

## 18 FLOOD EMERGENCY RESPONSE PLANNING

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### 18.1 Description of Flood Behaviour

The Local Flood Plan provides a general description of flood behaviour in the Bega Valley. Additionally, flood behaviour can be described from the flood modelling results presented in this study. While individual storm patterns may produce some variations in flood behaviour, it is possible to draw general conclusions from the design event behaviour.

Major flooding at Bega and downstream of Bega is normally the result of significant rainfall over both the Brogo River and Bega River catchments which combine at Bega, just downstream of the Princes Highway. The rivers upstream of Bega are generally well defined with narrow floodplains. Flows in the upper catchment respond rapidly to rainfall with minimal warning time. Approaching Bega, the rivers and floodplains widen and river velocities reduce. Downstream of Bega the floodplain widens and flows move into the large floodplain storage areas at Tarraganda, Jellat Jellat Flats and Wallagoot. Downstream of these areas, the river again narrows before reaching the ocean outlet at Mogareeka. Flooding in the lower reaches is influenced by the sand bar at the mouth of the river as well as tide and wave conditions.

The rise of flood waters at Bega, Jellat Jellat and Mogareeka at the ocean, for the 1% AEP flood, are shown on Figure 18.1. The Bega and Brogo Rivers rise over a period of approximately 24 hours from the onset of heavy rainfall to peak flood level at Bega township.

Both the Bega and Brogo River sub-catchments are noted to contribute significantly to flooding at Bega. In the 1%AEP flood the estimated peak flowrate along Bega River is 6160 m<sup>3</sup>/s and along Brogo River 3155 m<sup>3</sup>/s. At the junction the maximum combined peak flowrate is 9230 m<sup>3</sup>/s.

The Jellat Jellat Flats area peaks approximately 6 hours later, 30 hours after the onset of heavy rainfall. At this location, river flow is divided between the flow that continues along the Bega River and the flow that enters and fills the large floodplain storage area at the Jellat Jellat Flats. Constriction in the river and floodplain downstream of

At Mogareeka, flood waters rise more rapidly than at Jellat Jellat Flats as the main river flood peak continues to travel toward the ocean. Floodwaters at Mogareeka continue to rise as the Jellat Jellat Flats floodplain fills, resulting in a prolonged and attenuated flood peak at Mogareeka.

River velocities in the 1% AEP flood were found to vary between 1.5 m/s to in excess of 3.0 m/s. The various flood storages located off the main river generally have flows that are slow moving and which peak at less than 0.5 m/s. All inundated areas including the flood storage areas on the fringes of the Bega and Brogo Rivers are described as extremely hazardous due primarily to the deep flood waters, as shown on the Hazard Categorisation maps in Appendix G.

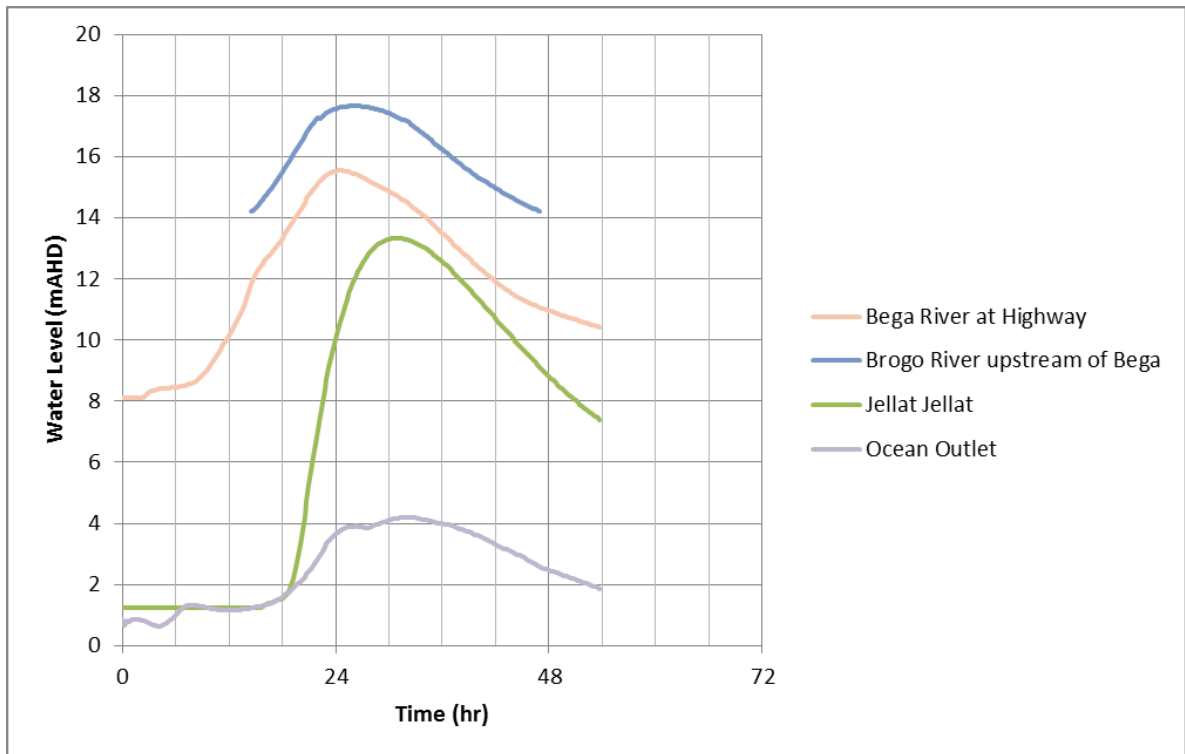
Tables 15.10 to 15.12 in Chapter 15 show the frequency of overtopping and duration of the key bridges in the study area. The Princes Highway Bridge at Bega has capacity for the 1% AEP flood and the Bega Bypass, opened in October 2013, will provide for 1% AEP immunity across the floodplain south of the bridge.

The Tarraganda Lane Main Bridge and Tarraganda Lane Anabranh Bridge are subject to frequent closure from overtopping. In the 1% AEP event, these bridges are submerged by approximately 4.5 m of water. The duration of inundation is approximately 31 hours and inundation would start at approximately 17 hours after the start of heavy rainfall. Closure of these bridges would isolate the Tarraganda and surrounding communities from Bega township.

The Tathra Bridge is subject to inundation in the 5% ARI and rarer events. This bridge is overtopped by about 1m in the 1% AEP flood with an inundation time of 18 hours, commencing 23 hours after the start of heavy rainfall.

At Candelo, the main bridge across Candelo Creek is closed for about 6 hours in the 1% AEP flood.

**Figure 18.1: 1% AEP Flood Levels vs Time**



The SES report “An integrated research assessment of the physical and social aspects of the March 2011 flash flooding in Shellharbour, Kiama and Bega Valley, NSW” describes the consequences of the flood that occurred on March 21<sup>st</sup> – 22<sup>nd</sup> 2011 when heavy rainfall generated flash flooding in Bega which caused extensive damage to public infrastructure including bridges and roads. The total cost of the damage was reported to be close to 18 million dollars.

Significant rainfalls were caused by the presence of a low pressure trough along the NSW coast with an embedded low. Bega was subject to heavy rainfall between the 21<sup>st</sup> and the 22<sup>nd</sup> of March. Major roads were closed and several bridges failed.

A summary of the ARIs (between 5 and 100yr) associated with various gauge heights for North Bye Gauge was provided and the March 2011 flood event was estimated to be a 20 yr ARI event with a gauge level of 8.45m at Bega.

Bermagui Tide Gauge indicated an abnormally high ocean level that could have contributed to high flood levels in Bega following the period of heavy rainfall. The flood river level at Bega remained elevated for almost a day before dropping.

## 18.2 The Bega Valley Shire Flood Emergency Sub Plan

The Bega Valley Shire Flood Emergency Sub Plan has been created as a sub plan the Bega Valley Shire Council Local Emergency Management Plan. This sub plan describes the area covered by the plan, the area affected by flood, the consequences of flooding as well as the responsibilities during a flood event. The plan considers preparedness, response and recovery.

The preparedness phase involves:

- Identified responsibilities
- Establishment floodplain and coastal risk management committees
- Maintenance of the flood plan and dam emergency plans

- Provision of details on levees and flood studies and information on consequence of dam failure
- Maintenance of plants and other equipment resource list
- Creation of an awareness and education program

The response phase involves:

- Aircraft management
- Deployment of personnel and resources
- Closure of council roads
- Provision of warning, information and advice to residents
- Provision of sandbags and protection to property where required
- Organisation of evacuation centre and assembly areas (including Bega Town Hall, Bega Showground and Bega Co-operative Dairy Company)
- Evacuation and rescue strategies including pets
- Supply to property owners and resupply of isolated properties

The recovery phase consists of:

- Management of health hazard risk generated by flood event
- Removal of debris
- Highlight buildings requiring to be demolished and the ones safe for reoccupation
- Organise storage of furniture of evacuees

The plan also describes the flood threat and provides details on the catchment, the dams located in the catchment, the climatic conditions and some flood history. A probability analysis of the historical floods and of various flood levels at the gauge is provided.

The plan describes the effects of flood on the community including the number of person and dwellings affected in the LGA and in Bega. It also highlights some area with particular risk. Other information contained in the Plan includes:

- Description of the gauges monitored by SES
- flood bulletins details (e.g. radio, television, newspaper).
- a template for the evacuation warning
- details on the coastal hazards
- details on the general evacuation arrangements and phases
- details on the evacuation of caravan parks
- details on warning and evacuation dam failure for the different dam in the catchment
- maps of the catchment showing the main road and railway lines, the location of emergency services and other services such as school, hospital or caravan park.

The information provided in this Flood Study and associated models can be used to update and supplement the Plan. Relevant information from the flood study includes:

- Flood Level, Depth, Velocity and Hazard mapping for a range of flood frequencies up to the PMF
- Revised North Bye Gauge Flood Frequency Analysis
- Frequency Analysis of a number of upstream gauges
- Time dependent behaviour of floods can be extracted from the models enabling targeted response
- Community Emergency Response classifications can be developed from the model information

## 18.3 Flood Emergency Response Planning Classification Of Communities

OEHL, in conjunction with the State Emergency Service (SES) have developed a guideline document entitled "Flood Emergency Response Planning Classification of Communities". The guideline recommends that Emergency Response Planning (ERP) classifications are assigned according to the nature of the flood risk for the 5% AEP, 1% AEP and PMF events. The classifications are described as follows:

- **Flood Islands** are areas that will eventually be completely surrounded by floodwater. High Flood Islands would remain dry and provide refuge floods events up to a PMF. These areas may require evacuation and resupply, depending on the circumstances and duration of isolation.
- **Low Flood Islands** are areas that would initially be surrounded by floodwater and which may then become submerged, depending on the magnitude of the flood,. These areas require early evacuation before access routes are cut. Once access routes are cut, these areas would need to be evacuated by air or boat.
- **Areas with Rising Road Access** are those areas where people can walk or drive to safe ground above the PMF, as the flood rises. In these areas, people may still become trapped if they delay evacuation until roads become impassible.
- **Areas with Overland Escape Route** area those areas where access roads may eventually be cut by floodwaters, preventing vehicular evacuation to flood free land. However in these areas people can still evacuate by walking to areas are above the PMF.
- **Low Trapped Perimeter Areas** are those areas where barriers to evacuation or insufficient land for the number of people in the area may prevent people accessing safe ground and these areas may become submerged as floods rise. Communities in these areas would need to evacuate early and may require air or boat evacuation.
- **High Trapped Perimeter Areas** are areas where flood free refuge is accessible but barriers would trap people in these areas until floods subside. These areas would require resupply during prolonged flooding.
- **Indirectly Affected Areas** are those areas that are not flooded or isolated but where communities may be affected by loss of transport links, communications, services

The type of emergency response required for each classification is shown in Table 18.1.

**Table 18.1: Response Required for Different ERP Classifications (Source: OEHL)**

Classification	Response Required		
	Resupply	Rescue/Medivac	Evacuation
High Flood Island	Yes	Possibly	Possibly
Low Flood Island	No	Yes	Yes
Area with Rising Road Access	No	Possibly	Yes
Areas with Overland Escape Routes	No	Possibly	Yes
Low Trapped Perimeter	No	Yes	Yes
High Trapped Perimeter	Yes	Possibly	Possibly
Indirectly Affected Areas	Possibly	Possibly	Possibly

The implications of the extreme hazard throughout much of the floodplain around Bega and the 24 to 30 hour time of rise to peak are that emergency response needs to be instigated within 12 hours or less of heavy rainfall in the catchment. Vulnerable communities should be identified and those communities that may first become isolated (low flood islands and low trapped perimeters) should be prepared and evacuated within a matter of hours of heavy rainfall occurring.

An interim assessment of classifications and community vulnerability has been carried out to assist with emergency response planning and is detailed below. This assessment covers the extent of the hydraulic model only and there may be vulnerable communities outside this area not identified. The 5%, 1% AEP and PMF flood extents have been mapped to provide a context for the preliminary findings.

This Flood Study provides detailed modelling information which shows the time dependent behaviour of floods in the study area. This information can be incorporated in the emergency response planning that will occur during the next stage of this study which is the preparation of a Floodplain Risk Management Study. More detailed mapping of the flood classification of particular areas in accordance with the OEH/SES guideline will be undertaken as part of a future Floodplain Risk Management Study.

### **Bega River upstream of Princes Highway**

In the Bega River reach upstream of the Princes Highway Bridge there are a number of properties with buildings located within the floodplain. In this part of the floodplain, refuge on higher ground above the PMF can be readily accessed. Communities needing to access Grosses Creek Road and Buckajo Road would be unable to use these roads in a 5% AEP event due to road closure and may require emergency response.

On the right bank of the Bega River, properties accessing Charlotte St and Ravenswood St may also be isolated. Portions of these streets have been raised recently as part of the Bega Bypass work.

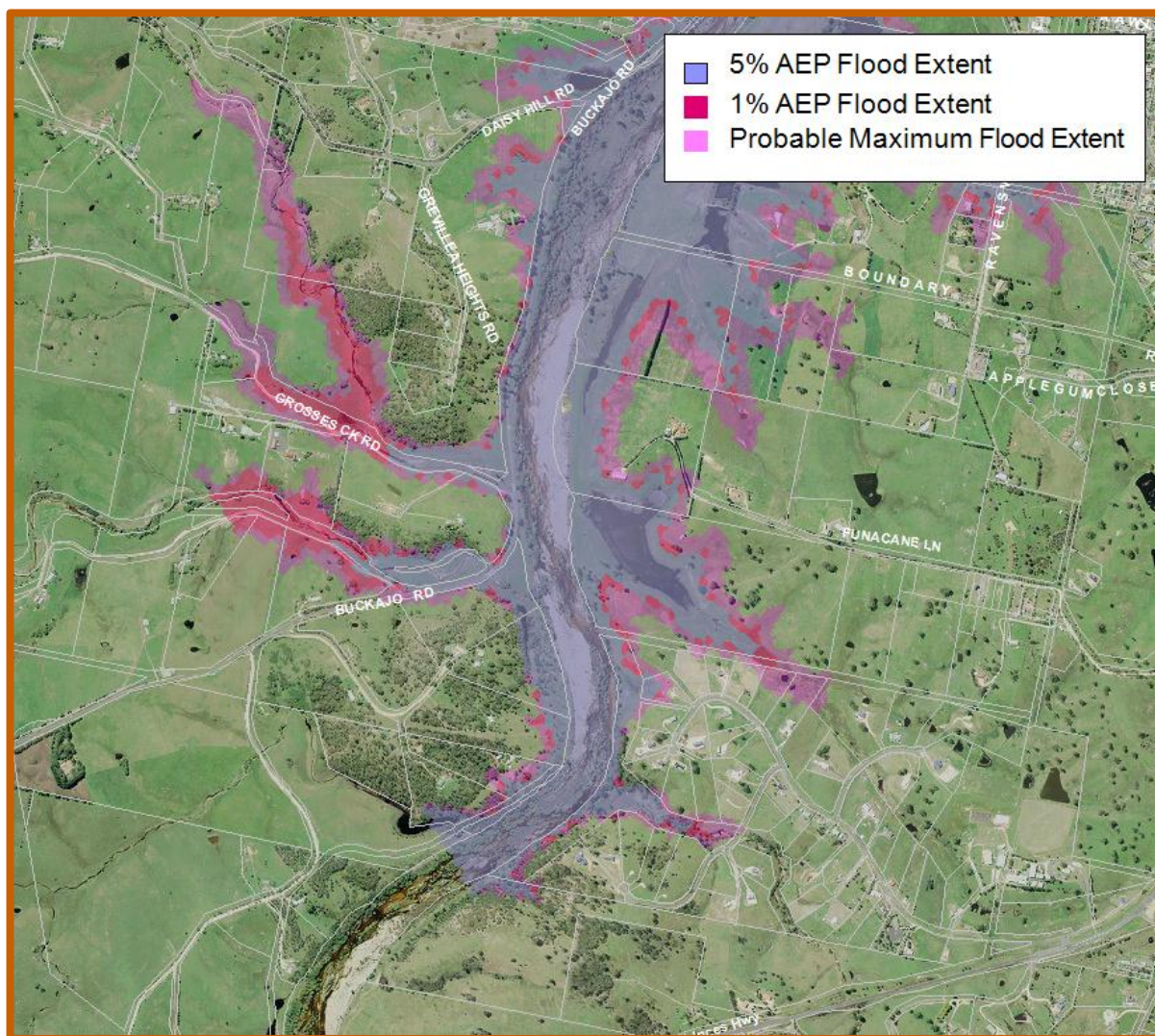
Properties at the west end of Fairview St and High St and properties in Angel St and Valley St have Rising Road Access for evacuation. Some properties in this area would be affected in a 5% AEP flood.

On the north side of the Bega River, west of the Princes Highway, industrial properties accessing Buckajo Rd would be isolated from Bega township in a PMF but would have rising Road Access to the Highway from North of Ridge St. South of Ridge St, Buckajo Road will be cut in a 5% AEP event.

On the east side of the Princes Highway, low lying properties in Parrabel St are vulnerable in a 5% AEP flood. These communities would need to evacuate early along Parrabel St which provides Rising Road Access for evacuation. In this region, some industrial properties in Lagoon St are vulnerable to the 5% AEP flood. Rising Road Access to the Princess Highway is possible via Bridge St.

Figures 18.2 and 18.3 show the extent of flood inundation for communities located on the Bega River floodplain upstream of Bega. Figure 18.3 shows the extent of inundation in the vicinity of the Princes Highway crossing of the Bega River.

**Figure 18.2: Extent of inundation, Bega River upstream of Bega – Map 1**



5% AEP Flood Extent  
1% AEP Flood Extent  
Probable Maximum Flood Extent

**Figure 18.4: Extent of inundation, Bega River upstream of Bega – Map 3**



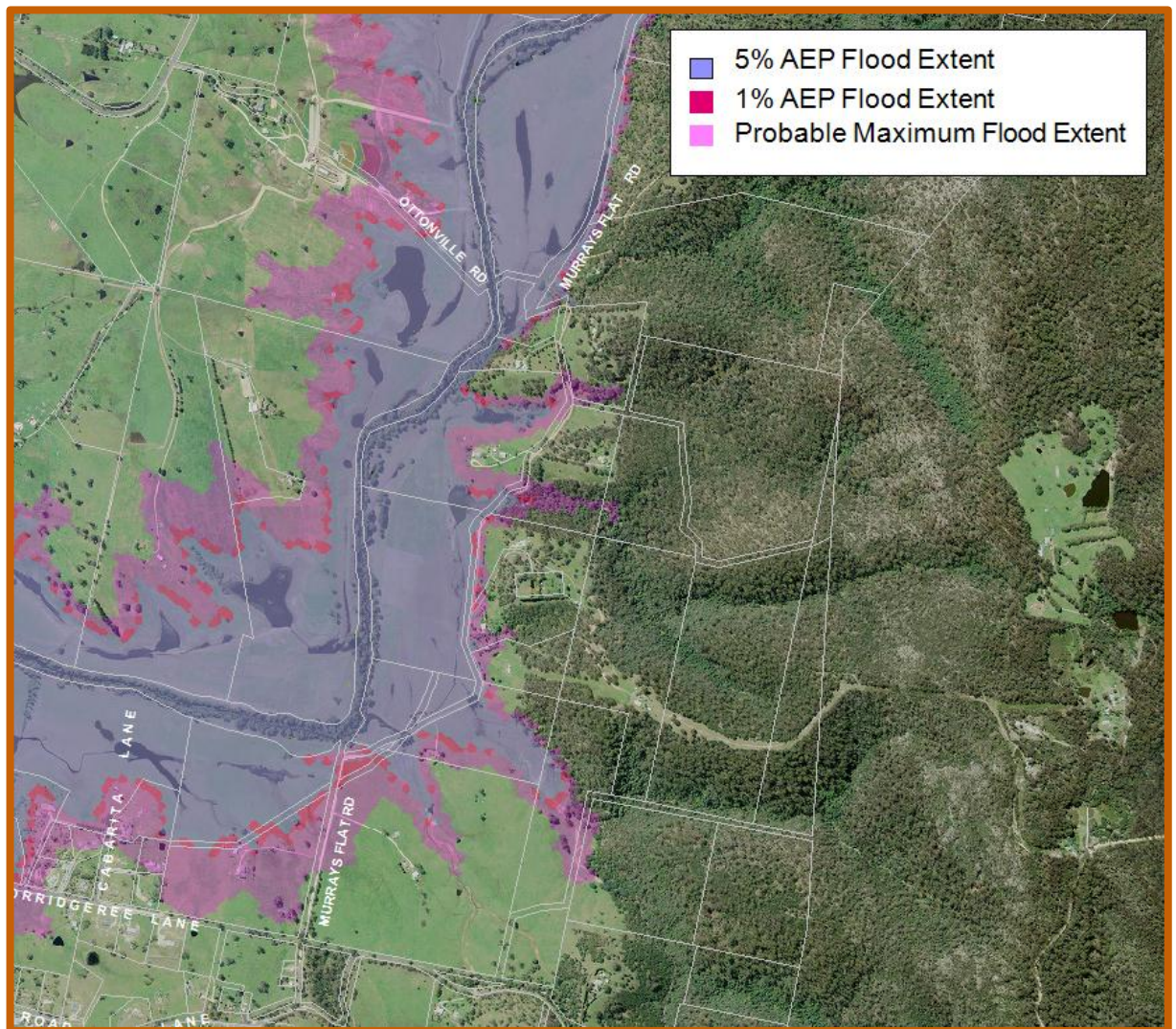
### **Brogo River Upstream of Bega River**

There are a number of properties on the eastern bank of the Brogo River that access Murrays Flat Road where communities may be isolated during a 5% AEP flood. These areas would be classified as High Trapped Perimeter areas and may require evacuation or resupply during a flood event. In some instances, residences are above the PMF while in other cases, communities would have access to higher land but may need air or boat rescue.

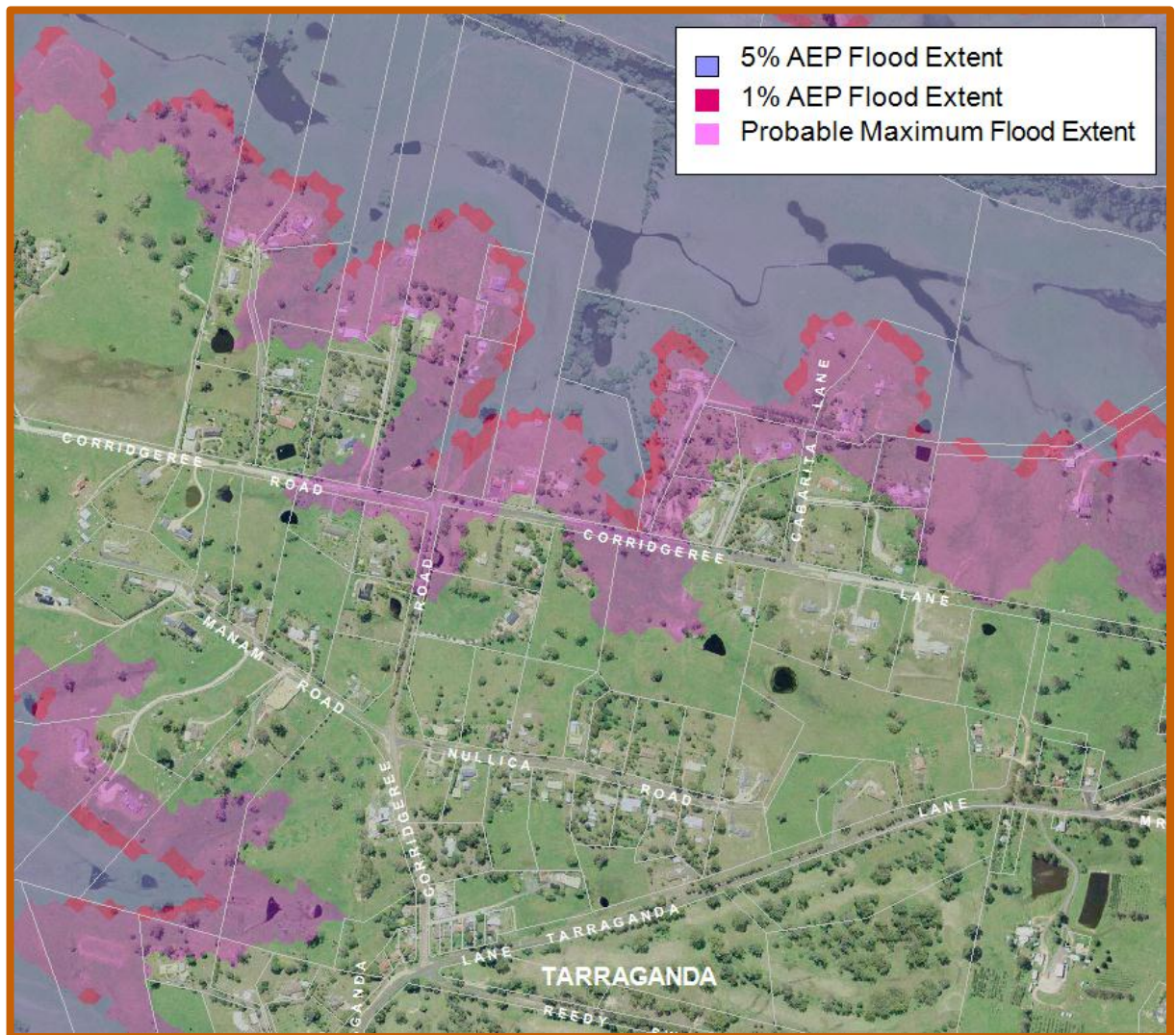
Closer to the Bega River, properties accessing Corridgere Lane would have Rising Road Access, enabling evacuation to Tarraganda as flood waters rise. However Tarraganda is frequently isolated from Bega. Most communities in this area are above the 1% AEP flood and the need for evacuations would be rare.

The extent of flood inundation of communities along the Brogo River, upstream of Bega, is shown on Figures 18.5 and 18.6.

**Figure 18.5: Extent of inundation, Brogo River upstream of Bega – Map 1**



**Figure 18.6: Extent of inundation, Brogo River upstream of Bega – Map 2**



### **Bega River – Bega to Jellat Jellat Flats**

In the Bega Town centre, inundation occurs along the fringes of the town adjacent to the Bega River. The roads in this area generally rise to higher elevations toward the centre of town which is above the level of the PMF and would provide safe refuge. The low lying communities on the edge of the flood plain in the Bega Town Centre would be able to access safety provided that they leave their properties and move to higher ground along the roads of Bega as flood waters rise. To the north of Bega, most properties have access to refuge although in some instances may become isolated

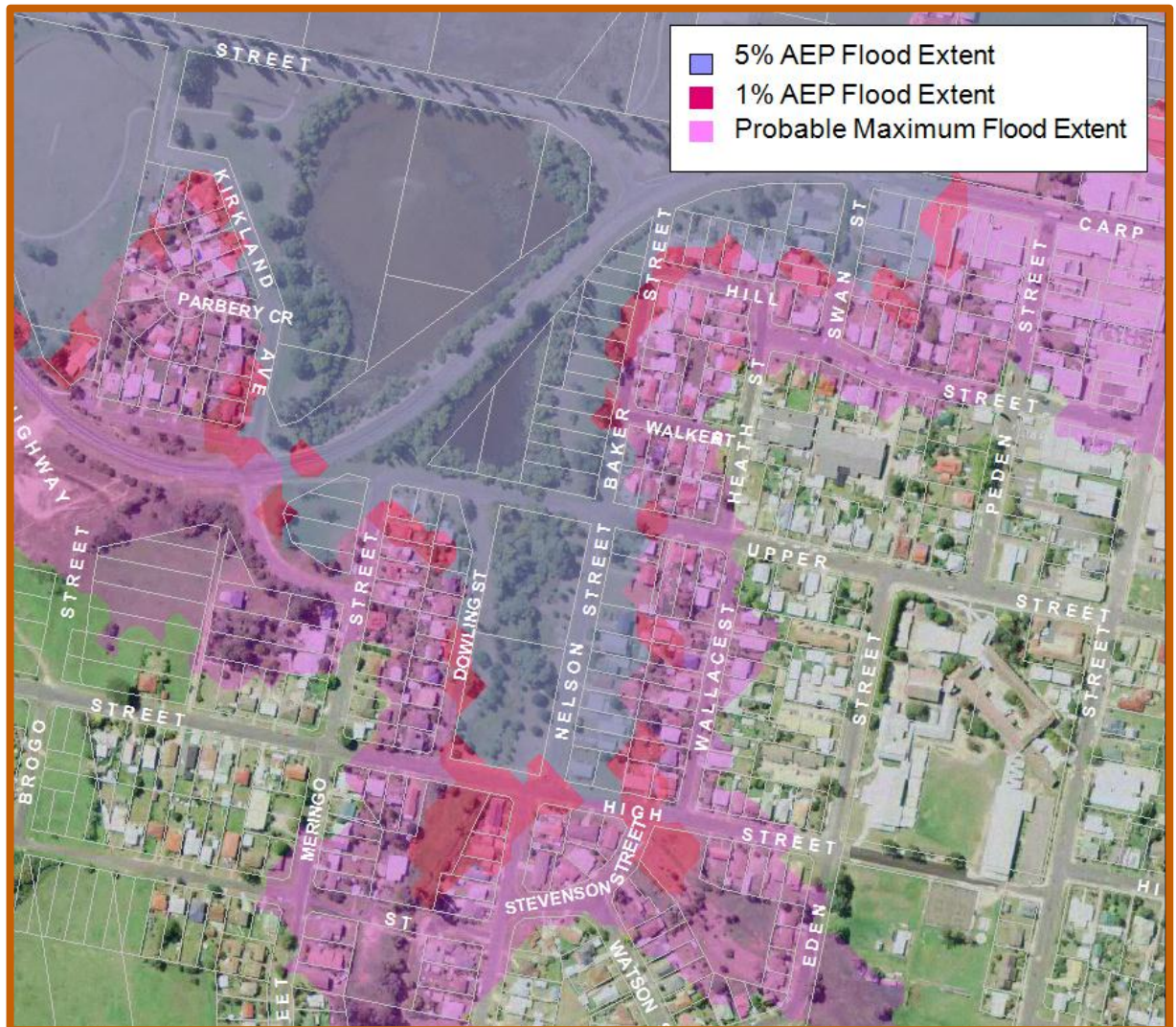
While there are a large number of properties submerged in the 5% AEP through to PMF in Bega township, all areas generally have Rising Road Access to higher ground above level of the PMF in the centre of Bega. However communities in low lying areas are vulnerable if they delay evacuation.

In the north west part of Bega township, the 5% AEP flood would affect a number of low lying properties which includes residences in Nelson St, Hill St, Swan St, Carp St, Dowling St, Meringo St, Kirkland Avenue. In Lagoon St, while there are few residences in this street, some properties are below the 5% AEP and Lagoon St is almost entirely submerged in a 5% AEP flood.

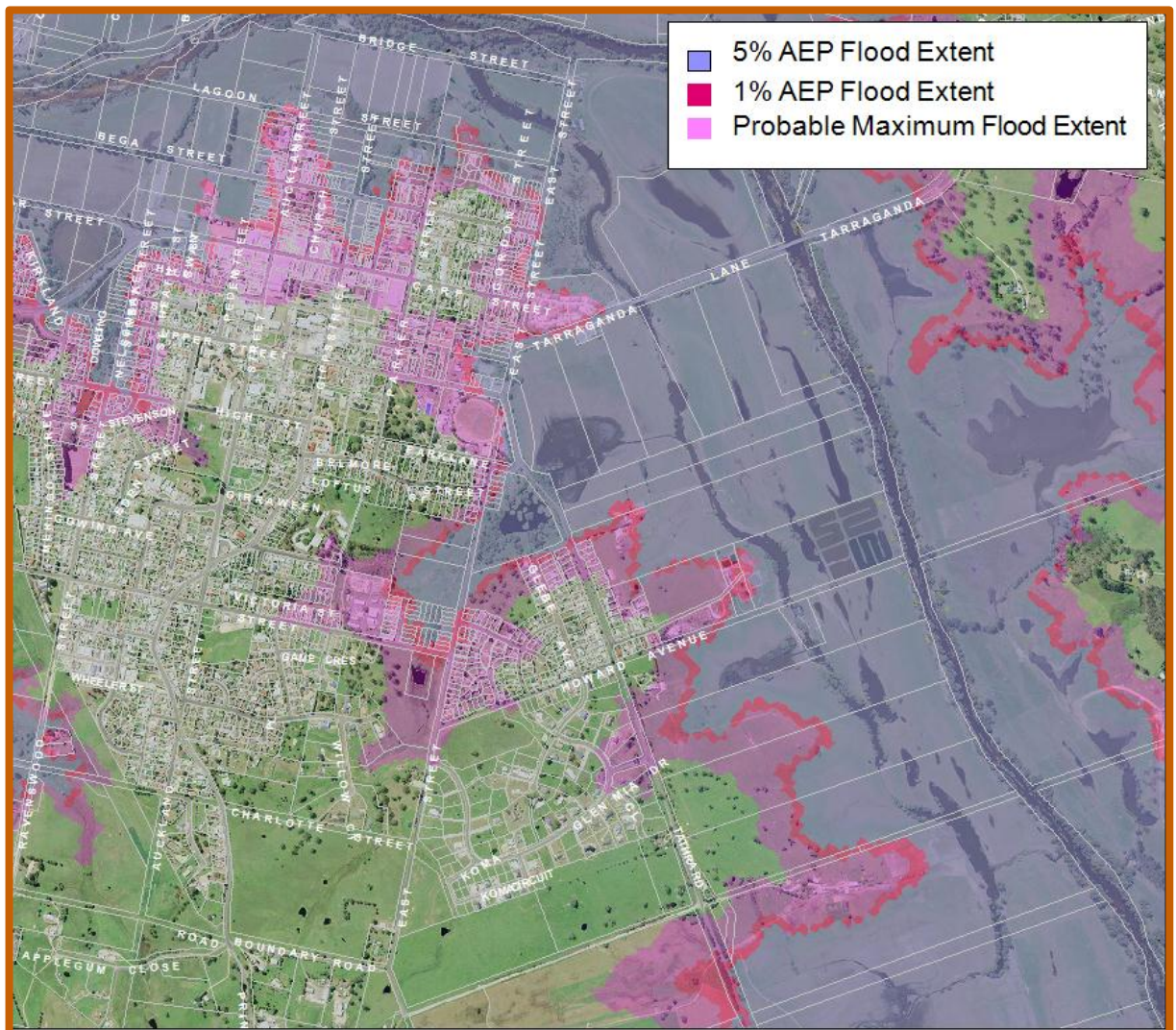
In Parker St, Auckland St and Bega St, most properties are above the 1% AEP flood but many are below the PMF. In East St and Gordon St, there are properties below the 5 % AEP.

Figures 18.7 and 18.8 show the extent of inundation in Bega Township.

**Figure 18.7: Extent of inundation, Bega Township – Map 1**



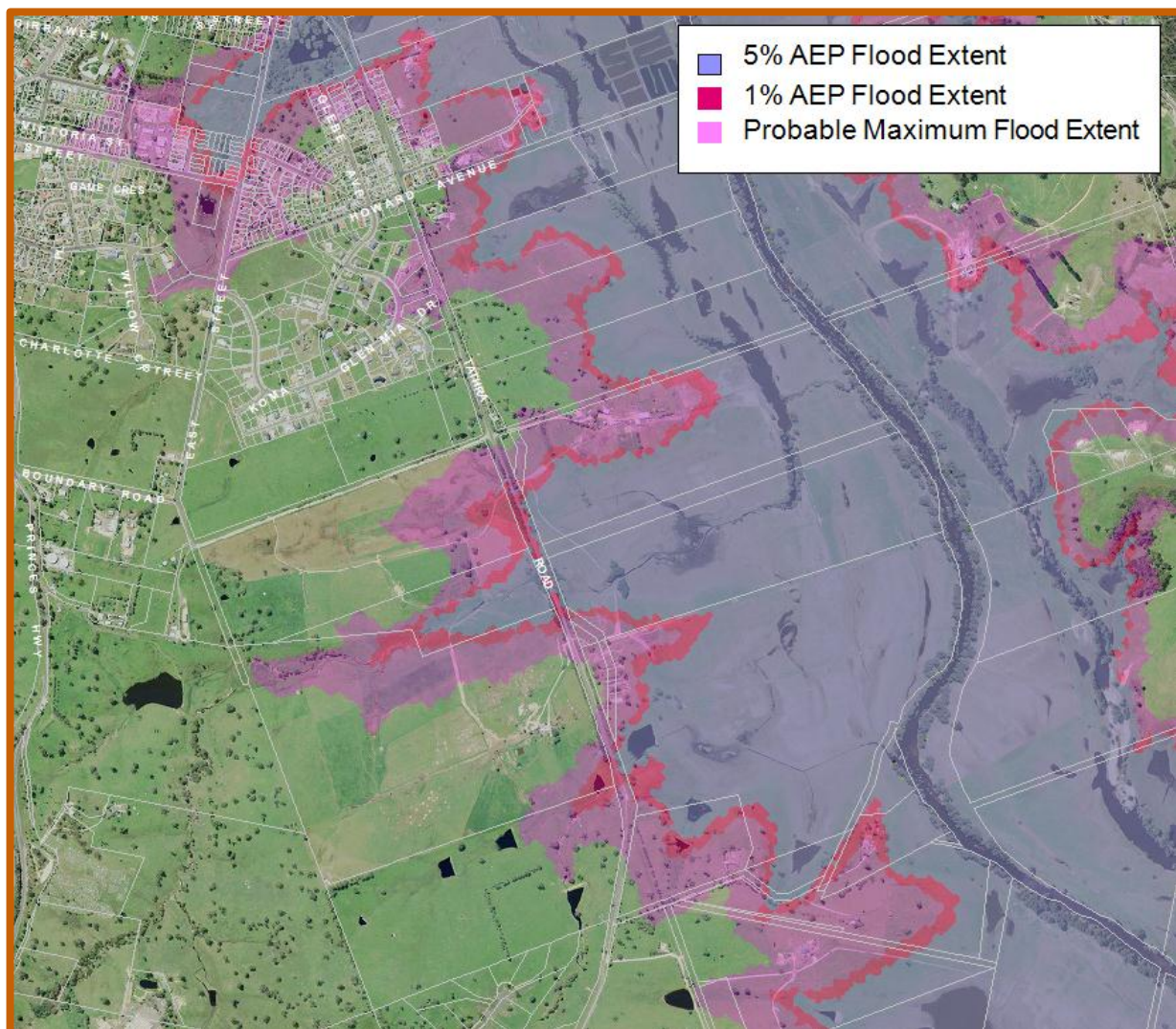
**Figure 18.8: Extent of inundation, Bega Township – Map 2**



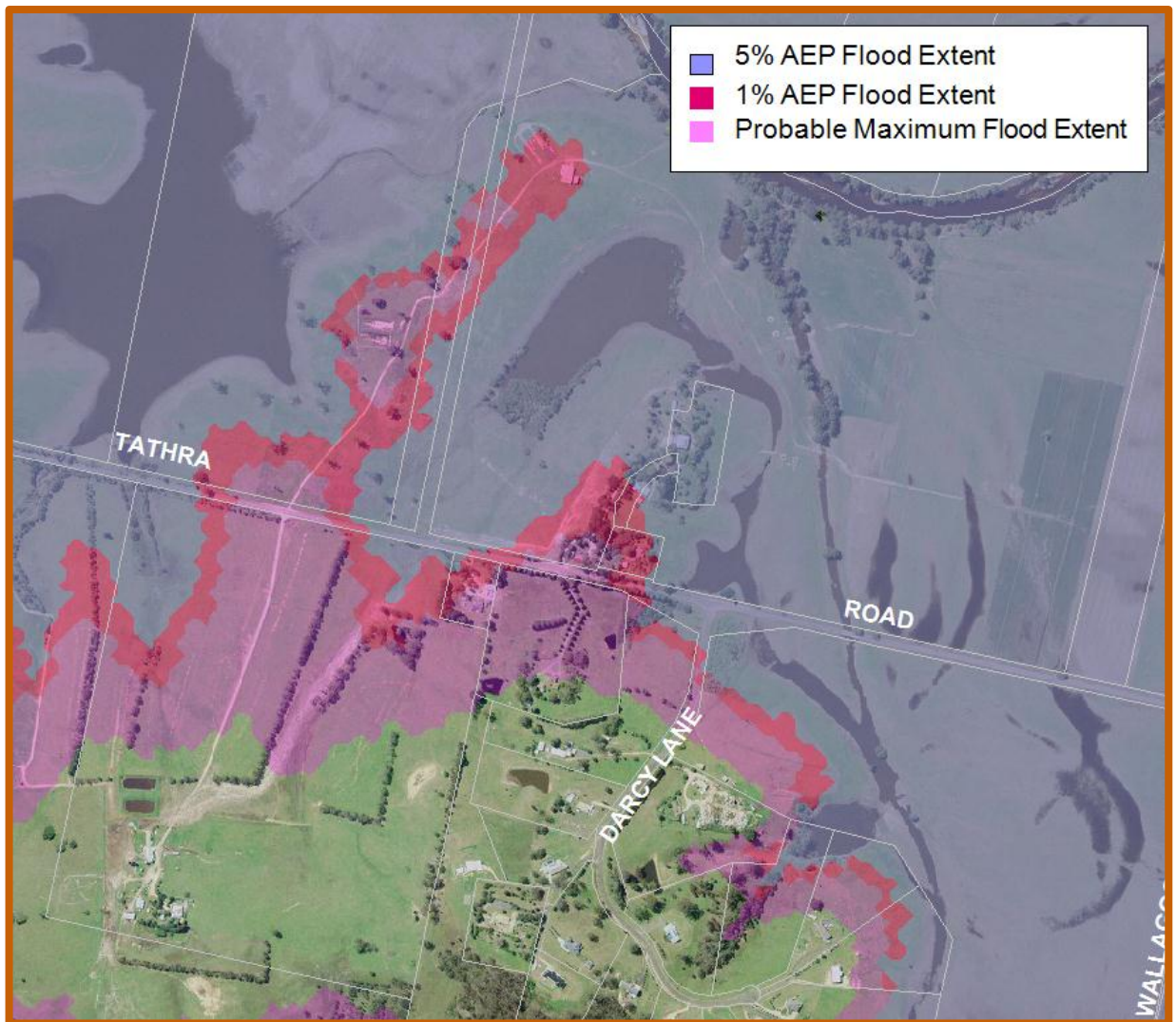
Just to the south east of Bega, communities that access Tathra Road may be isolated as Tathra Road is cut at many locations. These communities generally have access to safe high ground but may require evacuation or resupply in the event of prolonged flooding. Figure 18.9 shows the extent of flood inundation along Tathra Road at this location.

Further east, to the west of Darcy Lane on the north side of Tathra Rd, there are several properties that highly vulnerable that may be classified as low flood island and low trapped perimeter. These properties would require early warning and evacuation during floods to minimise risk to life. The extent of inundation and vulnerable properties at this location are shown on Figure 18.10.

**Figure 18.9: Example of communities accessing Tathra Road that may become isolated**

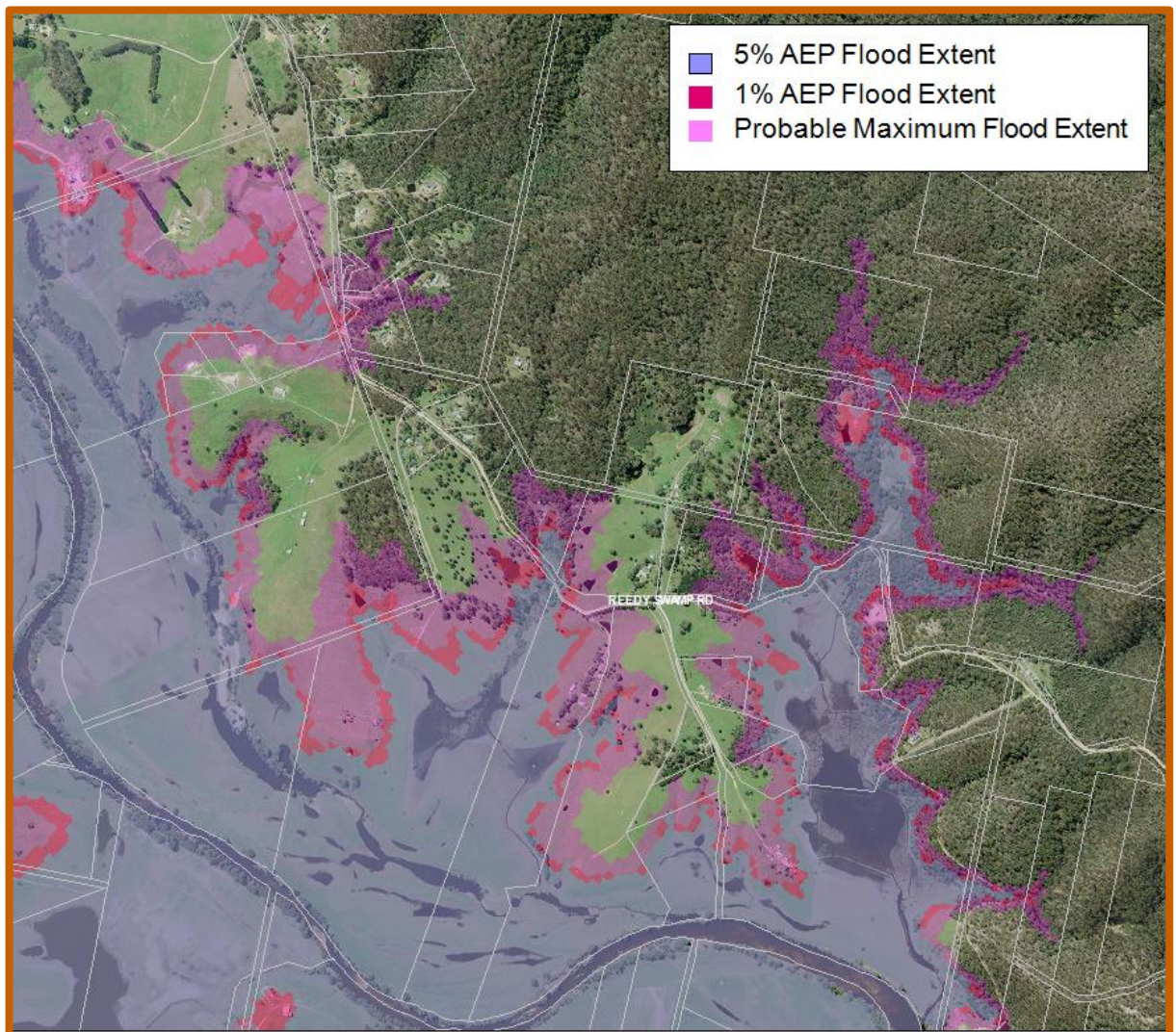


**Figure 18.10: Vulnerable communities - north side of Tathra Rd**



On the north side of the Bega River, downstream of Tarraganda, a large number of communities rely on Reedy Swamp Road to evacuate to Tarraganda during floods. Reedy Swamp Road is severed in the 5% AEP flood at a number of locations and this would leave communities isolated during floods. Flood prone properties generally have safe access to flood segments of Reedy Swamp Road. Resupply or evacuation may be needed by these communities in the event of prolonged flooding.

**Figure 18.11: Reedy Swamp Road – isolated communities**



### **Jellat Jellat Flats**

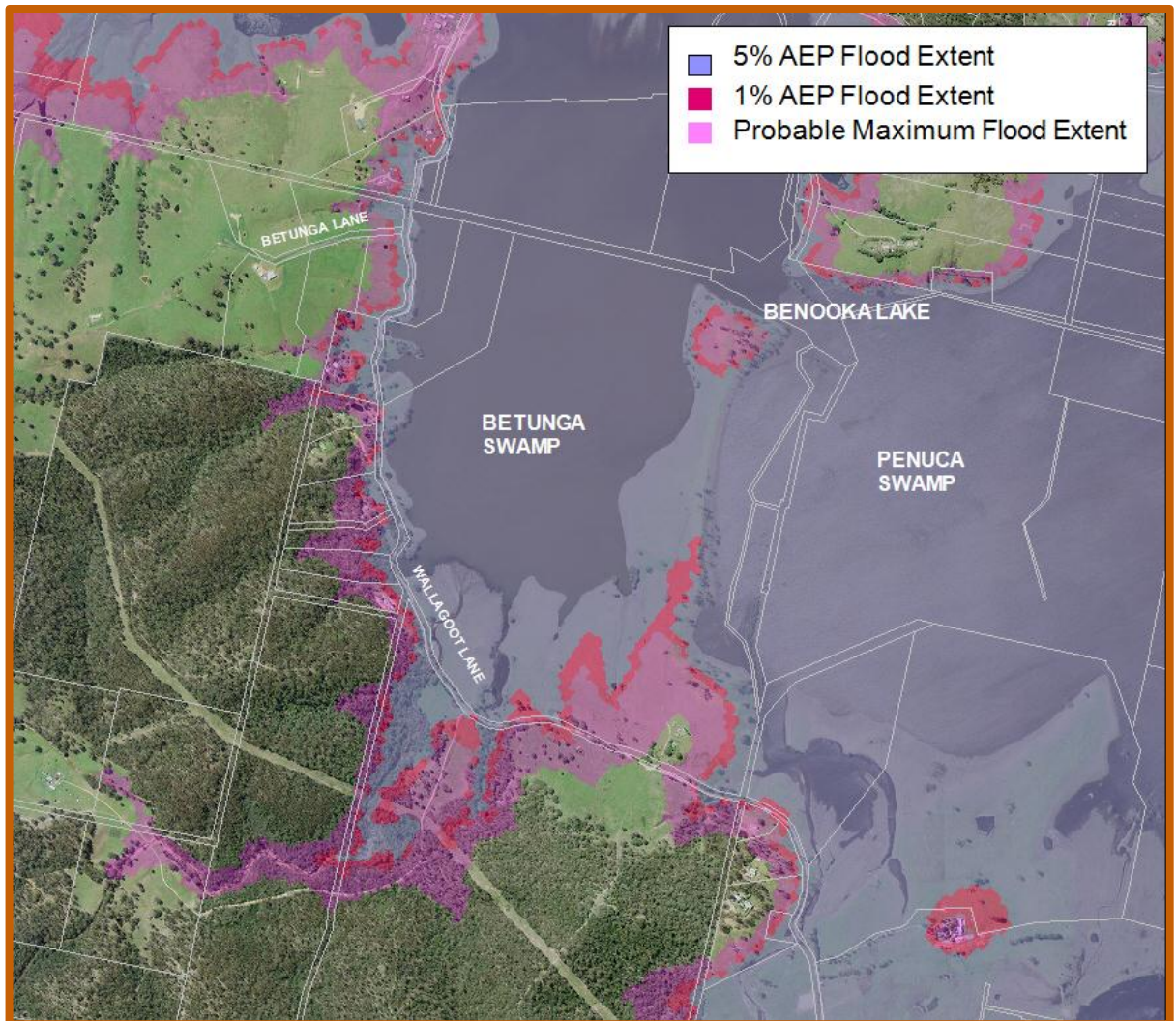
The Jellat Jellat Flats area is a large floodplain storage area off line to the Bega River. Flood waters rise slowly but are slow moving.

There are communities around the fringe of Betunga Swamp which are subject to inundation in the 5% AEP flood. Wallagoot Lane is the only road evacuation route for these communities and this road has a flood immunity less than the 5% AEP flood. While most lots have some portion of land above the PMF level, resupply and evacuation may be necessary.

At Wallagoot, properties along the East side of Horseshoe Lagoon generally have Rising Road Access to Tathra via Sapphire Coast Drive and Tathra Road. These roads are above the level of the PMF east of the Horseshoe Lagoon. In this region, most residences are above the 1% AEP flood level, although there are a few residences below the 5% AEP flood level which would need to evacuate early.

Flood extents along the western edge of the Betunga Swamp are shown on Figure 18.12.

**Figure 18.12: Extent of inundation, western edge of Betunga Swamp showing Wallagoot Lane submerged in 5% AEP**



### **Bega River – Jellat Jellat to Mogareeka**

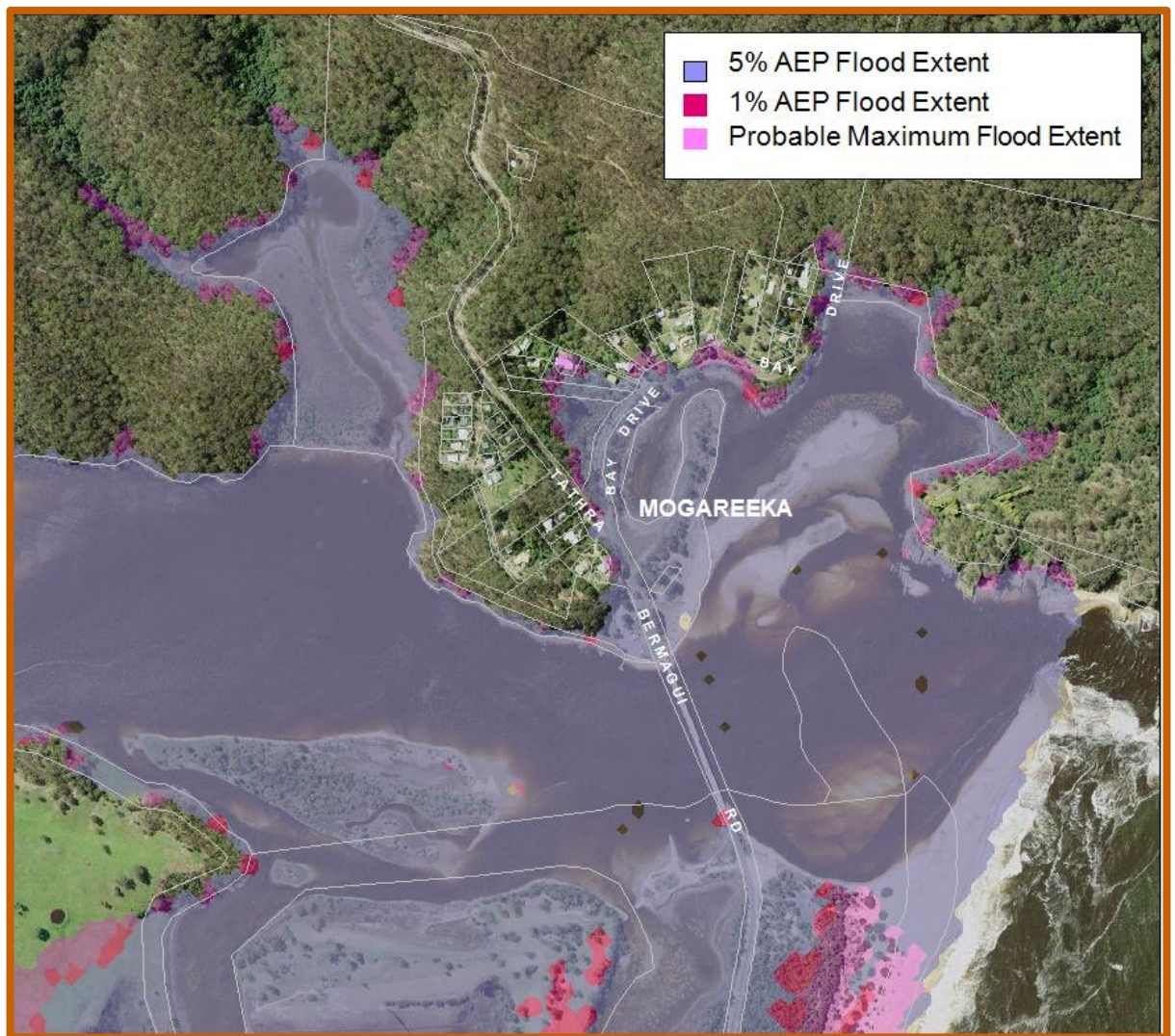
From Jellat Jellat to Blackfellows Lagoon, there were no vulnerable residences identified. At Blackfellows Lagoon, on off line floodplain storage, most buildings are above the 1% AEP flood level however there are many buildings below the PMF. Flood prone properties in this area have Rising Road Access to Tathra in a 1% AEP flood but would be isolated in a PMF.

Mogareeka would be isolated from Tathra during a 5% AEP event. Furthermore, Bay Drive would be submerged in a 5% AEP flood and residents would be unable to evacuate by vehicle.

Flood inundation extents between Jellat Jellat and the ocean outlet at Mogareeka are shown in Figures 18.13 and 18.14.



**Figure 18.14: Extent of inundation, Mogareeka Area**



**Figure 18.13: Mogareeka Area**