APPENDIX A

COMMUNITY CONSULTATION

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Risk Management Study & Plan

The preparation and implementation of *Floodplain Risk Management Plans* is the cornerstone of the *Floodplain Management Program.* Management plans can eliminate the ad-hoc decision making process which has contributed to many present day flooding problems.

The *Floodplain Risk Management Study and Plan* is the focus of the current project.

The purpose of the project is to find an appropriate mix of management measures and strategies to effectively manage the full range of flood risk through an effective public participation and community consultation program.

The outcome will be a plan that details how the existing and future flood risk within the Bega and Brogo Rivers Catchment will be managed.

Flooding at Tarranganda Lane - 23 March 2011

Flood management measures and strategies could possibly include a mixture of:

- On ground works such as improved flow paths, detention basins, modifications to bridges and / or barriers to flow;
- Planning controls such as development controls for future development in flood prone land; and
- Emergency response measures such as improvement evacuation routes, community education of the flood risk and how to respond when flooding occurs and installation of flood warning signage and depth markers.

What does this mean for me?

The outcomes of this study can help provide protection of you, your family and your property from flooding.

This may mean there will be works undertaken in the future near your home or work, or you may have to incorporate flood compatible design into any future development, or at the very least you will receive advice and information to assist you in making your home or work 'flood safe'.

Consultation and Feedback Form

There will be several opportunities for you to be involved in the study. The first of which is the completion of the attached feedback form (or online version).

Previous consultation for the Flood Study was undertaken to gain information on community experiences with flooding.

The current Floodplain Risk Management Study and Plan is undertaking consultation with the community in order to:

- Identify the key areas of concern with regards to flooding; and
- What flood management measures would be most preferred by the community.

We would appreciate your input to this project by filling and returning the attached feedback form to Council.

We would also welcome the opportunity to discuss your thoughts on flood risk and management face to face. You are invited to attend a workshop with the project staff in late April. Further details can be obtained from the project website.

Contact Us

bega valley shire council

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Bega and Brogo Rivers Floodplain Risk Management Study and Plan

Information Brochure

Bega Valley Shire Council has engaged Cardno to assist with the preparation of the Bega and Brogo Rivers Floodplain Risk Management Study and Plan.

The Floodplain Risk Management Study and Plan follows from the Bega and Brogo Rivers Flood Study, undertaken in 2014, which identified existing flooding behaviour within the river catchments. The purpose of the Floodplain Risk Management Study and Plan is to identify and recommend appropriate actions to manage flood risks in the Bega and Brogo River catchments.

This brochure provides an introduction to the Floodplain Risk Management Study and Plan to inform you of the project objectives and how you can provide input. There is also a short survey attached to gain your input to the study.

For more information regarding this project visit:

Provide Council's project-specific webpage address

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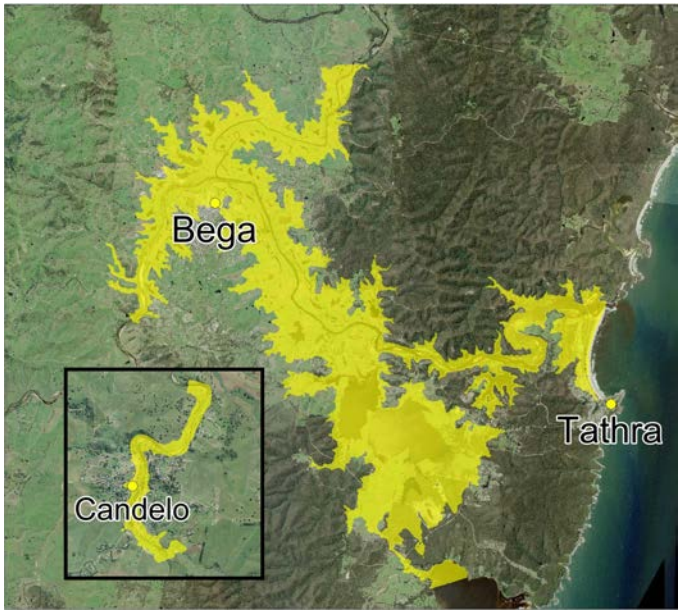
Study Area

The Bega and Brogo River catchments have a combined area of approximately 1790 km^2, and converge at the township of Bega before flowing into the Pacific Ocean approximately 24km downstream. Both rivers originate in farmland below an escarpment of the Great Dividing Range to the north and west of Bega.

Flooding within the catchment has the potential to impact a number of communities including Bega, Mogareeka, Tathra, Candelo, Bemboka and Cobargo.

The Bega River borders the township of Bega on its western, northern and eastern sides. The inundation patterns for past floods indicate that Bega township is mainly flooded by overbank flow from the Bega River. Floodwaters back up from the confluence of the two rivers and spread over low-lying areas.



Study area (including Candelo shown in inset) with existing Probable Maximum Flood (PMF) extent, shown in yellow

History of Flooding

The Bega township has a history of flooding from the Bega and Brogo Rivers. In February 1971 Bega experienced a record flood that inundated numerous properties and created significant damages. Another large flood event impacted the area in March 2011. There were also a number of other significant events in March 2012, February 2010 and March 1983.

Flooding Around Bega Township February 2010

The 1971 flood event resulted in substantial damage in the town of Bega. It was reported that two people lost their lives, over 50 bridges were destroyed, and the damage was estimated at $7 million, and electricity and telephone lines were out of service. Towns south of Bega were out of water supply as water mains were destroyed. Hancocks (i.e. Tathra) Bridge spanned 700 feet near Mogareeka but only six of the fifteen spans remained in place after the flood had passed.

Floodplain Management

Local councils have lead responsibility for managing flood prone areas, but the State Government plays a key role by helping these councils manage flood threats faced by their residents. The State Government assists local council by providing financial and technical support under the *Floodplain Management Program*.

Under the program Council must first prepare a Flood Study to identify the flooding problems. This is then followed by the preparation of a *Floodplain Risk Management Study and Plan*, which aims to address the flooding problems.

Council has established a *Floodplain Risk Management Focus Group* to guide the floodplain management process for the Bega and Brogo Rivers. The committee comprises of Council Staff, Councillors and Community Representatives.

Previous Flood Study

The Bega and Brogo River Flood Study was completed in 2014 by SMEC on behalf of Bega Valley Shire Council. The Flood Study identified that there are a number of private properties and public assets likely to be impacted by flooding. In addition, road access during flood events is of significant concern in some locations.

The Flood Study provided flood mapping for design flood events, including the 10%, 5%, 2%, 1%, 0.2% AEP and PMF events.

Community consultation was undertaken during this Flood Study, during which residents indicated areas most affect by flooding and their experiences with past floods. Results from this consultation were used to calibrate and validate the flood modelling results.

Bega and Brogo Rivers Floodplain Risk Management Study and Plan

Feedback Survey

Are you concerned about flooding of your property or in your local area? Do you have any suggestions for ways in which Council could manage flooding along the Bega River and Brogo River? Council would like to hear about your experiences, concerns and suggestions and would be grateful if you could complete this short survey. Your responses will help us understand the flooding problems in more detail. Local knowledge and personal experiences of flooding are an invaluable source of data and we appreciate your input.

Cardno, on behalf of Bega Valley Shire Council, is preparing a Floodplain Risk Management Study and Plan for the Bega and Brogo Rivers. The Floodplain Risk Management Study aims to help Councils to help make informed decisions on how to manage flood risks in the future.

Tell us about your concerns and suggestions and return the survey via mail using the prepaid return envelope.

We anticipate it will take around 20 minutes of your time.

Thank you for your time and responses.

Q1. Could you please provide us with the following contact details?

Name : .....

Postal Address : .....

Daytime Phone Number: .....

Email : .....

Q2. Do you give permission to be contacted about your responses to this survey?

☐ Yes

☐ No

Q3. Would you like to be added to a project email list to be notified of upcoming project milestones and community consultation activities?

☐ Yes

☐ No

FLOOD RISK

Q4. In your opinion, what is the greatest flood risk in the Bega and Brogo River Floodplain?

- ☐ Risk to property
- ☐ Risk to life
- ☐ Inconvenience
- ☐ Other (please specify) ……
  ……

Q5. What area or property are you most concerned about?

- ☐ My property
  Please specify address: ……
- ☐ Public area (e.g. park, shopping centre)
  Please specify: ……
- ☐ Specific road (s)
  Please specify: ……
- ☐ Other
  Please specify: ……
  ……

FLOOD PLANNING LEVEL

Q6. A Flood Planning Level is a flood level derived from a predicted flood event, plus a freeboard (see Glossary). Flood Planning Levels are used in the planning of developments to ensure that they are built in a flood-compatible manner.

Have you heard of Flood Planning Levels before?	☐	Yes	☐	No	
Do you feel that Flood Planning Levels are necessary for the protection of property and life?	☐	Yes	☐	No	☐ Yes, to some degree
Do you understand what a freeboard is and why it is included in the Flood Planning Levels?	☐	Yes	☐	No	☐ Yes, to some degree

FLOOD RISK

Q7. What level of control do you consider Council should place on new development to minimise flood-related risk?

- ☐ Stop all new development only in areas where flooding is most sever (i.e. deep and fast flowing).
- ☐ Stop all new development on land with any potential to flood.
- ☐ Place restrictions on development on flood prone land (e.g. minimum floor levels, use of flood-compatible materials).
- ☐ Advise people of flood risks and allow individuals to choose how they would reduce flood damage.
- ☐ There should be no control on development in flood affected areas.

Q8. As a local resident who may have witnessed flooding/drainage problems, you may have your own ideas on how to reduce flood risks. Which of the following management options would you prefer for the Bega and Brogo Rivers area (**where 1 = most preferred , 5 = least preferred)** ?

Please also provide comments as to the location where you think the option might be suitable.

Please note that this study is not looking at works for minor street drainage. The works proposed from this study will be designed to protect property and life against the impacts of flooding from the Bega and Brogo Rivers (and tributaries).

Possible Options	Preference (please tick) Highest → Lowest	Location/other comments
Retarding or detention basins; these temporarily hold water and may reduce flooding.	1 2 3 4 5	
Improved flood flow paths through drain reshaping.	1 2 3 4 5	
Environmental channel improvements, including removal of weeds and/or bank stabilisation.	1 2 3 4 5	
Raising of bridges, enlarging pipes under road crossings.	1 2 3 4 5	
Levee banks (note Glossary on final page).	1 2 3 4 5	
Voluntary purchase of highly-affected properties by Council and demolition of any buildings on the property.	1 2 3 4 5	
Planning and flood-related development controls to ensure future development does not add to the existing flood risk.	1 2 3 4 5	
Education of community, providing greater awareness of potential hazards and ways to maximise your own personal safety.	1 2 3 4 5	
Flood forecasting, flood warning, evacuation planning and emergency response such as early warning systems, improved local SES capabilities/ resources or improved radio and phone communication.	1 2 3 4 5	
Other (please specify any options you believe are suitable. Please attach extra pages for other suggestions).	1 2 3 4 5	

Bega and Brogo Rivers Floodplain Risk Management Study and Plan

Feedback Survey

Q9. Do you have any other comments or suggestions to manage flooding in the Bega and Brogo Rivers floodplain?

……
……
……
……
……
……

GLOSSARY

Culvert	A drain or covered channel that passes under a road or railroad.
Levee Banks	An embankment usually constructed from earth or concrete built along the banks of a river to help prevent overflow of its waters. These can often be incorporated into other features such as cycleways or footpaths. The height of the levee depends on the depth of flooding and the level of protection design from the levee.
Retarding / Detention Basin	A naturally occurring or constructed depression in the land surface that detains storm-water runoff by allowing it to slowly drain out of the basin into the adjoining natural drainage line or creek.
Freeboard	A factor of safety that is usually expressed as the difference in height between the level of the floodwaters and the adopted flood planning level. Provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain.
Flood Planning Level	A combination of a flood level and a freeboard used for planning purposes.
Flood Planning Area	The areas of land below the flood planning level and thus subject to flood related development controls.
Flood Control Lots	A parcel of land that has development controls to reduce the impacts of flooding.

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APPENDIX B

BOURNDA DAM ASSESSMENT

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Bournda Dam is a small dam to the east of Sapphire Coast Drive near Bournda Parkway. Originally constructed as a gully erosion structure for the private land owner, and now utilised for water supply for private use, road works and firefighting, the dam also provides visual amenity and recreational value.

B.1 Information Brochure – Bournda Parkway Dam

An additional information brochure and questionnaire was distributed to those properties surrounding the Bournda Parkway Dam area in December 2016 looking particularly at the risk associated with failure of the Bournda Parkway Dam. The brochure provided the opportunity for the public to inform the future management of the dam at Bournda Parkway. A copy of the information brochure is provided at the conclusion of the appendix

The brochure and questionnaire were delivered to approximately 74 properties on the 4th January 2017. Due to the holiday period, respondents were given until the 25th January 2017 to provide feedback (additional responses received in the week following this were also included). From the distribution, 26 responses were received, representing a return of approximately 35% of direct distribution.

B1.1 Background and Purpose of Information Brochure

A small dam exists to the east of Sapphire Coast Drive near Bournda Parkway. Council understands that the dam was originally constructed as a gully erosion structure for the private land owner. During the subdivision of the surrounding land the dam was used for sediment control. The dam is now used for water supply for private use, road works and firefighting and provides visual amenity and recreational value.

Due to the temporary nature of its original intended purposes, it is Council's understanding that the dam was likely not constructed to comply with design guidelines and dam safety regulations that would provide some certainty of its structural stability and longevity.

In 2014, Council was notified that erosion had been identified at the dam wall. Remediation works were subsequently undertaken by Council in an attempt to stabilise the damage.

Council has some ongoing concerns regarding the sustainability of the dam structure and is looking for options regarding the future management of the dam. The purpose of this engagement was to identify how the community values the dam, what it is used for, concerns regarding dam failure and input to potential management strategies.

Prior to the distribution of the brochure, dam break analsysis was undertaken to understand the potential impacts if dam break were to occur. Details of this analysis are provided in **Section B.2**Error! Reference source not found. and a brief summary of the results was provided in the brochure for residents.

B1.2 Value of Bournda Parkway Dam

The survey asked respondents to identify how they valued the Bournda Parkway Dam. The responses are summarised in 0.

The majority of respondents (92%) indicated that visual amenity was an important value of the dam. Recreation such as swimming, canoeing/kayaking, fishing, bird watching and walking were also highly valued (69%). Water supply was also of value to the respondents (35%).

More than half of the respondents identified "other" values (54%). These values were primarily identified as habitat value and access to firefighting water.

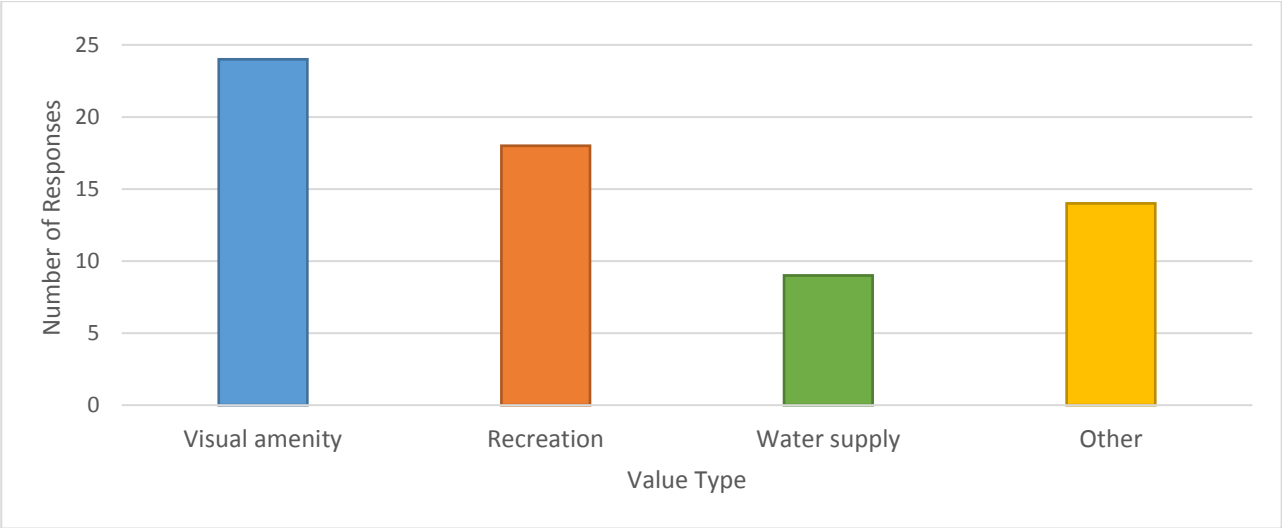

Figure B-1 Value of Bournda Parkway Dam

B.1.3 Concerns Regarding Flooding from Bournda Parkway Dam

The majority of respondents (92%) indicated that they were not at all concerned about flooding from the Bournda Parkway Dam. One respondent (4%) was concerned about flooding due to further development and clearing in the area, while another respondent (4%) indicated they were only concerned if the dam wall fails.

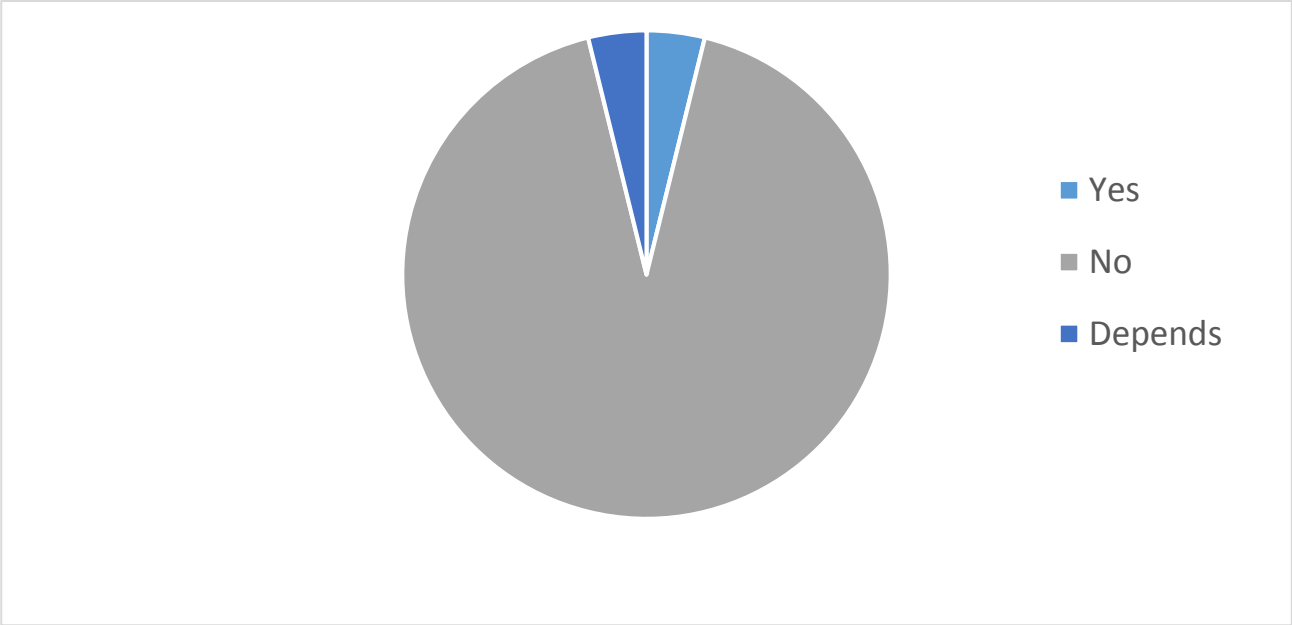

Figure B-2 Concerns Regarding Flooding from Bournda Parkway Dam

B.1.4 Preferred Approach to Managing Erosion at Dam Wall

The survey asked the respondents to select the preferred approach to managing the Bournda Parkway Dam wall considering that it is not possible to remediate the existing wall to achieve safety standards. Some respondents indicated two answers, which are both represented in the graph. Two respondents ranked the approaches from most preferred to least, the pie chart represents the top two answers for these respondents.

It should also be noted that respondents were given the opportunity to also provide other approaches. One respondent indicated that controlling of the black wattles on the dam wall could help with the erosion issue.

One respondent also asked for further information regarding cost of each option to provide a better understanding and selection of approach.

The most popular maintenance option with sixty-two percent (62%) of respondents was to monitor the dam wall regularly and respond to any continued erosion of the spillway and wall as issues arise. Thirty-five percent (35%) of respondents preferred to undertake additional works at the dam and then monitor the dam wall regularly and respond to any continued erosion of the spillway and wall as issues arise. No respondents wished to replace the dam with a stream, while twenty-seven percent (27%) opted for draining of the existing dam and reconstruction of the dam wall in accordance with safety standards and allow the dam to be reinstated.

One respondent also suggested that before developing a management approach to the dam wall erosion, it was necessary to understand the risk of failure, not just the outcome of the failure (see **Section B.2** for details of dam failure assessment).

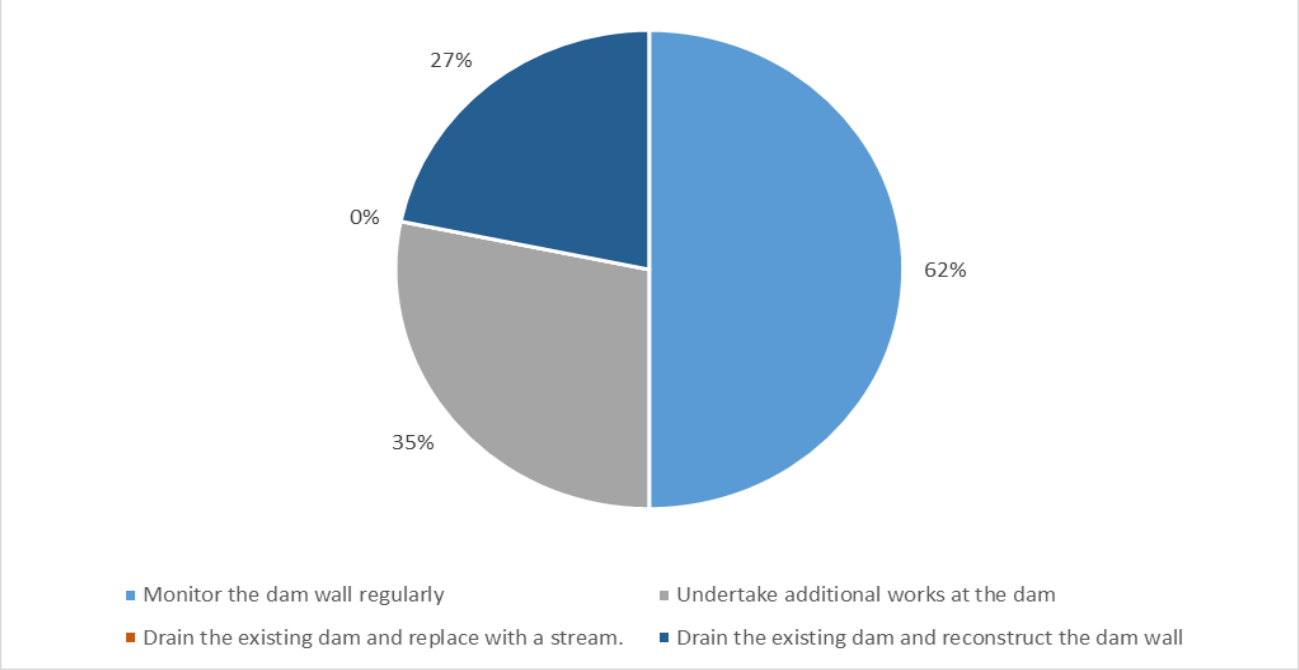

Figure B-3 Preferred Management Approach for Bournda Parkway Dam

B.1.5 Additional Comments

Respondents were asked if they wished to provide any additional information, comments or information. Respondents identified the following suggestions:

> Blackberry management on the dam wall should be maintained;

> Better controls for major flooding above the dam (and leading into);

> Develop the area nearby (i.e. picnic tables) and make the dam an asset;

> Going into drought, the dam would be required by everyone (community, council, animals and residents);

> Further information on costs of each maintenance option and risk assessment.

Other comments were based on the wildlife / habitat produced by the dam and how the dam adds to the visual amenity (reason for living in that particular area.

Another comment raised was the reason behind the initial construction of the dam. One resident indicated that the dam was not built as a “gully erosion structure” as indicated on the brochure. This resident indicated that the dam was built as a bird sanctuary, for fishing purposes and for cattle watering and was keyed into the ground for a depth of 3 feet.

B.1.6 Outcomes

It is clear from the responses received to the consultation brochure that the dam is highly valued by the community for numerous reasons. The communities perceived risk of dam failure is low and they seem unconcerned of the impacts of flooding as a result of dam failure. However, as suggested by one respondent, it would be prudent to quantify the likelihood of failure so that this can be coupled with the impact of failure to inform a robust risk assessment and assist in the development of an appropriate management strategy.

B.2 Dam Break Assessment of Bournda Dam

Due to the temporary nature of its original intended purposes, it is Council's understanding that the dam was likely not constructed to comply with design guidelines and dam safety regulations that would provide some certainty of its structural stability and longevity.

To assist Council in planning for the future of the dam, a dam break assessment was undertaken to determine the impact of the dam failing. For the assessment, a local TUFOW model was constructed. The model adopted all the model parameters of the full TUFLOW model, but was able to utilise a finer, 2m grid cell.

The results showed that there was no change in the 1% AEP peak flood extents as a result of the dam failing. This is due to the dam volume being significantly less than the volume in the Bega River, so that the additional volume applied did not result in any changes in peak water levels.

The results show that:

> Failure of the dam does not affect any existing properties;

> The kennels become isolated due to the dam flood waters. However, this isolation lasts less than 30mins in both sunny day and flooding scenarios, so is not considered to be a major concern;

> Depths through the properties reach a peak of 0.2m, although they are less than 0.1m for most of the flow path;

> The response time is rapid, due to the proximity of the dam to the affected properties, with the flood reaching its peak within 1 hour of failure commencing;

> While the response is rapid, the distance required for anyone on the property to reach flood free land is short (less than 50m) so this behaviour is not considered to place any persons in the field in significant risk; and,

> Access along the highway is lost for a length of 40m, for less than 30mins at the peak of the failure.

Feedback

Could you please provide us with the following details (you information will remain confidential)?

Name: _____

Postal Address: _____

_____

Daytime Phone Number: _____

Email: _____

Do you give permission to be contacted about this survey?

_____

What (if any) of the following do you value about the Bournda Parkway Dam?

☐ Visual amenity

☐ Recreation. Details: _____

☐ Water supply

☐ Other: _____

_____

_____

_____

Are you concerned about flooding from the Bournda Parkway Dam? If so, please provide details.

_____

_____

_____

_____

Feedback

There are some concerns regarding the stability of the Bournda Parkway Dam wall. Stability works were recently undertaken, but due to the original construction of the dam, it is not possible to remediate the existing wall to achieve safety standards. What would be your preferred approach to managing this issue?

☐ Monitor the dam wall regularly and respond to any continued erosion of the spillway and wall as issues arise.

☐ Undertake additional works at the dam wall and then monitor the dam wall regularly and respond to any continued erosion of the spillway and wall as issues arise.

☐ Drain the existing dam and replace with a stream.

☐ Drain the existing dam and reconstruct the dam wall in accordance with safety standards and allow the dam to be reinstated.

☐ Other: _____

_____

_____

_____

_____

Do you have any other relevant comments or suggestions?

_____

_____

_____

_____

Contact Us

Bega Valley Shire Council
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Bega NSW 2550
P: 02 6499 2222
E: council@begavalley.nsw.gov.au

Bega and Brogo Rivers Floodplain Risk Management Study and Plan

Bournda Parkway Dam Assessment

Information Brochure

Bega Valley Shire Council has engaged Cardno to assist with the preparation of the Bega and Brogo Rivers Floodplain Risk Management Study and Plan.

The Floodplain Risk Management Study and Plan follows from the Bega and Brogo Rivers Flood Study, undertaken in 2014, which identified existing flooding behaviour within the river catchments. The purpose of the Floodplain Risk Management Study and Plan is to identify and recommend appropriate actions to manage flood risks in the Bega and Brogo River catchments.

As part of this study Council is looking at the risk associated with failure of the dam at Bournda Parkway and looking at options for the future management of the dam.

Catchment wide community input was sought previously in April 2016 to inform the management of Brogo and Bega Rivers. This brochure is seeking feedback from the community that will inform the future management of the dam at Bournda Parkway.

Bournda Parkway Dam

A small dam exists to the east of Sapphire Coast Drive near Bournda Parkway. It is understood that the dam was originally constructed as a gully erosion structure for the private land owner. During the subdivision of the surrounding land the dam was used for sediment control. The dam is now used for water supply for private use, road works and firefighting and provides visual amenity and recreational value.

Due to the temporary nature of its original intended purposes, the dam was likely not constructed to comply with design guidelines and dam safety regulations that would provide some certainty of its structural stability and longevity.

In 2014 Council was notified that erosion had been identified at the dam wall. Remediation works were subsequently undertaken by Council in an attempt to stabilise the damage.

Council has some concerns regarding the sustainability of the dam structure and is looking for options regarding the future management of the dam.

Bournda Parkway Dam Location and Catchment

Flood Risk

As part of the Bega River and Brogo River Floodplain Risk Management Study, hydraulic modelling of the Bournda Parkway Dam has been undertaken. The modelling assessed the impacts of the dam failing during a flood event and during a "sunny day" (i.e. no rainfall).

The results of the modelling showed that during a 100 Year ARI flood event the peak flood levels downstream of the dam are not significantly increased as a result of the dam failure (when compared to a flood event when the dam wall does not fail). This is because during a flood a significant amount of water would be spilling over the dam wall anyway.

If the dam wall were to fail during a day with no rainfall then the area impacted downstream would be contained primarily to the natural low point that extends from the dam to Sapphire Coast Drive. No residential properties are impacted by this flooding. Ponding at Sapphire Coast Drive results in some flooding of the road and impacts on the boarding kennels and cattery.

Bournda Parkway Dam Break Flood Extent (Sunny Day)

Dam Management

Due to the uncertainty associated with the dam's original construction and concerns raised regarding existing erosion, Council are looking at options for the future management of the dam. Any future management strategy seeks to balance safety concerns with the environmental and social values of the waterway.

Management options may include:

- removal of the dam wall and reinstating a creekline,
- reconstruction of the dam wall to achieve current design standards,
- modification of the dam wall and waterway to reduce safety concerns, or
- ongoing monitoring of any erosion and undertaking works as required.

Community Input

Council is seeking your input to help develop a management strategy for the Bournda Parkway Dam. Council is interested to understand if and how you currently use the Dam and how you value it. Council would also like to know how you would prefer to see the dam managed into the future.

This brochure contains a short feedback survey. Please provide the completed survey to Council by post or email, or please feel free to contact Council by phone.

Post: PO Box 492, Bega NSW 2550
Email: council@begavalley.nsw.gov.au
Phone: Gary Louie 02 6499 2222

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APPENDIX C

DAMAGE METHODOLOGY

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The following sections set out the methodology for the determination of damages within the Bega and Brogo Rivers catchment.

C.1 Residential Damage Curves

The draft DNR (now OEH) Floodplain Management Guideline No. 4 Residential Flood Damage Calculation (NSW Government, 2005) was used in the creation of the residential damage curves. These guidelines include a template spreadsheet program that determines damage curves for three types of residential buildings, namely:

> Single story, slab on ground,

> Two story, slab on ground,

> Single story, high set.

Damages are generally incurred on a property prior to any over floor flooding. The OEH curves allow for a damage of $10,988 (December 2016 dollars) to be incurred when the water level reaches the base of the house, with the base of the house assumed to be 0.3 m below the floor level for slab on ground. We have assumed that this remains constant until over floor flooding occurs. A nominal $3,000 has been allowed to represent damage to gardens where the ground level of the property is overtopped by more than 0.3m of depth but only up to 0.3 m below the floor of the house. This may occur on steeper properties and larger properties where the garden and fences may be impacted, but the floodwaters do not reach the house.

There are a number of input parameters required for the OEH curves, such as floor area and level of flood awareness. The following parameters were adopted:

> A value of 100 m^2 was adopted as a conservative estimate of the floor area for residential dwellings in the floodplain based on an analysis of aerial photographs. With a floor area of 150 m^2, the default contents value is $61,500 (December 2016 dollars),

> The effective warning time has been assumed to be zero due to the absence of any flood warning systems in the catchment. A long effective warning time allows residents to prepare for flooding by moving valuable household contents and hence reduce the potential damages of household contents.

C.1.1 Average Weekly Earnings

The OEH curves are derived for late 2001 and were updated to represent December 2016 dollars (refer **Table C-1**). General recommendations by OEH are to adjust the values in residential damage curves by Average Weekly Earnings (AWE) rather than by the inflation rate as measured by the Consumer Price Index (CPI). OEH proposes that AWE is a better representation of societal wealth, and hence an indirect measure of the building and contents value of a home. The most recent data from the Australian Bureau of Statistics at the time of this study was for December 2016. Therefore, all ordinates in the residential flood damage curves were updated to June 2014 dollars. In addition, all damage curves include GST as per OEH recommendations.

The OEH guidelines were derived in November 2001, which allows us to use the November 2001 AWE statistics (issued quarterly) for comparison purposes. June 2014 AWE values were taken from the Australian Bureau of Statistics website (ABS, 2011).

Consequently, damages have been increased by 64% and GST has been included compared to 2001 values.

Table C-1 Average Weekly Earnings (AWE) Statistics for Residential Damage Curves

Month	Year	AWE
November	2001	$673.60
December	2016	$1,104.70

C.2 Commercial Damage Curves

Commercial damage curves were adopted from the FLDamage Manual (Water Studies Pty Ltd, 1992). FLDamage allows for three types of commercial properties:

> Low value commercial,

> Medium value commercial,

> High value commercial.

In determining these damage curves, it has been assumed that the effective warning time is approximately zero, and the loss of trading days as a result of the flooding has been taken as 10.

These curves are determined based on the floor area of the property. The floor level survey provides an estimate of the floor area of the individual commercial properties. These have been used to factor these curves.

The Consumer Price Index (CPI) was used to bring the 1990 data to December 2016 dollars, using data from the Australian Bureau of Statistics (ABS, 2011). It was assumed that the FLDamage data was in June 1990 dollars. The CPI data is shown in **Table C-2**.

Consequently, commercial damages have been increased by 81.8% and GST has been included compared to 1990 values.

Table C-2 CPI Statistics for Commercial Damage Curves

Month	Year	CPI
June	1990	$102.50
December	2016	$204.93

C.3 Industrial Damage Curves

Cardno, as part of a previous floodplain management study (Cardno, 1998) conducted a survey of industrial properties in 1998 for Wollongong City Council. The damage curves derived from this survey are more recent than those presented in FLDamage and have been used in a number of previous studies. We therefore have used these damage curves for this study.

The curves were prepared for three categories:

> Low value industrial,

> Medium value industrial,

> High value industrial.

Within the catchment, there are no properties considered to be representative of high value industrial properties, and hence these curves were not used.

The floor areas for the industrial properties were estimated during the floor level survey. To normalise the damages for property size, the curves have been factored to account for floor area.

The survey conducted only accounts for structural and contents damage to the property. Clean-up costs and indirect financial costs were estimated based on the FLDamage Manual (Water Studies Pty Ltd, 1992). Actual internal damage could be estimated, along with potential internal damage, using various factors within FLDamage. Using both the actual and potential internal damages, estimation of both the clean-up costs and indirect financial costs could be made.

Consequently, damages have been increased by 56.0% and GST has been included compared to the 1998 values.

Table C-3 CPI Statistics for Industrial Damage Curves

Month	Year	CPI
June	1998	$121.00
March	2017	$188.43

C.4 Adopted Damage Curves

The adopted damage curves are shown in **Figure C-1**. For purposes of illustration, the residential and commercial damage curves are shown for a property with a floor area of 150m^2, although the size will be individually determined for each residential and commercial property when calculating catchment damages.

C.5 Average Annual Damage

Average Annual Damage (AAD) is calculated using a probability approach based on the flood damages calculated for each design event.

Flood damages (for a design event) are calculated by using the damage curves described above. These damage curves attempt to define the damage experienced on a property for varying depths of flooding. The total damage for a design event is determined by adding all the individual property damages for that event.

The AAD value attempts to quantify the flood damage that a floodplain would receive on average during a single year. It does this using a probability approach. A probability curve is drawn, based on the flood damages calculated for each design event. For example, the 1% AEP design event has a probability of occurring of 1% in any given year, and as such the 1% AEP flood damage is plotted at this point (0.01) on the AAD curve. AAD is then calculated by determining the area under the plotted curve. Further information of the calculation of AAD can be found in Appendix M of the Floodplain Development Manual (NSW Government, 2005).

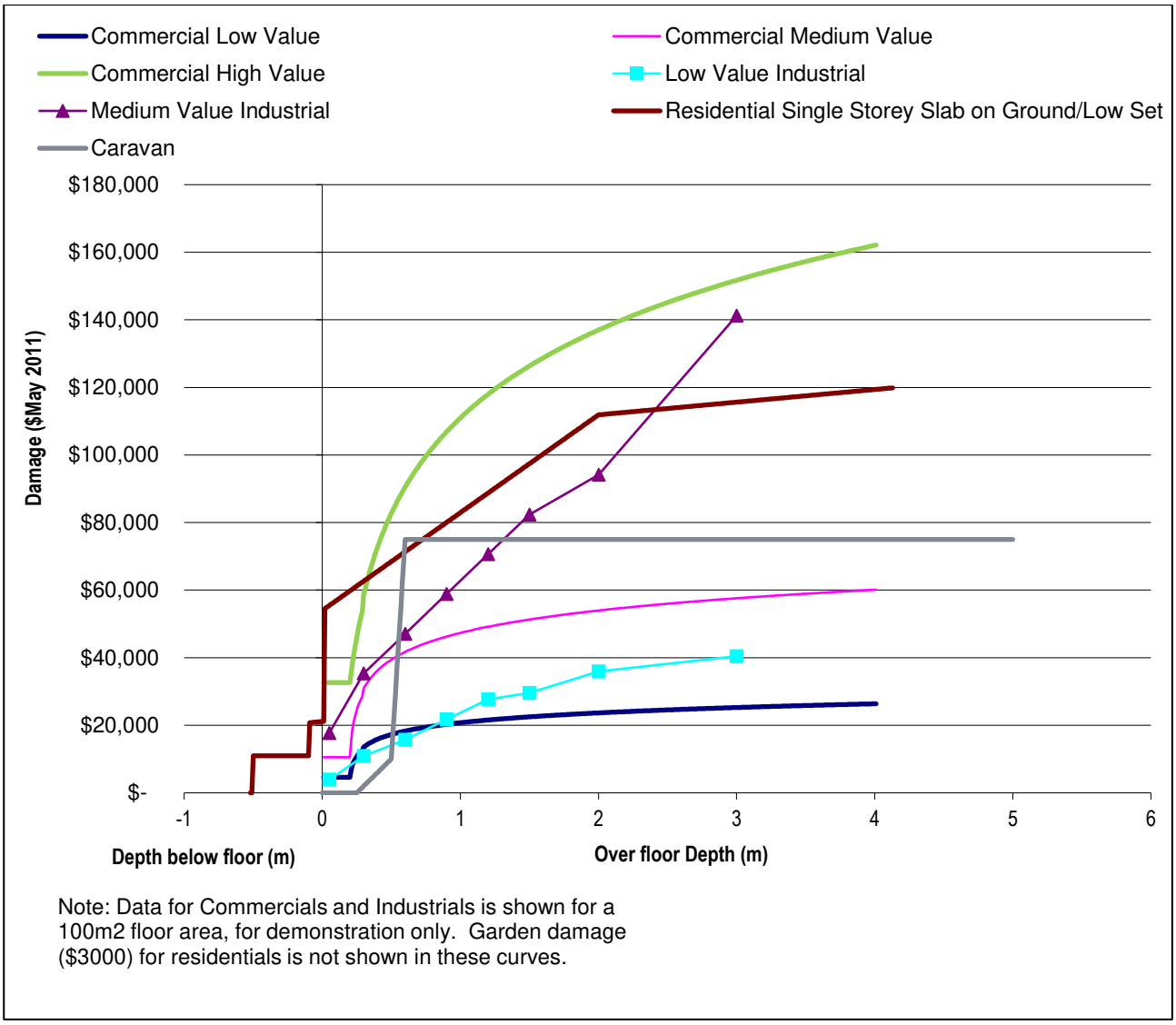

Figure C-2 Adopted Damage Curves

(Damage data sourced from FLDamage, and plotted for a 100 m^2 property. Refer **Section C.1** and **Section C.2** for further details)

Bega & Brogo Rivers FRMSP

APPENDIX D

OPTION COSTINGS

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Bega and Auckland St Levee Cost Estimate			10% AEP		v3		5% AEP		v3		1% AEP		v3
ITEM NO.	**DESCRIPTION OF WORK**	**QUANTITY**	**UNIT**	**RATE**	**COST**	**QUANTITY**	**UNIT**	**RATE**	**COST**	**QUANTITY**	**UNIT**	**RATE**	**COST**
1.0	**GENERAL AND PRELIMINARIES**												
1.1	Site establishment, security fencing, facilities & disestablishment	1	item			1	item			1	item		
1.2	Provision of sediment & erosion control	1	item			1	item			1	item		
1.3	Construction setout & survey	1	item			1	item			1	item		
1.4	Work as executed survey & documentation	1	item			1	item			1	item		
1.5	Geotechnical supervision, testing & certification	1	item			1	item			1	item		
	SUBTOTAL (Assumed as 15% of works cost)				**349,700**				**330,300**				**335,700**
2.0	**DEMOLITION, CLEARING AND GRUBBING**												
2.1	Clearing & grubbing	21,228	sq. m	10	212,280	4,800	sq. m	10	48,000	4,800	sq. m	10	48,000
2.2	Strip topsoil & stockpile for re-use (assuming 150mm depth)	3184.2	cu. m	20	63,684	720	cu. m	20	14,400	720	cu. m	20	14,400
2.3	Dispose of excess topsoil (nominal 10% allowance)	318.42	cu. m	50	15,921	72	cu. m	50	3,600	72	cu. m	50	3,600
	SUBTOTAL				**291,885**				**66,000**				**66,000**
3.0	**LEVEE**												
3.1	Construct levee	0.00	cu. m	50	0		cu. m	50	0		cu. m	50	0
3.2	Construct flood wall	2,436.00	face sq.m	750	1,827,000	2,784.00	face sq.m	750	2,088,000	2,832.00	face sq.m	750	2,124,000
	SUBTOTAL				**1,827,000**				**2,088,000**				**2,124,000**
4.0	**MINOR LANDSCAPING**												
4.1	Repair disturbed areas in accordance with landscape architects requirements (nominal allowance)	21,228	sq. m	10	212,280	4,800	sq. m	10	48,000	4,800	sq. m	10	48,000
	SUBTOTAL				**212,280**				**48,000**				**48,000**
	CONSTRUCTION SUB-TOTAL				**2,680,865**				**2,532,300**				**2,573,700**
5.0	**CONTINGENCIES**												
5.1	50% construction cost				**1,340,433**				**1,266,150**				**1,286,850**
	CONSTRUCTION TOTAL, excluding GST				***4,021,298***				***3,798,450***				***3,860,550***
	GST				***402,130***				***379,845***				***386,055***
	CONSTRUCTION TOTAL, including GST				***4,423,427***				***4,178,295***				***4,246,605***
	CONSTRUCTION TOTAL, rounded				***4,423,500***				***4,178,300***				***4,246,700***

DISCLAIMER:

1. This estimate of cost is provided in good faith using information available at this stage. This estimate of cost is not guaranteed.

Cardno (NSW) will not accept liability in the event that actual costs exceed the estimate.

NOTES:

1. Estimate does not include Consultant's fees, including design or project management.

2. Assume existing drainage at sufficiently deep level to remain undisturbed.

3. Estimate / rates in 2016 dollars and does not allow for inflation.

Auckland St Levee Cost Estimate			10% AEP		v3		5% AEP		v3		1% AEP		v3
ITEM NO.	**DESCRIPTION OF WORK**	**QUANTITY**	**UNIT**	**RATE**	**COST**	**QUANTITY**	**UNIT**	**RATE**	**COST**	**QUANTITY**	**UNIT**	**RATE**	**COST**
1.0	**GENERAL AND PRELIMINARIES**												
1.1	Site establishment, security fencing, facilities & disestablishment	1	item			1	item			1	item		
1.2	Provision of sediment & erosion control	1	item			1	item			1	item		
1.3	Construction setout & survey	1	item			1	item			1	item		
1.4	Work as executed survey & documentation	1	item			1	item			1	item		
1.5	Geotechnical supervision, testing & certification	1	item			1	item			1	item		
	SUBTOTAL (Assumed as 15% of works cost)				**95,500**				**219,800**				**299,700**
2.0	**DEMOLITION, CLEARING AND GRUBBING**												
2.1	Clearing & grubbing	11,210	sq. m	10	112,100	14,797	sq. m	10	147,972	20,178	sq. m	10	201,780
2.2	Strip topsoil & stockpile for re-use (assuming 150mm depth)	1681.5	cu. m	20	33,630	2219.58	cu. m	20	44,392	3026.7	cu. m	20	60,534
2.3	Dispose of excess topsoil (nominal 10% allowance)	168.15	cu. m	50	8,408	221.958	cu. m	50	11,098	302.67	cu. m	50	15,134
	SUBTOTAL				**154,138**				**203,462**				**277,448**
3.0	**LEVEE**												
3.1	Construct levee	7,398.60	cu. m	50	369,930	0	cu. m	50	0	0	cu. m	50	0
3.2	Construct flood wall	0.00	face sq.m	750	0	1,485.00	face sq.m	750	1,113,750	2,025.00	face sq.m	750	1,518,750
	SUBTOTAL				**369,930**				**1,113,750**				**1,518,750**
4.0	**MINOR LANDSCAPING**												
4.1	Repair disturbed areas in accordance with landscape architects requirements (nominal allowance)	11,210	sq. m	10	112,100	14,797	sq. m	10	147,972	20,178	sq. m	10	201,780
	SUBTOTAL				**112,100**				**147,972**				**201,780**
	CONSTRUCTION SUB-TOTAL				**731,668**				**1,684,984**				**2,297,678**
5.0	**CONTINGENCIES**												
5.1	50% construction cost				**365,834**				**842,492**				**1,148,839**
	CONSTRUCTION TOTAL, excluding GST				***1,097,501***				***2,527,475***				***3,446,516***
	GST				***109,750***				***252,748***				***344,652***
	CONSTRUCTION TOTAL, including GST				***1,207,251***				***2,780,223***				***3,791,168***
	CONSTRUCTION TOTAL, rounded				***1,207,300***				***2,780,300***				***3,791,200***

DISCLAIMER:

1. This estimate of cost is provided in good faith using information available at this stage. This estimate of cost is not guaranteed.

Cardno (NSW) will not accept liability in the event that actual costs exceed the estimate.

NOTES:

1. Estimate does not include Consultant's fees, including design or project management.

2. Assume existing drainage at sufficiently deep level to remain undisturbed.

3. Estimate / rates in 2016 dollars and does not allow for inflation.

Millowine Ave Levee Cost Estimate			10% AEP		v3		5% AEP		v3		1% AEP		v3
ITEM NO.	**DESCRIPTION OF WORK**	**QUANTITY**	**UNIT**	**RATE**	**COST**	**QUANTITY**	**UNIT**	**RATE**	**COST**	**QUANTITY**	**UNIT**	**RATE**	**COST**
1.0	**GENERAL AND PRELIMINARIES**												
1.1	Site establishment, security fencing, facilities & disestablishment	1	item			1	item			1	item		
1.2	Provision of sediment & erosion control	1	item			1	item			1	item		
1.3	Construction setout & survey	1	item			1	item			1	item		
1.4	Work as executed survey & documentation	1	item			1	item			1	item		
1.5	Geotechnical supervision, testing & certification	1	item			1	item			1	item		
	SUBTOTAL (Assumed as 15% of works cost)				**47,400**				**111,300**				**185,400**
2.0	**DEMOLITION, CLEARING AND GRUBBING**												
2.1	Clearing & grubbing	5,883	sq. m	10	58,834	7,060	sq. m	10	70,601	11,767	sq. m	10	117,668
2.2	Strip topsoil & stockpile for re-use (assuming 150mm depth)	882.51	cu. m	20	17,650	1059.012	cu. m	20	21,180	1765.02	cu. m	20	35,300
2.3	Dispose of excess topsoil (nominal 10% allowance)	88.251	cu. m	50	4,413	105.9012	cu. m	50	5,295	176.502	cu. m	50	8,825
	SUBTOTAL				**80,897**				**97,076**				**161,794**
3.0	**LEVEE**												
3.1	Construct levee	3,517.25	cu. m	50	175,863	0	cu. m	50	0	0.00	cu. m	50	0
3.2	Construct flood wall	0.00	face sq.m	750	0	765.00	face sq.m	750	573,750	1,275.00	face sq.m	750	956,250
	SUBTOTAL				**175,863**				**573,750**				**956,250**
4.0	**MINOR LANDSCAPING**												
4.1	Repair disturbed areas in accordance with landscape architects requirements (nominal allowance)	5,883	sq. m	10	58,834	7,060	sq. m	10	70,601	11,767	sq. m	10	117,668
	SUBTOTAL				**58,834**				**70,601**				**117,668**
	CONSTRUCTION SUB-TOTAL				**181,497**				**426,363**				**710,556**
5.0	**CONTINGENCIES**												
5.1	50% construction cost				**1,657,594**				**1,846,763**				**2,216,135**
	CONSTRUCTION TOTAL, excluding GST				***544,490***				***1,279,090***				***2,131,667***
	GST				***54,449***				***127,909***				***213,167***
	CONSTRUCTION TOTAL, including GST				***598,939***				***1,406,999***				***2,344,834***
	CONSTRUCTION TOTAL, rounded				***599,000***				***1,407,000***				***2,344,900***

DISCLAIMER:

1. This estimate of cost is provided in good faith using information available at this stage. This estimate of cost is not guaranteed.

Cardno (NSW) will not accept liability in the event that actual costs exceed the estimate.

NOTES:

1. Estimate does not include Consultant's fees, including design or project management.

2. Assume existing drainage at sufficiently deep level to remain undisturbed.

3. Estimate / rates in 2016 dollars and does not allow for inflation.

Bega St Levee Cost Estimate			10% AEP		v3		5% AEP		v3		1% AEP		v3
ITEM NO.	**DESCRIPTION OF WORK**	**QUANTITY**	**UNIT**	**RATE**	**COST**	**QUANTITY**	**UNIT**	**RATE**	**COST**	**QUANTITY**	**UNIT**	**RATE**	**COST**
1.0	**GENERAL AND PRELIMINARIES**												
1.1	Site establishment, security fencing, facilities & disestablishment	1	item			1	item			1	item		
1.2	Provision of sediment & erosion control	1	item			1	item			1	item		
1.3	Construction setout & survey	1	item			1	item			1	item		
1.4	Work as executed survey & documentation	1	item			1	item			1	item		
1.5	Geotechnical supervision, testing & certification	1	item			1	item			1	item		
	SUBTOTAL (Assumed as 15% of works cost)				**432,500**				**481,800**				**578,200**
2.0	**DEMOLITION, CLEARING AND GRUBBING**												
2.1	Clearing & grubbing	25,850	sq. m	10	258,500	31,020	sq. m	10	310,200	37,224	sq. m	10	372,240
2.2	Strip topsoil & stockpile for re-use (assuming 150mm depth)	3877.5	cu. m	20	77,550	4653	cu. m	20	93,060	5583.6	cu. m	20	111,672
2.3	Dispose of excess topsoil (nominal 10% allowance)	387.75	cu. m	50	19,388	465.3	cu. m	50	23,265	558.36	cu. m	50	27,918
	SUBTOTAL				**355,438**				**426,525**				**511,830**
3.0	**LEVEE**												
3.1	Construct levee	0.00	cu. m	50	0	0	cu. m	50	0	0	cu. m	50	0
3.2	Construct flood wall	3,025.00	face sq.m	750	2,268,750	3,300.00	face sq.m	750	2,475,000	3,960.00	face sq.m	750	2,970,000
	SUBTOTAL				**2,268,750**				**2,475,000**				**2,970,000**
4.0	**MINOR LANDSCAPING**												
4.1	Repair disturbed areas in accordance with landscape architects requirements (nominal allowance)	25,850	sq. m	10	258,500	31,020	sq. m	10	310,200	37,224	sq. m	10	372,240
	SUBTOTAL				**258,500**				**310,200**				**372,240**
	CONSTRUCTION SUB-TOTAL				**3,315,188**				**3,693,525**				**4,432,270**
5.0	**CONTINGENCIES**												
5.1	50% construction cost				**1,657,594**				**1,846,763**				**2,216,135**
	CONSTRUCTION TOTAL, excluding GST				***4,972,781***				***5,540,288***				***6,648,405***
	GST				***497,278***				***554,029***				***664,841***
	CONSTRUCTION TOTAL, including GST				***5,470,059***				***6,094,316***				***7,313,246***
	CONSTRUCTION TOTAL, rounded				***5,470,100***				***6,094,400***				***7,313,300***

DISCLAIMER:

1. This estimate of cost is provided in good faith using information available at this stage. This estimate of cost is not guaranteed.

Cardno (NSW) will not accept liability in the event that actual costs exceed the estimate.

NOTES:

1. Estimate does not include Consultant's fees, including design or project management.

2. Assume existing drainage at sufficiently deep level to remain undisturbed.

3. Estimate / rates in 2016 dollars and does not allow for inflation.

Candelo Rd Raising Cost Estimate					v3
ITEM NO.	**DESCRIPTION OF WORK**	**QUANTITY**	**UNIT**	**RATE**	**COST**
1.0	**GENERAL AND PRELIMINARIES**				
1.1	Site establishment, security fencing, facilities & disestablishment	1	item		
1.2	Provision of sediment & erosion control	1	item		
1.3	Construction setout & survey	1	item		
1.4	Work as executed survey & documentation	1	item		
1.5	Geotechnical supervision, testing & certification	1	item		
	SUBTOTAL (Assumed as 15% of works cost)				**183,800**
2.0	**DEMOLITION, CLEARING AND GRUBBING**				
2.1	Clearing & grubbing	7,400	sq. m	10	74,000
2.2	Strip topsoil & stockpile for re-use (assuming 150mm depth)	1110	cu. m	20	22,200
2.3	Dispose of excess topsoil (nominal 10% allowance)	111	cu. m	50	5,550
2.4	Pull up and dispose existing road surface	3700	sq.m	35	129,500
	SUBTOTAL				**101,750**
3.0	**EARTHWORKS**				
3.1	Raise road base to new levels including compaction of fill	2,590.00	cu. m	50	129,500
	SUBTOTAL				**129,500**
4.0	**ROADWORKS**				
4.1	Reinstate disturbed road pavement, including demolition and disposal of additional material to provide good jointing	3,700	sq. m	50	185,000
4.2	Construct new bridge to match new road levels	3,500	m	210	735,000
	SUBTOTAL				**920,000**
5.0	**MINOR LANDSCAPING**				
5.1	Repair disturbed areas in accordance with landscape architects requirements (nominal allowance)	7,400	sq. m	10	74,000
	SUBTOTAL				**74,000**
	CONSTRUCTION SUB-TOTAL				**1,409,050**
5.0	**CONTINGENCIES**				
5.1	50% construction cost				**704,525**
	CONSTRUCTION TOTAL, excluding GST				***2,113,575***
	GST				***211,358***
	CONSTRUCTION TOTAL, including GST				***2,324,933***
	CONSTRUCTION TOTAL, rounded				***2,325,000***

DISCLAIMER:

1. This estimate of cost is provided in good faith using information available at this stage. This estimate of cost is not guaranteed.

Cardno (NSW) will not accept liability in the event that actual costs exceed the estimate.
NOTES:
1. Estimate does not include Consultant's fees, including design or project management.
2. Assume existing drainage at sufficiently deep level to remain undisturbed.
3. Estimate / rates in 2016 dollars and does not allow for inflation.

Bega & Brogo Rivers FRMSP

APPENDIX E

MULT-CRITERIA ASSESSMENT

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Bega and Brogo Rivers FRMSP - Multi Criteria Assessment

ID	Description	Estimate of Capital Cost	Estimate of Recurrent Cost	Net Present Value (7%, 50 years)	Reduction in AAD	NPV of Reduction in AAD	Benefit - Cost Ratio	Score on Benefit Cost Ratio	Reduction in Risk to Property	EconomicScore	Reduction in Risk to Life	Reduction in Social Disruption	Community Criteria	Council Support	Social Score	Surface water Quality	Groundwater	Flora/fauna Impat	Acid Sulfate Soils	Heritage	Environmental Score	TOTAL SCORE	RANK on TOTAL SCORE
L.1.1	10% AEP Levee - Bega and Auckland Streets	$4,423,500	$20,000	$4,699,515	$27,380	$377,864	0.1	-2	0	-1.3	0	0	-1	1	0.0	0	0	-1	0	-1	-0.2	-2.9	22
L.2.1	10% AEP Levee - Auckland Street	$1,207,300	$10,000	$1,345,307	$35,755	$493,446	0.4	-1	0	-0.7	0	0	-1	1	0.0	0	0	0	0	-1	-0.2	-1.5	16
L.3.1	10% AEP Levee - Millowine Ave	$599,000	$5,000	$668,004	$953	$13,152	0.0	-2	0	-1.3	0	0	-1	1	0.0	0	0	-2	0	-1	-0.2	-2.9	22
L.4.1	10% AEP Levee - Bega Street	$5,470,100	$30,000	$5,884,122	$29,641	$409,068	0.1	-2	0	-1.3	0	0	-1	1	0.0	0	0	0	0	-1	-0.2	-2.9	22
L.1.2	5% AEP Levee - Bega and Auckland Streets	$4,178,300	$30,000	$4,592,322	$103,940	$1,434,450	0.3	-1	1	-0.4	1	1	-2	1	0.3	0	0	-1	0	-1	-0.2	-0.7	14
L.2.2	5% AEP Levee - Auckland Street	$2,780,300	$15,000	$2,987,311	$96,212	$1,327,797	0.4	-1	1	-0.3	1	1	-2	1	0.3	0	0	0	0	-1	-0.2	-0.6	13
L.3.2	5% AEP Levee - Millowine Ave	$1,407,000	$10,000	$1,545,007	$927	$12,793	0.0	-2	1	-1.0	1	1	-2	1	0.3	0	0	-2	0	-1	-0.2	-2.0	21
L.4.2	5% AEP Levee - Bega Street	$6,094,400	$40,000	$6,646,430	$106,201	$1,465,653	0.2	-1	1	-0.4	1	1	-2	1	0.3	0	0	0	0	-1	-0.2	-0.8	15
L.1.3	1% AEP Levee - Bega and Auckland Streets	$4,246,700	$40,000	$4,798,730	$205,863	$2,841,063	0.6	-1	1	-0.4	2	1	-2	1	0.5	0	0	-1	0	-1	-0.2	-0.4	11
L.2.3	1% AEP Levee - Auckland Street	$3,791,200	$25,000	$4,136,219	$176,053	$2,429,663	0.6	-1	1	-0.3	2	1	-2	1	0.5	0	0	0	0	-1	-0.2	-0.4	10
L.3.3	1% AEP Levee - Millowine Ave	$2,344,900	$15,000	$2,551,911	$2,262	$31,217	0.0	-2	1	-1.0	2	1	-2	1	0.5	0	0	-2	0	-1	-0.2	-1.7	18
L.4.3	1% AEP Levee - Bega Street	$7,313,300	$50,000	$8,003,337	$208,636	$2,879,333	0.4	-1	1	-0.4	2	1	-2	1	0.5	0	0	0	0	-1	-0.2	-0.5	12
R.12	Candelo Road Raising	$2,325,000	$25,000	$2,670,019	$28,774	$397,103	0.1	-2	1	-1.0	1	1	-2	1	0.3	0	0	0	0	0	0.0	-1.8	19
U.2	Flood Flaps on Sharpe St Culverts	$50,000	$10,000	$188,007	NC	N/A	N/A	2	0	1.3	0	1	0	1	0.5	0	0	0	0	0	0.0	3.2	8
P1	Voluntary Purchase	$4,500,000	$0	$4,500,000	$1,356,000	$18,713,812	4.2	2	1	1.7	1	1	-2	0	0.0	1	0	0	0	0	0.2	3.5	7
P2	Building and Development Controls	$15,000	$500	$21,900	NC	N/A	N/A	2	2	2.0	1	1	0	1	0.8	0	0	0	0	0	0.0	4.8	1
P3	Flood Proofing Guidelines	$15,000	$1,000	$28,801	NC	N/A	N/A	2	1	1.7	0	0	1	1	0.5	0	0	0	0	0	0.0	3.8	5
EM1	Infomation transfer to the SES	$3,000	$0	$3,000	NC	N/A	N/A	2	0	1.3	1	0	2	2	1.3	0	0	0	0	0	0.0	3.9	4
EM2	Flood warning system	$250,000	$2,500	$284,502	NC	N/A	N/A	1	2	1.3	2	2	2	2	2.0	0	0	0	0	0	0.0	4.7	2
U.1	Upgrade of Boundary Road	$945,000	$9,450	$1,075,417	NC	N/A	N/A	0	1	0.3	1	1	2	1	1.3	1	0	0	0	0	0.2	2.1	9
R.11	Riasing of Tathra Road and Kirkland Avenue	$750,000	$7,500	$853,506	NC	N/A	N/A	-2	0	-1.3	1	1	1	1	1.0	0	0	0	0	0	0.0	-1.7	17
R.5	Riasing of Ravenswood Road	$1,000,000	$10,000	$1,138,007	NC	N/A	N/A	-2	0	-1.3	0	1	1	1	0.8	0	0	0	0	0	0.0	-1.9	20
EM3	Public Awareness and Education	$25,000	$1,000	$38,801	NC	N/A	N/A	2	0	1.3	1	1	2	2	1.5	0	0	0	0	0	0.0	4.2	3
DC1	Data collection following a flood event	$5,000	$3,000	$46,402	NC	N/A	N/A	2	0	1.3	0	0	2	2	1.0	0	0	0	0	0	0.0	3.7	6

NC - Not Costed

Bega and Brogo Rivers FRMSP - Multi Criteria Assessment - Ranked

ID	Description	Estimate of Capital Cost	Estimate of Recurrent Cost	Net Present Value (7%, 50 years)	Reduction in AAD	NPV of Reduction in AAD	Benefit - Cost Ratio	Score on Benefit Cost Ratio	Reduction in Risk to Property	EconomicScore	Reduction in Risk to Life	Reduction in Social Disruption	Community Criteria	Council Support	Social Score	Surface water Quality	Groundwater	Flora/fauna Impat	Acid Sulfate Soils	Heritage	Environmental Score	TOTAL SCORE	RANK on TOTAL SCORE
P2	Building and Development Controls	$15,000	$500	$21,900	NC	N/A	N/A	2	2	2.0	1	1	0	1	0.8	0	0	0	0	0	0.0	4.8	1
EM2	Flood warning system	$250,000	$2,500	$284,502	NC	N/A	N/A	1	2	1.3	2	2	2	2	2.0	0	0	0	0	0	0.0	4.7	2
EM3	Public Awareness and Education	$25,000	$1,000	$38,801	NC	N/A	N/A	2	0	1.3	1	1	2	2	1.5	0	0	0	0	0	0.0	4.2	3
EM1	Infomation transfer to the SES	$3,000	$0	$3,000	NC	N/A	N/A	2	0	1.3	1	0	2	2	1.3	0	0	0	0	0	0.0	3.9	4
P3	Flood Proofing Guidelines	$15,000	$1,000	$28,801	NC	N/A	N/A	2	1	1.7	0	0	1	1	0.5	0	0	0	0	0	0.0	3.8	5
DC1	Data collection following a flood event	$5,000	$3,000	$46,402	NC	N/A	N/A	2	0	1.3	0	0	2	2	1.0	0	0	0	0	0	0.0	3.7	6
P1	Voluntary Purchase	$4,500,000	$0	$4,500,000	$1,356,000	$18,713,812	4.2	2	1	1.7	1	1	-2	0	0.0	1	0	0	0	0	0.2	3.5	7
U.2	Flood Flaps on Sharpe St Culverts	$50,000	$10,000	$188,007	NC	N/A	N/A	2	0	1.3	0	1	0	1	0.5	0	0	0	0	0	0.0	3.2	8
U.1	Upgrade of Boundary Road	$945,000	$9,450	$1,075,417	NC	N/A	N/A	0	1	0.3	1	1	2	1	1.3	1	0	0	0	0	0.2	2.1	9
L.2.3	1% AEP Levee - Auckland Street	$3,791,200	$25,000	$4,136,219	$176,053	$2,429,663	0.6	-1	1	-0.3	2	1	-2	1	0.5	0	0	0	0	-1	-0.2	-0.4	10
L.1.3	1% AEP Levee - Bega and Auckland Streets	$4,246,700	$40,000	$4,798,730	$205,863	$2,841,063	0.6	-1	1	-0.4	2	1	-2	1	0.5	0	0	-1	0	-1	-0.2	-0.4	11
L.4.3	1% AEP Levee - Bega Street	$7,313,300	$50,000	$8,003,337	$208,636	$2,879,333	0.4	-1	1	-0.4	2	1	-2	1	0.5	0	0	0	0	-1	-0.2	-0.5	12
L.2.2	5% AEP Levee - Auckland Street	$2,780,300	$15,000	$2,987,311	$96,212	$1,327,797	0.4	-1	1	-0.3	1	1	-2	1	0.3	0	0	0	0	-1	-0.2	-0.6	13
L.1.2	5% AEP Levee - Bega and Auckland Streets	$4,178,300	$30,000	$4,592,322	$103,940	$1,434,450	0.3	-1	1	-0.4	1	1	-2	1	0.3	0	0	-1	0	-1	-0.2	-0.7	14
L.4.2	5% AEP Levee - Bega Street	$6,094,400	$40,000	$6,646,430	$106,201	$1,465,653	0.2	-1	1	-0.4	1	1	-2	1	0.3	0	0	0	0	-1	-0.2	-0.8	15
L.2.1	10% AEP Levee - Auckland Street	$1,207,300	$10,000	$1,345,307	$35,755	$493,446	0.4	-1	0	-0.7	0	0	-1	1	0.0	0	0	0	0	-1	-0.2	-1.5	16
R.11	Riasing of Tathra Road and Kirkland Avenue	$750,000	$7,500	$853,506	NC	N/A	N/A	-2	0	-1.3	1	1	1	1	1.0	0	0	0	0	0	0.0	-1.7	17
L.3.3	1% AEP Levee - Millowine Ave	$2,344,900	$15,000	$2,551,911	$2,262	$31,217	0.0	-2	1	-1.0	2	1	-2	1	0.5	0	0	-2	0	-1	-0.2	-1.7	18
R.12	Candelo Road Raising	$2,325,000	$25,000	$2,670,019	$28,774	$397,103	0.1	-2	1	-1.0	1	1	-2	1	0.3	0	0	0	0	0	0.0	-1.8	19
R.5	Riasing of Ravenswood Road	$1,000,000	$10,000	$1,138,007	NC	N/A	N/A	-2	0	-1.3	0	1	1	1	0.8	0	0	0	0	0	0.0	-1.9	20
L.3.2	5% AEP Levee - Millowine Ave	$1,407,000	$10,000	$1,545,007	$927	$12,793	0.0	-2	1	-1.0	1	1	-2	1	0.3	0	0	-2	0	-1	-0.2	-2.0	21
L.1.1	10% AEP Levee - Bega and Auckland Streets	$4,423,500	$20,000	$4,699,515	$27,380	$377,864	0.1	-2	0	-1.3	0	0	-1	1	0.0	0	0	-1	0	-1	-0.2	-2.9	22
L.3.1	10% AEP Levee - Millowine Ave	$599,000	$5,000	$668,004	$953	$13,152	0.0	-2	0	-1.3	0	0	-1	1	0.0	0	0	-2	0	-1	-0.2	-2.9	22
L.4.1	10% AEP Levee - Bega Street	$5,470,100	$30,000	$5,884,122	$29,641	$409,068	0.1	-2	0	-1.3	0	0	-1	1	0.0	0	0	0	0	-1	-0.2	-2.9	22

NC - Not Costed

Bega & Brogo Rivers FRMSP

APPENDIX F

PUBLIC EXHIBITION SUBMISSIONS

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Shaping the Future

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Bega and Brogo Rivers FRMS&P - Public Submissions

Submission no.	Contact Method	Date submission received (Council)	Summary / key issues	Section of doc relevant to submission	Response
1	Phone Call	24/10/2017	Interested in outcomes of Bournda Dam assessment. Agreed with community sentiment that the dam be kept and monitored	Appendix B	Noted. Comments taken on board.
2	Phone Call On site meeting	31/10/2017	Overbank flows breaking out of Bega River near the end of Carp Street	S. 5 Behaviour	This comment has been confirmed in the model and supported by Council information that a "green gym", Council facilities such as the sewage pumping station and Kiss's Laogoon area suffered damage in this region during the last flood event
			These flows move with significant velocity through the adjacent parkland and sports field to meet with flood waters emerging from Kisses Lagoon		
			Noted that the issue was made worse as a result of timing – when the river breaks the banks, the receiving waters are still low, resulting in a long, fast moving flowpath being activated		
			Also concerned by willows and current tree plantings slowing the water and forcing it to back up in the river	S. 11 Options	An additional option to assess the effect of vegetation management was added to the study. The modelling has indicated that vegetation management has a very minor impact on large flood behaviour. However, it is still an important issue for genera management. Discussion has been added to the FRMS report that while flood benefits are minimal, environmental and social benefits are significant and works could be undertaken under a different funding arrangement to respond to these issues. The LLS office (previously Southern Rivers Catchment Authority) have undertaken a large program of willow removal along large stretches of the Bega River both upstream and downstream of Bega. It is hoped that they can receive more funding to continue this work.
			Would like to see the riverbank depression filled to control the break out		
			Understand that breakout would still occur, but waiting for receving waters to rise would result in a reduction in the severity of the overtopping flows		
			Would like to see a vegetation management plan implemented to give more space to the river		
3	Email	26/10/2017	Noted that the PMF is significantly higher than the other events modelled, and suggested that the hyteograph be confirmed	-	Hyteograph is correct. Was checked when model was converted, and new model provides a validation of the previous results, indicating that the PMF as modelled is correct.
4	Email	24/10/2017	Requested a more recent aerial be used on images to show the hospital and byass, as well as recent development within the township (such as works done at their school)	Figures	Update mapping to include more recent aerial were possible. The updated imagery only covers the immediate township of Bega. The imagery is from 2014 and shows the bulk earthworks for the hospital, the constructed bypass and new buildings on the school lot
5	Community Workshop	2/11/2017	Commented that drainage under the access road to their property is flood damaged, and at risk or further damage. Moved into property just after 2011 event, and neighbours noted that waters reached their front fence, but did not impact dwelling. Concerned runoff from adjacent road will be directed into their property and that floodwaters have the potential to back up stormwater pipes into their property.	S. 11 Options	Flood risk mitigation options for the adjacent road and stormwater pipes were identified and included as part of the Floodplain Risk Management Study and Plan.
6	Submissions Portal	3/11/2017	Believes that historical road raising to Ravenswood St has resulted in adverse flood behaviour across their property and resulted in a greater flood risk to them	S. 5 Behaviour	Model results were reviewed to examine this issue. The results did not replicate the severity as photos demonstrate for the local catchment event frequency.
			Subsequent damage has occured to the road due to overtopping flows	S.11 Options	Additional option added to the assessment for augementing the culvert to reduce overtopping flows
			Would like an option included to augement the crossing capacity		
			Concerned with how new levels may impact insurance premiums	-	This is a common concern amongst community. Many insurance policies now cover for flood damage, where before they did not. It is up to individual property owners to evaluate inclusions in their own policies and obtain best value from the market offerings for their specific situation.
			Inquired if Council would purchase houses outside of OEH program for those propoerties approved using old, now lower, flood levels.	-	Council are only able to provide advice based on best data available at the time.
			Requested updated aerial imagery	Figures	Figures have been updated with new aerial imagery
7	In person at Council offices	3/11/2017	Attendee brought in records of historic flooding. Observed that modelled 1% AEP flood extent closely matched 1971 extent at Reedy Swamp. Was concerned that the PMF extent may limit his ability to re-develop a burnt down building on his property	-	The draft Bega and Brogo Floodplain Risk Management Study and Plan have been prepared in accordance with the 2005 NSW Government Floodplain Development Manual, The Management of Flood liable land which requires consideration of a full range of events up to and including the PMF. Further, the NSW Department of Planning circular PS 07-003 and issued guideline define flood prone land as the area inundated by the Probable Maximum Flood. Council's current flood related planning controls and the draft recommendations of the Floodplain Risk Management Study and Plan are consistent with the issued Planning Circular and the 2005 Floodplain Development Manual. Council's current Local Environment Plan (2013) (clause 6.3) uses the 1:100 year flood level as its guide for assessing development.
8	Submissions Portal	3/11/2017	Concerned that new mapping will be restrictive of future development	S. 9 Planning	While a legitimate concern, the new mapping does not change the existing flood behaviour, only documents it. Council are required to act on the best information available, and to make this information available (such as through s149 certificates) as legally required to do so. The information provided on s149 certificates provide a benefit for subsequent owners who are able to act on this prior knowledge.
			Concerned about S149 notification of flood affectation		
			Primary concern is that site is a private hospital, so has the potential to be impacted by PMF controls		
			Noted that the 1% AEP was difference to the observed behaviour in 1971 in the township. Raised question as to how the 1% AEP was higher than the 1971 if the 1971 event was a 1 in 98 year event.	-	Important to note that all events are different. There are also different durations for the same recurrence interval. While the 1971 was given a rating of a 1 in 98 year recurrence interval, this does not mean that the flood behaviour during 1971 will be equal to that of the design 1% AEP. Other feedback from residents both during the Flood Study and this study, have indicated agreement with the shown flood extents.
			Concerned about increased insurance premiums	-	This is a common concern amongst the community. Many insurance policies now cover for flood damage, where before they did not. It is up to individual property owners to evaluate inclusions in their own policies and obtain best value from the market offerings for their specific situation.
			Concerned that the PMF is "theoretical" only, and the resulting 6 to 7m above the 1% AEP is significant, with the potential to result in a lot of lots being classed as floodplain, when they aren't	S. 5 Behaviour S. 9 Planning	Whilst the PMF is extremely rare, it does not mean that it is impossible. The PMF flooding was determined using the most up to date information from Australian Rainfall and Runoff technical guidance and Bureau of Meteorology methodlogies, and is the best estimate of this extreme event . Given how extreme the PMF event is, and the substatial restriction downstream at Bottleneck Reach, the observed behaviour is not unexpected. The draft Bega and Brogo Floodplain Risk Management Study and Plan have been prepared in accordance with the 2005 NSW Government Floodplain Development Manual, The Management of Flood liable land which requires consideration of a full range of events up to and including the PMF. Further, the NSW Department of Planning circular PS 07-003 and issued guideline define flood prone land as the area inundated by the Probable Maximum Flood.
9	Submissions Portal	5/11/2017	Concerned about insurance premiums and development restrictions arising from the 1% AEP and PMF extents. Concern that their property will be classed as floodplain, even though it was 2m above the 1971 event.	S. 5 Behaviour S. 9 Planning	See responses to Submission No. 8 above on this same issues.
10	On site meeting	10/11/2017	Noted that the 1% AEP extents and resulting flood islands accurately represent the behaviour he has observed in large flood events. Would like to see some vegetation management to manage erosion and foreign species.	S. 11 Options	Noted. See response to Submission No. 2 regarding vegetation management as detailed above.