watling and Crystal Graham	Flood Diversion Mitigation Plan 2022	A range of suggestions to address the overall concept: 1) Produce another flood water exit. This exit to be at least half that of the Ballina Bar exit through a channel. 2) The purpose of the channel is to have some control over the incoming and outgoing tides in times of flooding. 3) To remove at least half of the maximum flood waters 4) Reduce extreme flood water levels. Now and into the future of the Richmond and Wilsons Rivers. 5) Reducing impacts on other shires indirectly. 6) Reducing death, property lost and hardships.
Byron	Jim Mangelson and Ocean Shores Community Association	Ocean Shores Flood History and Council Liability	Byron Shire Council has admitted liability for flooding by ordering the closure of a flood outlet to the ocean in 1976, which was a "condition of consent for the development of the Ocean Shores Estate". This liability was recorded in Council minutes and cannot be waived in the Deed of Agreement between the Council and State Gov. Byron Shire Council has also allowed Tweed Shire to drain cane fields through Ocean Shores thus causing further flooding. They insist the original condition be enforced. Liability bond in 1969 was $170,000. https://brunswickvalley.com.au/flood-history/current_updates.htm
Byron	Rebecca McNaught and Bronwyn Elliott (CRTs for South Golden Beach, New Brighton and Ocean Shores)	Mayday community flood debrief and disaster preparedness event report	Debrief from CRT session post-event. Important information contained within includes list of issues from people's experiences and solutions to address them.

*Submission is a formal project proposal that has been scored in the MCA

LGA	Author	Submission title	Brief description
Byron	Robert Crossley	Review of Historical Changes to the Marshalls Creek Floodplain and Potential Impacts on Flood Flows	Shows terrain models built from historical aerial imagery showing historical drainage lines across floodplain. Author suggests investigating the following strategies further: 1) stop pumping water from SGB into canal as this simply recirculates the flood water to Billinudgel Nature Reserve or back in Marshalls Creek, contributing to New Brighton flooding. Needs to be pumped out to the ocean instead. 2) Remove water that used to naturally flow across floodplain via ocean outlets. Investigate the relationship between amount/rate of water needed to impactfully reduce flood levels. 3) Remove floodwater from Billinudgel Nature Reserve before it overtops the area east of Fern Beach and floods SGB, using same approach as 2). 4) Consider engineering options that can deliver outcomes based on investigation of amount/rate of water needed to impactfully reduce flood levels.
Clarence Valley	Anonymous	Historical photos of Maclean	Shows changes in riverbank looking across to Ashby and existence of an island now drowned out.
Clarence Valley	Anonymous	Installation of Goddards drain pump	Suggest the need for a pump at Goddards drain (east of Maclean). The levee wall surrounds these farms and stormwater runoff cannot flow out, leaving the farms inundated for ~5 weeks after Feb floods. Another pump is being installed at Essex drain - could this be put at Goddard's drain instead? Submission shows map.
Clarence Valley	Anthony Shannon	Serpentine Channel drainage issues	Drainage issues near Serpentine channel brought about by new Harwood bridge (M1 raised and therefore no longer acting as a dam, stopping flows from west to east). Submission outlines issues raised to council, they have replied stating they will carry out the works, but no action since email received April 2020.
Clarence Valley	Australian Water Exploratory Company	The Clarence/Copeton Dam Scheme	Information brochure describing proposed hydropower Clarence/Copeton Dam Scheme.
Clarence Valley	Clarence Valley Council	The Clarence 2032 Strategic Plan	A copy of the Clarence 2032 Strategic Plan
Clarence Valley	Richard Grandon	Diversion of Clarence Tributaries to Western Rivers	An historical newspaper article about a feasibility study to divert Clarence River tributaries west to generate a hydro-electricity scheme. Details about the scheme are included (authored by engineer David Coffey)
Clarence Valley	Ron Parker	Email correspondence regarding stormwater flooding on Marandowie Drive, Iluka	Email providing evidence of stormwater flooding in Iluka (corner Melville and Marandowie Drive) and urging council to act
Clarence Valley	Yamba CAN (represented by Bob and Lynne Cairns)	Submission	Authors raise concerns about how the impacts of Park Ave development on flooding Yamba. Submission includes: - short video presentation - Valley Watch Inc Flood Inquiry submission - Independent Peer Review done as commissioned by the Northern Region Planning Panel in relation to the Park Avenue Development
Clarence Valley	Debrah Novak	Food Inc. brochure and North Coast Regional Plan 2041	Information highlights the point that Clarence Valley is a food bowl and supports the suggestion of making Grafton a regional airport to ensure food security during flooding
Clarence Valley	Greg Nicholls	Comment on defining Grafton levees project	Suggests: - CL9 'up-to-date' survey of Grafton levees' adopts approach of identifying levee banks built between 1965 -1975 (original banks), between 1975-2000 and between 2000-2022. - Soundings of the Clarence River (from 1970 and 2018) are used to determine rate of silting
Clarence Valley	Jim Fear and Jim Shannon	M1 impacts on local drainage issues (Harwood Island)	Plea for action by council to address local drainage issues caused by the highway upgrade. Council have been informed, yet no action yet (see email correspondence).
Clarence Valley	Tony Beadman	Drone footage of South Grafton levee breaching	Footage of South Grafton levee breaching. An example of the lack of maintenance to previously well maintained flood mitigation infrastructure - this levee is now well under its original design height, trees have been allowed to flourish on and near the levee and washout below trees. Damaged in 2010 or 2012, yet to be repaired. Suggests a need for designated authority responsible for flood mitigation works.
Clarence Valley	Sunshine Sugar and cape Byron Management (David Wood)	Proposal to protect three major sugar mills*	Proposal to protect three major sugar mills - Condong Sugar Mill and Cape Byron Power Cogeneration Facility (Tweed River), Broadwater Sugar Mill and Cape Byron Power Cogeneration Facility, and Harwood Sugar Mill and Refinery (Clarence River), by way of flood walls and specially designed flood gates.
Lismore	Annie Kia	New NSW SES	Information and evidence about improvements to NSW SES

LGA	Author	Submission title	Brief description
Lismore	Anonymous	Northern Rivers Catchments and mm Watch	Information about self-organised group 'Northern Rivers Catchments and mm Watch' established to address the need for rainfall information sharing during extreme weather events. It is an open platform for upstream communities to share mm readings. It offers a broader picture than just official gauges for downstream communities. Gives downstream communities an opportunity to make informed, timely decisions. https://www.facebook.com/groups/387771786798735
Lismore	Auinah Ayres	Crown Lane Pictures	Photos of Crown Lane/Webster Street, South Lismore demonstrating need for curbs and guttering.
Lismore	Col Baker	AML submission	Series of flood mitigation suggestions, including retention basins in upper catchments, four diversion channels and raising levee height in Lismore.
Lismore	George Newby	New Dunoon Dam	Support for Dunoon Dam
Lismore	Lindsay Hill	Submission to the CSIRO's Northern Rivers Resilience Initiative	Suggestions for flood mitigation measures with the approach to arriving at those suggestions outlined. Suggestions include: 1) Retention dams in upper catchment 2) Building Dunoon Dam 3) Funding Landcare activities to re-vegetate the riparian zones along rivers and creeks as well as other areas 4) Constructing flood drainage channel from Paul Weir's farm on Leycester Creek at Tuncester across the floodplain west of Lismore airport to enter Wilsons River at Loftville 5) Creating short-cuts at various bends of the river 6) Constructing a drainage channel or canal across the former Tuckean Swamp at one of three possible locations 7) Constructing a drainage channel or canal from the Richmond River at Broadwater to the sea at Broadwater Beach possibly utilising the course of Boundary Creek 8) Constructing a drainage channel or canal in the Empire Vale area to the sea at Patches Beach or possibly utilising the course of Empire Vale Creek 9) Dredging the rivers 10) Maintaining existing flood mitigation infrastructure
Lismore	Colin Wight (Lismore Drains Community Action Group)	Application for Emergency Funding re Lismore Flood Mitigation, Northern Rivers Resilience Initiative (CSIRO Project Group)	Proposal for undertaking an urgent drain clearance operation across the identified areas (60 streets). Given the third La Nina, residents believe this is an emergency that requires action to be conducted as soon as possible. Summary Report and community survey included.
Lismore	Mark Dowling	Flood Mitigation Submission	Expression of concern about adequacy of electronic warning systems. Author also conducting an independent flood study.
Lismore	Nan Nicholson (WATER Northern Rivers Alliance)	Opposition to Dunoon Dam construction	Expression of opposition to Dunoon Dam construction with substantiated reasoning provided
Lismore	Beth Trevan (Lismore Citizens Flood Review Group)	Feasibility study of Richmond/Wilsons River catchment for climate resilience and adaption planning*	An extensive proposal for a comprehensive Climate Resilience and Adaptation Feasibility Study for the Richmond/Wilsons River Catchment. The feasibility study results will inform a business case involving economic resilience and water management recommendations for both flood and drought.
Lismore	Richard Cassels	Submission	The author notes a lack of political and legal mechanisms in Australia to develop coordinated land management and whole-of-landscape policies, suggesting the Northern Rivers region would provide the perfect opportunity to attempt such an approach and a study be undertaken to determine how this could be achieved. Other points include 1) long term mitigation of floods in the upper parts of the catchment should be prioritised 2) 'saving the soil' is vital
Lismore	Nathan Kestevan	Nature-based Flood Mitigation Strategies in Australia info	Article regarding nature-based flood mitigation by Jacob Evans. Nature-Based Flood Mitigation Strategies in Australia - RISK FRONTIERS
Various	Jeremy Stewart	Ideas for feedback to CSIRO/Alluvium Consultation	Feedback includes evidence to support the rejection of Lismore City Council project options derived from FRMP (2020) (Options L1 to L5). The floodplain management committee have considered and rejected these options based on the following faults:

LGA	Author	Submission title	Brief description
			A) There was little gain in peak flood height reduction. B) The options were expensive for community gain. C) It was a winner's and loser's approach, with the losers being those of lower socio-economic backgrounds
Various	Jeremy Stewart	Nature-based Flood Mitigation: observations of the disappearance of Corndale Hall	Committee and community support investigation of nature-based strategies. Other constructive feedback is also offered. Information regarding Corndale Hall being swept away in the flood. Author uses the location as an example of a 'catchment pinch point', which can make an effective water slowing device with the addition of intensive native revegetation around it.
Various	Jeremy Stewart	Nature-based Flood Mitigation: observations centred around Protestors Falls day use area	An example of a functioning upper catchment floodplain at Protestors Falls day use area, Nightcap National Park. Submission includes details of how the Protestors Falls palm forest example shows us that complex native vegetation communities have evolved to play a critical role in sediment capture, and even landscape formation.
Various	Mark Jackson (The Carbon Store Pty Ltd) with support from Richmond River Keeper	Caring for our Catchments: Riparian revegetation and reforestation for flood resilience in the Clarence, Richmond, Tweed and Brunswick Catchments*	Proposal for a pilot project aimed at achieving biodiverse revegetation of riparian zones and reforestation of marginal grazing country to achieve benefits of slowing overland and stream water flows, retaining additional water until saturation and full runoff occurs, stabilising erodible soils including on streambanks and reducing stream and estuarine siltation and turbidity.
Various	Oliver Costello (representing the Jagun Alliance) with Conservation Futures (Bush Heritage/University of Melbourne) and Resilience Landscapes Hub	Heal the Rivers Flood Recovery and Landscape Restoration Proposal *	Proposal for the development of a First Nations-led strategy for Bundjalung Country in the Northern Rivers to deliver cultural landscape restoration and Country and nature-based flood mitigation and adaptation.
Various	Tammy Jones and Diana Bernadi (Red Cross)	Community-led Resilience Teams project proposal*	Proposal for a two-year funded project delivered across 7 LGA in Northern Rivers area, reaching approximately a total of 70 communities and providing a minimum of 4 engagement opportunities in establishing a CRT.
Various	Amanda Reichelt-Brushett (Richmond River Keeper president and Southern Cross University professor)	Northern Rivers Resilience Initiative response	Main points: - Tuckean swamp should be restored to a functioning water retention basin - Bungawalbin swamp should also be considered as a water retention basin - SCU's ARC linkage project should be a priority project for funding - Innovative solutions are essential in light of the new and never predicted flood heights. Natural pinch points in the catchment should be targeted for investment opportunities to assess the benefits of innovative solutions. E.g. Corndale Hall location - Priorities in the Coastal Zone Management Plan for the Richmond River vol. 1 (2011) and the Richmond River Floodplain Prioritisation Study (2020) should be considered - Sediment load modelling should be considered because sediment contribution is likely to affect the accuracy of flood modelling studies - Real time river height/rainfall data loggers should be implemented across the Northern Rivers - Streambank stability (focussing on the source abatement) should be prioritised over dredging, which is only a short-term solution - The rapid approach is not conducive to receiving input from our indigenous community

LGA	Author	Submission title	Brief description
Various	Various	Rain and river gauge recommendations*	See Appendix E for further details.
Richmond Valley	Anonymous	Bureau of Meteorology failing the residents of Woodburn and surrounding rural areas	Need to increase amount of automatic rain and river gauges in the Bungawalbyn Creek catchment area. It is almost twice the size of Wilsons River catchment area yet currently only 2 auto rain gauges and 3 auto river height gauges (Neileys Lagoon Rd was washed away in Feb 2022 flood). BOM showed lack of commitment and inability to forecast flood peak for Woodburn. At 2.30am on Monday 28th February, BOM stated Woodburn may reach 5.3m on Tuesday and this forecast remained unchanged for ~24 hours. At 1.30am Tuesday, BOM revised its warning for Woodburn (10.5 hours after Coraki surpassed its highest ever flood peak level and Bungawalbyn junction equalled its highest ever recorded flood) predicting 6m at 4.30am Tuesday morning. Flood levels reached 6.01m by 2.30am. Shows BOM has no understand of the impact Bungawalbyn Creek has on flooding at Woodburn and surrounding areas.
Richmond Valley	Deborah Johnston	NSW Flood Inquiry submission	Very detailed submission summarised by: 1) Pacific Hwy upgrade created a dam (needs to be fixed immediately) 2) SES/BOM warnings were wrong and insufficient 3) Volunteers were pushed away by authorities 4) Abolish Resilience NSW 5) 3 months on, recovery is slow. Army Corps needed. No sign of housing solutions for rural areas 6) Bungawalbyn levee needs emergency repairs 7) SES and army were not sufficiently trained or equipped 8) financial assistance needed 9) Government needs to step in with insurance companies 10) restoration of the environment should be a concurrent priority.
Richmond Valley	Everyday Legal	Bungawalbyn resident buy-out (associated with Bungawalbyn levee repair)*	Author proposes that residents at 650 Bungawalbyn Whiporie Rd (Lot 1 DP805371), West Bungawalbyn are bought out due to unsafe levee condition (irreparable) in current location. The levee can then be built further inland, increasing the benchland and protection against further erosion. Levee could be incorporated into Bungawalbyn Whiporie Rd to achieve a range of specified benefits. Property could become a nature reserve, complying with the Inquiry's recommendation of using floodplains as assets. Author suggests this is a more economically viable option than repairing levee in-situ. Estimated property value $2.8 million.
Richmond Valley	Jason Regan	M1 and Lang's Way	Letter of complaint to the Clarence Valley Council regarding design faults of the M1 and Lang's Way, which have caused severe impacts resulting in substantial damages and losses to business and property as well as ongoing inconvenience and limitations to its use, as well as severe trauma and stress to residents.
Richmond Valley	Jim McCormack	Tuckombil Canal issues	History of Tuckombil Canal and issues its current state presents
Richmond Valley	Jim McCormack	Short and Long-term solutions	1) Replace current Tuckombil Canal fixed weir with fabridam 2) Additional pipe capacity under Woodburn/Coraki Rd at Thearles Draina as part of Stage 3 upgrade of that road to drain Swan Bay basin 3) Repair existing levee along Bungawalbyn Creek in the Boggy Creek area 4) Rous Water to clean all major Flood Mitigation drains including Thearle's, Campbell's, O'Connor's and Readon's drains. Regular spraying and maintenance necessary. 5) Restore flood gates and essential infrastructure (winches, chains etc) on these drains so they can be appropriately operated. 6) Increase Flood Intelligence (gauges) in Bungawalbyn catchment 7) Educate BOM about issues related to poor warnings in this flood - include Bungawalbyn catchment area in future flood watches and warnings 8) Update Grafton radar 9) Investigate role of M1 in exacerbating flooding in Woodburn area
Richmond Valley	Jim McCormack	Proposed mitigation projects for consideration	1) As the Woodburn/Coraki Rd is being upgraded, there are two drains, Thearle's drain and Reardon's drain that need the size of pipes and box culverts increased. Water currently backs up on southern side of drains, causing a bottleneck effect, leading to prolonged inundation, prolonged isolation of the community, increased damage to infrastructure, crops and

LGA	Author	Submission title	Brief description
			pastures. Growing area (35 new homes built and occupied in the last 4 years, plus further subdivision of 55 blocks recently approved) 2) Removal of the current Tuckombil Canal fixed weir
Richmond Valley	Jim McCormack	My Story	Long-term Evans Head resident and past Richmond Valley Councillor sharing personal experience of the flood as well as thoughts on 'causes and contributing factors' (extreme event, permanent fabridam at Tuckombil Canal and lack of additional outlets to ocean besides Richmond river mouth), 'preparation and planning', and 'response to floods'. Emphasises not to forget smaller towns of Coraki, Woodburn and Broadwater.
Richmond Valley	Paul Hannon	NSW Independent Flood Inquiry	Request to investigate: - 'a flood diversion canal from Tuckurimba across Tuckean into the Broadwater with an outlet into the sea at Boundary Creek'. - A 'river diversion from Bungawalbyn at Moonem or above to sea at Jerusalem Creek or the Esk River' - Removal of the fixed weir at Tuckombil Canal and replaced with a 'gate-like' structure
Richmond Valley	Andrew and Deborah Rogelja	Significant Hazard Notification - Bungawalbyn, Swan Bay and Woodburn: Erosion of Levee	Information regarding severe erosion of levee at 650 Bungawalbyn-Whiporie Road, West Bungawalbyn NSW 2471. Supports public proposal PP8 (Everyday Legal submission).
Richmond Valley	Richmond Valley Council	Casino and Mid Richmond Flood Studies	A timeline of relevant flood studies and Floodplain Risk Management Studies and Plans for Casino and the Mid Richmond
Tweed Valley	Anonymous	Map showing silting of Tweed River	Map showing silting of Tweed River
Tweed Valley	Anonymous	Model the relationship between flood height, river height and tides for Fingal Head, Barney's Point, Chinderah and Tumbulgum	Map and tide charts supporting the need to model the relationship between flood height, river height and tides for Fingal Head, Barney's Point, Chinderah and Tumbulgum
Tweed Valley	Anonymous	Photo of Barney's Point Bridge, Tweed River (1937)	Photo of Barney's Point Bridge, Tweed River (1937)
Tweed Valley	Anonymous	Photos of floodplain development (Chinderah)	Photos of floodplain development (Chinderah)
Tweed Valley	Joanne Iva (Tweed Drainage Council)	Community petition: Study to investigate costs/benefits of dredging the Tweed River	1097 online signatures and 660 paper signatures in support of pursuing a study focussed on the costs and benefits of dredging the Tweed River.
Tweed Valley	Joanne Iva (Tweed Drainage Council)	Flood mitigation in the Northern Rivers region	Requesting Northern Rivers Reconstruction Corporation and CSIRO to undertake flood modelling to show the benefits or otherwise of dredging rivers, creeks and drains as a flood mitigation option. There is strong community support for dredging and the issue needs to be investigated.
Tweed Valley	Jennifer Kidd and Steve Smith (Tumbulgum Community Association)	Flood impacts on the Tweed floodplain particularly impacting Tumbulgum	Information regarding flood impacts in Tumbulgum, plus four key recommendations to help alleviate the flooding experienced.
Tweed Valley	David Norris	Tweed South submission	Information regarding Bushland hazard reduction burning, Pottsville Waters Canal flood mitigation, Ocean outfall, Planning and Koala Proof fencing
Tweed Valley	Andy Williams (Cabarita Beach & Bogangar Residents Association (CBBRA) Flood Mitigation Sub-committee)	Cudgen Lake Flood Mitigation Options Assessment proposal*	Fund study - *Local Catchment Flood Mitigation Study for Cabarita Beach and Bogangar* - to identify/review proposed solutions for flood mitigation as per our proposal.
Kyogle	John Tart	Submission	Issues for Bonalbo

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