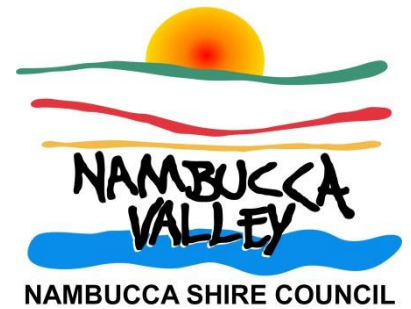




Office of
Environment
& Heritage



NAMBUCCA SHIRE FLOODPLAIN RISK MANAGEMENT PLAN

FINAL



JUNE 2017



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Project Nambucca Shire Floodplain Risk Management Plan		Project Number 111036-06	
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NAMBUCCA SHIRE FLOODPLAIN RISK MANAGEMENT PLAN

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FOREWORD

The NSW State Government's Flood Policy provides a framework to ensure the sustainable use of floodplain environments. The Policy is specifically structured to provide solutions to existing flooding problems in rural and urban areas. In addition, the Policy provides a means of ensuring that any new development is compatible with the flood hazard and does not create additional flooding problems in other areas.

Under the Flood Prone Land Policy, the management of flood liable land remains the responsibility of local government. The NSW Government, administered through the Office of Environment and Heritage (OEH), provides financial assistance and specialist technical advice to assist councils in the discharge of their floodplain management responsibilities. The Australian Government may also provide financial assistance in some circumstances.

The Flood Prone Land Policy provides for specialist technical and financial support to councils by the NSW Government through the four sequential stages set out in the *Floodplain Development Manual – the management of flood liable land* (NSW Government, 2005, being:

1. **Flood Study**
 - Determine the nature and extent of the flood problem.
2. **Floodplain Risk Management**
 - Evaluates management options for the floodplain in respect of both existing and proposed development.
3. **Floodplain Risk Management Plan**
 - Involves formal adoption by Council of a plan of management for the floodplain.
4. **Implementation of the Plan**
 - Construction of flood mitigation works to protect existing development, use of Local Environmental Plans to ensure new development is compatible with the flood hazard.

The Nambucca Shire Floodplain Risk Management Draft Plan constitutes the third stage of this management process. It has been prepared by WMAwater for Nambucca Shire Council (herein Council) under the guidance of Council's floodplain management committee (herein Committee). This Plan provides the basis for the future management of the flood liable land within Nambucca Shire.

EXECUTIVE SUMMARY

The recommended draft Floodplain Risk Management Plan for Nambucca Shire has been prepared in accordance with the NSW Development Manual (Reference 2) and:

- is based on a comprehensive and detailed evaluation of all factors that affect and are affected by the use of flood prone land; and
- provides a long-term plan for the future development of the floodplain.

The Nambucca Shire Floodplain Risk Management Plan includes the Nambucca River, Warrell Creek and Deep Creek catchments located in Nambucca Shire. The Shire encompasses mixed land uses, including areas of low density residential, industrial, business development, recreation and other non-developed uses in flood-affected areas, however the majority of flood affected land is zoned residential, commercial or primary production.

The Nambucca Shire Floodplain Risk Management Study (Reference 2) undertook a detailed assessment of flood risk in the catchment. The assessment included a description of flood hazard, as well as an estimate of the economic impact of flooding. The study gave a description of the relevant flood policy, as well as a review of the flood planning level and flood planning area.

The Floodplain Risk Management Study (FRMS) also included an investigation of possible options for the management of flood risk in the area. The measures were assessed for their ability to reduce flood risk while also considering their economic, social and environmental impact. A multi-criteria matrix assessment was used to directly compare the options. Of the options identified, 13 were recommended for implementation, with a priority and time frame assigned to each.

1. FINDINGS OF THE FLOODPLAIN RISK MANAGEMENT STUDY

1.1. Background

The study area (Figure 1) includes Nambucca River, Warrell Creek and Deep Creek catchments located in Nambucca Shire. Warrell Creek joins with the Nambucca River and discharges to the ocean at Nambucca Heads. Deep Creek outflows directly to the ocean at Valla. The catchment area of the Nambucca River, Warrell Creek and their tributaries (including Taylors Arm) is 1315 km², whilst the Deep Creek catchment is 92 km².

The headwaters of both the Nambucca and Taylors Arm catchments are located in the Great Dividing Range and characterised by steep topography. The lower reaches of the Nambucca River are characterised by broad floodplains and farmland. The lower reaches of Warrell Creek is a narrow meandering channel with dense overbank vegetation. Residential development within the catchments generally occurs as small settlements. Major centres exist at Macksville, Bowraville and Nambucca Heads on the Nambucca River. The small settlement of Warrell Creek and coastal village of Scotts Head are located on Warrell Creek.

Deep Creek is an ICOLL (Intermittently Closed and Open Lake and Lagoon) and meets the coast at the northern end of Hyland Beach in the lee of Valla Headland. Unlike most ICOLL's it is predominately open with the entrance migrating along the beach. The creek has a catchment area of 92 km². Like many catchments along the north coast the catchment is characterised by steep upper reaches with a distinct rainfall gradient. Land use within the catchment consists of forestry and agricultural uses with some urban development closer to the coast. In excess of 500 hectares of land within the catchment has been marked for future urban development including industrial and residential land.

1.2. Existing Flood Behaviour

As part of the FRMS existing hydraulic models for Nambucca River and Warrell Creek (Reference 2) were updated to include the additional study areas. No significant changes in flood levels occurred. Figure 2 and Figure 4 depict the 1% AEP and PMF events for these catchments. Design flood levels for Deep Creek were developed as a part of the Deep Creek Flood Study (Reference 3) and are shown on Figure 3 and Figure 5 for the 1% AEP and PMF design events.

Bowraville is approximately 28km upstream from the entrance at Nambucca Heads. The town is situated on the south side of Nambucca River and to the east of South Creek on high ground. Isolation is the main flood issue in the area as the main roads get cut in a 5 year ARI (Average Recurrence Interval) design event.

Macksville is located downstream of the confluence of Taylors Arms and Nambucca River. Tilly Willy Creek is located to the west of Macksville, while Town Drain is to the east. Properties are affected in smaller events though in limited numbers. Evacuation of the majority of the area is relatively simple. Kings Point and East Macksville are both low flood islands and will need evacuation early. Events rarer than a 5% AEP event will result in floodwaters through the commercial and residential centre of the town.

Nambucca Heads is situated at the entrance of Nambucca River adjacent to the Pacific Ocean. It has limited property damage from riverine events. Isolation can be an issue for some areas, though as it is so close to the ocean inundation times are relatively short.

Scotts Head is located between the coast and Warrell Creek. Isolation in rare events can be an issue. No properties are affected in events less than a 2% AEP event.

Hyland Park is located on the south bank of Deep Creek on high ground. Areas within the zone can be inundated however, no property damage occurs until a 2% AEP event and only minimal damages occur in overfloor flooding. The majority of properties are above the PMF or are only inundated in the PMF.

Valla Beach is close to the entrance of Deep Creek and consists of residential properties and a caravan park. It is on high ground and many properties are raised resulting in overfloor flooding only occurring in large events, equal to or greater than the 1% AEP design event.

1.3. Flood Hazard

Classification of flood hazard in the catchments (Figures 6 and 7) was based on a combination of the provisional flood hazard categories and a range of other factors not captured by the provisional categories. These factors include, but are not limited to: rate of rise of floodwater, duration of flooding, community awareness, and effective warning time. A qualitative assessment of these factors was undertaken, the results of which are summarised in Table 1. The provision categories complement this assessment as they delineate areas of the floodplain where depth or velocity of floodwaters is considered hazardous.

Table 1: Hazard Classification

Criteria	Nambucca Catchment	Deep Creek Catchment	Comment
Size of flood	Medium	Low	Flood affected areas of population is generally low in the 1% AEP event. In the Nambucca system, once floods are greater than the 1% AEP event, hazard significantly increases.
Flood Awareness of the Community	Medium	Medium	Whilst residents are aware that flooding along occurs and many will have experienced the relatively small events.
Depth and Velocity of Floodwaters	Medium	Medium	High velocities and large depths of floodwaters in some areas mean the risk to life is medium.
Effective Warning and Evacuation Times	High	Low	Warning time 24 hours in the Nambucca Catchment. There is only a very small likelihood that residents would be caught completely unaware but they are unlikely to have the foresight to react appropriately to the situation, particularly if the event happens during the night. Deep Creek is a smaller catchment and has a much shorter warning time.
Evacuation Difficulties	Medium	Low to Medium	For the majority of residents evacuation should be relatively easy as there is nearby high ground for vehicles and the majority of goods can be saved by raising them 1 m off the ground within the building.
Rate of Rise of Floodwaters	Low	High	The rate of rise of floodwaters is generally slow for the Nambucca Catchment and fast for the Deep Creek Catchment.
Duration of Flooding	High	Low	The duration of inundation is relatively long for the Nambucca Catchment and short for the Deep Creek Catchment.
Effective Flood Access	Medium	Medium	The Nambucca catchment has many areas of low and high flood islands as well as rising road access and overland escape routes. Low flood islands are well known to the community and are either uninhabited or are evacuated swiftly. The majority of the area in Deep Creek has an overland escape route and low trapped perimeter areas. SES boats can effectively be used to ferry residents to high ground. Four wheel drive access (by the SES) is possible early in an event.

A detailed description of the flood hazard classification is given in Section 3.3 of the Nambucca Shire FRMS.

1.4. Economic Impact of Flooding

The economic impact of flooding in Nambucca Shire was assessed as part of the FRMS and are summarised in Table 2. Damages were calculated for residential and commercial/industrial properties, based on a floor level survey of properties inundated in the 1% AEP event. The flood damages estimate does not include the cost of restoring or maintaining public services and infrastructure. It should be noted that damages calculations do not take into account flood damages to any basements or cellars. Further details on the approach are provided in Section 4.1 of the FRMS.

The damages assessment found that 1002 properties within the Shire are liable to over floor inundation in the 1% AEP event, while 22 properties are liable in the 10% AEP. The assessment estimated the average annual damage to be approximately \$1.2 million for the Shire.

Table 2: Estimated Combined Flood Damages for Nambucca Shire

Event	Number of Properties Flood Affected	No. of Properties Flooded Above Floor Level	Total Tangible Flood Damages	Average Tangible Damages Per Flood Affected Property
20.0%	16	5	\$ 282,700	\$ 17,700
10.0%	22	8	\$ 504,500	\$ 22,900
5.0%	178	47	\$ 3,314,600	\$ 18,600
2.0%	407	159	\$ 11,751,100	\$ 30,500
1.0%	579	358	\$ 25,463,300	\$ 57,700
0.5%	882	613	\$ 47,617,200	\$ 78,600
0.2%	1002	834	\$ 72,428,500	\$ 107,200
0.05%	1074	985	\$ 99,112,100	\$ 149,400
PMF	1118	1091	\$138,944,700	\$ 213,900
Average Annual Damages (AAD)			\$ 1,209,600	\$ 1,100

2. RECOMMENDED MANAGEMENT MEASURES

The Nambucca Shire FRMS made a full assessment of the existing flood risk in the Shire. Based on this assessment, the study investigated a range of management measures for the area, which can be categorised as Response Modification Measures, Property Modification Measures, and Flood Modification Measures, as per the NSW Floodplain Development Manual (Reference 1). Measures were assessed for their efficacy across a range of criteria, which allowed them to be compared against one another and their overall effectiveness ranked. Measures which were shown to cost-effectively improve the management of flood risk in the catchment were selected and form the primary content of this draft Plan.

The measures have been categorised by their type (Response, Flood or Property) and given a priority ranking. The ranking is based upon a combination of reduction in flood risk, ease of implementation, cost/funding implications and outcomes based on the multi-criteria matrix assessment (refer to Section 8 of the FRMS). More information on each measure is available in the FRMS, including discussion of its implementation and its effect on the existing flood behaviour.

2.1. Timeframe for Implementation

Floodplain management measures recommended in this draft Plan have been assigned a timeframe for implementation in order to form short, medium and long-term strategies for the area's floodplain management. Use of different timeframes ensures that priority is given to those measures, which can be undertaken in the near future, while also retaining less feasible options for long-term implementation.

Short term measures are those that are able to be implemented in the next 1 – 5 years, medium term refers to 5 - 15 year timeframe. Long term measures are those have greater constraints (usually financial or logistical) and are therefore planned to be implemented in the next 15 – 50 years.

2.2. High Priority Management Measures

2.2.1. Evacuation Planning (Option H1)

It may be necessary for some residents to evacuate their homes in a major flood event. This would be undertaken under the direction of the SES who are the lead agency under the Displan.

The NSW SES Local Flood Plan was prepared in Nov 2015 and a review scheduled for no later the 2020. It is unclear whether this review has taken place, in which case it should be done so as a matter of urgency.

Any major future events within this time should be incorporated into flood intelligence and evacuation planning. Signs advising of the risk of driving through floodwaters should be placed on inundated roads to reduce the number of people driving through floodwaters.

2.2.2. Flood Awareness and Preparedness (Option H2)

The success of any flood warning system and evacuation process is partly dependant on the flood awareness and preparedness of the community at risk. Nambucca River catchment residents generally have a moderate level of flood awareness, geared towards the smaller more frequent events such as those which occurred in 2009 and 2013. Residents would be less aware of the implication of larger events such as the 1% AEP. Deep Creek residents in the upper catchment would have a higher awareness of rarer events.

Regular awareness campaigns are recommended to ensure that the level of flood awareness in the Shire is high. Different messages will be required for the Nambucca River and Deep Creek catchments due to the different nature of flooding, warning times and flood risk. It is important that the system be web/GIS based and publicly available. The awareness campaign should also include an explanation of the relationship between the new gauge and Lanes Bridge.

The cost of this option is minimal.

2.2.3. Flood Planning Levels (Option H3)

Flood Planning Levels (FPLs) are an important development control tool in floodplain risk management. Stipulating FPLs for all new development is one of the most effective measures in reducing flood damages to new properties without preventing development in a flood prone area entirely.

Nambucca Shire Council currently provides minimum floor levels for different development types via the development control matrix contained within the 2005 Floodplain Risk Management Plan (Reference 4), referenced from the DCP. It should be updated to include references to the FPL specifically.

The Floodplain Risk Management study has amended the 1% AEP event flood level throughout the hydraulic model extent from those levels used to define the FPL in the current DCP. Therefore it is recommended that the DCP be updated to reflect this. The recommended Flood Planning Area is recommended in Figure 8 to Figure 9. It is recommended that Council update its flood planning area and flood planning levels based on the current modelling. Council should consider making the FPL and other flood information and extents available on its website.

2.2.4. Revise LEP and DCP (Option H4)

The primary objective of the NSW Government's Flood Policy is "to reduce the impact of flooding and flood liability on individual owners and occupiers, and to reduce private and public losses resulting from flooding, utilising ecologically positive methods wherever possible".

Appropriate development controls involve consideration of the social, economic, environmental and risk to life of consequences associated with the occurrence and management of floods. This involves trading off various benefits of reducing the impacts of flooding on development, against the costs of restricting land use in flood prone areas and of implementing appropriate management measures.

The outcomes of the FRMS should feed into an updated DCP in respect to flood related development controls or, alternatively, the existing documents can simply refer to this study and plan. Council has recently updated its LEP to the NSW standard instrument and adopted a revised DCP.

Updated and relevant planning controls are important in flood risk management. A review of Council's existing planning policy was undertaken as part of the FRMS, and a number of recommendations for revision made. These are detailed in Section 6.4.3.2 of the FRMS.

2.2.5. Flood Warning (Option H5)

The amount of time for evacuation depends on the available warning time. Providing sufficient warning time has the potential to reduce the social impacts of the flood as well as reducing the strain on emergency services. It can also reduce the damages if the community is given sufficient time to raise goods, move cars, etc.

The warning time for the Nambucca catchment is in the order of 12 – 24 hours depending on the magnitude of the event. Flood predictions are currently supplied for Macksville and Bowraville. It is recommended that additional warnings be developed for Warrell Creek and Utungun.

The warning time for on the Deep Creek is in the order of hours, and there are limited rain gauges in the catchment. An additional rain gauge is recommended for the upper reaches of Taylors Arm. The estimated cost of an additional gauge is \$20,000 plus maintenance costs.

The gauge at Bowraville has recently been relocated. It is important that during the next few flood events measurements are taken at both locations so that an accurate correlation between the sites can be developed. The timing difference between Utungun, Macksville and Bowraville should also be monitored.

Refer to Section 6.5.1 of the FRMS for further detail.

2.2.6. Flood Proofing (Option H6)

Flood proofing is a good solution for reducing flood risk to commercial and industrial properties. Flood proofing for residential dwellings is considered less appropriate as there can still be risk to life if people remain in the building; raising floor levels above flood levels is considered to be safer. However, as existing houses cannot be raised, flood proofing is useful for existing properties.

Grant funding is usually not available for flood proofing. This option is generally less expensive than house raising. Although Council cannot be responsible for flood proofing existing properties, they can enforce flood proofing for any new development within flood prone areas through planning controls. Furthermore, Council can, through a flood awareness campaign targeted at both commercial and residential property owners, make available information on flood proofing existing buildings such as temporary flood barriers.

Appendix A of the 2005 Floodplain Risk Management Plan includes the flood proofing policy, which is referred to in the current DCP. This policy should be included in the DCP. Council should also promote flood proofing for commercial properties in the Macksville CBD and Nambucca Heads.

2.3. Medium Priority Management Measures

2.3.1. Section 149 Certificates (Option M1)

Section 149 Planning Certificates provide information on the planning policies and controls that apply to a particular parcel of land. Councils issue planning certificates to potential purchases under Section 149 of the Environmental Planning and Assessment Act of 1979. Identification of potential flood affectation and therefore flood related development controls on a Section 149 Planning Certificate is mandatory for residential developments located below the residential FPL.

It is recommended that the certificates provided by Nambucca Shire Council are updated and reissued base on the outcomes of this study. It is also recommended that a public awareness program be developed to inform all properties identified as being within the FPA of their current flood affectation and any development constraints imposed by their Section 149 status.

2.4. Land Use Zoning (Option M2)

Suitable and correct zoning of flood liable land is a key aspect in managing flood prone areas, Council's current practices should be continued. Outside the study area for the Hydraulic Models flood level information is currently not available. Council should undertake simplified modelling such as those provided by WaterRIDE to provide first pass flood levels for rural area DAs. However these will require sanity checking.

2.5. Low Priority Management Measures

2.5.1. East Macksville Levee (Option L1)

The East Macksville levee (Figure 10) is located on public land the eastern side of the Macksville Highway Bridge and would restrict water entering East Macksville. The levee height was set at 2.25 mAHd – 2.35 m AHD which corresponds to a 5% AEP level plus 0.5m freeboard to minimise the visual impact of the levee. The levee would require raising a low point in the river bank. Alternate routes one street back from the river may be possible subject to further detailed investigation.

Behind the levee, flood levels are reduced by up to 0.034m, and was shown to reduce the AAD by \$8,400. The cost of the levee is estimated to be \$200,000. The levee would also hold back water and keep the road open for longer, which facilitates evacuation of the area.

The cost benefit of this option is 1.07 and therefore recommended for further detailed investigation as a low priority.

2.5.2. Flood Access – Raise Wilson Road (Option L2)

One of the main ways of improving evacuation is to ensure that there are adequate evacuation routes, and appropriate warning is to be provided as to when routes will become impassable. Currently, a low point on Wilson Road just south of Bowraville is inundated in a 5 year ARI event. Raising this 130m section (Figure 13) to above the 5 year ARI level (8.75 mAHd) would improve access between Bowraville and Macksville), and whilst the option does increase flood levels by to 0.6 m, no houses are affected. The option would increase access between Bowraville and Macksville in frequent nuisance events, allowing residents to still access key services and allowing the road to reopen earlier.

Additionally, review of Council assets should be undertaken in conjunction with the design of bridges and road infrastructure to assess the feasibility of works to improve flood resilience in the community.

The costs for the works cannot be justified solely on a flood risk management basis, but should be considered as part of future road maintenance or works budgets.

2.5.3. House Raising (Option L3)

House raising has been widely used throughout NSW to eliminate inundation from habitable floors, and is suitable for most non-brick single storey buildings on piers. It is particularly relevant to those houses situated in low hazard areas on the floodplain. Most houses in the study area which are subject to frequent flooding have been raised in the past. A total of 47 properties have been identified in the Nambucca River catchment which are flooded in events of a 5% AEP or more frequent. No properties in the Deep Creek catchment are flooded above floor level in events more frequent than a 5% AEP. A total of 358 houses within the Shire in a 1% AEP event. The cost of basic house raising is typically in the order of \$60,000 per house.

Eight properties were identified as being flooded in frequent events (10% or less). It is recommended that Council investigate a house raising program and prioritise houses should funding become available.

2.5.4. Hyland Park Infill (Option L4)

Council's management strategy stipulates that the berm at the entrance is mechanically opened at 1.4m AHD, however, inundation of back yards at Hyland Park occurs prior to this, whilst the berm of the entrance is closed. Filling some of the low lying terrain to 1.4m AHD in this area could therefore reduce nuisance property flooding. Figure 11 shows which properties the levee would be on or which properties could fill to the 1.4m AHD level.) Filling or a levee was found to have no impact on flooding given the low height. Allowing filling to 1.4m AHD would prevent nuisance inundation. The option would result in a positive environmental outcome in the long term. The cost of the filling would be at the owners expense.

2.5.5. Temporary Flood Barriers (Option L5)

Temporary flood barriers include demountable defences, wall systems and sandbagging which are deployed before the onset of flooding. The effectiveness of these measures relies on a sufficient warning time and the ability of a workforce to install them. They are therefore often used as a means to assist in current mitigation measures rather than the sole protection measure. Temporary barriers could be used to optimise the East Macksville Levee (Section 2.5.1) to block selected streets between natural high points during the time of flooding.

2.5.6. Town Drain Levee (Option L6)

During the initial stages of an event water backs up Gumma Gumma Swamp and into Town Drain flooding low lying areas of Macksville. A small levee at the southern end of Wall Street on Town Drain would stop water flowing into Macksville in a small event (5% AEP event). The levee would be overtopped in a large event when water overtops the banks of the Nambucca River and enters Macksville from the north. A 100m long 3.1m AHD levee (5% AEP plus 0.5m) levee was modelled (Figure 12). In a 5% AEP event flood levels are reduced by up to 0.8m. Fifty one properties experience reduced flooding in a 5% AEP event. Further investigation of alternatives to Town Drain Levee such as flap gates should be undertaken.

2.5.7. Voluntary Purchase (Option L7)

Voluntary purchase involves the acquisition of flood affected residential properties, particularly those frequently flooded in high hazard areas, and demolition of the residence to remove it from the floodplain. Generally the land is then returned to open space.

Two properties in Bowraville were identified as being potentially suitable for a voluntary purchase scheme. Further investigation and an assessment of their viability should be undertaken in the short term, and if shown to be viable, implemented over the long term.

2.5.8. Voluntary Purchase (Option L8)

The Nambucca Estuary Management Plan (Reference 5) identifies serious erosion adjoining Gumma Road and Rodeo Drive that may be impacted by flooding. Council's stabilisation program of monitoring in these areas is supported (as documented in Reference 5) to alleviate the threat of roads being impacted by flooding.

3. FLOODPLAIN RISK MANAGEMENT PLAN

Option	Timescale	Description	Economic Assessment	Impacts	Responsibility	Funding
H1	Short – Medium	Evacuation Planning <ul style="list-style-type: none"> The NSW SES Local Flood Plan was prepared in 2015 and scheduled for a review in 2020. Incorporate any major future events into flood intelligence and evacuation planning. Place signs advising risk of driving through floodwaters on roads subject to inundation. 	Minimal	Helps to maintain community awareness of flooding	SES	
H2	Short	Flood Awareness and Preparedness Develop a flood awareness program, which also includes information about the relationship between the new gauge and Lanes Bridge. Utilise web/GIS based presentations of this information that are publically available.	Minimal	Will reduce damages and disruptions during and post flood event	Council, SES	
H3	Short	Flood Planning Levels <ul style="list-style-type: none"> Revise FPL and FPA as per the outcome of this study. Make the FPL and other flood information and extents available on its website. 	Minimal	Ensures new development does not incur flood damages	Council	Council
H4	Short	Revise LEPs and DCPs Changes to LEP and DCP as specified in Section 6.4.3.2 of the FRMS.	Minimal	Ensures development is compatible with flood risk and an effective measuring in reducing flood damages	Council	Council
H5	Short	Flood Warning <ul style="list-style-type: none"> Develop additional warnings for Warrell Creek and Utungun Install additional gauge in upper reaches of Taylor Arm Develop accurate correlation between new and old sites of Bowraville gauge Monitor timing difference between Utungun, Macksville and Bowraville Add two DPI owned gauges to Event Reporting Radio Telemetry System 	\$60,000	Improved flood warning and safety	Council, SES	

H6	Short	Flood Proofing <ul style="list-style-type: none"> Flood proofing policy should be included in the DCP. Continue to promote flood proofing for commercial properties in the Macksville CBD and Nambucca Heads. Continue to recommend flood proofing requirements for all new development. 	Minimal	An effective measure to minimise flood damages for commercial and industrial properties. May be applicable for some existing residential properties	Council	Council/Owners
M1	Short	Section 149 certificates Reissue s149 certificates to all residents affected by revised FPA. Issue 149(5) at the same time as 149(2) at no additional cost in order to promote flood awareness.	Minimal	Raise awareness of flooding to those properties within the FPA	Council	Council
M2	Short	Land Use Use of simplified modelling to quantify flood risk for Rural DAs	Minimal	Improved flood estimates	Council	Council
L1	Medium	East Macksville Levee Undertake further detailed investigation for the construction of a levee on the eastern side of the Macksville Highway Bridge.	1.07 Estimated costs: \$200,000 Reduction in AAD: \$8,400	Levee will retain water for longer facilitating in evacuation of the area. Levee height has been set to reduce visual impact. Restricts water from entering East Macksville up to and including the 5% AEP flooding event.	Council	
L5	Medium	Flood Access Raise the low point on Wilson Road as part of future road maintenance or works budgets. Review of Council assets in conjunction with the design of bridges and road infrastructure to assess the feasibility of works to improve flood resilience of the community.	As part of maintenance	Provides flood free access up to and including the 5 year ARI flood event. Flood levels are increased upstream of the raised section by up to 0.6m and decreased downstream by 0.08m. Will improve flood access and reduce the frequency of isolation with reconstruction of roads in the future.	Council	
L3	Short (assessment) Long (implementation)	House Raising Undertake further investigations into potential for house raising in the Shire.	\$60,000 per house	Eliminates inundation to the height of the flood and consequently reduces flood damages	Council and Landowner	
L4	Medium	Hyland Park Fill low lying terrain in Hyland Park to 1.4m AHD.	Minimal	Will reduce inundation of land on properties	Landowner	

L6	Medium	Temporary Flood Barriers Consider optimising the East Macksville Levee to include a temporary flood barrier.		Block floodwaters from entering gaps in flood defence levee structures, assuming adequate warning time to implement structures before onset of flooding.	Council	
L7	Short	Town Drain levee Further investigations of Town Drain levee or flap gates		Reduce flood levels	Council	
L2	Short (assessment) Long (implementation)	Voluntary Purchase Assess and consider the viability for voluntary purchase of the two properties in Bowraville.	High	Removal of residents and potential rescuers from danger and cost of future floods. Difficulty in establishing a market value acceptable to State Valuation Office and the resident Residents unwilling to move even with reasonable purchase price Progressive removal of properties may impose stress on social fabric of an area and it may be difficult to find equivalent priced housing in the nearby are with similar aesthetic value or features. Restores the hydraulic capacity of the floodplain		
L8	Short	Stabilisation Program Continue Council's erosion monitoring and stabilisation program.	Low	Monitor riverbank erosion particularly in the vicinity of roads that may be impacted by flooding such as Gumma Road and Rodeo Drive. Implement stabilisation works as necessary.	Council	

4. ACKNOWLEDGEMENTS

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- Nambucca Shire Council
- NSW Office of Environment and Heritage
- Council's Estuary Group
- The residents of Nambucca Shire

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2. WMAwater
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Figures

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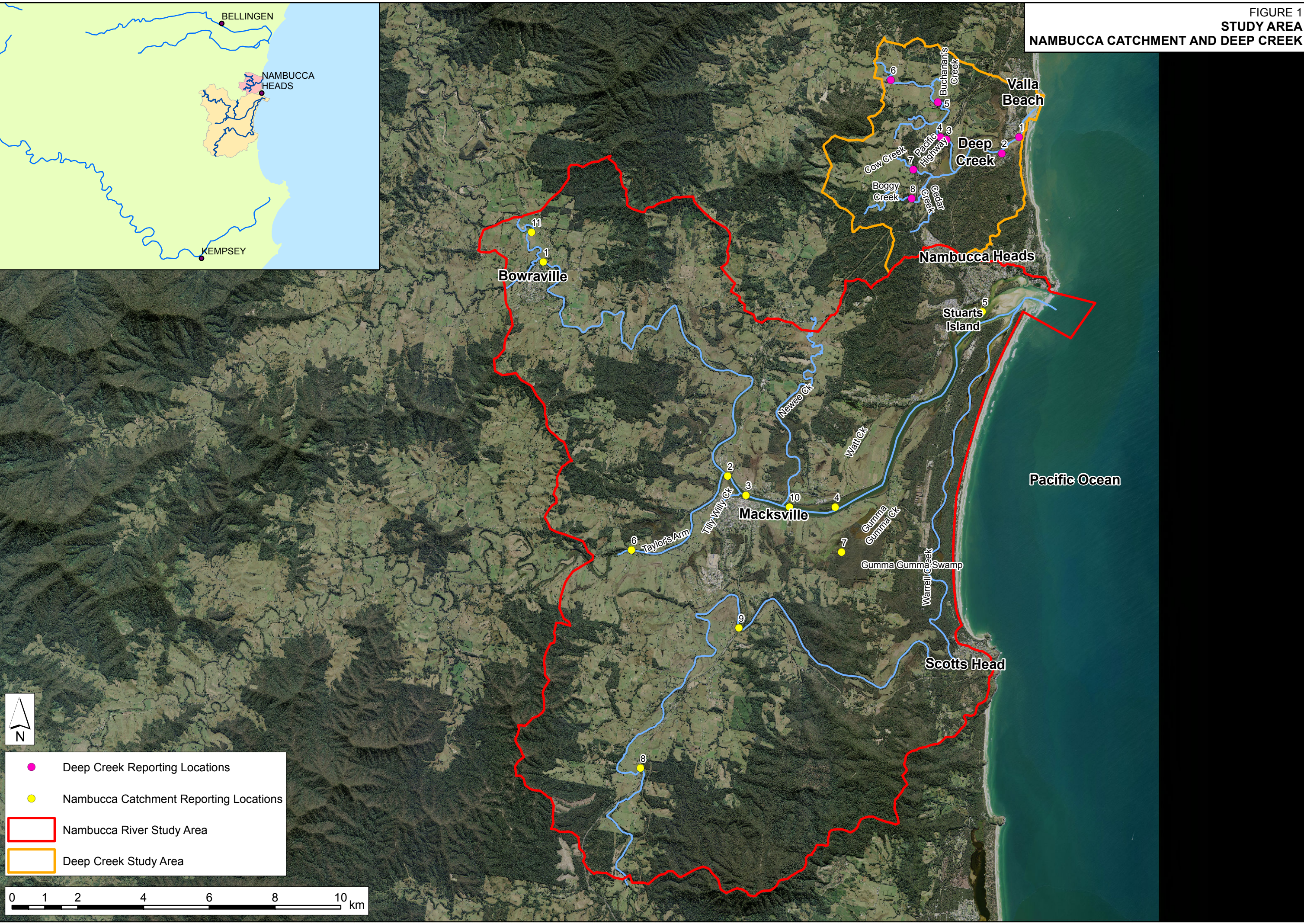
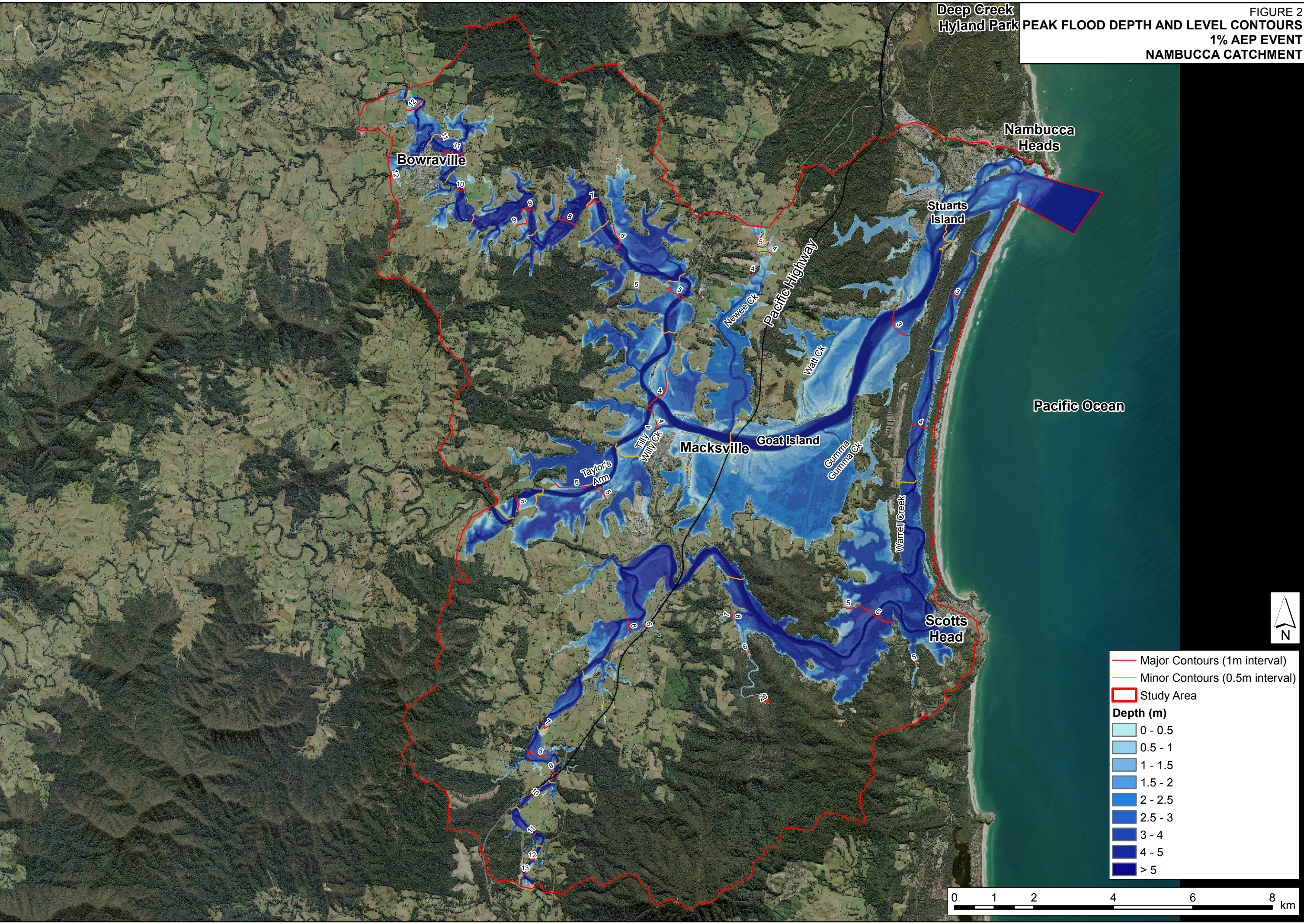
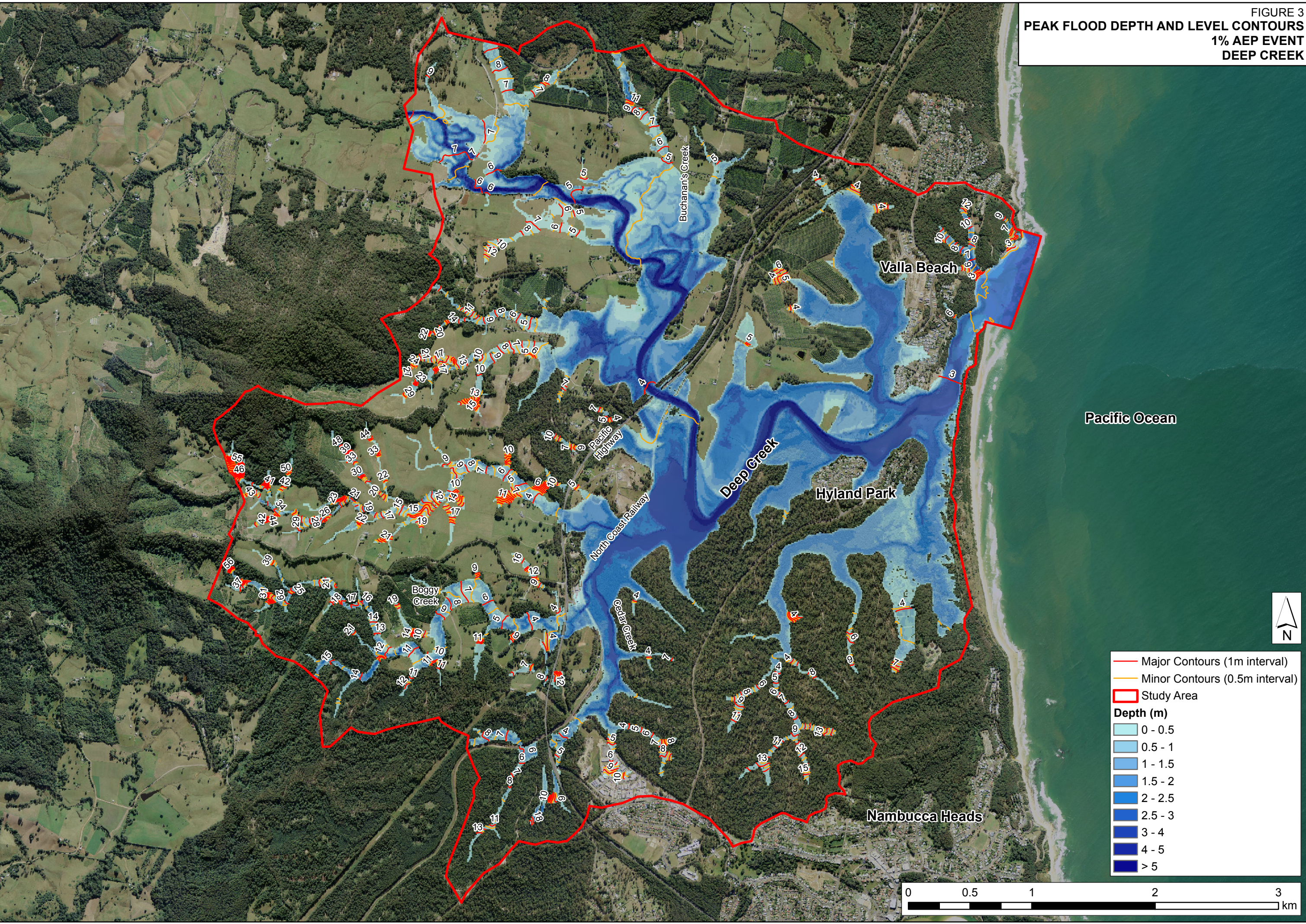


FIGURE 1
STUDY AREA
NAMBUCCA CATCHMENT AND DEEP CREEK



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FIGURE 3
PEAK FLOOD DEPTH AND LEVEL CONTOURS
1% AEP EVENT
DEEP CREEK



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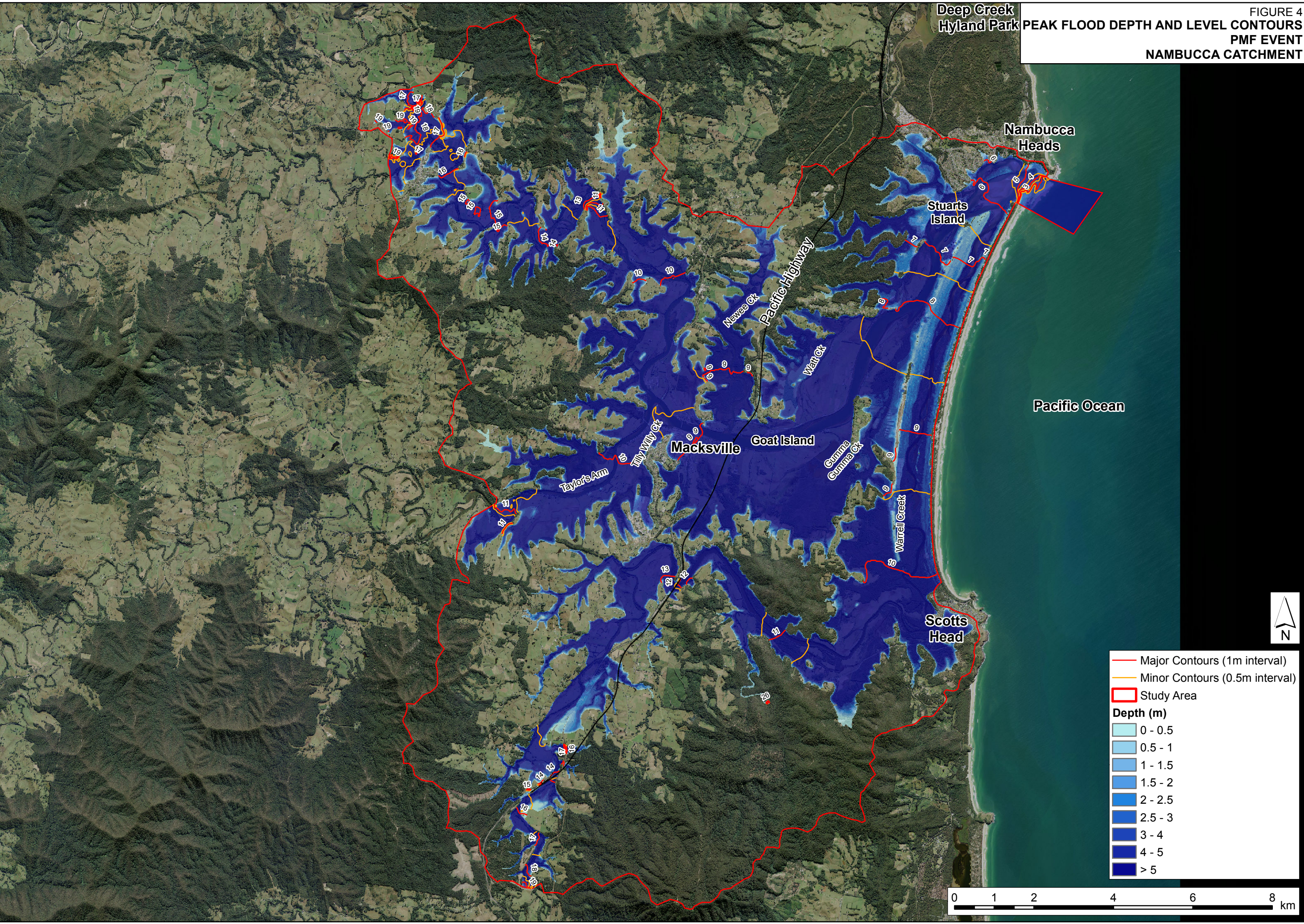


FIGURE 4
PEAK FLOOD DEPTH AND LEVEL CONTOURS
PMF EVENT
NAMBUCCA CATCHMENT

FIGURE 5
PEAK FLOOD DEPTH AND LEVEL CONTOURS
PMF EVENT
DEEP CREEK

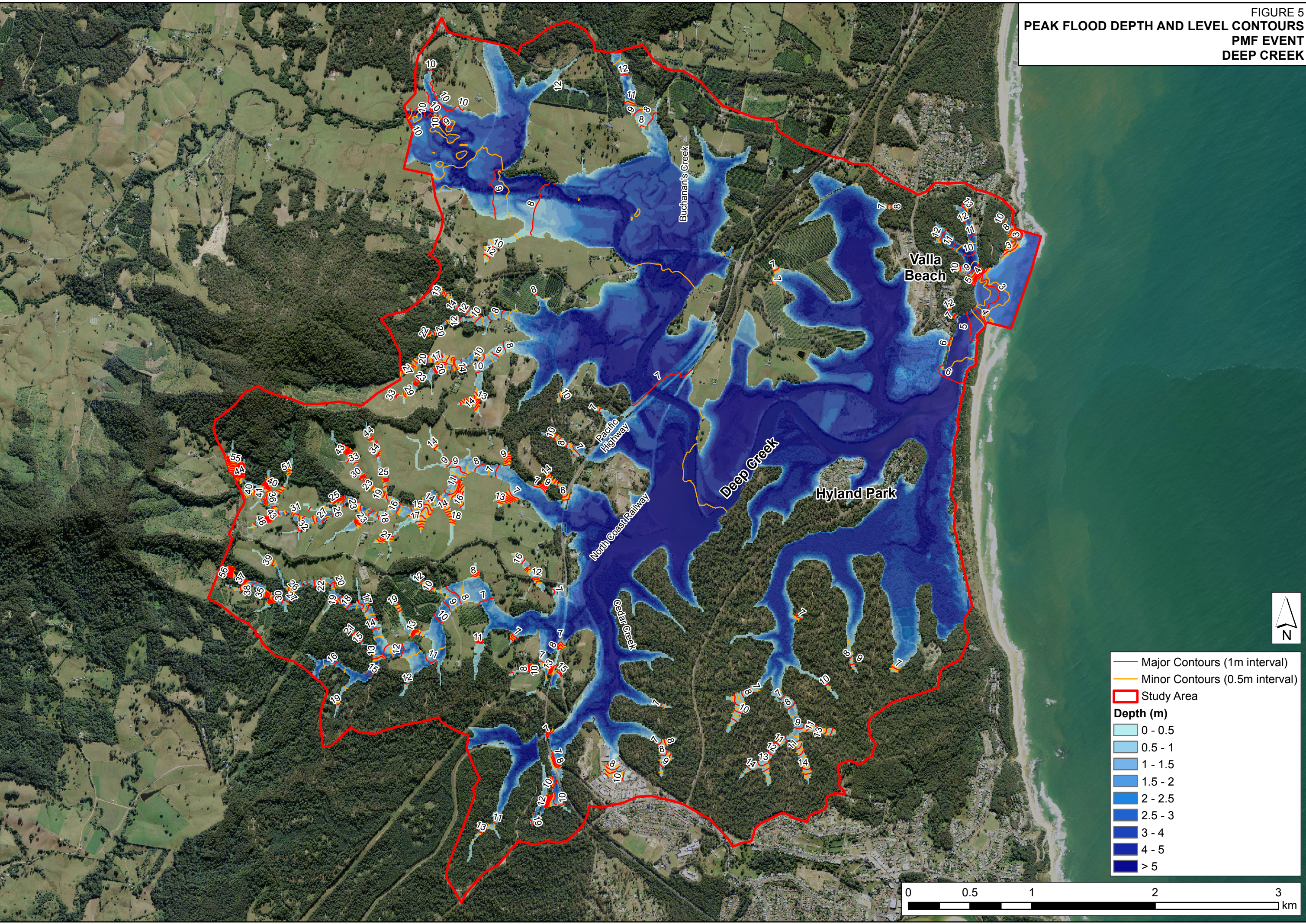


FIGURE 6
HYDRAULIC HAZARD
1% AEP EVENT
NAMBUCCA CATCHMENT

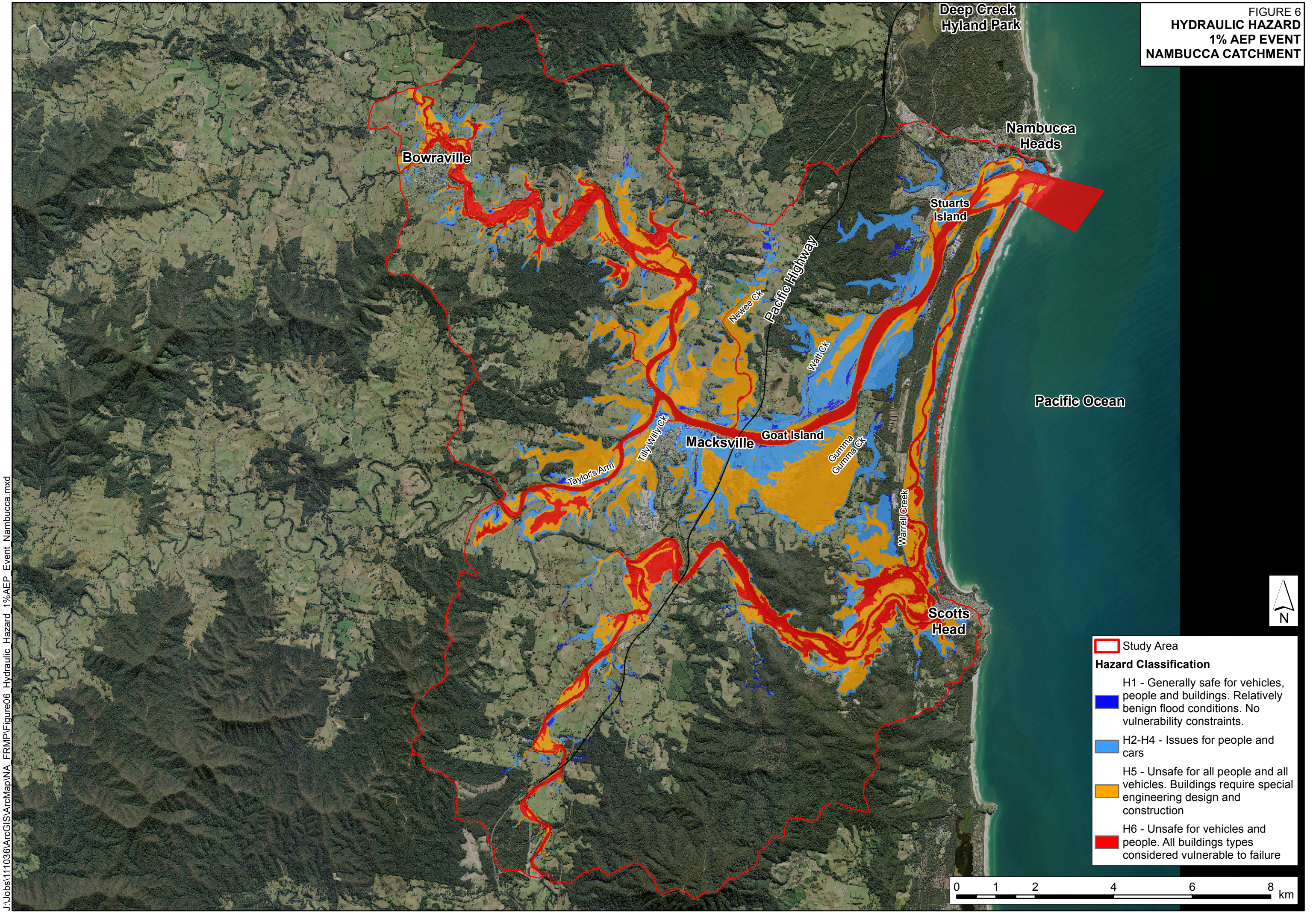
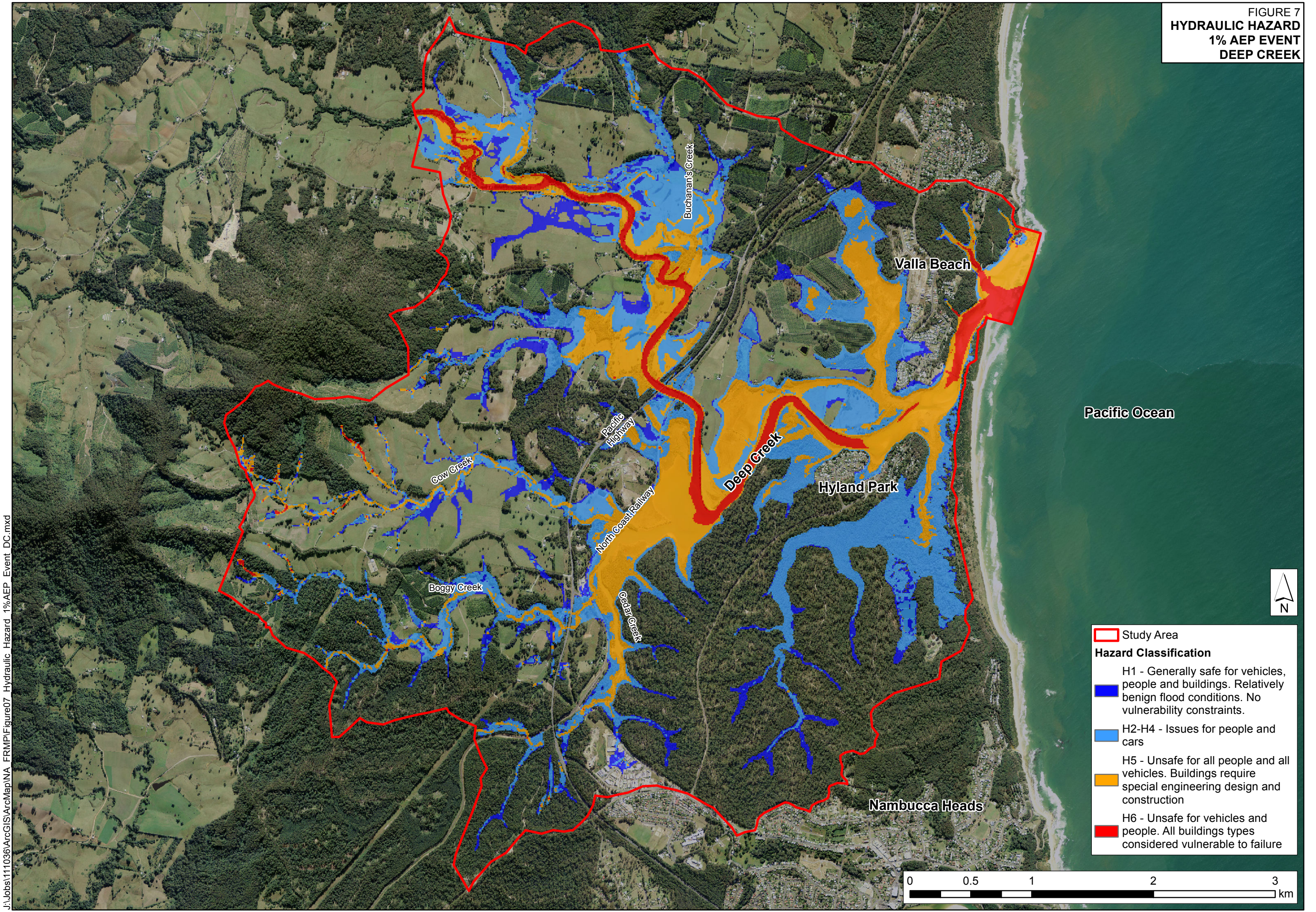


FIGURE 7
HYDRAULIC HAZARD
1% AEP EVENT
DEEP CREEK



Study Area

Hazard Classification

H1 - Generally safe for vehicles, people and buildings. Relatively benign flood conditions. No vulnerability constraints.

H2-H4 - Issues for people and cars

H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction

H6 - Unsafe for vehicles and people. All buildings types considered vulnerable to failure

FIGURE 8
FLOOD PLANNING AREA
NAMBUCCA CATCHMENT

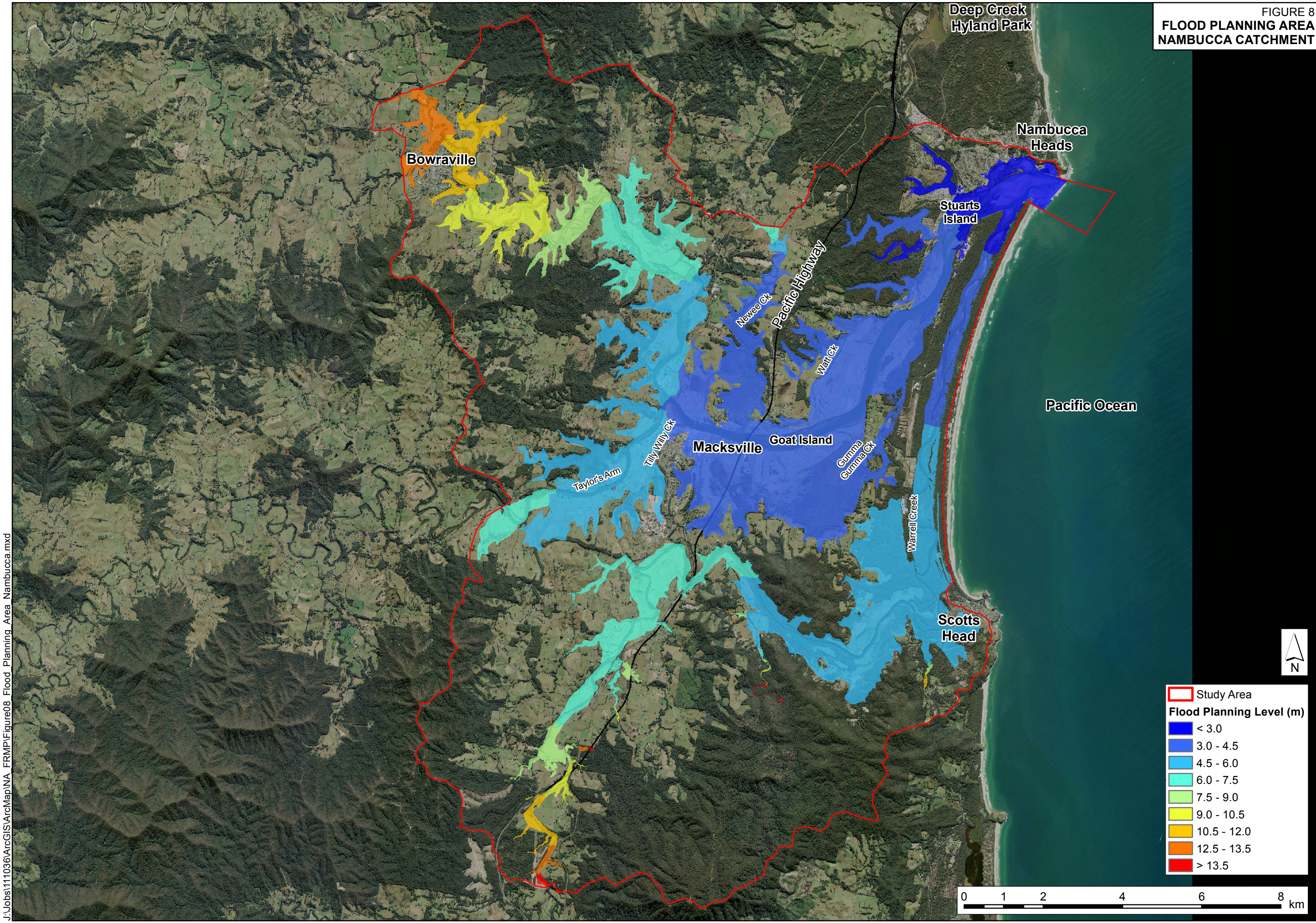


FIGURE 9
FLOOD PLANNING AREA
DEEP CREEK

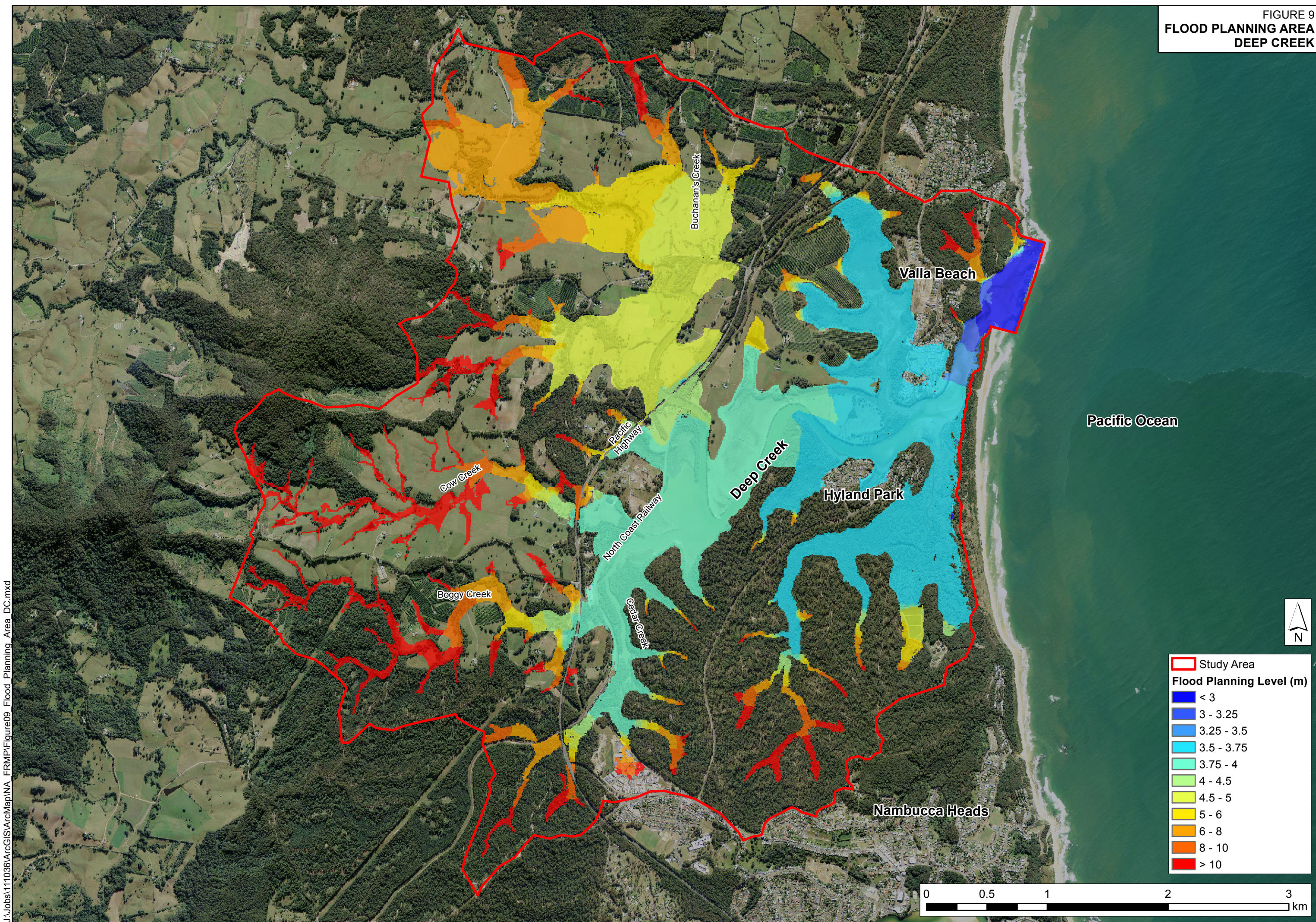


FIGURE 10
EAST MACKSVILLE LEVEE



FIGURE 11
HYLAND PARK FILL



FIGURE 12
TOWN DRAIN LEVEE



Town Drain flow control.
Set to 5% AEP level +0.5m
(Level: 3.1mAHD)

FIGURE 13
FLOOD ACCESS WILSON ROAD





APPENDIX A: GLOSSARY

Taken from the Floodplain Development Manual (April 2005 edition)

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

	redevelopment: refers to rebuilding in an area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either rezoning or major extensions to urban services.
disaster plan (DISPLAN)	A step by step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations, with the object of ensuring the coordinated response by all agencies having responsibilities and functions in emergencies.
discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m ³ /s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).
ecologically sustainable development (ESD)	Using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the Local Government Act 1993. The use of sustainability and sustainable in this manual relate to ESD.
effective warning time	The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.
emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
flash flooding	Flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.
flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
flood awareness	Flood awareness is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.
flood education	Flood education seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.
flood fringe areas	The remaining area of flood prone land after floodway and flood storage areas have been defined.
flood liable land	Is synonymous with flood prone land (i.e. land susceptible to flooding by the probable maximum flood (PMF) event). Note that the term flood liable land covers the whole of the floodplain, not just that part below the flood planning level (see flood planning area).

flood mitigation standard	The average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding.
floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
floodplain risk management options	The measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.
floodplain risk management plan	A management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
flood plan (local)	A sub-plan of a disaster plan that deals specifically with flooding. They can exist at State, Division and local levels. Local flood plans are prepared under the leadership of the State Emergency Service.
flood planning area	The area of land below the flood planning level and thus subject to flood related development controls. The concept of flood planning area generally supersedes the 'flood liable land' concept in the 1986 Manual.
Flood Planning Levels (FPLs)	FPLs are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans. FPLs supersede the 'standard flood event' in the 1986 manual.
flood proofing	A combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.
flood prone land	Is land susceptible to flooding by the Probable Maximum Flood (PMF) event. Flood prone land is synonymous with flood liable land.
flood readiness	Flood readiness is an ability to react within the effective warning time.
flood risk	<p>Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below.</p> <p>existing flood risk: the risk a community is exposed to as a result of its location on the floodplain.</p> <p>future flood risk: the risk a community may be exposed to as a result of new development on the floodplain.</p> <p>continuing flood risk: the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.</p>
flood storage areas	

	<p>Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.</p>
floodway areas	<p>Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flows, or a significant increase in flood levels.</p>
freeboard	<p>Freeboard provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the flood planning level.</p>
habitable room	<p>in a residential situation: a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom.</p> <p>in an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.</p>
hazard	<p>A source of potential harm or a situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community. Definitions of high and low hazard categories are provided in the Manual.</p>
hydraulics	<p>Term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.</p>
hydrograph	<p>A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.</p>
hydrology	<p>Term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.</p>
local overland flooding	<p>Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.</p>
local drainage	<p>Are smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.</p>
mainstream flooding	<p>Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.</p>
major drainage	<p>Councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purpose of this manual major drainage involves:</p> <ul style="list-style-type: none">• the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or

	<ul style="list-style-type: none"> • water depths generally in excess of 0.3 m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; and/or • major overland flow paths through developed areas outside of defined drainage reserves; and/or • the potential to affect a number of buildings along the major flow path.
mathematical/computer models	The mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.
merit approach	<p>The merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State=s rivers and floodplains.</p> <p>The merit approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into Council plans, policy and EPIs. At a site specific level, it involves consideration of the best way of conditioning development allowable under the floodplain risk management plan, local floodplain risk management policy and EPIs.</p>
minor, moderate and major flooding	<p>Both the State Emergency Service and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood:</p> <p>minor flooding: causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded.</p> <p>moderate flooding: low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered.</p> <p>major flooding: appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.</p>
modification measures	Measures that modify either the flood, the property or the response to flooding. Examples are indicated in Table 2.1 with further discussion in the Manual.
peak discharge	The maximum discharge occurring during a flood event.
Probable Maximum Flood (PMF)	The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation

works and controlling development, up to and including the PMF event should be addressed in a floodplain risk management study.

**Probable Maximum
Precipitation (PMP)**

The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.

probability

A statistical measure of the expected chance of flooding (see AEP).

risk

Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.

runoff

The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.

stage

Equivalent to Awater level@. Both are measured with reference to a specified datum.

stage hydrograph

A graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum.

survey plan

A plan prepared by a registered surveyor.

water surface profile

A graph showing the flood stage at any given location along a watercourse at a particular time.

wind fetch

The horizontal distance in the direction of wind over which wind waves are generated.