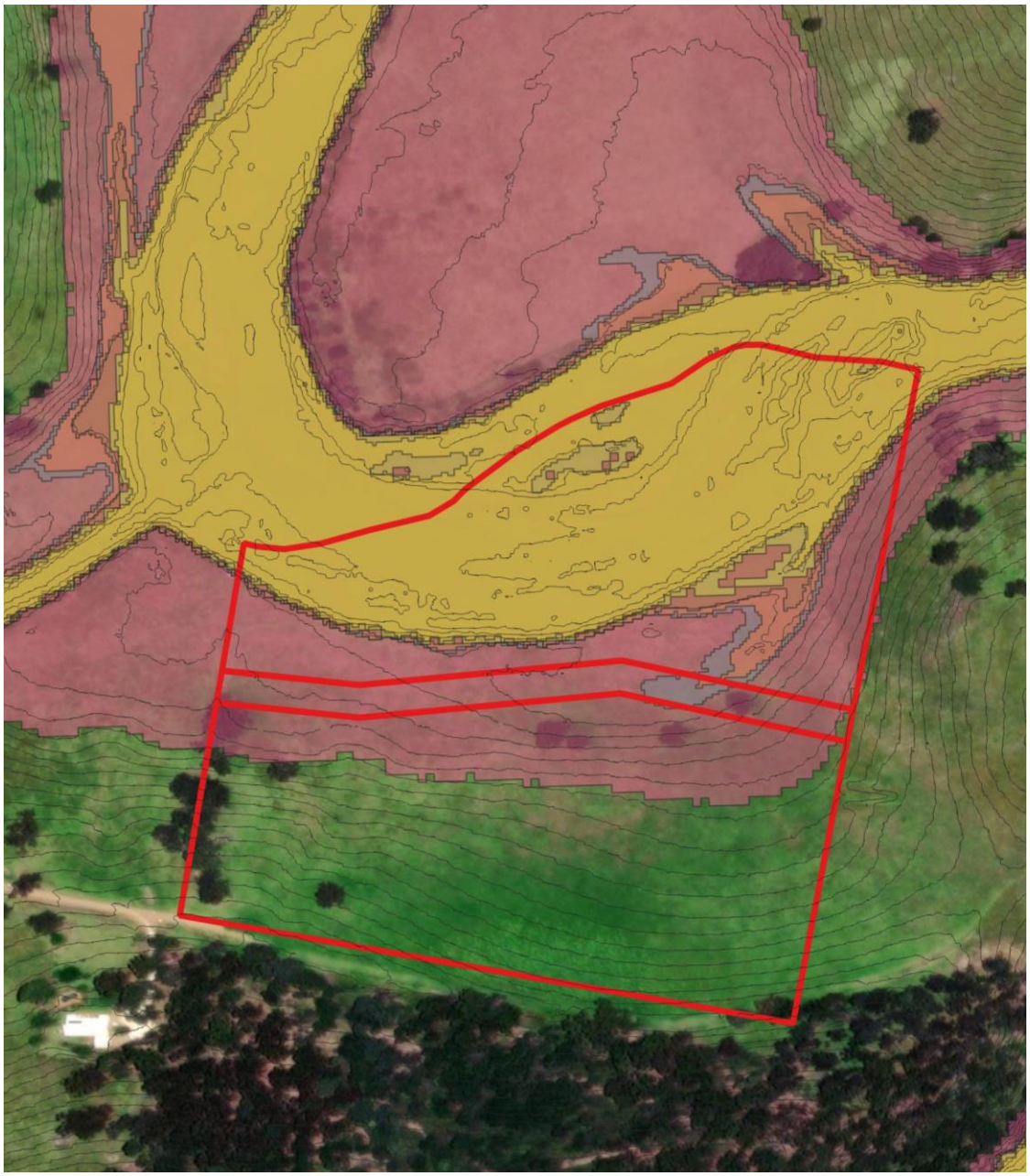
TA PROJECT SERVICES
TOGETHER ACHIEVE



TA Project Services – J229

Flood Impact Risk Assessment

Tuesday, 18 February 2025

1. Document Control

Revision	Description	Prepared	Reviewed	Date
V0.1	First Draft	Benjamin Mead	Benjamin Mead, Carley McGregor	27 August 2024
V1.0	Final Report	Benjamin Mead	Benjamin Mead, Carley McGregor	18 November 2024
V2.0	Amended R5 Proposal	Benjamin Mead	Benjamin Mead, Carley McGregor	13 February 2025
V2.1	Client Review	Benjamin Mead	Benjamin Mead	18 February 2025

Summary

A Flood Impact Risk Assessment has been undertaken to support the planning proposal to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The planning proposal seeks to rezone the portion of the subject site above the PMF Flooding Extent, to enable six R5 Large Lot Residential lots of minimum lot size of 7000m^2. The proposed rezoning and concept subdivision proposal has been prepared with consideration to flood risk, proposing to rezone the portion above the PMF only to ensure all future residential development following the subdivision is not flood affected.

As part of this Flood Impact Risk Assessment, an analysis of the adopted Pambula River, Pambula Lake and Yowaka River Flood Study has been carried out at the subject site, to assess the direct and indirect impacts of flooding. This Flood Impact Risk Assessment has supported the findings of the adopted Flood Study, through the review of historical flood events and undertaking a site inspection to confirm the current-day landform is consistent with the modelled landform within the Flood Models.

The outcome of this Flood Impact Risk Assessment supports the planning proposal to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, which will facilitate residential development on the newly created lots.

1. Introduction

1.1. Background

Cobandrah Pty Ltd has engaged TA Project Services to complete a Flood Impact Risk Assessment (FIRA) to support the Planning Proposal of Lot 1 DP 130034 & Lot 5 DP750207 (herein referred to as the subject site). The Planning Proposal seeks to rezone approximately 4.6 hectares of the subject site from RU2 Rural Landscape to R5 Large Lot Residential. This rezoning is proposed to reduce the minimum lot size from 120ha to 7000m^2 and enable subdivision of the subject site into six lots.

The subject site is addressed as 299/300 Mount Darragh Road, Lochiel NSW 2549, legally defined as Lot 1 DP130034 & Lot 5 DP750207. The combined land area of the subject site is approximately 13 hectares and is bounded by the Pambula River to the North, an unformed, unnamed road to the West an unformed, unnamed road to the South and vacant property to the East. The nearest formed road to the subject site is Mount Darragh Road (MR91) which is approximately 230m to the west, and the nearest urban centre is the village of Pambula, which is approximately 7.8km from the subject site via Mount Darragh Rd and the Princes Highway. A Locality Plan is provided in Figure 1.

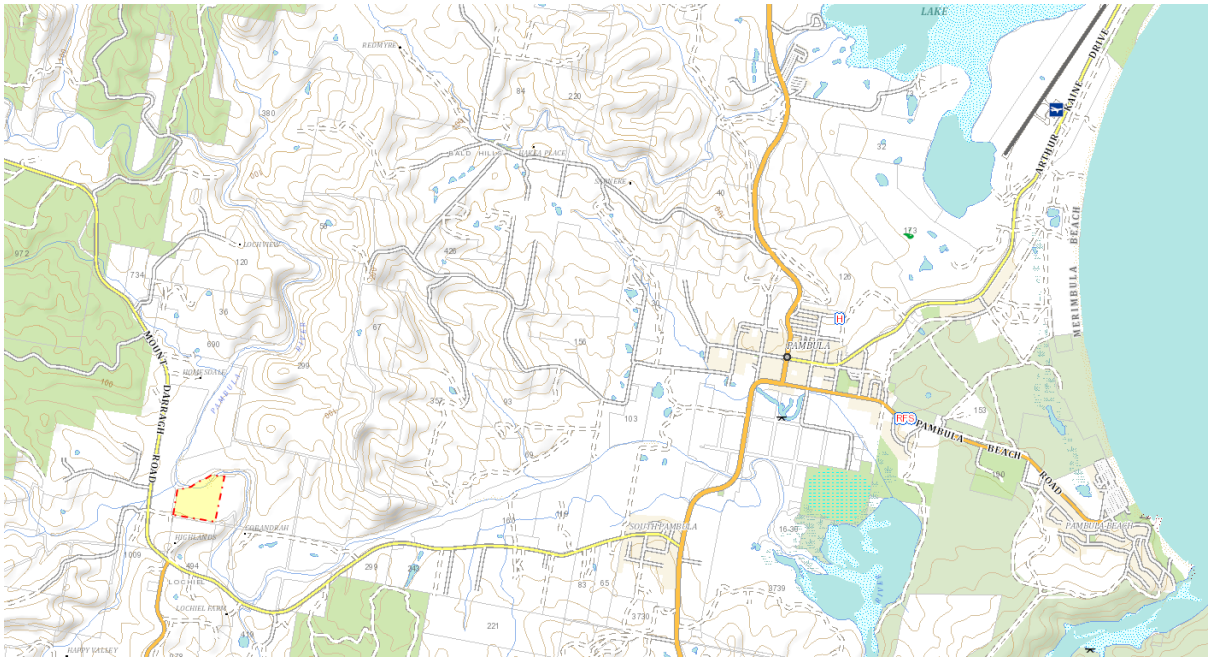


*Figure 1: Locality Plan (*SIX Maps*, n.d.)*

1.2. Strategic Planning Considerations

The Planning Proposal seeks to develop the unformed road to the south of the subject site, to provide legal access and frontage to six R5 Large Lot Residential lots. The proposed subdivision concept is detailed in Figure 2.

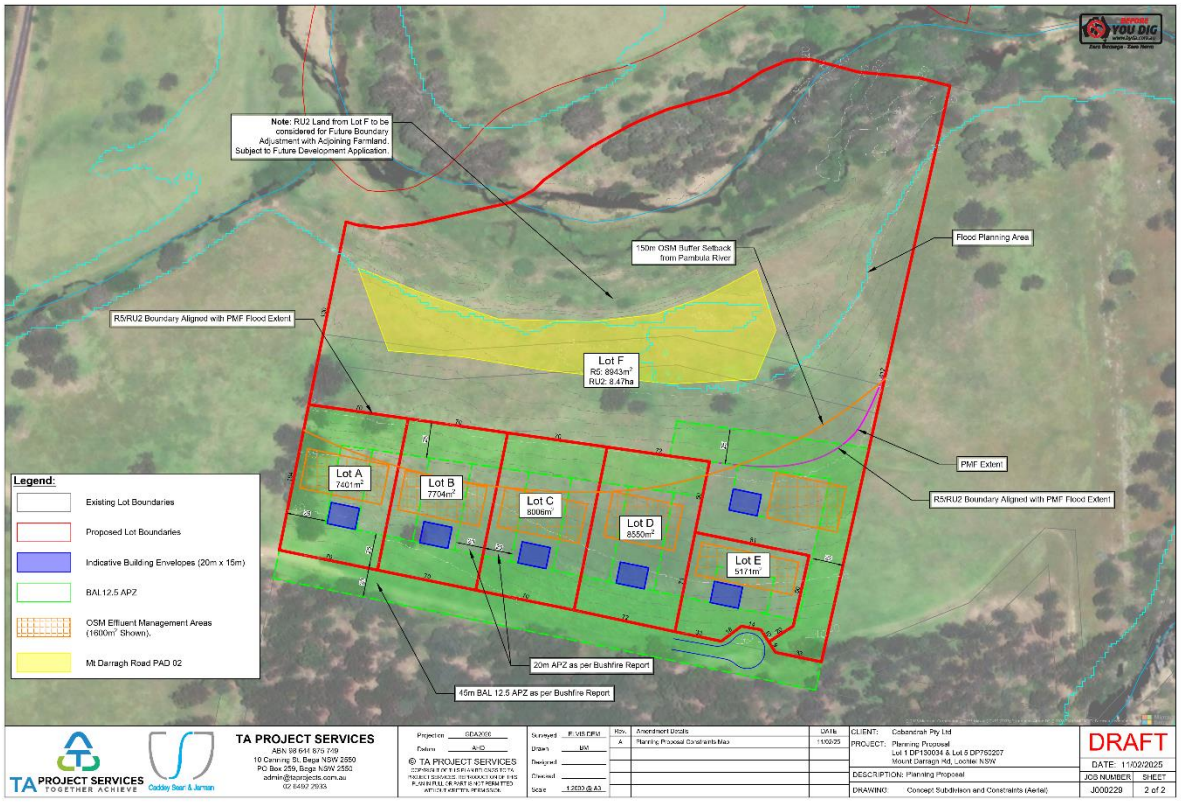


Figure 2: Concept Subdivision Proposal

Bega Valley Shire Council has previously identified the subject site as an opportunity for future rural residential development, forming part of 'Area 3' in the Pambula Catchment of the BVSC Rural Residential Land Strategy 2020. Area 3 is generally described as *relatively unconstrained and generally contains lower quality agricultural land despite a small area of Category 2 Agricultural Class Land alongside the river. The area is sufficient distance from an existing agricultural activity likely to cause land use conflict, has good access to existing road infrastructure and is close to existing rural residential development surrounding South Pambula* (Bega Valley Shire Council, 2020, p. 32). The subject site is shown within Area 3 in Figure 3.

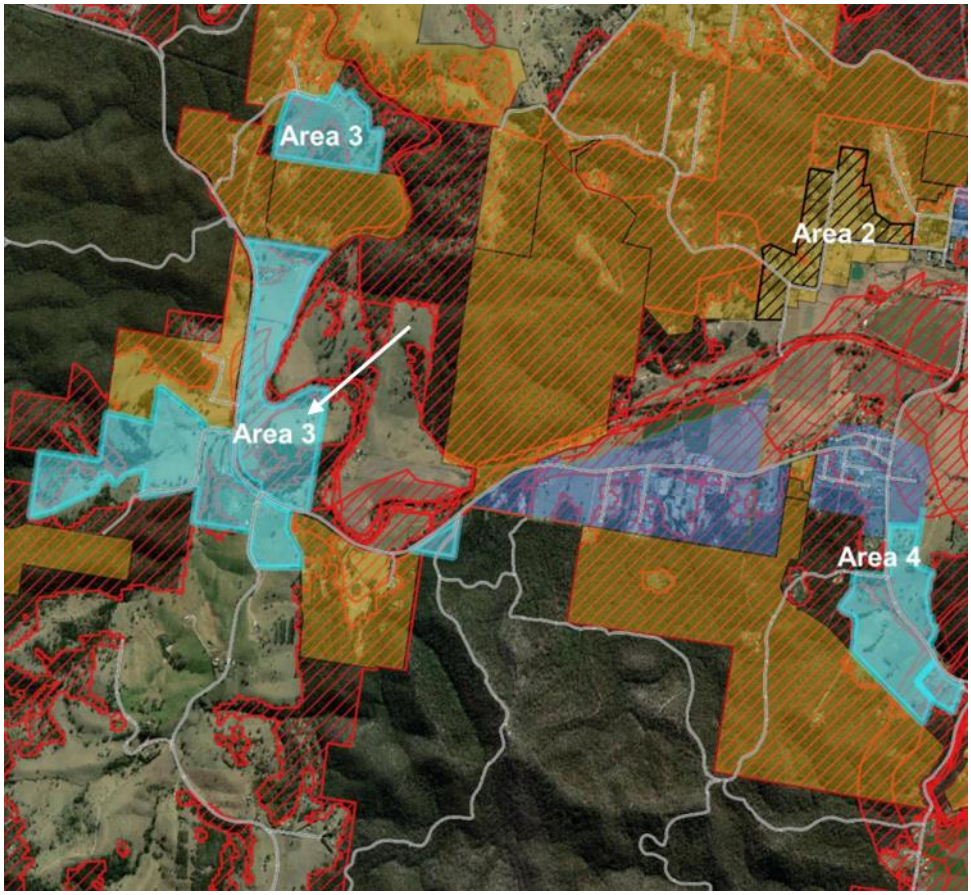


Figure 3: Extract of Pambula Future Directions (Bega Valley Shire Council, 2020, p. 33)

The primary reason for the rezoning under the planning proposal is to reduce the minimum lot size of the subject site, to permit future subdivision. Currently, the subject site does not have sufficient lot size to meet the minimum lot size of the RU2 zoning, preventing it from being developed for residential purposes. A summary of the Land Use changes which would accompany the rezoning proposal is presented in Table 1, which highlights the land uses that would no longer be permitted through Red Text, and the land uses that would now be permitted through Green Text.

Table 1: Land Use Table (Bega Valley Local Environmental Plan 2013, n.d.)

Land Use Table	
Zone RU2 Rural Landscape	Zone R5 Large Lot Residential
Objectives of zone To encourage sustainable primary industry production by maintaining and enhancing the natural resource base. To maintain the rural landscape character of the land. To provide for a range of compatible land uses, including extensive agriculture. **2 Permitted without consent.** Environmental protection works; Extensive agriculture; Home businesses; Home industries; Home occupations. **3 Permitted with consent.** Agritourism; Airstrips; Animal boarding or training establishments; Aquaculture; Bed and breakfast accommodation; Boat launching ramps; Building identification signs; Business identification signs; Camping grounds; Cellar door premises; Cemeteries; Charter and tourism boating facilities; Community facilities; Crematoria; Dual occupancies; Dwelling houses; Eco-tourist facilities; Environmental facilities; Farm buildings; Farm stay accommodation; Flood mitigation works; Function centres; Garden centres; Hardware and building supplies; Heavy industrial storage establishments; Helipads; Home-based child care; Information and education facilities; Intensive plant agriculture; Jetties; Landscaping material supplies; Light industries; Places of public worship; Plant nurseries; Recreation areas; Recreation facilities (outdoor); Restaurants or cafes; Roads; Roadside stalls; Rural industries; Rural supplies; Rural workers' dwellings; Secondary dwellings; Storage premises; Vehicle body repair workshops; Vehicle repair stations; Veterinary hospitals; Water recreation structures; Water supply systems; Wholesale supplies **4 Prohibited** Any development not specified in item 2 or 3	**Objectives of zone** To provide residential housing in a rural setting while preserving, and minimising impacts on, environmentally sensitive locations and scenic quality. To ensure that large residential lots do not hinder the proper and orderly development of urban areas in the future. To ensure that development in the area does not unreasonably increase the demand for public services or public facilities. To minimise conflict between land uses within this zone and land uses within adjoining zones. **Permitted without consent.** Environmental protection works; Extensive agriculture; Home businesses; Home industries; Home occupations. **Permitted with consent.** Bee keeping; Cellar door premises; Dwelling houses; Information and education facilities; Landscaping material supplies; Oyster aquaculture; Plant nurseries; Pond-based aquaculture; Roads; Roadside stalls; Tank-based aquaculture; Any other development not specified in item 2 or 4 **Prohibited** Advertising structures; Air transport facilities; Airstrips; Amusement centres; Attached dwellings; Backpackers' accommodation; Biosolids treatment facilities; Boat building and repair facilities; Boat sheds; Camping grounds; Car parks; Caravan parks; Cemeteries; Charter and tourism boating facilities; Correctional centres; Crematoria; Depots; Dairies (pasture-based); Eco-tourist facilities; Emergency services facilities; Entertainment facilities; Exhibition villages; Extractive industries; Forestry; Freight transport facilities; Funeral homes; Heavy industrial storage establishments; Helipads; Highway service centres; Home occupations (sex services); Industrial retail outlets; Industrial training facilities; Industries; Intensive livestock agriculture; Local distribution premises; Marinas; Mooring pens; Moorings; Mortuaries; Multi dwelling housing; Office premises; Open cut mining; Passenger transport facilities; Port facilities; Recreation facilities (indoor); Recreation

	facilities (major); Recreation facilities (outdoor); Registered clubs; Residential flat buildings; Restricted premises; Retail premises; Rural industries; Rural workers' dwellings; Semi-detached dwellings; Seniors housing; Service stations; Serviced apartments; Sewage treatment plants; Sex services premises; Shop top housing; Storage premises; Transport depots; Truck depots; Vehicle body repair workshops; Vehicle repair stations; Warehouse or distribution centres; Waste or resource management facilities; Water recycling facilities; Water reticulation systems; Water treatment facilities; Wharf or boating facilities; Wholesale supplies

1.3. Project Context

The subject site is located adjacent to the Pambula River. The Pambula River is located in the Towamba River Basin (No 220), with a permanent water monitoring station 220003 located approximately 350m downstream of the subject site, which has been in service since 31/08/1966 (WaterNSW, n.d.).

The subject site is in the Local Government Area of the Bega Valley. The Bega Valley Shire Council commissioned a Flood Study for the Pambula River in 2019, in conjunction with the Pambula Lake and Yowaka River(Bega Valley Shire Council, 2021b). Bega Valley Shire Council adopted the Final Flood Study Report on 21 July 2021 as per Council Resolution 173/21(Bega Valley Shire Council, 2021a). Bega Valley Shire Council has not yet adopted a Floodplain Risk Management Study or Floodplain Risk Management Plan for the Pambula River. Without a Floodplain Risk Management Study and Plan to consider, key findings from the Pambula River, Pambula Lake and Yowaka River Flood Study are:

- The Flood Planning Level is the 1:100ARI (1% AEP) Flood Event, plus 0.5m freeboard.
- The peak flood levels from the 1% AEP Flood with a 0.9m increase in sea level were used for the basis of the FPL.
- A 0.5m freeboard is suitable to account for uncertainty in the 1% AEP Flood Level Estimates.
- Future development may have small localised adverse impacts on flood behaviour (i.e., increases in flood discharges and levels), however, flooding across the broader catchment is not predicted to be significantly impacted (Catchment Simulation Solutions, 2021, pp. 93–94, 101).

The proposed development of the subject site has previously been assessed as a scoping proposal by Government Agencies, from referral by Bega Valley Shire Council. The scoping proposal addressed flood risk via the following statement.

> *Pambula River is situated on the northern boundary, and areas of the Site adjacent to the river are constrained by potential flooding (see Pambula River, Pambula Lake, Yowaka River Flood Study 2021). The proposed lots, and the location of building envelopes, have been designed having regard to this potential flooding risk. Relatedly, consideration of onsite sewage management has also had regard to this aspect (see Appendix B), incorporating requirements outlined in the BVSC Development Control Plan 2013, in particular as it relates to precluding activity within 150m of council nominated waterways (which includes the Pambula River).*

Referral response from Bega Valley Shire Council and the Department of Climate Change, Energy, the Environment and Water specified the need for a Flood Impact Risk Assessment which considered a range of floods up to the Probable Maximum Flood to be prepared to identify and address issues relating to flood risk, impacts and public safety. The requirements of the FIRA as requested are detailed in Section 1.4 FIRA Requirements.

1.4. FIRA Requirements

Bega Valley Shire Council is the Consent Authority for the Bega Valley LGA and has reviewed the initial scoping proposal of the subject site, submitted 9 February 2024. As part of the Bega Valley Shire Council's Assessment, a Flood Impact Risk Assessment was requested to be prepared and submitted with the planning proposal. The detailed request from Bega Valley Shire Council was:

> *A Flood Impact and Risk Assessment (FIRA) to address the requirements of the local planning direction over the range of floods up to the Probable Maximum Flood (PMF) and issues relating to flood risk, impacts and public safety identified in BCS feedback.*

In addition to Bega Valley Shire Council's assessment, the NSW Department of Climate Change, Energy, the Environmental and Water (Biodiversity Conservation and Science) requested a site-specific FIRA. The detailed request from Biodiversity Conservation and Science was:

> *The proposal involves the rezoning and intensification of development on flood prone land and therefore will need to be considered in accordance with Section 9.1(2) Local Planning Direction 4.1-Flooding and the NSW Government's Flood Prone Land Policy as set out in the Flood Risk Management Manual, 2023. The policy aims 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.*
>
> *The site is subject to a Flood Planning Constraint Category (FPCC) 1 flooding as identified in council's Pambula River, Pambula Lake and Yowaka River Flood Study (2021). The planning proposal should be based on a thorough understanding of flood behaviour to avoid adverse flood impacts to people, property and the environment during times of flood. The scoping proposal documentation does not currently provide consideration of flood risk or impacts both on and off the subject land. A site-specific Flood Impact Risk Assessment (FIRA) will need to be undertaken and demonstrate consistency with the requirements of the local planning direction and Flood Risk Management Manual. Guidance on the requirements for a fit for purpose FIRA can be found at: Flood Impact and Risk Assessment \| NSW Environment and Heritage*
>
> *The FIRA should assess flood risk over the full range of possible floods up to the probable maximum flood (PMF) and address the following key matters:*
>
> - *The impact of flooding on the proposed development.*
> - *The impact of the proposed development on flood behaviour, including any offsite flood impacts due to any land-use and landform changes.*
> - *The impact of flooding on the safety of people for the full range of floods including issues linked with isolation and accessibility for emergency services during times of flood.*
> - *Assess the effectiveness of any proposed management measures to manage the impacts of flooding to future development and off-site impacts.*
> - *Establish that proposed land-use zones are informed by an understanding of flood behaviour and is compatible with the flood function, hazard, natural flow paths and Bega Valley Local Environmental Plan (LEP) 2013 for flood risk, riparian land and watercourse environment objectives. The proposed land use zone for high hazard and riparian lands could be an environmental conservation zone and establish if there are any conflicts with permissible use in the LEP such as residential development in hazardous areas.*
> - *If the planning proposal includes land-use zones that enables residential use of the floodplain, it will require a thorough assessment of flood planning levels considering flood risk, the implications of climate change to flooding (particularly increased rainfall intensity), cumulative development impacts, structure blockage and inherit flood estimation variability and uncertainty. We note that council has not yet completed its Flood*

Risk Management Study and Plan for this area and as such flood planning levels consistent with the principles of the Flood Risk Management Manual are not yet established.

With regard to flood risks to public safety and emergency service implications, we recommend the proponent also seek early advice of the NSW State Emergency Service (SES) as the responsible authority for emergency management planning. As a minimum, the FIRA should demonstrate how flood access/egress to all proposed residential lots is possible and the merit of emergency management strategies developed in consultation with the SES. Typically such an assessment would address:

- *Potential isolation times over a range of design flood events and durations for from frequent events and up to the PMF.*
- *Number of lots that are likely to be isolated.*
- *Number of lots which will be isolated then inundated (including consideration of peak inundation level as well as peak isolation event) particularly where residential development is permissible on flood prone land (i.e. PMF). Evidence should be provided on the event that causes the longest duration of isolation (see below).*
- *Any alternate isolation risks which are beyond the site and outside of the area of potential influence of this development proposal (i.e. other points at which road access routes may be cut including those not in the vicinity of the development).*
- *The requirements of a flood emergency management strategies and capability assessment should be prepared consistent with available guidance and in consultation with the SES.*

Reference and details to undertake an isolation assessment and emergency capability assessment can be found in the following EMO1 guide: Support for Emergency Management Planning | NSW Environment and Heritage

As per the NSW Government Flood Risk Management Guideline for Flood Impact and Risk Assessment, a Detailed Flood Impact and Risk Assessment is required as the proposal includes Rezoning of Land. The following information will be provided herein for the FIRA:

- Flooding Background
- Available Flooding Information
- Flood Related Requirements
- Pre-developed Modelling and Analysis
- Post-developed Modelling and Analysis
- Key Risks to be Managed
- Conclusion and Recommendations

2. Background

2.1. Study Area

The subject site is partially within the riverbanks of the Pambula River; however, most of the site area is above the riverbanks of the Pambula River, on cleared, gently sloping land which has been utilised for pastoral farming previously. The upstream catchment area consists of similar landscapes and steep forested regions.

Figure 4: Subject Site Aerial Image

The upstream catchment area is approximately 105km^2 and consists of major tributaries of Burtons Creek, Seven Mile Creek and Chalkhills Creek. The majority of the catchment area is State Forest and National Parks, with the remaining area consisting of forested rural land, for agricultural and residential purposes The approximate boundaries of the 105km^2 catchment area are presented in Figure 5 and Figure 6.

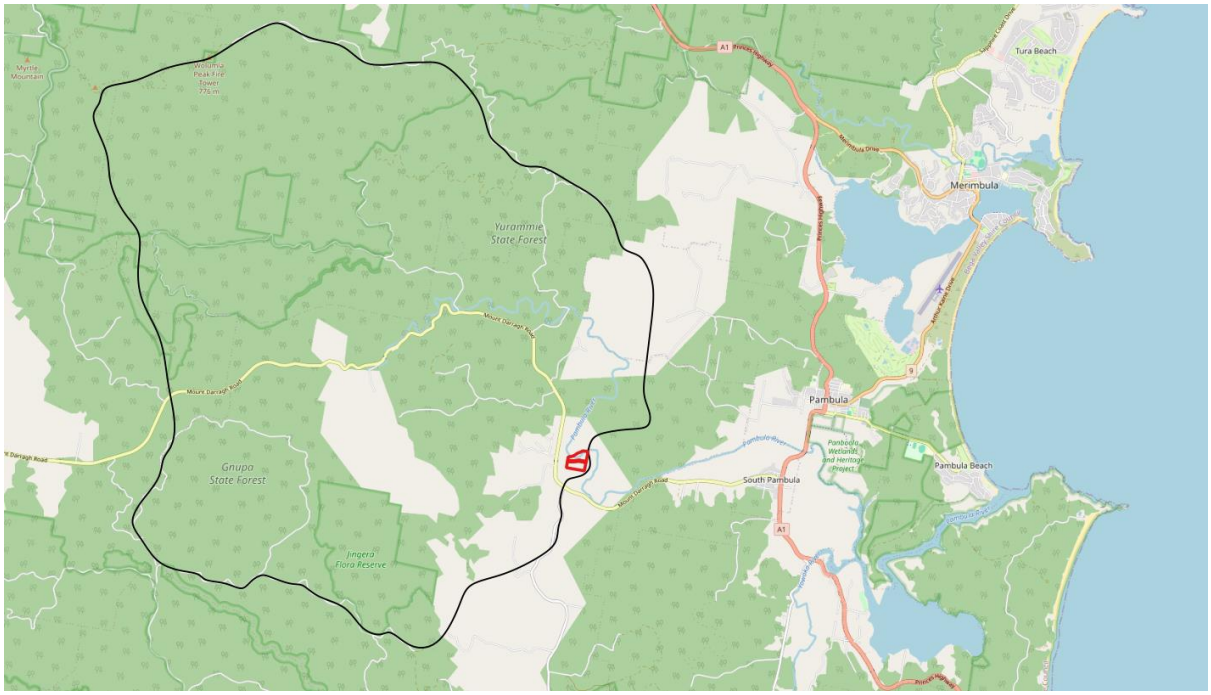


Figure 5: Subject Site Catchment Area

Figure 6: Subject Site Catchment Area (Aerial Image)

The Tidal Limit of the Pambula River is identified as 100m downstream of the Princes Highway Bridge (Instream Ecological Value for NSW Freshwater Riverine Ecosystems, n.d.), which is approximately 6.6km downstream of the subject site. The Pambula River, Pambula Lake, and Yowaka River Flood Study identifies that the extent of Oceanic Influence through Sea Level Rise does not impact the subject site for the 1% AEP Flood.

2.2. Known Flooding Behaviour

Flooding associated with the Pambula River is Riverine Flooding or Mainstream Flooding. Whilst being riverine flooding conditions, the conditions also resemble flash-flooding conditions as flood levels rise rapidly in the first six hours of rainfall. Flooding across the catchment can occur from a variety of different storms and rainfall durations, however, worst-case flooding typically occurs from a critical storm duration of 12 hours for flood events up to the 0.2% AEP, reducing to a critical storm duration of 4 hours for the PMF Flood Event (Catchment Simulation Solutions, 2021, p. 102). The flood extent at the subject site is contained within the flood banks of the Pambula River for all flood events up to the 0.2% AEP, with only the PMF flood event overtopping the flood banks. An extract of the Flooding Extents Map for the Subject Site is presented in Figure 7, with the full map provided as Figure 97. The flooding extent map demonstrates that the southern extent is flood-free for all flood events, for a distance of approximately 100m.

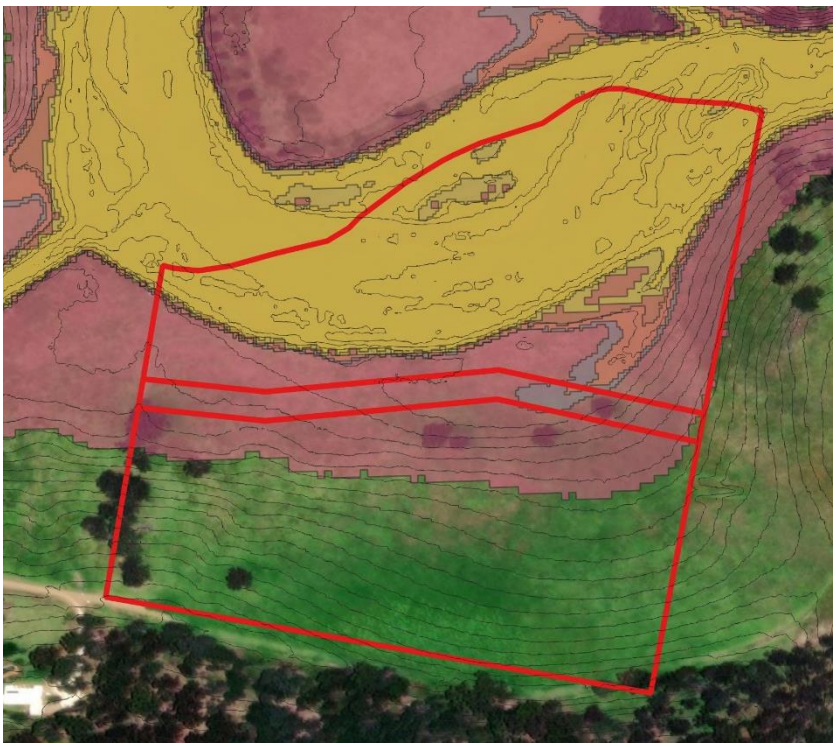


Figure 7: Flood Extent Extract

The main channel flows of flood waters within the Pambula River adjacent to the subject site are of high hazard to people, vehicles and buildings, resulting in an H6 Hazard Rating for all events from the 5% AEP to the PMF Flood Event. As the flow conveyance for flood events up to the 0.2% AEP are contained within the flood banks of the Pambula River, there is only a small portion of the flood extent which is of low hazard. An extract of the 1% AEP Flood Hazard is presented in Figure 8, with the full map provided as Figure 98. The flood category for flows associated with the 1% AEP Flood is primarily defined as a floodway; the areas that convey a significant discharge of water during floods and are sensitive to changes that impact flow conveyance. Therefore, any proposed development within the flood extents is generally not compatible with the flood function, and development must generally occur beyond the flooding extent on the subject site. An extract of the 1% AEP Flood Category is presented in Figure 9, with the full map provided as Figure 99.

Figure 8: 1% AEP Flood Hazard Extract

Figure 9: 1% AEP Flood Category Extract

2.3. Flood History

Flooding of the Pambula River has been apparent since early settlement when flooding in 1851 and 1860 forced the Pambula Township to be relocated to its current position. Historical Flooding information and the impacts on the Pambula township from 1851 to 1990 are summarised in the Pambula River Data Assessment Study (Public Works Department, 1990, pp. 3–13). Flooding experiences at the subject site are unknown, as the site has previously been used for pastoral grazing and has not been subject to development which would be impacted by flooding.

Several significant flood events were relied upon for calibration as part of the Pambula River, Pambula Lake and Yowaka River Flood Study. The five events used were the 1971, 1985, 2011, 2012 and 2016 floods. The 1971 flood is famous for being the largest recorded flood in the Bega Valley, which resulted in the loss of two lives, and over 50 bridges being destroyed throughout the Bega Valley (SMEC, 2014, p. 29). The 2011, 2012 and 2016 floods were the key flood events that contributed to the Pambula River, Pambula Lake and Yowaka River Flood Study being commissioned (Bega Valley Shire Council, 2021b).

Stream flow data from the Water Monitoring Station 220003 immediately downstream of the subject site also provides instantaneous flow rates of the Pambula River and has records from 1966 to current. Based on the instantaneous flow rates recorded, it is also apparent that the Pambula River experienced significant flood events in 1992, 1978, 1989, 2000, 2021, 1990, 2023, 1973, 2014, and 1970 (shown further in Table 2). The largest recorded flood event was the 1992 Flood, occurring on 10-11 February 1992, after 158mm of rainfall over 24 hours (Wyndham Post Office Station 069066). The recorded stream flow rate from the February 1992 flood has been presented in Figure 10, demonstrating the time to peak flow, and the time of receding flows. The graph demonstrates a time to peak of approximately 6 hours (18:00-0:00), before receding immediately receding. Considering the peak flow of the February 1992 flood occurred around midnight and for a short peak duration, it is expected that there is minimal anecdotal evidence from this flood event in terms of disruptions to traffic and floodplain observations.

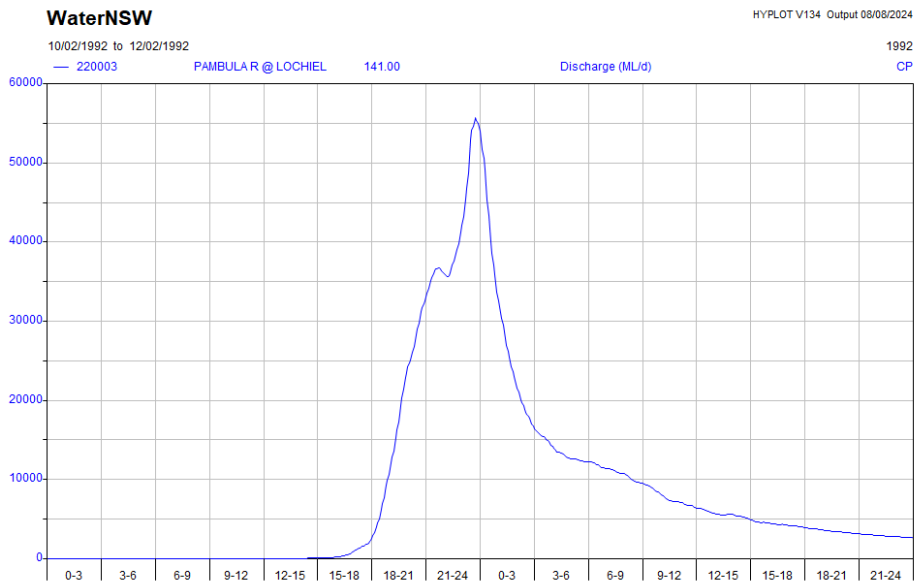


Figure 10: February 1992 Flood Hydrograph

Changes to the catchment conditions of historical flood events to current-day conditions are expected to be minimal, due to the large presence of national parks and state forests area within the catchment area of the subject site, and upstream of the 220003-stream gauge. A extract of the Catchment Map showing the extent of State Forests and National Parks is provided as Figure 11, with the full map provided as Figure 96.

Figure 11: Catchment Boundary with State Forest and National Parks Extract

2.4. Emergency Management

Riverine Flooding is a hazard covered under the Bega Valley Local Emergency Management Plan (LEMP). Riverine Flooding is described as high likelihood, with a moderate consequence, and a high-risk priority (Bega Valley Local Emergency Management Committee, 2019, p. 23). The responsible agency for the Riverine Flooding is the NSW State Emergency Service (SES). The Bega Valley Local Flood Plan is a supporting plan for the Bega Valley LEMP.

The Bega Valley Local Flood Plan nominates evacuation as the primary response strategy for people impacted by flooding (NSW State Emergency Service, 2021, p. 7). The four primary evacuation centres in the Bega Valley are Bega Showground, Bermagui Surf Club, Club Sapphire Merimbula and Eden Fisherman's Club[1] (Bega Valley Local Emergency Management Committee, 2019, p. 39). Most notably, evacuation centres are nominated by Council or the LEOCON at the time of the event, and the nominated location above may or may not be suitable or utilised during specific flood events.

There is no physical warning system in place for the Pambula River Catchment, with flood warnings only available to residents through weather forecasts, and broadcasted warnings from government agencies such as Council, SES, TfNSW via Radio, Social Media, Television etc. Flood Warnings issued by

[1] The Edens Fisherman's Club has since been demolished, and the BVLEMP is yet to be updated. It is assumed that an alternative location will be nominated at the time of a flood event.

the Bureau of Meteorology for the Bega Valley are informed by the Bega (North Bye) Stream Guage 219900, with levels of 4.60m, 7.00m and 8.00m for minor, moderate and major flood classifications. The application of flood warnings for the Pambula/Lochiel catchment based on this gauge is generally unsuitable due to the differing catchments/basins and critical storm durations. The critical storm duration for the Bega River for all events except the 0.2% AEP and PMF is 36 to 48 hours (SMEC, 2014, p. 105), whilst the Pambula River is generally 12 hours (Catchment Simulation Solutions, 2021, p. 102). The discrepancy in critical storm durations would typically mean that peak flows for the Pambula River would be reached at a time when flows within the Bega River are rising, and potentially yet to reach any flood warning trigger.

Based on the primary evacuation centres in the BVLEMP, the Subject Site has two practical evacuation locations, Merimbula and Eden. Evacuation to the township of Merimbula is impacted by the inundation of the Mount Darragh Road and the Princes Highway, as well as flooding outside the of the Pambula River Catchment, such as Arthur Kaine Drive, Princes Highway (Millingandi) and Market Street Merimbula. Evacuation to the township of Eden is impacted by the inundation of Mount Darragh Road and the Princes Highway, and the inundation of Back Creek Road in the PMF Event, as well as flooding outside of the Pambula/Yowaka River Catchment such as Imlay Street, Eden. Evacuation is also possible to the West towards Wyndham, which can be relied upon for access to the Candelo village and the Bega township. The travel maps for evacuation from Lochiel to Merimbula, Eden and Wyndham are presented as Figure 12, Figure 13 and Figure 14.

Emergency Management for the Lochiel locality will be best informed through the completion of a Floodplain Risk Management Study and Plan, which is yet to be commissioned by Bega Valley Shire Council.

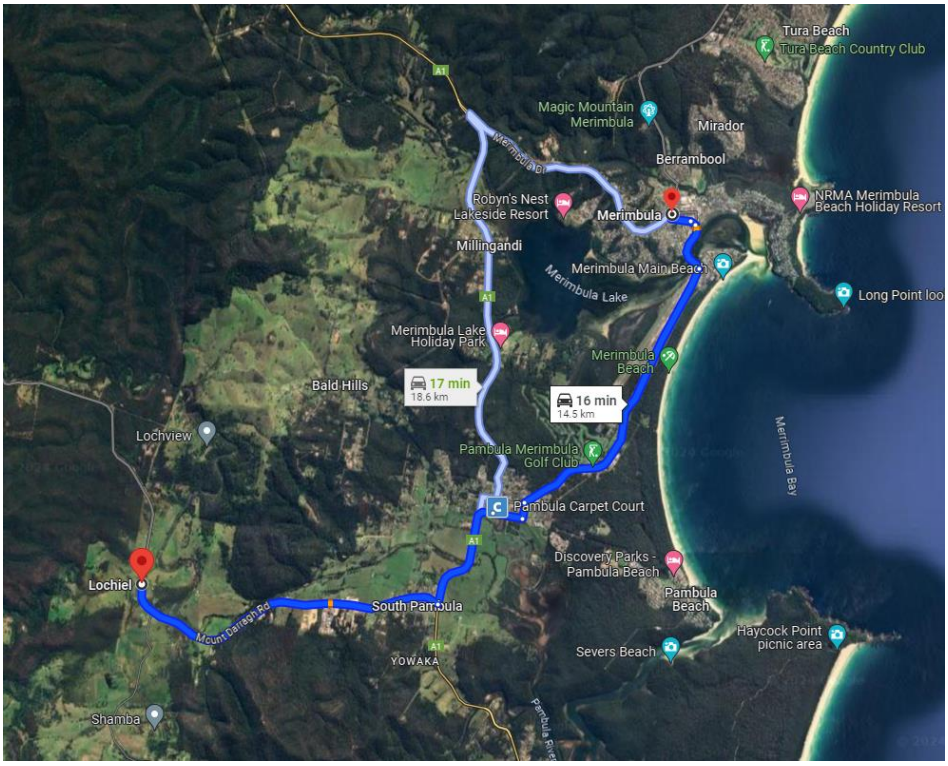


Figure 12: Travel from Lochiel to Merimbula, NSW

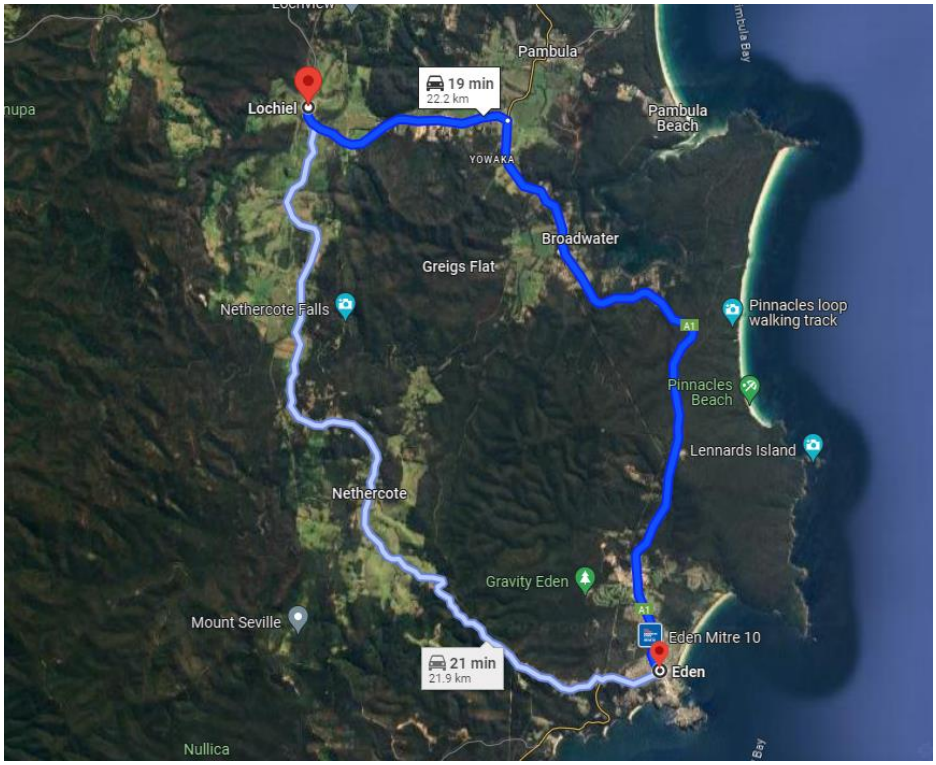


Figure 13: Travel from Lochiel to Eden, NSW

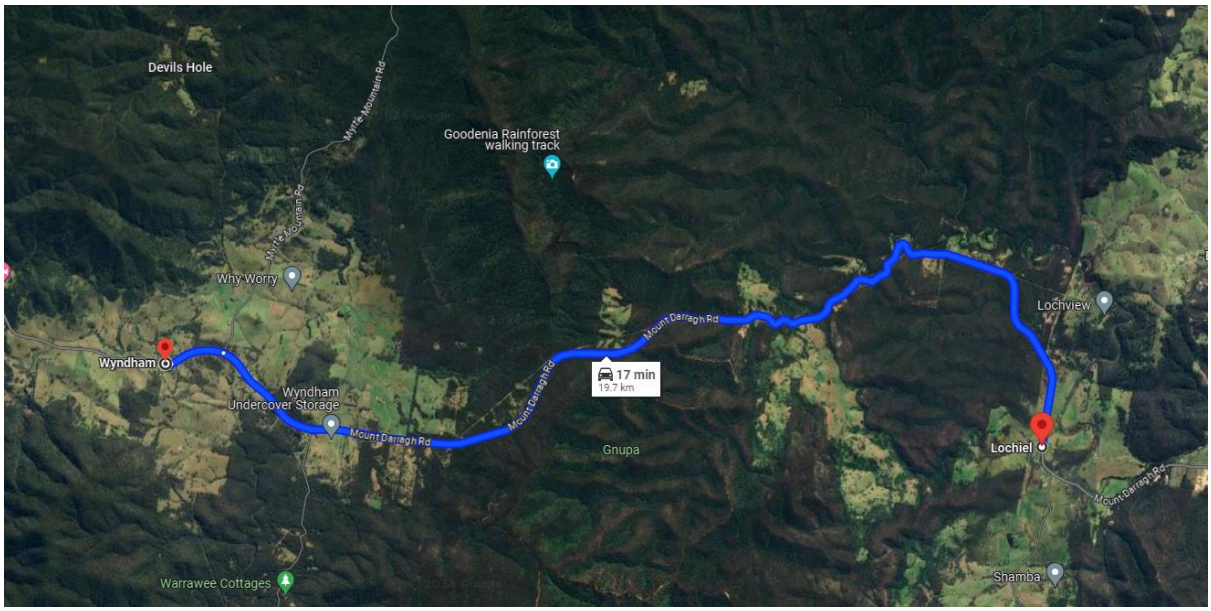


Figure 14: Travel from Lochiel to Wyndham

3. Available Information

3.1. Flood Studies

The Pambula River, Pambula Lake and Yowaka River Flood Study is the applicable flood study for the subject site, which was commenced in September 2019 and endorsed by Bega Valley Shire Council in July 2021. The Flood Study is considered fit for purpose for this assessment, as it remains the best available information for qualitative and quantitative information for Bega Valley Shire Council and will form the basis of the consent authority's assessment. The Pambula River, Pambula Lake and Yowaka River Flood Study Report is readily available on Council's Website (Bega Valley Shire Council, 2021b). The Pambula River, Pambula Lake and Yowaka River Flood Study and associated flood models are also available on the NSW SES Flood Data Portal, which includes the following information:

- Dataset handover checklist and description.
- Hydraulic modelling post-processed files for AVIs.
- Emergency Response Planning.
- Spatial Flood Layers (post-processed layers).
- Hydrological, Hydraulic and flood damage pre-processed model output files.
- Hydrological, Hydraulic and flood damage model input files.
- Hydrological, Hydraulic and flood damage pre-processed model output files.
- Land use planning.
- Community Consultation.
- Survey Information.
- Report PDFs.

The post-processed spatial flood layers from the SES Flood Data portal have been utilised to carry out this assessment, which has been reproduced as Section 10.3. Flood Maps.

A Floodplain Risk Management Study and Plan is yet to be commissioned for the Pambula River, Pambula Lake and Yowaka River catchments. A Floodplain Risk Management Study and Plan would be beneficial for the catchment, to allow the assessment of the floodplain on a broader level, as opposed to the isolated assessment of a single site under this Flood Impact Risk Assessment. A Flood Risk Management Study and Plan would be pivotal in determining the necessary upgrades to road infrastructure, particularly Mount Darragh Road and the Princes Highway in providing flood-free access for a range of flood events.

3.2. Relevant Legislation, Policy and Guidance

Bega Valley Shire Council is the consent authority for the development of the subject site. All development will be required to be assessed under the Bega Valley Local Environmental Plan 2013. The flood planning requirements of the Bega Valley LEP are detailed in Section 5.21 Flood Planning and Section 5.22 Special Flood Considerations. These requirements have been considered in detail in Section 4 Flood Related Requirements of this report. Additional Flood Requirements to be addressed as part of this Flood Impact Risk Assessment include the Bega Valley Shire Council Development Control Plan and the NSW Local Planning Directions, Direction 4.1 Flooding.

3.3. Flood Emergency Management Guidelines

Evacuation is the primary response strategy for people impacted by flooding (NSW State Emergency Service, 2021, p. 7). Evacuation is only a suitable strategy when people are not exposed to greater risks during evacuation than they would face by remaining where they are (Australian Institute for Disaster Resilience, 2009, p. 45). Successful evacuation requires a warning system that delivers enough lead time to accommodate the operational decisions, the mobilisation of the necessary resources, the warning, and the movement of people at risk (AFAC, 2018, p. 4). NSW SES experience indicates that the time allowance for decision-making, resource mobilisation and warning cannot be safely reduced below a planning figure of nine hours minimum, with six hours decide and mobilise plus a minimum of three hours warning and traffic (Opper, 2004, p. 13).

The applicable time for evacuation operations is calculated as 3.5 hours, from the initial evacuation order to reaching a suitable evacuation destination. Evacuation operations are reliant upon the evacuation order being issued and received by residents. Due to the rural nature of the subject site, the likelihood of physical evacuation orders being received (i.e. doorknocking) is low. The 3.5 hours would likely only be appliable to self-evacuation by residents, and comprises of the following:

- 1-hour Warning Acceptance Factor (WAF), to account for the delay between receiving an evacuation order and acting upon it.
- 1-hour Warning Lag Factor (WLF) is the allowance for the time taken by occupants to prepare for evacuation.
- 0.5-hour Travel Time (TT), based on the travel time from Lochiel to Eden, Merimbula or Wyndham.
- 1.0-hour Traffic Safety Factor (TSF), to account for any delays that occur along the evacuation route (Molino et al., 2013, p. 6).

Shelter-in-place is an alternative response strategy for people impacted by flooding and is typically utilised when it is unsafe to evacuate, however, there are inherent risks with allowing people to shelter-in-place, as they become isolated. The isolation of people is not without risk, and hence there is no such thing as a 'safe period of isolation' (Australian Institute of Disaster Resilience, 2009, p. 52). Shelter-in-place is considered an acceptable response strategy if:

- The duration for flood inundation is less than six hours.
- The development is not located in an area of high risk (e.g. floodway's and H5 or H6 flood hazard areas).
- Access to on-site systems to provide power, water, and sewerage services during and beyond the event for the full range of flooding.
- The location of storage of food, water and medical emergency for SIP purposes should be above the PMF level and available during and beyond the event for the full range of flooding.
- SIP floor level is above PMF.
- SIP provides a minimum floor space per person.
- SIP must be structurally safe and accessible during floods up to the PMF.

Education is critical to ensuring that the community is aware of actions to be taken before, during and after SIP and the key triggers that require SIP. If SIP is proposed there needs to be ongoing community education campaigns for the areas where SIP will apply (NSW Department of Planning and Environment, 2022).

Flood Emergency Response Classifications (FERC) is a method of large-scale, land use planning which applies a classification to each lot, or part lot. Classification is undertaken at three levels. Primary classification concentrates on whether the area is flooded by the probable maximum flood, or a similar

extreme event. Secondary classification examines whether or not a community or precinct area has an exit to community evacuation facilities in a flood-free area outside the broader floodplain during a flood event. Tertiary classification relates to the potential consequences of flooding on the area and any limitations of available evacuation routes. For areas that are not flooded, there is no secondary classification, and the tertiary classification relates to whether there are any indirect consequences on the area (Australian Institute of Disaster Resilience, 2017, p. 3)

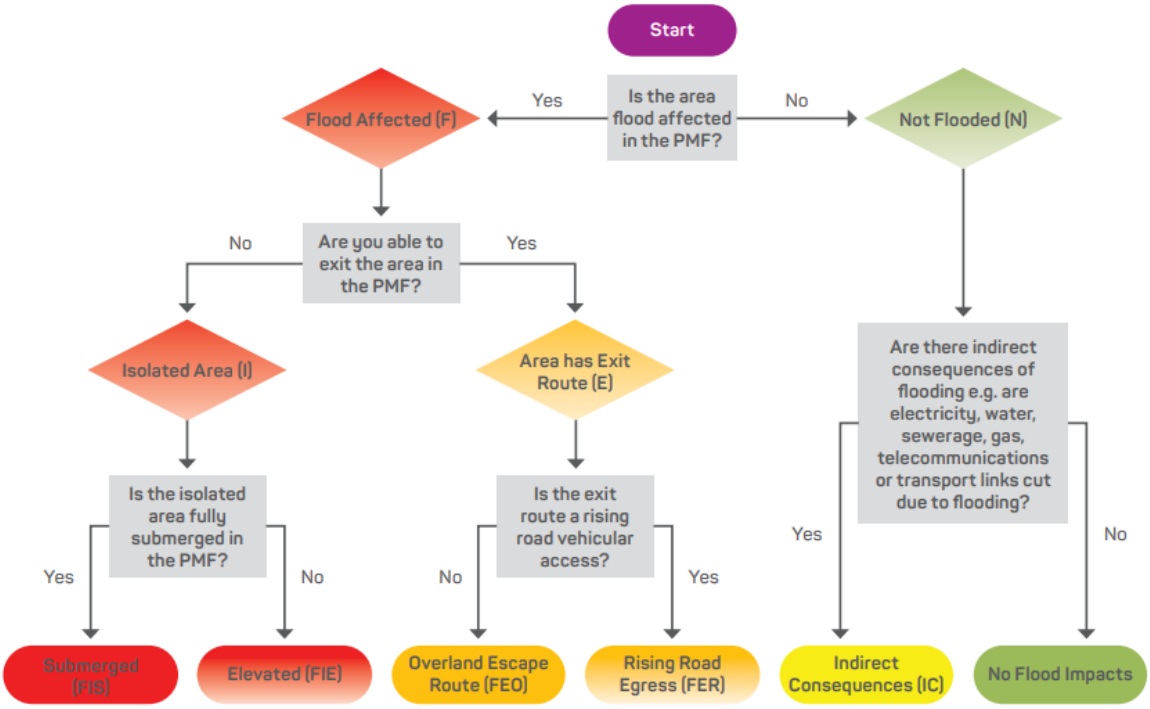


Figure 15: FERC Flow Chart (Australian Institute of Disaster Resilience, 2017, p. 9)

3.4. Historic Data

Pambula River has experienced several significant flood events throughout history, with five notable events being used for calibration as part of the Pambula River, Pambula Lake and Yowaka River Flood Study (Catchment Simulation Solutions, 2021, pp. 41–42). The five events utilised were:

- 4-7 June 2016
- 1-2 March 2012
- 20-25 March 2011
- 25-30 November 1985
- 4-8 February 1971

In addition to these five events, Table 2 provides a summary of the peak flows recorded at the Lochiel Gauge (220003), which is immediately downstream of the subject site. The flows recorded demonstrate that flooding events up to the 1:100 Year Flood (1% AEP) have occurred. Due to the upstream catchment of the Pambula River being primarily State Forest and National Parks, and forested rural land, the historic catchment area conditions are believed to be consistent with the current day catchment area conditions.

Table 2: Historic Flooding Information (WaterNSW, 2024)

Historic Flooding Information							
Date and Time	**Depth (m)**	**Level (m)***	**Discharge (ML/d)**	**Discharge (m^3/s)**	**Quality Code**	**Nearest Flood Event**	**Flood Hydrograph**
10/02/1992 23:45	6.81	21.778	55737.9	645	91	1% AEP	Figure 31
6/02/1971 1:58	6.312	21.28	48056.15	556	91	5% AEP	Figure 25
3/06/1978 9:48	6.043	21.011	44121.75	511	95	5% AEP	Figure 27
3/04/1989 7:46	5.972	20.94	43104.45	499	91	5% AEP	Figure 29
9/03/2000 15:25	5.771	20.739	40249.79	466	91	10% AEP	Figure 32
23/03/2021 19:30	5.697	20.665	39237.53	454	130	10% AEP	Figure 37
27/11/1985 3:57	5.618	20.586	38155.05	442	95	10% AEP	Figure 28
21/04/1990 4:52	5.281	20.249	33680.44	390	91	<10% AEP	Figure 30
22/03/2011 8:15	5.251	20.219	33298.87	385	130	<10% AEP	Figure 33
29/11/2023 17:15	4.936	19.904	29267.11	339	130	<10% AEP	Figure 38
4/11/1973 16:22	4.877	19.845	28645.07	332	95	<10% AEP	Figure 26
5/06/2016 23:45	4.649	19.617	25957.94	300	130	<10% AEP	Figure 36
7/12/2014 5:15	4.569	19.537	25038.61	290	130	<10% AEP	Figure 35
10/12/1970 7:08	4.473	19.441	23939.71	277	95	<10% AEP	Figure 24
1/03/2012 14:45	4.376	19.344	22854.83	265	130	<10% AEP	Figure 34
*Depth provided from Guage Level has been added to a value of 14.968m as per Details for Gauge 220003.							

Community Consultation was undertaken as part of the Pambula River, Pambula Lake and Yowaka River Flood Study to collect anecdotal information regarding historical floods. Flooding has impacted the community primarily through the closure of roads due to inundation, most notably the Princes Highway, Chalkhills Road, Nethercote Road and Oaklands Road, and the flooding of paddocks. Only 1

respondent as part of the adopted Flood Study reported inundation of front/back yards (Catchment Simulation Solutions, 2021, pp. 27–31).

3.5. Hydrological and Hydraulic Data

Flooding associated with the Pambula River is Riverine Flooding or Mainstream Flooding. The flooding extents for all events up to the 0.2% AEP Flood are contained within the Flood Banks of the Pambula River, with the 10% AEP Flooding extent generally within the 24m Contour Line and the 0.2% AEP Flooding extent within the 25m Contour Line of the subject site. The PMF Flooding extent overtops the banks of the Pambula River, reaching the 30m Contour Line of the subject site.

The Flood Hazard for all Flooding Events from the 5% AEP to the PMF, reaches an H6 Flood Hazard within the main channel of the Pambula River, with the extent of the H6 Hazard Area extending further from the main channel with the increasing severity of the Flood Event. The peak flooding velocity for the 10% AEP at the subject site is approximately 2.8m/s, increasing to approximately 3.2m/s for the 0.2% AEP Flood Event, and reaching approximately 4.4m/s for the PMF.

The XP-RAFTS ID closest to the Subject Site from the Flood Study is 1.20, as per Figure 7.5 of Volume 2 of the Final Report. The Factored Peak Discharges from the Flood Study is:

- 438m^3/s for 10% AEP.
- 527m^3/s for 5% AEP.
- 613m^3/s for 2% AEP.
- 651m^3/s for 1% AEP.
- 696m^3/s for 0.5% AEP.
- 742m^3/s for 0.2% AEP.
- 2625m^3/s for PMF Event.

(Catchment Simulation Solutions & Bega Valley Shire Council, 2021, Appendix M & N)

The design flood hydrograph presented in Figure 16 was produced from the Pambula River, Pambula Lake and Yowaka River Flood Study - TUFLOW Outputs Design Results available through the NSW SES Flood Data Portal. The Flood Hydrograph demonstrates an initial lag of 2-4 hours for the increase in flows from rainfall in the upstream catchment before flows rapidly increase over 5-7 hours and peak flows are achieved at the 9-9.5-hour mark. Flows recede immediately after peaking, with the majority of flows reducing over 6-12 hours. Increased flows within the river will remain for days to weeks post-rainfall event, as seepage from the upstream catchment continues.

The design flood hydrograph is consistent with the flood hydrograph of historic flood events presented in 10.1. Historical Flooding Hydrographs which demonstrates a rapid increase of flows over generally 6 hours to its peak, before flows recede immediately after peaking, and reducing the greatest amount over 6-12 hours. The most comparable historical flood hydrographs to the design flood hydrograph are Figure 25, Figure 26, Figure 28, Figure 29, Figure 31, Figure 32, Figure 34, Figure 35 and Figure 37 Notably, historic floods presented different hydrograph shapes to the design flood events, which would be based on differing rainfall conditions between the historic event and the design flood model. The design flood model is produced based on rainfall conditions, producing the most significant results, even if the duration isn't substantial. The historical flood hydrographs, such as Figure 27, Figure 30, Figure 33, Figure 36 and Figure 38, demonstrate floods that have occurred when the flows are not as significant as the peak design floods, however, flooding has occurred over a longer duration, generally 24 hours.

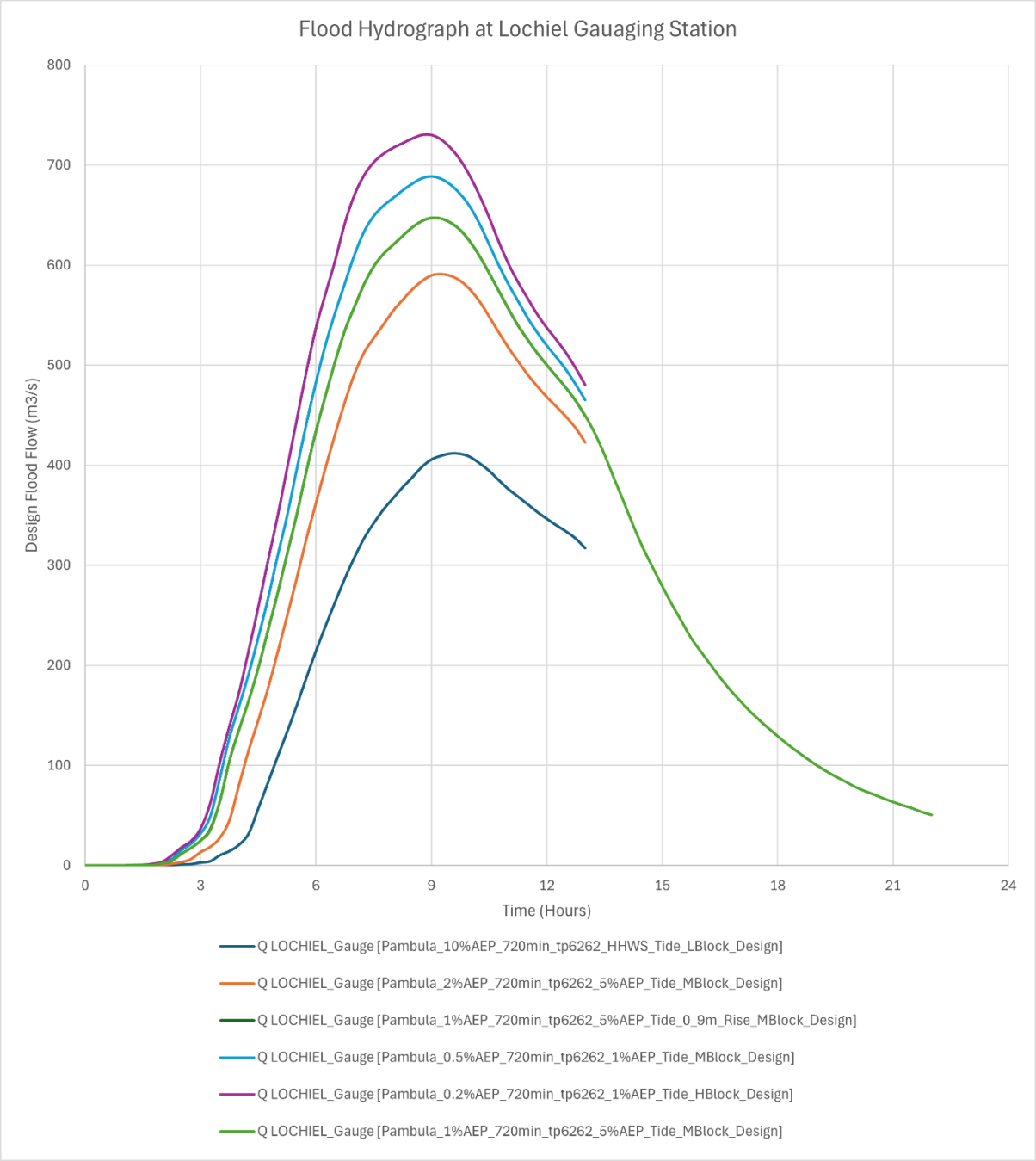


Figure 16: Design Flood Hydrograph

3.6. Site Visit

TA Project Services attended the subject site on Thursday, 22 August 2024 at 14:00. During the site inspection, the weather conditions were mostly clear. Over the 24 hours preceding the inspections, 0.00mm of rainfall was observed. Over the 31 days preceding the inspection, 5.2mm of rainfall was observed. The available weather observation for the preceding period is presented as Table 7 and Table 8. The most recent declared flood event for the Bega Valley was AGRN 1100, NSW Storms and Floods 25 December 2023. During the time of inspection, recording at the Lochiel Stream Guage 220003 was 6.719ML/day (0.08m^3/s), with a water level height of 0.625m (WaterNSW, n.d.).

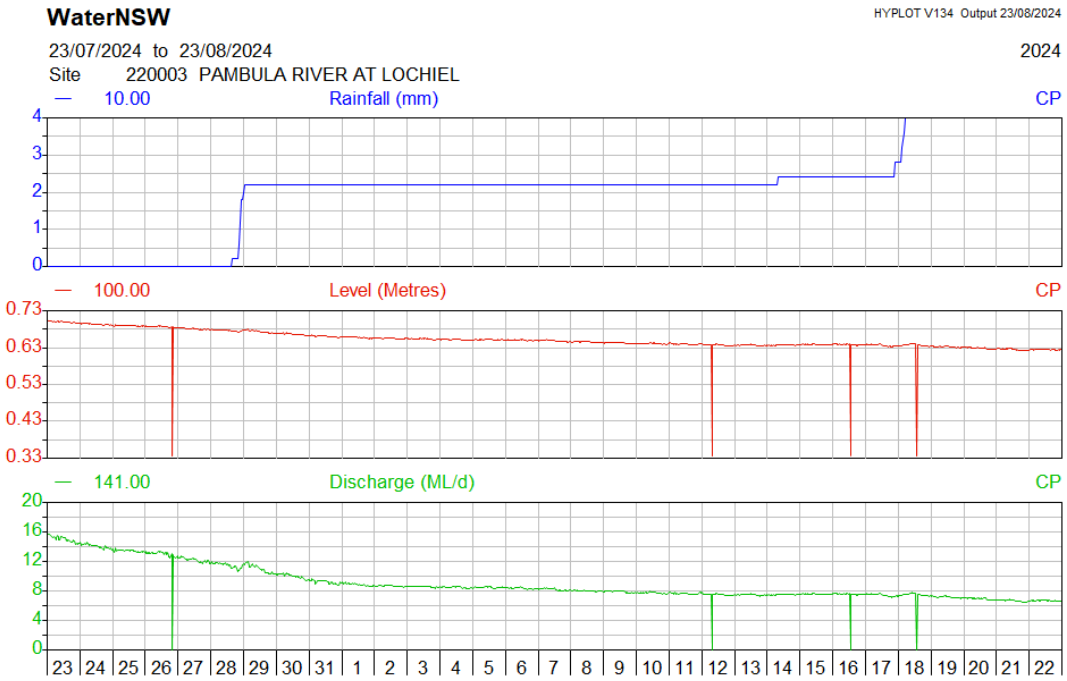


Figure 17: Preceding Stream Guage Observations (WaterNSW, n.d.)

During the site inspection, observations of the entire subject site were carried out, with photographs captured and presented as Figure 40-Figure 95. The following observations were made:

- The landform of the subject site shows no signs of recent transformation, with the landscape appearing to reflect the natural landform.
- The subject site shows signs of agricultural use, consistent with grazing of livestock.
- Flow was present within the Pambula River and was most noticeable at constrictions in the lower parts of the channel.
- Flow within the banks of the Pambula River was divided into two smaller channels, most noticeable at the eastern extent of the subject site.
- The river channel was well established with ground cover vegetation, and varying size plants/trees.
- Flood debris within the river channel was apparent, having been caught by established vegetation within the river channel. There was no observation of flood debris within the river channel that was constricting river flows.
- A well-defined foodbank is apparent on the southern edge of the Pambula River, fronting the subject site. The riverbank was observed at a height of approximately 3.0m for the length of the subject site.

- Above the southern bank of the river, was a relatively flat portion of land that resembled the landscape of a floodplain. The portion of land extended approximately 50-70m from the top of the riverbank for the length of the subject site.
- A depression above the southern riverbank, at the northeastern part of the subject site was observed.
- A fence spanned across the width of the river channel, at the western point of the subject site. The fence appeared in good condition, free from flood debris and damage from flood waters. The age of the fence is unknown, however, it is expected that constant upkeep of the fence to control livestock is undertaken, which would address any potential damages from floodwaters.

The outcome of the site inspection supports the validity of the flood study, and flood model in resembling the flood conditions at the subject site. The dividing of flow between two channels supports the flood study, particularly the high-frequency events, where the flood hazard category mapping demonstrates peak flows being within two distinct channels at the eastern portion of the site. The well-defined flood bank on the southern side supports the flood model, where the flood banks contain the majority of flood flows, from 10% AEP to 0.2% AEP. The portion of land above the southern flood bank which resembles a floodplain supports the flood model, where the PMF extent extends beyond the flood banks for a distance of approximately 80-100m. The depression above the southern flood bank, supports the flood model, particularly the 1% AEP where Flood Storage/Flood Fringe is shown in this area.

3.7. Survey Data

Ground Surface Levels and terrain data for the subject site have been obtained from the Elvis Elevation and Depth website, which brings together elevation and bathymetry data from Commonwealth, State and Territory Governments (Elvis, n.d.) Digital Elevation Models produced by LiDAR by NSW Government – Spatial Services have been utilised to provide contour details and ground elevations for the subject site. The digital elevation models *Bega201308-LID1-AHD-7505906_55_0002_0002_1m* and *Bega201308-LID1-AHD_7505908_55_0002_0002_1m* have been used. The data used to prepare the Digital Elevation Model has a reported accuracy of 0.3m vertical and 0.8m horizontal, based on a 95% confidence interval (NSW Spatial Services, n.d.).

The Pambula River, Pambula Lake and Yowaka River Flood Study and associated flood models were prepared using 2013 LiDAR data as captured by the NSW Government (Catchment Simulation Solutions, 2021, p. 21). The LiDAR dataset underwent sensitivity analysis as part of the flood study, which identified high LiDAR point density across grassed and paved areas but reduced ground points in the vicinity of dense trees/vegetation, and a reasonable representation of the channel geometry across channel sections not subject to significant water coverage (i.e., nontidal areas upstream of the Princes Highway) (Catchment Simulation Solutions, 2021, pp. 21–23).

Considering the suitability to utilise the NSW Government 2013 LiDAR data for the Flood Study and associated modelling, it was considered appropriate to utilise the 2013 LiDAR data for the purpose of this FIRA.

3.8. GIS Data

Assessment of Flood Models has been completed as part of this FIRA. Flood Models have been retrieved from the NSW SES Flood Data Portal for the Pambula River, Pambula Lake and Yowaka River Flood Study. The list of individual GIS Files within the flood study is exhaustive; therefore, the below summary is provided:

Flood Model Dataset	
Pambula River, Pambula Lake and Yowaka River Flood Study	https://flooddata.ses.nsw.gov.au/flood-projects/pambula-river-pambula-lake-and-yowaka-river-flood-study
Pambula River, Pambula Lake and Yowaka River Flood Study - Data Handover Summary	https://flooddata.ses.nsw.gov.au/related-dataset/data-handover-summary
Pambula River, Pambula Lake and Yowaka River Flood Study - Emergency Response Outputs	https://flooddata.ses.nsw.gov.au/related-dataset/emergency-response-outputs
Pambula River, Pambula Lake and Yowaka River Flood Study - Spatial Outputs	https://flooddata.ses.nsw.gov.au/related-dataset/spatial-outputs
Pambula River, Pambula Lake and Yowaka River Flood Study - TUFLOW Outputs	https://flooddata.ses.nsw.gov.au/related-dataset/tuflow-outputs
Pambula River, Pambula Lake and Yowaka River Flood Study - Flood planning GIS layers	https://flooddata.ses.nsw.gov.au/related-dataset/flood-planning-gis-layers
Pambula River, Pambula Lake and Yowaka River Flood Study - Community Consultation Material	https://flooddata.ses.nsw.gov.au/related-dataset/community-consultation-material
Pambula River, Pambula Lake and Yowaka River Flood Study - Final flood study report and figures	https://flooddata.ses.nsw.gov.au/related-dataset/final-flood-study-report-and-figures

Assessment of the subject site and landform has been completed as part of this FIRA. Spatial data for the entire Bega Valley LGA has been retrieved from NSW Six Maps (Clip and Ship). The list of individual GIS files included in this data set is exhaustive; therefore, the below summary of datasets used is provided:

- Hydroarea.shp
- Hydroline.shp
- Lot.shp
- NPWSReserve.shp
- StateForest.shp

Retrieved from: https://maps.six.nsw.gov.au/clipnship.html

4. Flood Related Requirements

The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The concept subdivision proposal is presented as Figure 18. The subdivision proposal consists of subdivision of the subject site into six lots for residential development. Access to the proposed subdivision is via the unnamed road, south of the subject site, which would be formalised as a public road to provide legal access to the proposed lots. The unnamed road is free from flood inundation for all flooding events including the PMF, providing a connection to Mount Darragh Road. An extract of the flooding extent and the unnamed road is provided as Figure 19, with the full map provided as Figure 100. It is therefore demonstrated that access proposed as part of the proposed subdivision, is flood-free, and flooding/inundation constraints with the existing road network (ie. Mount Darragh Road, Back Creek Road, Princes Highway) are the associated constraints to be considered.

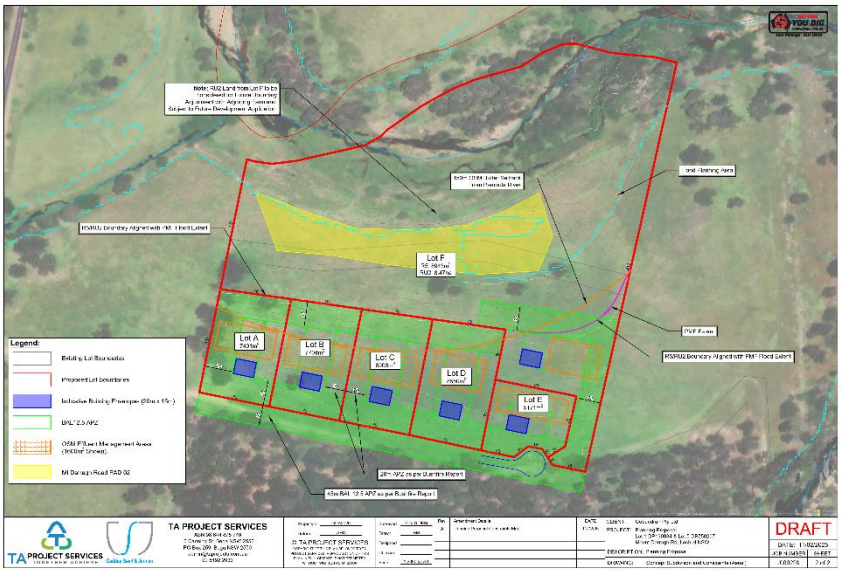


Figure 18: Concept Subdivision Proposal

Figure 19: The Unnamed Road Flood Extent Extract

The planning proposal seeks reduce the minimum lot size to 7000m^2 for a 4.6-hectare area of the subject site. The 4.6-hectare area is the area of the subject site above the PMF Flooding Extents. Based on the current concept subdivision arrangements, five of the six lots exceed the proposed minimum lot size of 7000m^2. One lot is currently proposed as being 5171m^2 which is below the proposed minimum lot size, however, permissible under Section 4.1B of the Bega Valley LEP which permits a reduced lot size of 3000m^2 for R5 Large Lot Residential zoning when the average lot sizes remain above the minimum lot size. The proposed rezoning maps, including the proposed lot zone map and the proposed minimum lot size map, are presented as Figure 20 and Figure 21 respectively.

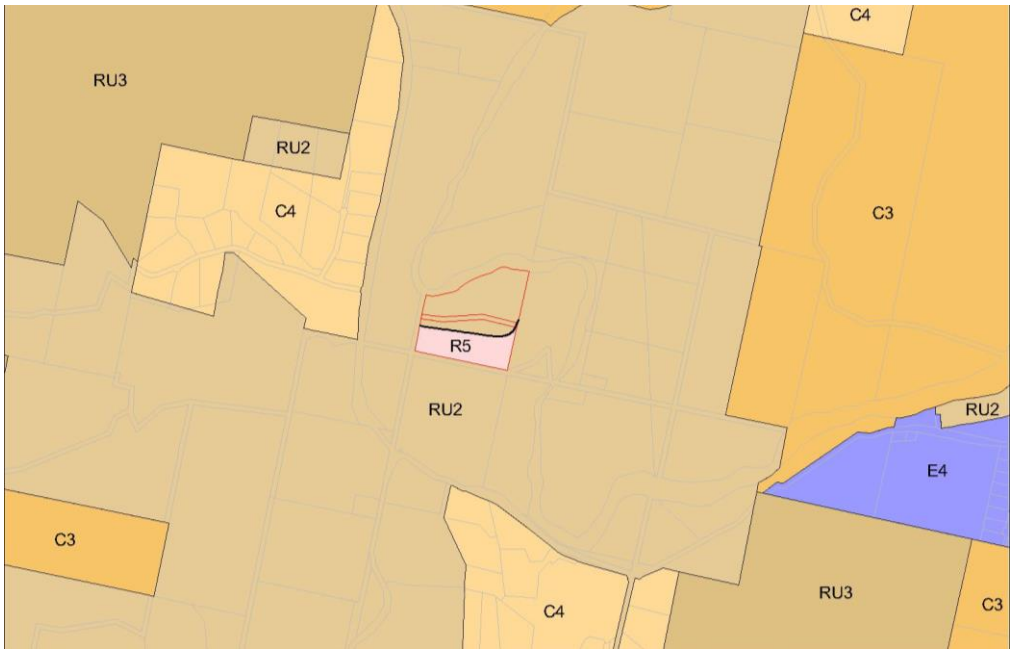


Figure 20: Proposed Lot Zone Map

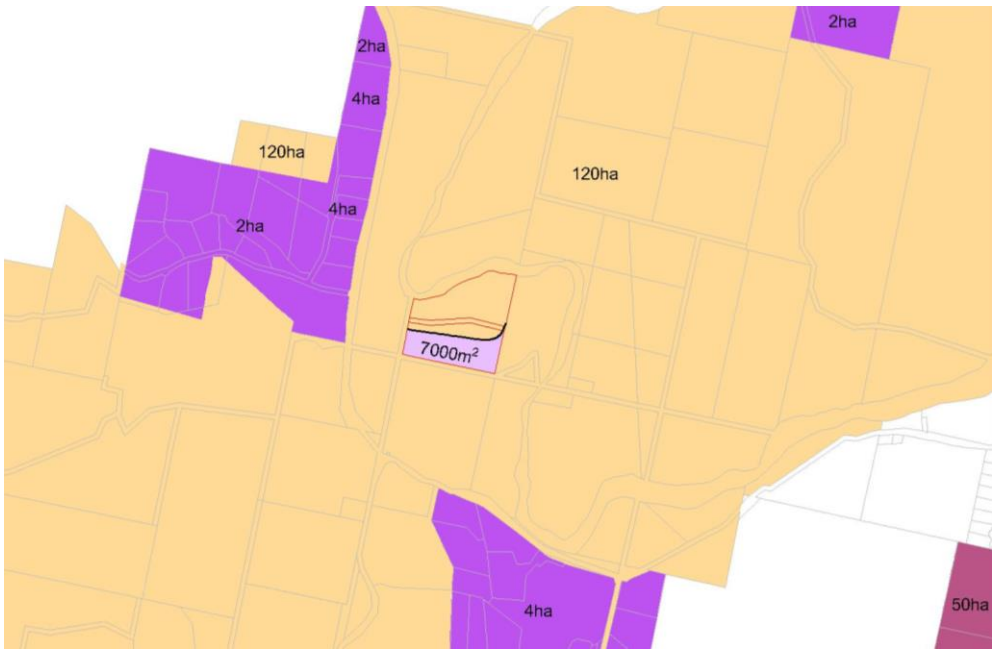


Figure 21: Proposed Minimum Lot Size Map

4.1. Emergency Response Requirements

The adopted Flood Study provides the Flood Emergency Response Classification for the Subject Site. The site can be assessed in 3 portions, the Northern Portion of Lot 5 DP 750207, Lot 1 DP130034 and the Southern Portion of Lot 5 DP 750207. The Flood Emergency Response Classifications indicate a FIS Classification for the Northern Portion of Lot 5 DP 750207 and Lot 1 DP130034, and a FER Classification for the Southern Portion of Lot 5 DP 750207. The FIS Classification represents an area flood affected by the PMF, Isolated and Submerged, whilst the FER Classification represents an area flood affected by the PMF, with a Rising Road Exit Route.

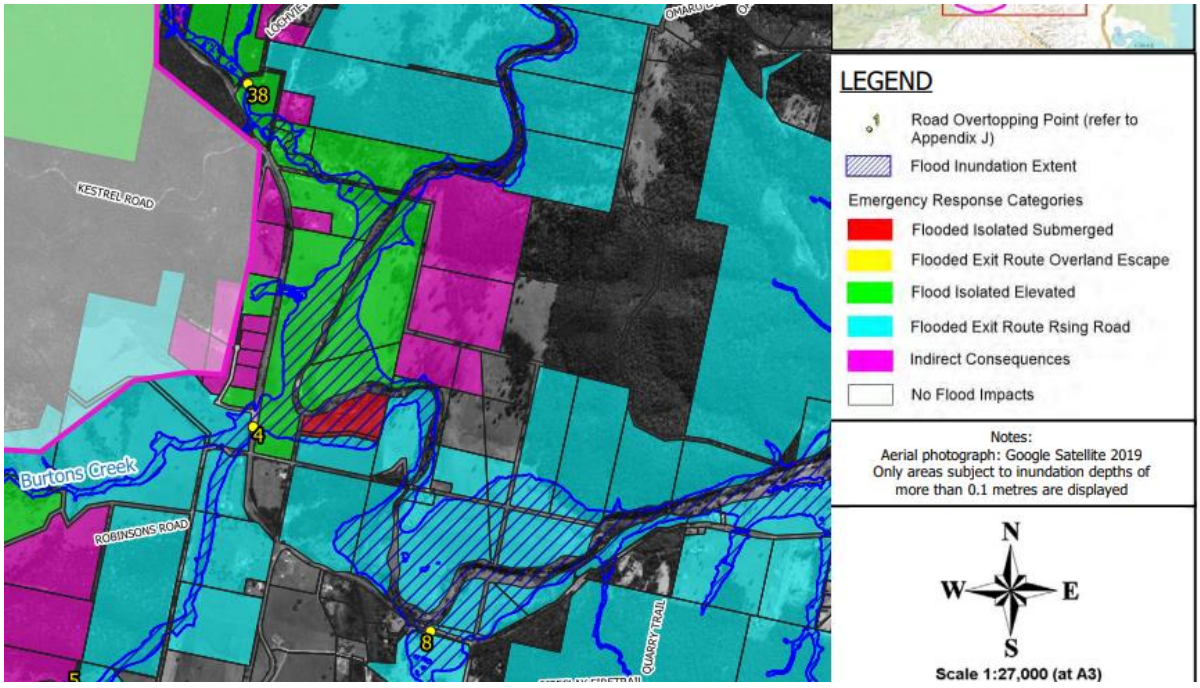


Figure 22: PMF FERC Extract from Flood Study (Catchment Simulation Solutions, 2021, Figure 45.1)

The FER Classification nominated as part of the flood study has not been relied upon for this FIRA, as it is believed that the FER classification for the southern portion of Lot 5 DP 750207 should be classified as FIE – Flood Isolated Elevation. The FER classification is not believed to be suitable, due to the inundation of Mount Darragh Road, Back Creek Road, Nethercote Road and the Princes Highway, preventing evacuation from the subject site to community evacuation facilities (evacuation centres).

Evacuation is the primary response strategy for people impacted by flooding (NSW State Emergency Service, 2021, p. 7). Evacuation is only a suitable strategy when people are not exposed to greater risks during evacuation than they would face by remaining where they are (Australian Institute for Disaster Resilience, 2009, p. 45). Evacuation from the subject site will be reliant on self-evacuation efforts, due to the lack of formal evacuation plans and procedures for the Pambula River. For the evacuation assessment, self-evacuation is assumed to commence at the onset of flooding.

Roadway inundation information is provided as part of the Pambula River, Pambula Lake and Yowaka River Flood Study (Catchment Simulation Solutions & Bega Valley Shire Council, 2021, Appendix J). Due to the rural nature of the subject site, evacuation towards urban centres including Merimbula and Eden, and the village of Wyndham will be dependent upon flood-free access through the road overtopping points below.

- 1: Mount Darragh Road at Six Mile Bridge
- 2: Mount Darragh Road at Lot 67 DP750202 Frontage

- 3: Mount Darragh Road at Lot 472 DP866950 Frontage
- 4: Mount Darragh Road at Burtons Creek.
- 8: Mount Darragh Road at Back Creek.
- 9: Mount Darragh Road, between Redfern Cl and Drive In Rd.
- 10: Mount Darragh Road, between Drive In Rd and Lloyd St.
- 17: Princes Highway between Yowaka St and Monaro St.
- 18: Princes Highway at Quondolo St/Bullara St intersection.
- 24: Arthur Kaine Drive between Narregol St and Munje St.
- 26: Princes Highway between Pambula River Bridge and Yowaka St.
- 27: Princes Highway at Pambula River
- 28: Princes Highway between Pambula River Bridge and Mount Darragh Road.
- 30: Princes Highway, west of Nethercote Road
- 31: Princes Highway at Yowaka River
- 35: Nethercote Road at Old Hut Creek
- 36: Nethercote Road at Centipede Creek

In many instances, across a range of flood events, inundation of the roadway occurs at an H1 or H2 hazard level. H1 and H2 hazard levels are generally safe for vehicles, particularly large vehicles associated with emergency response vehicles. H2 hazard levels are unsafe for small vehicles, and hazards H3-H6 are unsafe for all vehicles (NSW Department of Planning and Environment, 2023, p. 3).

Table 3: Roadway Inundation Times and Flood Hazards along Evacuation Routes

Travel Towards	Road Overtopping Point	5% AEP			1% AEP			0.5% AEP			PMF		
		Time First Inundated	Duration (hours)	Peak Hazard	Time First Inundated	Duration (hours)	Peak Hazard	Time First Inundated	Duration (hours)	Peak Hazard	Time First Inundated	Duration (hours)	Peak Hazard
Merimbula	8										1.43	4.98	H6
	9	2.31	1.11	H1	6.75	3.06	H1	5.64	4.3	H1	1.26	4.98	H2
	10	0.16	0.46	H1	0.13	0.5	H1	0.12	0.51	H1	1	4.16	H2
	28	7.26	5.74	H1	6.22	6.78	H5	7.26	7.03	H5	2.13	3.99	H5
	27										4.43	1.68	H4
	26				7.75	5	H1	7.25	6.75	H2	2.25	10.75	H5
	17				9.7	5.3	H1	9	12	H2	2.25	10	H5
	18										3.34	2.77	H5
	24										1	5.36	H3
Eden via Princes Highway	8										1.43	4.98	H6
	9	2.31	1.11	H1	6.75	3.06	H1	5.64	4.3	H1	1.26	4.98	H2
	10	0.16	0.46	H1	0.13	0.5	H1	0.12	0.51	H1	1	4.16	H2
	30							6.18	6.88	H2	3.06	2.95	H5
	31										3.54	2.52	H6
Eden via Back Creek & Nethercote Rd	7										1.31	3.43	H5
	35										0.72	5.41	H5
	36	5.43	7.85	H5	4.46	8.86	H5	4.14	9.14	H5	0.85	5.19	H6
Wyndham	4										1.81	3.66	H6
	3										1.72	3.13	H2
	2										1.51	4.59	H4
	1										0.41	5.6	H6

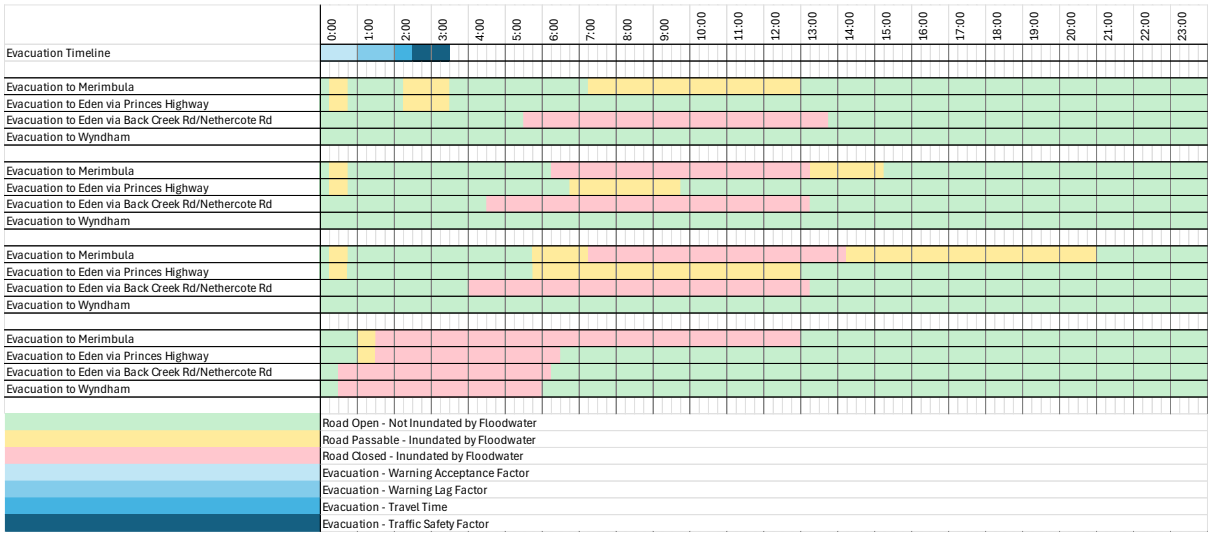


Figure 23: Evacuation Route Status

The roadway inundation data indicates that for the 5% AEP, evacuation from the subject site to Merimbula, Eden and Wyndham is possible. Evacuation to Merimbula and Eden (via Princes Highway) will likely require the crossing of H1 hazard floodwater at road overtopping point 9 and may potentially require the crossing of H1 hazard floodwater at road overtopping points 10 and 28, depending on the timing of evacuation. Delayed evacuation to Eden (via Back Creek Rd and Nethercote Rd) by more than 2 hours will prevent this route from being utilised, as the route will become impassible for approximately 8 hours (5:26 – 13:17). Evacuation to Wyndham is flood-free for the entire duration.

The roadway inundation data indicates that for the 1% AEP, evacuation from the subject site to Merimbula, Eden and Wyndham is possible. Evacuation to Merimbula and Eden (via Princes Highway) may potentially require the crossing of H1 hazard floodwater at road overtopping point 10, depending on the timing of evacuation. Evacuation to Eden (via Princes Highway) may potentially require the crossing of H1 hazard floodwater at road overtopping point 9, depending on the timing of evacuation. Delayed evacuation to Merimbula by more than 2.75 hours will prevent this route from being utilised, as the route will become impassible for approximately 7 hours (6:13 – 13:00). Delayed evacuation to Eden (via Back Creek Rd and Nethercote Rd) by more than 1 hour will prevent this route from being utilised, as the route will become impassible for approximately 9 hours (4:27 – 13:19). Evacuation to Wyndham is flood-free for the entire duration.

The roadway inundation data indicates that for the 0.5% AEP, evacuation from the subject site to Merimbula, Eden and Wyndham is possible. Evacuation to Merimbula and Eden (via Princes Highway) may potentially require the crossing of H1 hazard floodwater at road overtopping point 10, depending on the timing of evacuation. Evacuation to Merimbula may potentially require the crossing of H2 hazard floodwater at road overtopping points 17 and 26, depending on the timing of evacuation. Evacuation to Eden (via Princes Highway) may potentially require the crossing of H1-H2 hazard floodwater at road overtopping points 9 and 30, depending on the timing of evacuation. Delayed evacuation to Merimbula by more than 3.75 hours will prevent this route from being utilised, as the route will become impassible for approximately 7 hours (7:15-14:17). Delayed evacuation to Eden (via Back Creek Rd and Nethercote Rd) by more than 0.5 hour will prevent this route from being utilised, as the route will become impassible for approximately 9 hours (4:08 – 13:17). Evacuation to Wyndham is flood-free for the entire duration.

The roadway inundation data indicates that for the PMF, evacuation from the subject site to neither Merimbula, Eden nor Wyndham is possible. There is a time shortage of 2-2.5 hours for evacuation to Merimbula and Eden (via Princes Highway), and a time shortage of 3.0 hours for evacuation to Eden (via Back Creek Rd and Nethercote Rd) and Wyndham. The egress route to Merimbula will be impassable for approximately 11.5 hours (1:30-13:00). The egress route to Eden (via Princes Highway) will be impassable for approximately 5 hours (1:30-6:30). The egress route to Eden (via Back Creek Rd and Nethercote Rd) will be impassable for approximately 5.75 hours (0:30-6:15). The egress route to Wyndham will be impassable for approximately 5.5 hours (0:30-6:00).

Evacuation is generally the primary response strategy for people impacted by flooding, however, its reliance on forecasts, warnings and preparation has the potential to place people at risk during the evacuation, should there be any delay in carrying out the evacuation operations. Due to the lack of warning systems for the Pambula River, the potential for evacuation to be delayed is high, and the potential for people to enter flood waters during evacuation is increased. Evacuation is also not possible for the PMF Flood Event, and people who are to evacuate from the subject site would become stranded or enter dangerous flood waters during their travel. Due to these risks, a shelter-in-place emergency response is recommended to be utilised for the subject site, to allow consistency across all flood events, and to address the risk of people entering floodwaters due to delayed evacuation. A shelter-in-place framework can be supported, as complete isolation due to the flooding is only applicable during the PMF event, for approximately 5.5 hours. Adopting a shelter-in-place emergency response ensures consistency across all flood events and increases the effectiveness of the emergency response and the safety of occupants.

Table 4: Flood Isolation Duration

Flooding Isolation Duration				
Flood Event	**Merimbula**	**Eden (via Princes Highway)**	**Eden (via Back Creek Rd and Nethercote Rd)**	**Wyndham**
5% AEP	Road Remains Passable (H1 Hazard)	Road Remains Passable (H1 Hazard)	8 hours Isolation	Flood Free Access
1% AEP	7 hours Isolation	Road Remains Passable (H1 Hazard)	9 hours Isolation	Flood Free Access
0.5% AEP	7 hours Isolation	Road Remains Passable (H1 Hazard)	9 hours Isolation	Flood Free Access
PMF	11.5 hours Isolation	5 hours Isolation	5.75 hours Isolation	5.5 hours Isolation

Future residential development is expected to be self-sufficient during periods of isolation, as dwellings will require on-site management for water supply, sewerage and stormwater.

- Water supply will be managed via rainwater collection from dwellings and/or outbuildings and utilised for domestic and firefighting purposes. No provision of reticulated water supply from a council-managed system is proposed as part of the proposed subdivision. In the event of a flood, water supply for domestic purposes is expected to remain in service, due to the entire system being managed on-site.
- Sewerage management will be via an on-site sewerage management system (OSMS), with a report prepared at the time of subdivision to demonstrate that a suitably sized system can be accommodated on each proposed lot, and a report prepared at the time of dwelling

construction to detail the necessary system to be constructed to service the proposed dwelling. OSMS is constrained by the proximity of the subject site to the Pambula River, requiring a buffer between the OSMS land application area and the Pambula River. This requirement restricts residential development from being close to the Pambula River, and within the flooding extent. In the event of a flood, sewerage management is expected to remain in service, due to the entire system being managed on-site.

- Stormwater runoff from the future developments will be managed on-site, with most of the stormwater (rainwater) being directed to rainwater tanks for domestic and firefighting use.
- Grid Electricity Supply is expected to be provided to each future lot to satisfy the requirements of the Consent Authority. Grid Supply is currently available at the intersection of Robinsons Road and Mount Darragh Road, with the infrastructure expected to be extended with the formalisation of The Unnamed Road. The Grid Electricity Supply will be managed by Essential Energy as the service provided.
- Telecommunications is expected to be available to each future lot. It is noted that an optic fibre cable runs through the subject site, however, it is unclear which telecommunications service will be available to future lots. It is expected that future lots will be best serviced for telecommunications using satellite technology.

4.2. Requirements of Bega Valley Local Environmental Plan

Bega Valley Local Environmental Plan	
Planning Requirement	**Development Proposal**
Section 5.21 Flood Planning	
(1) The objectives of this clause are as follows— (a) to minimise the flood risk to life and property associated with the use of land, (b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change, (c) to avoid adverse or cumulative impacts on flood behaviour and the environment, (d) to enable the safe occupation and efficient evacuation of people in the event of a flood.	
(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development—	
(a) is compatible with the flood function and behaviour on the land, and	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The area subject to the planning proposal which will facilitate future residential development is above the PMF Flood Extent. As future residential development will be above the PMF Flood Extent, there is no flood function or flood behaviour which the development must be compatible with.
(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The area subject to the planning proposal which will facilitate future residential development is above the PMF Flood Extent. As future residential development will be above the PMF Flood Extent, there will be no impacts on flood behaviour as a result of future development.
(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The formalisation of the unnamed road to the south of the subject site will be as a public road which will allow for two-way traffic flows, with a single lane in each direction. A Floodplain Risk Management Study and Plan is not yet prepared, or adopted for the Pambula River, which precludes the ability to understand the broader evacuation routes for the surrounding area. However, evacuation of the subject site is expected to be via Mount Darragh Road, Back Creek Road and/or Princes Highway. Each of these roads are sealed public roads, which allows for two-way traffic flows, with a single lane in each direction.
(d) incorporates appropriate measures to manage risk to life in the event of a flood, and	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The area subject to the planning proposal which will facilitate future residential development is above the PMF Flood Extent, preventing future residential development from occurring within the flood-affected portion of the subject site, and ensuring future residential development does not result in a risk to life due to flooding.
(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	The flood-affected portion of the subject site is not proposed to be rezoned under this planning proposal, with the flood-affected portion of land to be retained as RU2 Rural Landscape. The remaining RU2 Rural Landscape area of the subject site may be considered for a future boundary adjustment with neighbouring farmland, to consolidate the residual RU2 Rural

	Landscape area from the subject with surrounding RU2 Rural Landscape farmland.
(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters—	
(a) the impact of the development on projected changes to flood behaviour as a result of climate change,	The Pambula River, Pambula Lake and Yowaka River Flood Study indicate that it was prepared with consideration for Climate Change, which considers the implications of Sea Level Rise and Increased Rainfall. Figure 59.1 of the Pambula River, Pambula Lake and Yowaka River Flood Study details the increase in the 1% AEP flooding extent at the subject site when considering a 41% Increase in Rainfall and 0.9m Sea Level Rise for a 2090 planning horizon. The results of the climate change increase are generally relative to the current day 0.2% AEP flooding extent (Catchment Simulation Solutions, 2021, p. 91).
(b) the intended design and scale of buildings resulting from the development,	Future residential development will be low-impact residential development, consistent with the objectives of the R5 Large Lot Residential Zone and subject to future development applications. It will be the responsibility of the consent authority to assess future development applications against this matter.
(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The area subject to the planning proposal which will facilitate future residential development is above the PMF Flood Extent, preventing future development from occurring within the flood-affected portion of the subject site, and ensuring future residential development does not result in a risk to life due to flooding.
(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.	The area subject to the planning proposal which will facilitate future residential development is above the PMF Flood Extent, preventing future residential development from occurring within the flood-affected portion of the subject site, and ensuring future residential development does not result in dwellings being constructed within the area impacted by flooding. Due to the location of the subject site, impacts of Coastal Erosion are not applicable.
(4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.	
(5) In this clause— Considering Flooding in Land Use Planning Guideline means the Considering Flooding in Land Use Planning Guideline published on the Department's website on 14 July 2021. flood planning area has the same meaning as it has in the Flood Risk Management Manual. Flood Risk Management Manual means the Flood Risk Management Manual, ISBN 978-1-923076-17-4, published by the NSW Government in June 2023.	
Section 5.22 Special Flood Considerations (1) The objectives of this clause are as follows— (a) to enable the safe occupation and evacuation of people subject to flooding, (b) to ensure development on land is compatible with the land's flood behaviour in the event of a flood, (c) to avoid adverse or cumulative impacts on flood behaviour,	

(d) to protect the operational capacity of emergency response facilities and critical infrastructure during flood events, (e) to avoid adverse effects of hazardous development on the environment during flood events.	
(2) This clause applies to— (a) for sensitive and hazardous development—land between the flood planning area and the probable maximum flood, and (b) for development that is not sensitive and hazardous development—land the consent authority considers to be land that, in the event of a flood, may— (i) cause a particular risk to life, and (ii) require the evacuation of people or other safety considerations.	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The area subject to the planning proposal which will facilitate future residential development is above the PMF Flood Extent. This Clause applies to land between the Flood Planning Area and the Probably Maximum Flood, which is part of area which is not proposed to be rezoned as part of this planning proposal. Accordingly, future residential development and any special flood considerations as part of the development on the newly created lots would be above the PMF Flood Extent and would also be subject to development assessment by the consent authority.
(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority has considered whether the development— (a) will affect the safe occupation and efficient evacuation of people in the event of a flood, and (b) incorporates appropriate measures to manage risk to life in the event of a flood, and (c) will adversely affect the environment in the event of a flood.	The area subject to the planning proposal which will facilitate future residential development is above the PMF Flood Extent. Future residential development and any special flood considerations as part of the development on the newly created lots would be above the PMF Flood Extent and would also be subject to development assessment by the consent authority.
(4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.	
(5) In this clause— Considering Flooding in Land Use Planning Guideline—see clause 5.21(5). flood planning area—see clause 5.21(5). Flood Risk Management Manual—see clause 5.21(5). probable maximum flood has the same meaning as in the Flood Risk Management Manual. sensitive and hazardous development means development for the following purposes— (a) boarding houses, (b) caravan parks, (c) correctional centres, (d) early education and care facilities, (e) eco-tourist facilities, (f) educational establishments, (g) emergency services facilities, (h) group homes, (i) hazardous industries,	Despite the area subject to the planning proposal being above the PMF Flood Extent, many of the listed sensitive and hazardous developments are not permitted uses under the R5 Large Lot Residential Zone. Any sensitive and hazardous developments proposed on the future lots would be subject to development assessment by the consent authority.

	(j) hazardous storage establishments, (k) hospitals, (l) hostels, (m) information and education facilities, (n) respite day care centres, (o) seniors housing, (p) tourist and visitor accommodation.	

4.3. Requirements of Bega Valley Development Control Plan

The current proposal is for the subdivision of land to permit future rural residential development. Whilst the lot is flood-affected, as per the Bega Valley DCP, "*Where lots are partially impacted by flooding or have varying levels of flood risk the applicable controls for a proposed development will be determined by the location (development footprint) of the proposed building or structure, not the lot*". As the planning proposal seeks to rezone the area of land above the PMF Flooding Extent only, all future residential development on the newly created lots will be beyond the flooding extents, and not subject to flood related development controls. Regardless, a summary of the proposal against the requirements of the DCP is presented below.

5.8 Planning for Hazards	
5.8.1 Flood Planning	
Objectives: Ensure that new development does not interfere with existing flood flow, channel capacity or flood storage areas Reduce the impact of flooding and flood liability on owners and occupiers of flood prone land Reduce private and public losses from flooding by ensuring adverse and cumulative impacts on flood behaviour and the environment are managed Improve public safety with respect to flooding, including the safe occupation and efficient evacuation of people in flood events. As far as practical, ensure new development does not increase risk to life and property Deal equitably and consistently with all matters requiring Council approval on flood affected land, in accordance with the principles of the latest version of the NSW Flood Risk Management Manual (2023) or its update. Applicants must have regard to the provisions of Clause 5.21 and 5.22 of the Bega Valley Shire Local Environmental Plan 2013.	
Flood Planning Matrix	
Minimum Floor Level	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. Future Residential Developments on the newly created lots will be above the PMF, which will permit future floor levels to be well beyond the Flood Planning Level.
Minimum Ground Level	The natural channel/floodway of the Pambula River defines the flood-affected portion of the lot. Earthworks within the flood-affected portion of the lot would influence the flow conveyance of the Pambula River and are not recommended or considered necessary to service the proposed subdivision. Future Residential Developments on the newly created lots will be above the PMF, which will permit future floor levels to be well beyond the Flood Planning Level.
Building Components	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. Future Residential Developments on the newly created lots will be above the PMF, resulting in future dwellings being constructed above

	the PMF Flood Level, and negating the need for Flood Compatible Materials.
Structural Soundness	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. Future Residential Developments on the newly created lots will be above the PMF, resulting in future dwellings being constructed above the PMF Flood Level, and negating the need for structural engineering design to withstand flood forces.
Flood Affection	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. Future Residential Developments on the newly created lots will be above the PMF, resulting in future dwellings being constructed above the PMF Flood Level, and negating the need to consider the impacts of Flow Conveyance by structures within the Flood Extents.
Emergency Response	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. Future Residential Developments on the newly created lots will be above the PMF, and a shelter-in-place emergency response is recommended for the subject site, as detailed in 4.1. Emergency Response Requirements.
Management and Design	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The area proposed to be rezoned, and which will be subject to future residential development on the newly created lots, is above the PMF Flood Extent, which negates the need for meeting any FPCC requirements, meeting the requirements for subdivision under the DCP. A shelter-in-place emergency response is recommended for the subject site, as detailed in 4.1. Emergency Response Requirements, which should be incorporated into future Flood Safe Plans.
Parking and Driveway Access	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The location of legal access to all future lots will be via the unnamed road to the south of the subject site, which is beyond the PMF Flood Extent and ensures flood-free driveway access and parking will be achieved.

4.4. Requirements of NSW Department of Climate Change, Energy, the Environmental and Water (Biodiversity Conservation and Science)

Local Planning Direction 4.1-Flooding	
Focus area 4: Resilience and Hazards	
4.1 Flooding	
The objectives of this direction are to: (a) ensure that development of flood prone land is consistent with the NSW Government's Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005, and (b) ensure that the provisions of an LEP that apply to flood prone land are commensurate with flood behaviour and includes consideration of the potential flood impacts both on and off the subject land.	
Application This direction applies to all relevant planning authorities that are responsible for flood prone land when preparing a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land.	
Direction 4.1 (1) A planning proposal must include provisions that give effect to and are consistent with: (a) the NSW Flood Prone Land Policy (b) the principles of the Floodplain Development Manual 2005, (c) the Considering flooding in land use planning guideline 2021, and (d) any adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 and adopted by the relevant council.	
(2) A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Conservation Zones to Residential, Employment, Mixed Use, W4 Working Waterfront or Special Purpose Zones.	The proposal does not seek to rezone land within the flood planning area.
(3) A planning proposal must not contain provisions that apply to the flood planning area which:	As per the Pambula River, Pambula Lake, Yowaka River Flood Study, the flood planning area is defined as the area within the 1% Flood Extent (incorporating 0.9m Sea Level Rise) + 500mm Freeboard. The proposal seeks to locate all residential development in an area outside of the Flood Planning Area, and beyond the PMF Flooding Extent, by rezoning only the portion of the subject site which is above the PMF Flood Extent.
(a) permit development in floodway areas,	The proposal seeks to locate all residential development in an area outside of the PMF Flooding Extent, through the rezoning of land above the PMF Flood Extent only. This planning proposal does not seek to permit any future development within the flood affected area of the site, which will prohibit future development within the floodway areas. All future development of the subject site, and newly created lots will be assessed by the consent authority in relation to flooding.
(b) permit development that will result in significant flood impacts to other properties,	The proposal seeks to locate all residential development in an area outside of the PMF Flooding Extent, through the rezoning of land above the PMF Flood Extent only. This planning proposal does not seek to permit any future development within the flood affected area of the site, which will prohibit future development within the flood extents, and

	ensure there are no additional flood impacts to other properties. All future development of the subject site, and newly created lots will be assessed by the consent authority in relation to flooding.
(c) permit development for the purposes of residential accommodation in high hazard areas,	The proposal seeks to locate all residential development in an area outside of the PMF Flooding Extent, through the rezoning of land above the PMF Flood Extent only.
(d) permit a significant increase in the development and/or dwelling density of that land,	The proposal seeks to locate all residential development in an area outside of the PMF Flooding Extent, through the rezoning of land above the PMF Flood Extent only. The increase in dwelling density will be beyond the PMF Flood Extent, associated with the area proposed to be rezoned to R5 Large Lot Residential only.
(e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The nominated uses are not specifically permitted, or prohibited under the Bega Valley LEP, and may potentially be permitted with consent. However, it is expected that site constraints would prevent development beyond a single dwelling house on each of the newly created lots. Future evacuation of the subject site is considered to be effective for events up to the PMF via flood-free egress via the unnamed road, and then via Mount Darragh Road, Back Creek Road and/or Princes Highway.
(f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require development consent,	The planning proposal seeks to rezone part of the subject site to R5 Large Lot Residential zoning. The works permitted without consent under the Bega Valley LEP are Environmental protection works; Extensive agriculture; Home businesses; Home industries; Home occupations. As per the definitions of the works permitted without consent, the uses are either ancillary to works permitted with consent, or exempt development (Bega Valley Local Environmental Plan 2013, n.d., Section 1.4). The works permitted without consent under the proposed rezoning, will only apply to the area beyond the PMF Flood Extent. The works permitted without consent do not permit altercations to the flood conveyance of the Pambula River.
(g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or	The proposal seeks to formalise the unnamed road south of the subject site. The construction of a Public Road within the existing unnamed road corridor is above the PMF Flood Extent, and as such, would not be impacted by flooding or be susceptible to damages because of flooding of the Pambula River. The proposal seeks to rezone land and locate all residential development beyond the PMF Flooding Extent, negating the need for flood protection infrastructure.
(h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.	The proposal seeks to rezone the subject site to R5 Large Lot Residential zoning. The nominated uses are not specifically permitted, or prohibited under the Bega Valley LEP, and may be permitted with consent. As the proposed rezoning is beyond the PMF Flood Extent, any potential hazardous materials are not expected to be affected by flooding.
(4) A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which:	The planning proposal does not seek to rezone the part of the subject site between the flood planning area and the probably maximum flood. Many of the sensitive and hazardous developments as defined under s5.22 of the Bega Valley LEP are not permitted uses in the R5 Large Lot Residential Zoning, however, some may be permissible with consent. As the proposed rezoning is beyond the PMF Flood Extent, there are not expected to be any flood impacts with potential sensitive and hazardous developments.
(a) permit development in floodway areas,	The proposal seeks to locate all future development in an area outside of the PMF Flooding Extent, through the rezoning of land above the PMF Flood Extent only. This planning proposal does not seek to permit any future development within the flood affected area of the site, which will prohibit future development within the floodway areas. All future development of the subject site, and newly created lots will be assessed by the consent authority in relation to flooding.
(b) permit development that will result in significant flood impacts to other properties,	The proposal seeks to locate all future development in an area outside of the PMF Flooding Extent, through the rezoning of land above the PMF

	Flood Extent only. This planning proposal does not seek to permit any future development within the flood-affected area of the site, which will prohibit future development within the flood extents, and ensure there are no additional flood impacts to other properties. All future development of the subject site, and newly created lots will be assessed by the consent authority in relation to flooding.
(c) permit a significant increase in the dwelling density of that land,	The proposal seeks to locate all residential development in an area outside of the PMF Flooding Extent, through the rezoning of land above the PMF Flood Extent only.
(d) permit the development of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,	The planning proposal seeks to rezone part of the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The nominated uses are not specifically permitted, or prohibited under the Bega Valley LEP, and may potentially be permitted with consent. However, it is expected that site constraints would prevent development beyond a single dwelling house on each of the newly created lots. Future evacuation of the subject site during the PMF flood event is not considered suitable, due to the inundation of evacuation routes. Shelter in Place is considered the most appropriate method of emergency response.
(e) are likely to affect the safe occupation of and efficient evacuation of the lot, or	The proposal seeks to locate all residential development in an area outside of the PMF Flooding Extent, through the rezoning of land above the PMF Flood Extent only. Accordingly, future occupants of the newly created lot would be able to occupy the land during all flood events, including the PMF Flood Event. Evacuation from the subject site would be constrained by the inundation of Evacuation Routes.
(f) are likely to result in a significantly increased requirement for government spending on emergency management services, and flood mitigation and emergency response measures, which can include but not limited to road infrastructure, flood mitigation infrastructure and utilities.	The proposal seeks to formalise the unnamed road south of the subject site. The construction of a Public Road within the existing unnamed road corridor is above the PMF Flood Extent, and as such, would not be impacted by flooding or be susceptible to damages because of flooding of the Pambula River. The proposal seeks to rezone land and locate all residential development beyond the PMF Flooding Extent, negating the need for flood protection infrastructure.
(5) For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council.	
Consistency A planning proposal may be inconsistent with this direction only if the planning proposal authority can satisfy the Planning Secretary (or their nominee) that:	
(a) the planning proposal is in accordance with a floodplain risk management study or plan adopted by the relevant council in accordance with the principles and guidelines of the Floodplain Development Manual 2005, or	A Floodplain Risk Management Study and Plan has not been commissioned or adopted by Bega Valley Shire Council, for the Pambula River.
(b) where there is no council adopted floodplain risk management study or plan, the planning proposal is consistent with the flood study adopted by the council prepared in accordance with the principles of the Floodplain Development Manual 2005 or	This Flood Impact Risk Assessment has been completed with consideration and reliance on the adopted Pambula River, Pambula Lake and Yowaka River Flood Study prepared by Catchment Simulations Solutions.
(c) the planning proposal is supported by a flood and risk impact assessment accepted by the relevant planning authority and is prepared in accordance with the principles of the Floodplain Development Manual 2005 and consistent with the relevant planning authorities' requirements, or	This Flood Impact Risk Assessment has been prepared to meet this requirement.

(d) the provisions of the planning proposal that are inconsistent are of minor significance as determined by the relevant planning authority	The proposal is consistent with the objectives of the Bega Valley LEP, and the Local Planning Direction 4.1-Flooding as outlined throughout this Flood Impact Risk Assessment.
Note: In this direction: (a) "flood prone land" "flood storage" "floodway" and "high hazard" have the same meaning as in the Floodplain Development Manual 2005. (b) "flood planning level" "flood behaviour" and "flood planning area" has the same meaning as in the Considering flooding in land use planning guideline 2021. (c) Special flood considerations are outlined in the Considering flooding in land use planning guideline 2021 and an optional clause in the Standard Instrument (Local Environmental Plans) Order 2006. (d) Under the floodplain risk management process outlined in the NSW Government's Floodplain Development Manual 2005, councils may produce a flood study followed by a floodplain risk management study and floodplain risk management plan. Date commenced: 20 February 2023	

4.5. Flood-Related Development Controls

The planning proposal seeks to rezone the subject site, reduce the minimum lot size, and enable future subdivision, facilitating residential development on the newly created lots. The newly created lots will not be affected by the Flood Planning Area, or the PMF and would not be required to address any specific flood-related development controls. The critical flood control to be implemented for the subject site is flood education, which is best suited to be addressed at a broader level through the commissioning of a Floodplain Risk Management Study and Plan. The outcomes of the Floodplain Risk Management Study and Plan are likely to identify the necessary upgrades to infrastructure, particularly road infrastructure which would be relied upon for evacuation, and likely improve the evacuation efficiency and effectiveness from the subject site, and surrounding areas.

It is not considered necessary to introduce specific development controls to each lot, in the form of restrictions on title or otherwise, as this planning proposal has been prepared with consideration to the flood extents of the subject site, and only seeks to rezone to the part of the subject site above the PMF Flood Extent.

5. Pre-developed Modelling and Analysis

Flood Models were prepared as part of the Pambula River, Pambula Lake and Yowaka River Flood Study, adopted by the Bega Valley Shire Council as the consent authority. The report and associated appendices are publicly available on the Council's website and with the Flood Models available on the NSW SES Flood Data Portal.

The adopted flood study analyses a range of flood events from the 10% AEP as the most frequent event, to the PMF Flood Event. The flood events include 10% AEP, 5% AEP, 2% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and PMF. Consideration for climate change was also carried out as part of the flood study, with consideration for rainfall intensity increase and sea-level rise applied as part of the modelling process, and sensitivity assessment.

The flood study was carried out between 2019-2020 and endorsed by Bega Valley Shire Council in 2021. The flood study was carried out per Australian Rainfall and Runoff 2019 (ARR2019) (Catchment Simulation Solutions, 2021, pp. ii, 56), which remains the most current version of Australian Rainfall and Runoff and is the primary technical resource for the input parameters associated with flood estimation and modelling. The flood study provides consideration to the previous version of Australian Rainfall and Runoff, 1987 (ARR1987), on which several existing flood studies including the Bega and Brogo Rivers Flood Study, and the Merimbula Lake and Back Lake Flood Study were completed based on. The flood study applied the ARR1987 design storms within the flood model, which demonstrated discharges typically 40% to 70% higher than the ARR2019 discharges (Catchment Simulation Solutions, 2021, p. 88). The differences between the ARR2019 and ARR1987 flood discharges in proximity to the subject site (XP-Rafts Node 1.20) are summarized in Table 5. The ARR1987 discharge for the 1% AEP exceeds the 0.2% AEP discharge calculated based on the ARR2019 guideline. Whilst there is a notable difference between flood discharges and flood behaviour defined under ARR1987 and ARR2019, ARR2019 was adopted for the design flood events as it takes advantage of a greater amount of historic rainfall information and employs the latest available research in deriving the design flood estimates. Therefore, it is considered that the flood estimates defined under ARR2019 are reasonable and improved upon the flood estimates provided by ARR1987 (Catchment Simulation Solutions, 2021, p. 89).

Table 5: ARR2019 and ARR1987 Flood Estimation Comparison (Catchment Simulation Solutions & Bega Valley Shire Council, 2021, Appendix H & L)

Flood Discharges Comparison XP-Rafts ID 1.20											
ARR2019 Raw Discharge (m^3/s)				ARR2019 Factored Discharge (m^3/s)				ARR1987 Discharge (m^3/s)			
10% AEP	5% AEP	2% AEP	1% AEP	10% AEP	5% AEP	2% AEP	1% AEP	10% AEP	5% AEP	2% AEP	1% AEP
318	378	473	550	438	527	613	651	445	571	758	916

The calibration process undertaken as part of the flood study included five significant flood events from 1971-2016. It is noted within the flood study that preference towards floods occurring after 2011 was made as it provides the most comprehensive rainfall information and stream flow/level information for calibration purposes. (Catchment Simulation Solutions, 2021, p. 41). Figures D2-D14 of the flood study demonstrate the simulations undertaken to calibrate the design flood models to resemble historic flooding conditions, with reasonable reproduction of recorded hydrographs achieved, with regard to the shape of the hydrograph, timing of dual peaks and the magnitude of the peak discharge (Catchment Simulation Solutions, 2021, p. 43).

The planning proposal seeks to rezone the part of the subject site above the PMF Flood Extent only, and despite the variances associated with the calculated flood discharges associated with the ARR2019 and ARR1987 methodologies, the PMF Flood Extents were calculated from the Probable Maximum

Precipitation (PMP) which was derived from the Bureau of Meteorology's 'Generalised Short Duration Method' (GSDM). The GDSM used has been in place since 2003 and remains current. Therefore, the PMF Flood Extent which has been accounted for in this FIRA is consistent with current requirements, and suitable for relying upon for this FIRA.

6. Post-Developed Modelling and Analysis

The proposal does not seek to develop or alter the landform within the flooding extents. The proposal seeks to accommodate the flood behaviour within the natural terrain and allow future residential development beyond the PMF Flooding Extents through rezoning the part of the subject site above the PMF only. The only proposed construction works at the time of subdivision will be the construction of the unnamed road to a public road standard, in which all works are located beyond the PMF flooding extent. Future residential development will be restricted to be above the PMF Flood Extent, within the area proposed to be rezoned.

Accordingly, no post-developed modelling or analysis has been deemed necessary and carried out.

7. Key Risks to be Managed

The planning proposal seeks to rezone the area of the subject site above the PMF Flood Extent only, and ensures the risk of risk of damage to future dwellings and the risk to life of future residents due to flooding is considered low.

Dwellings will be required to be constructed above the PMF Flooding Extent, as the rezoning is only proposed beyond the PMF Flood Extent. Dwellings will require a further setback from the PMF Flood Extent, as DCP setbacks from property boundaries, asset protection zones and OSMS effluent management areas will also be required within each of the newly created lots.

As one lot may retain the land below the PMF Flood Extent, which is not proposed to be rezoned as part of this planning proposal, any development proposed will be subject to development controls under FPCC4, as per the Bega Valley Development Control Plan, which will require the assessment of the proposal against Flood Affection, Emergency Response and Management and Design Criteria. Any proposal would be subject to future reporting by the developer, and assessment by the consent authority, which is beyond the scope of this FIRA, considering sufficient flood-free development area can be demonstrated as part of this proposal.

The risk to life due to flooding is considered low for the subject site, due to the flood-free refuge which can be accommodated on each future lot. The risk to life will be greatest if a resident decides to evacuate the subject site, in particular towards the closest urban centres of Merimbula, Pambula or Eden, due to the extent of roadway inundation along Mount Darragh Road, Back Creek Road, Nethercote Road, and the Princes Highway. The risk to life will increase with the severity of the flood events, as the flood hazard increases and the time to evacuate decreases. To manage the risk to life of residents, it is recommended that a shelter-in-place emergency response be implemented for future dwellings, to prevent residents from entering floodwaters during evacuation.

To demonstrate the risk of a particular flood occurring, Table 6 has been reproduced from the AIDR to demonstrate the probability of experiencing a given sized flood in 80 years, to reflect the average life expectancy and average life of a dwelling. To demonstrate the probability of the PMF, the 0.01% AEP (10,000-year ARI) can be utilised, consistent with the NSW State Emergency Service, p. (2018, p. 10) definition for PMF.

Table 6: Probability of Experiencing a given-sized flood in 80 years. Reproduced from Australian Institute for Disaster Resilience, p. (2017, p. 30)

Probability of Experiencing a Given-Sized Flood in an 80-year period			
Annual Exceedance Probability (%)	**Approximate Average Recurrence Interval (Years)**	**Probability of experiencing a given-sized flood in an 80-year period**	
		At least once (%)	**At least twice (%)**
20	5	100	100
10	10	99.9	99.8
5	20	98.4	91.4
2	50	80.1	47.7
1	100	55.3	19.1
0.5	200	33.0	6.11
0.2	500	14.8	1.14
0.1	1,000	7.69	0.30
0.01	10,000	0.80	0.003

8. Conclusion and Recommendations

This FIRA addresses the requirements of Bega Valley Shire Council, and the NSW Department of Climate Change, Energy, the Environmental and Water (Biodiversity Conservation and Science), as specified in the agency referral responses to the initial scoping proposal.

This FIRA has reviewed the adopted Pambula River, Pambula Lake and Yowaka River Flood Study concerning the subject site, supporting its findings as the best available information. In the absence of an adopted Flood Risk Management Study and Plan, this FIRA has assessed the direct and indirect effects of flooding on the subject site, demonstrating that there is sufficient ability to develop the subject site beyond the PMF Flooding Extents and prevent any direct impacts due to flooding. This suitability permits the indirect effect of isolation due to flooding to be addressed, by demonstrating compliance with the shelter-in-place framework for emergency response.

This FIRA has assessed the proposal against the requirements of the Bega Valley Local Environmental Plan, Bega Valley Development Control Plan, and the NSW Government Local Planning Direction Section 4.1-Flooding, demonstrating compliance with these requirements.

Based on the findings of this FIRA, the risks associated with flooding have been suitably considered and addressed as part of the preparation of this proposal, and future residential development, thus supporting the proposal to rezone part of the subject site and permit future subdivision for residential purposes.

9. References

AFAC. (2018). *Emergency Planning and Response to Protect Life in Flash Flood Events GUIDELINE*.

Australian Institute for Disaster Resilience. (2009). *Australian Disaster Resilience Manual 20: Flood Preparedness*. http://www.dpmc.gov.au/

Australian Institute for Disaster Resilience. (2017). *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*.

Australian Institute of Disaster Resilience. (2009). *Australian Disaster Resilience Manual 22: Flood Response*. http://www.dpmc.gov.au/

Australian Institute of Disaster Resilience. (2017). *Flood Emergency Response Classification of the Floodplain*. http://www.dpmc.gov.au/

Bega Valley Local Emergency Management Committee. (2019). *Bega Valley Local Emergency Management Plan*.

Bega Valley Local Environmental Plan 2013. (n.d.). Version 5 July 2024. Retrieved August 2, 2024, from https://legislation.nsw.gov.au/view/html/inforce/current/epi-2013-0408

Bega Valley Shire Council. (2020). *Rural Residential Land Strategy 2020*.

Bega Valley Shire Council. (2021a). *Minutes of Council - 21 July 2021*. https://begavalley.infocouncil.biz/Open/2021/07/OC_21072021_MIN_611.htm

Bega Valley Shire Council. (2021b). *Pambula River, Pambula Lake and Yowaka River Flood Study*. https://begavalley.nsw.gov.au/services/pambula-river-pambula-lake-and-yowaka-river-flood-study

Catchment Simulation Solutions. (2021). *Pambula River, Pambula Lake and Yowaka River Flood Study*.

Elvis. (n.d.).

Instream Ecological Value for NSW Freshwater Riverine Ecosystems. (n.d.). Retrieved August 2, 2024, from https://trade.maps.arcgis.com/apps/webappviewer/index.html?id=91904a403e7742518ce42120321a76ad

Latest Weather Observations Merimbula. (n.d.). Retrieved August 23, 2024, from http://www.bom.gov.au/products/IDN60801/IDN60801.95929.shtml

Merimbula, NSW - August 2024 - Daily Weather Observations. (n.d.). Retrieved August 23, 2024, from http://www.bom.gov.au/climate/dwo/202408/html/IDCJDW2082.202408.shtml

Merimbula, NSW - July 2024 - Daily Weather Observations. (n.d.). Retrieved August 23, 2024, from http://www.bom.gov.au/climate/dwo/202407/html/IDCJDW2082.202407.shtml

Molino, S., Morrison, T., Howard, M., & Opper, S. (2013). *A TECHNICAL GUIDELINE FOR THE USE OF THE SES TIMELINE EVACUATION MODEL IN FLOOD EVACUATION PLANNING*. www.molinostewart.com.au

NSW Department of Planning and Environment. (2022). *Draft Shelter-in-place Guideline*.

NSW Department of Planning and Environment. (2023). *Flood Hazard Flood Risk Management Guideline*. www.environment.nsw.gov.au

NSW Spatial Services. (n.d.). *BEGA, 2kmx2km 1 metre Resolution Digital Elevation Model Metadata*. Retrieved August 21, 2024, from https://nsw-elvis.s3.ap-southeast-2.amazonaws.com/elevation/1m-dem/z55/Bega201308/metadata/Bega201308-LID1-AHD_7505906_55_0002_0002_1m.html

NSW State Emergency Service. (2018). *NEW SOUTH WALES STATE FLOOD PLAN GLOSSARY: Supporting Document to the NSW State Flood Plan*.

NSW State Emergency Service. (2021). *Bega Valley Local Flood Plan*. www.ses.nsw.gov.au

Opper, S. (2004). *The Application of Timelines to Evacuation Planning*.

Public Works Department. (1990). *Pambula River Data Assessment Study*.

SIX Maps. (n.d.). Retrieved August 5, 2024, from https://maps.six.nsw.gov.au/

SMEC. (2014). *Bega and Brogo Rivers Flood Study*.

WaterNSW. (n.d.). *Real-time Water Data*. 220003 (Pambula River at Lochiel). Retrieved August 2, 2024, from https://realtimedata.waternsw.com.au/water.stm

WaterNSW. (2024). *Custom Output Data for Stream Water Level and Discharge Rate for Gauge 220003 (Pambula River at Lochiel)*. https://realtimedata.waternsw.com.au/water.stm

10. Appendices

10.1. Historical Flooding Hydrographs

The following hydrographs have been exported from the Water NSW Real Time Data website, for floods listed in Table 2. The design flood flows from the Pambula River, Pambula Lake and Yowaka River Flood Study are reproduced below, in both m^3/s and ML/d flow rates for comparison against the below hydrographs.

Design Flood Flow Rates		
Design Flood	**Flow (m3/s)**	**Flow (ML/d)**
10% AEP	438	37,843
5% AEP	527	45,533
2% AEP	613	52,963
1% AEP	651	56,246
0.5% AEP	696	60,134
0.2% AEP	742	64,109
PMF	2625	226,800

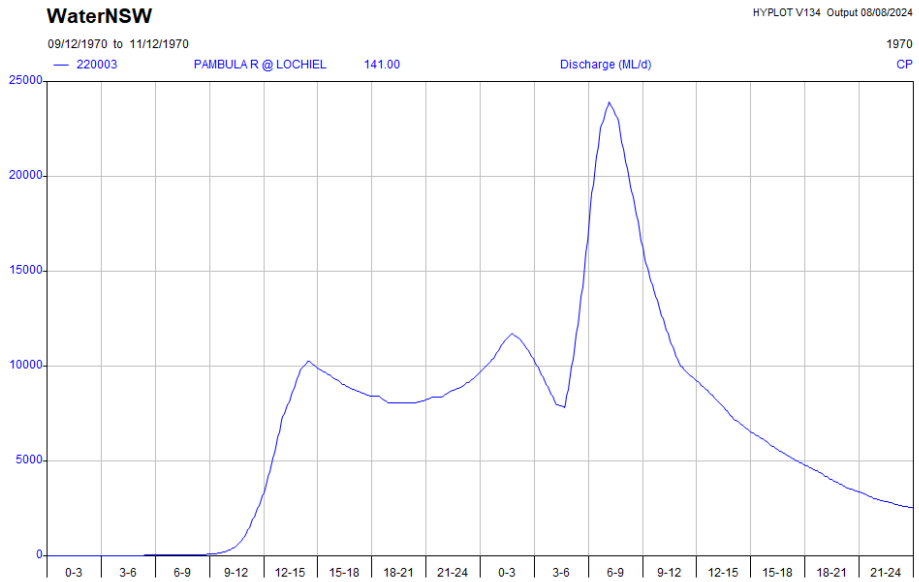


Figure 24: December 1970 Flood Hydrograph

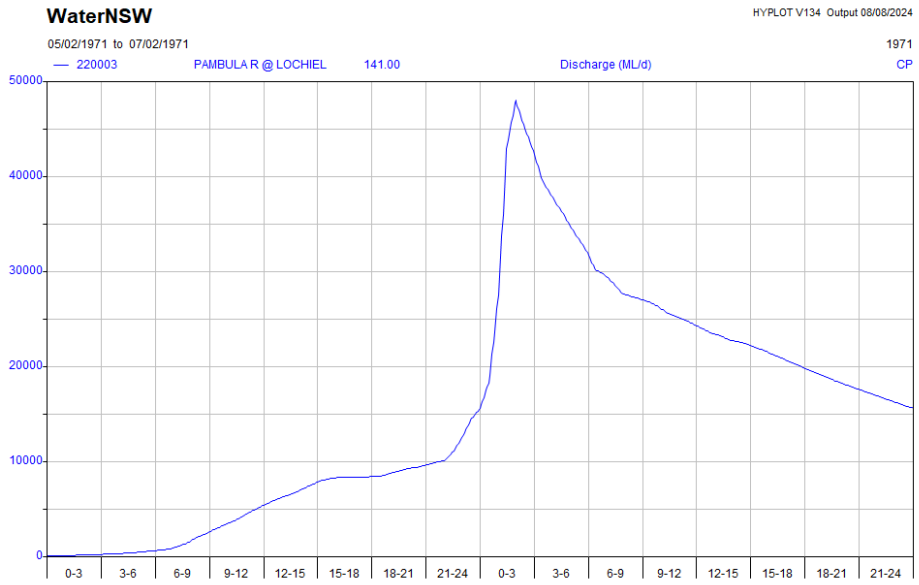


Figure 25: February 1971 Flood Hydrograph

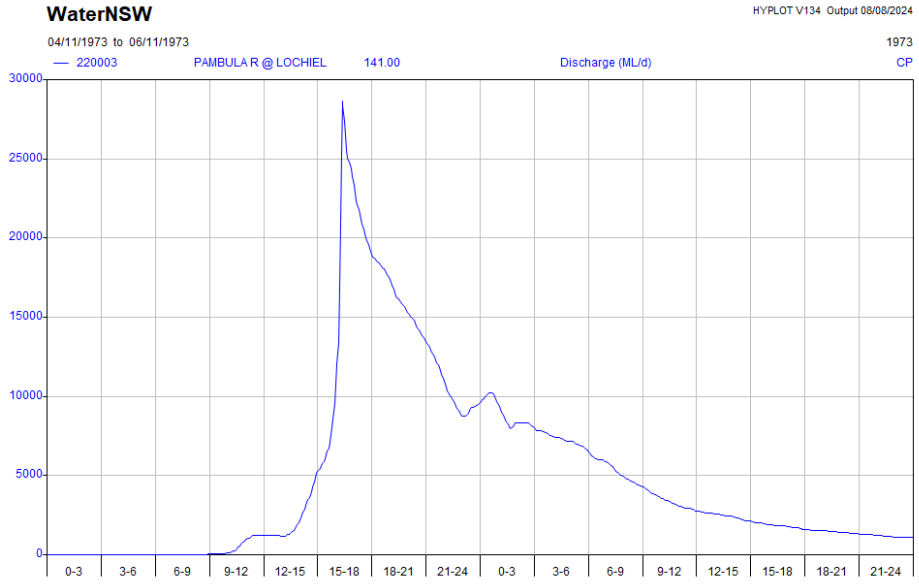


Figure 26: November 1973 Flood Hydrograph

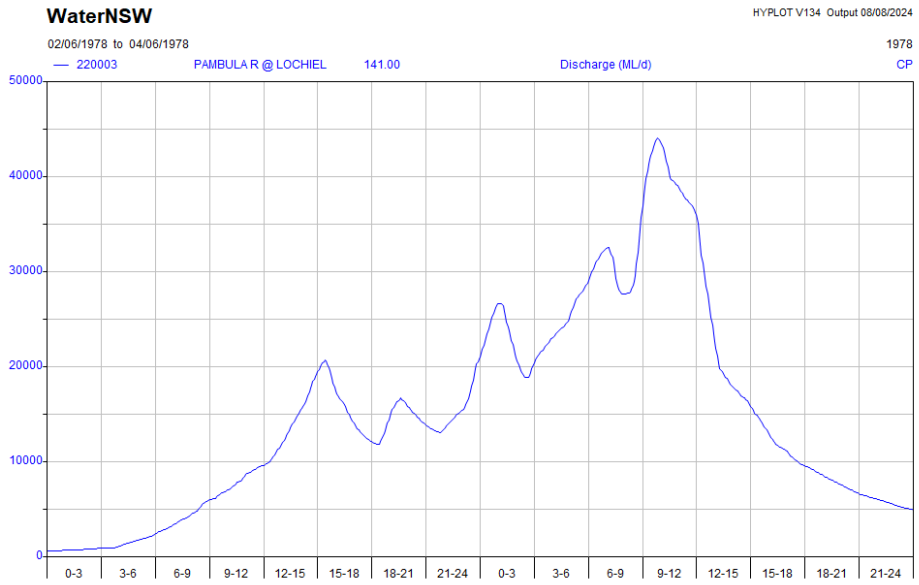


Figure 27: June 1978 Flood Hydrograph

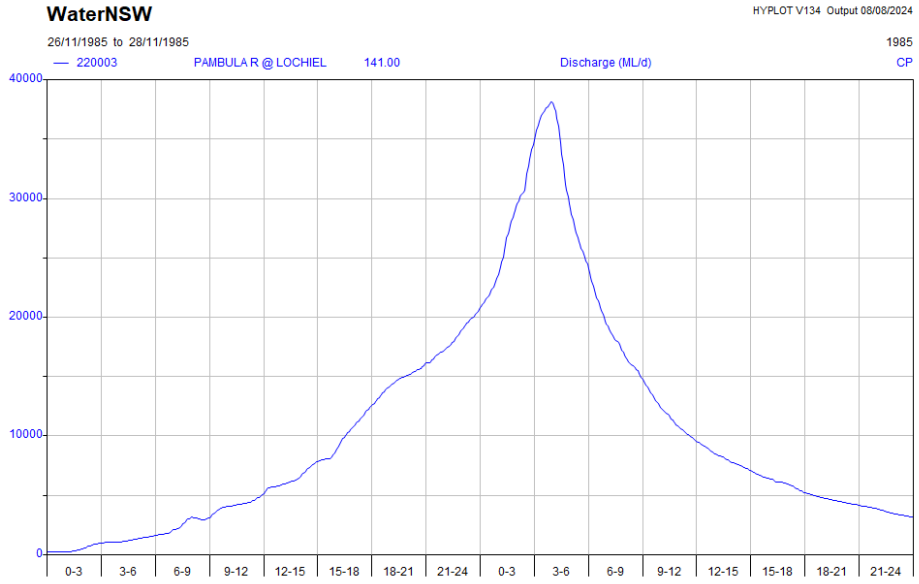


Figure 28: November 1985 Flood Hydrograph

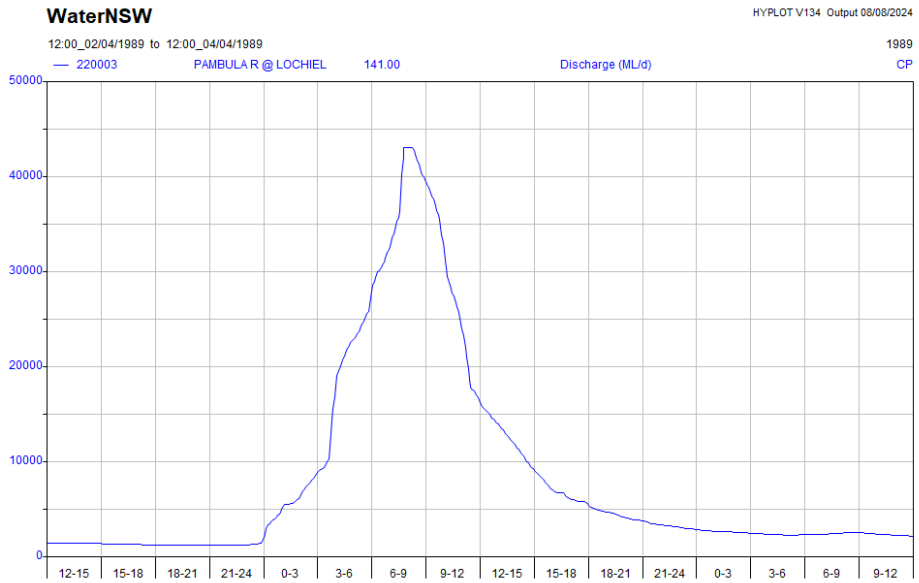


Figure 29: April 1989 Flood Hydrograph

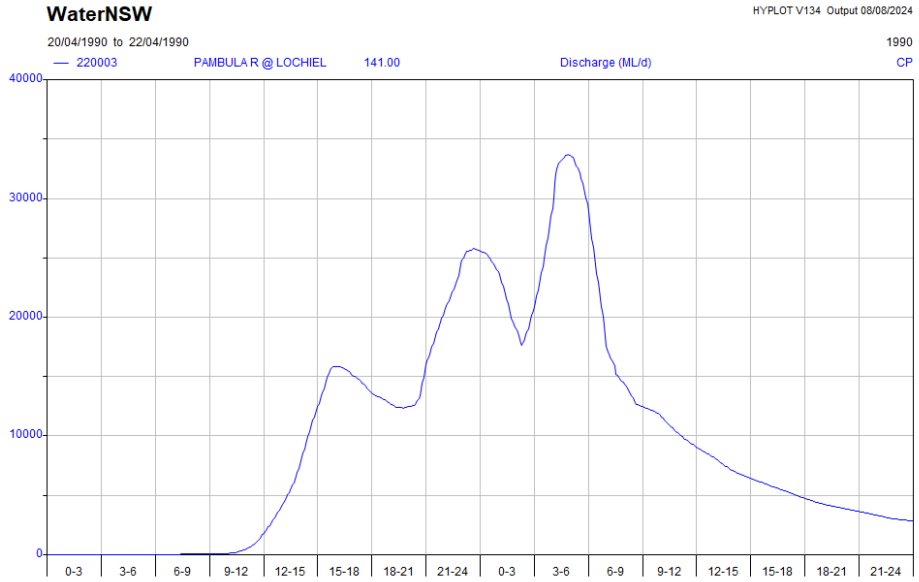


Figure 30: April 1990 Flood Hydrograph

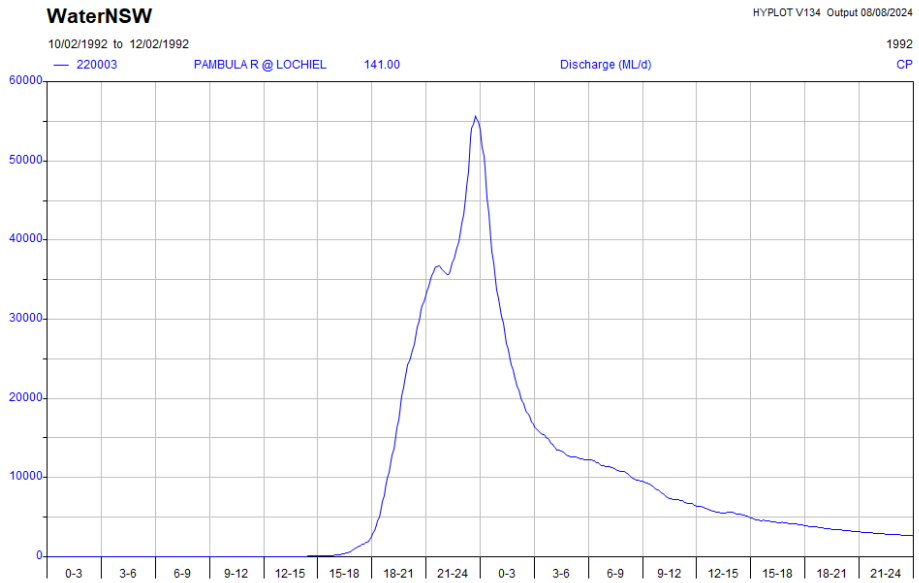


Figure 31: February 1992 Flood Hydrograph

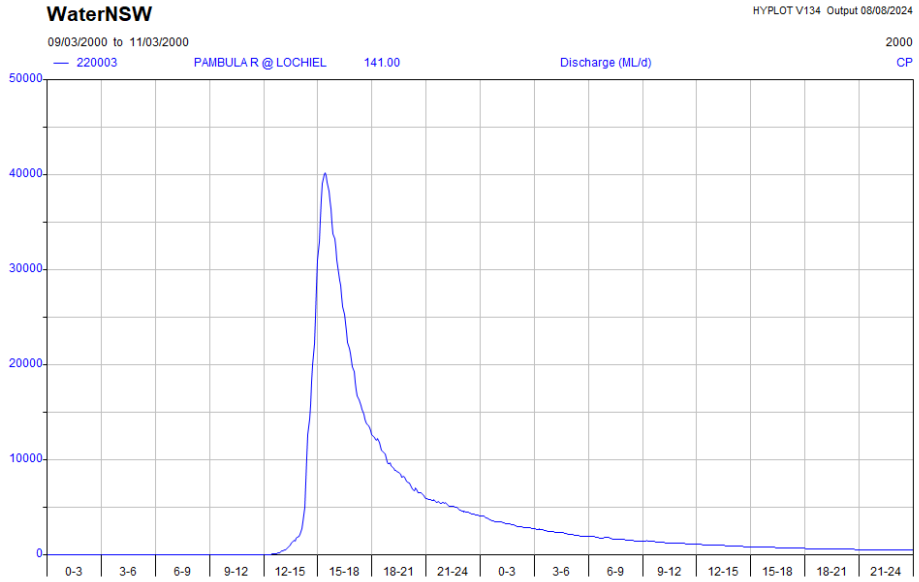


Figure 32: March 2000 Flood Hydrograph

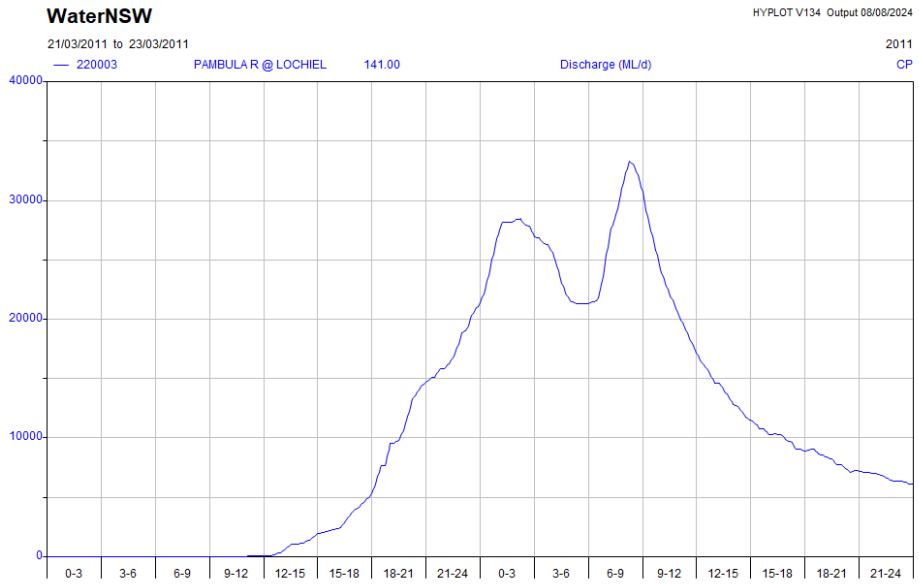


Figure 33: March 2011 Flood Hydrograph

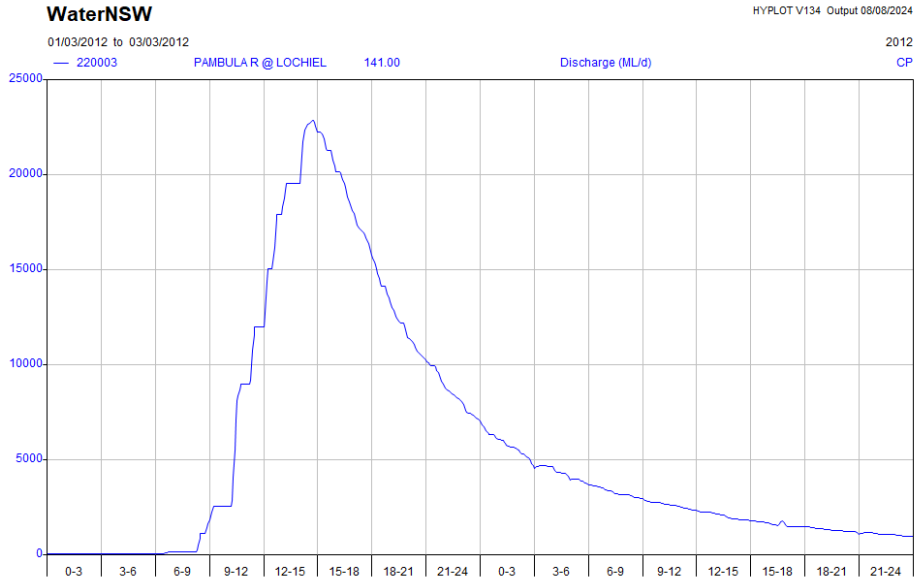


Figure 34: March 2012 Flood Hydrograph

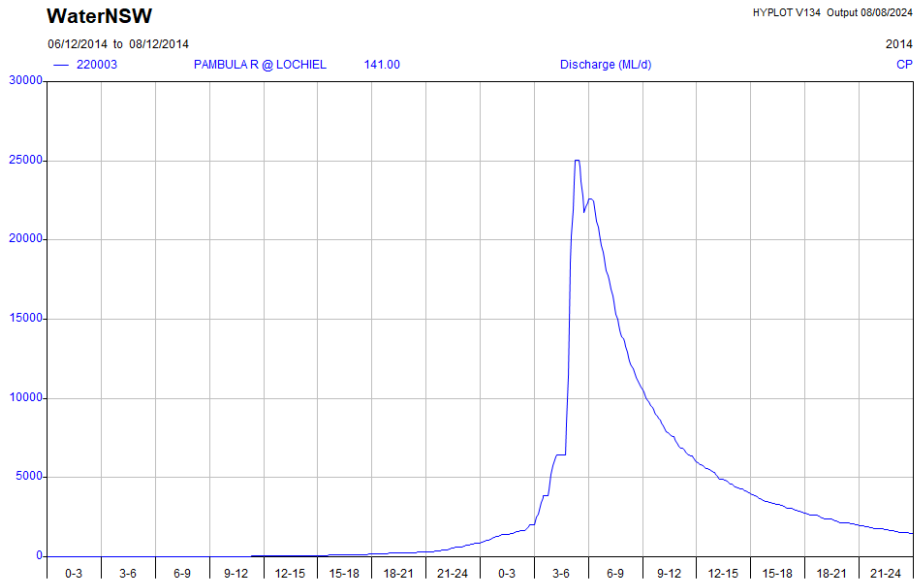


Figure 35: December 2014 Flood Hydrograph

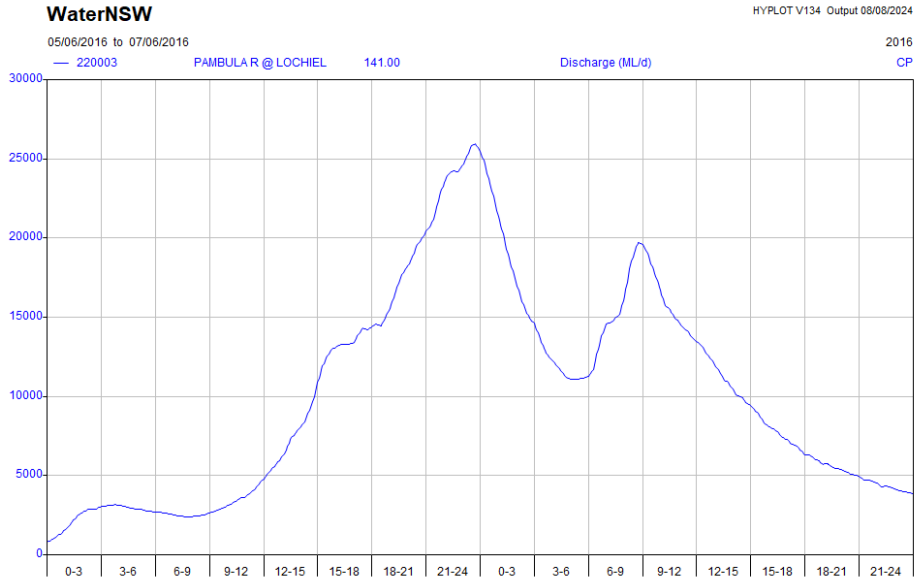


Figure 36: June 2016 Flood Hydrograph

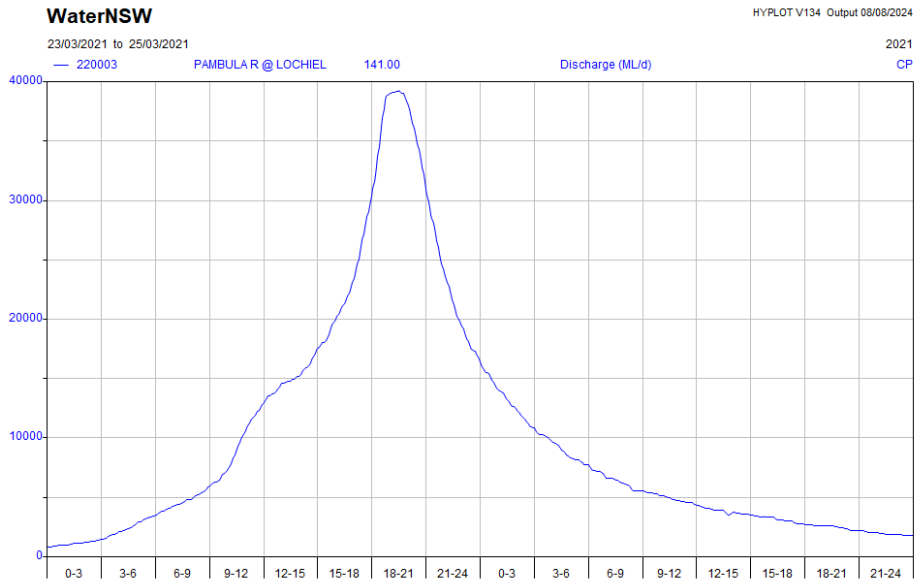


Figure 37: March 2021 Flood Hydrograph

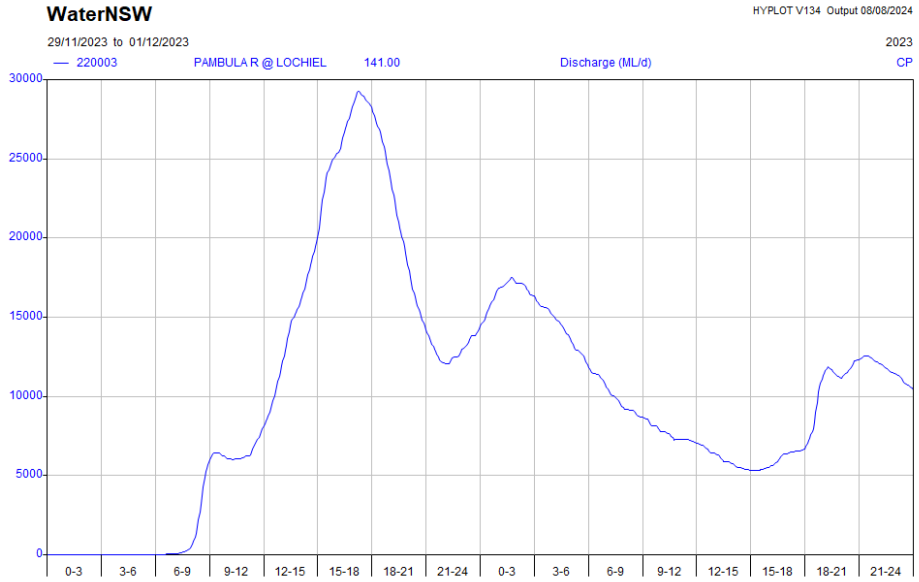


Figure 38: November 2023 Flood Hydrograph

10.2. Site Inspection

The following tables present the preceding weather conditions before the undertaking of the site inspections. Attached are the photographs which were taken through the site inspection.

Table 7: Weather Observations for Merimbula AWS for 24 hours preceding Site Inspection (Latest Weather Observations Merimbula, n.d.)

Latest Weather Observations for Merimbula							
Date/Time EST	**Temp °C**	**Dew Point °C**	**Rel Hum %**	**Delta-T °C**	**Press QNH hPa**	**Press MSL hPa**	**Rain since 9am mm**
22/02:00pm	16.7	12.5	76	2.3	1015.9	1015.9	0.0
22/01:30pm	15.5	10.7	73	2.5	1015.8	1015.8	0.0
22/01:00pm	18.2	9.3	56	4.7	1015.5	1015.5	0.0
22/12:30pm	19.1	10.4	57	4.7	1015.4	1015.4	0.0
22/12:00pm	18.7	10.5	59	4.4	1015.9	1015.9	0.0
22/11:30am	17.8	9.9	60	4.2	1016.2	1016.2	0.0
22/11:00am	17.3	8.7	57	4.4	1016.5	1016.5	0.0
22/10:30am	15.8	9.7	67	3.2	1016.7	1016.7	0.0
22/10:00am	14.9	9.1	68	3.0	1016.6	1016.6	0.0
22/09:30am	14.5	8.9	69	2.8	1016.7	1016.7	0.0
22/09:00am	13.6	9.5	76	2.1	1016.5	1016.5	0.0
22/08:30am	13.7	8.3	70	2.7	1016.3	1016.3	0.0
22/08:00am	13.4	8.3	71	2.5	1016.1	1016.1	0.0
22/07:30am	11.0	10.8	99	0.1	1015.8	1015.8	0.0
22/07:00am	10.5	9.9	96	0.3	1015.5	1015.5	0.0
22/06:30am	10.7	10.4	98	0.2	1015.2	1015.2	0.0
22/06:00am	10.3	10.0	98	0.2	1015.0	1015.0	0.0
22/05:30am	10.6	10.4	99	0.1	1014.7	1014.7	0.0
22/05:00am	10.2	10.1	99	0.1	1014.5	1014.5	0.0
22/04:30am	10.9	10.7	99	0.1	1014.5	1014.5	0.0
22/04:00am	10.3	10.1	99	0.1	1014.6	1014.6	0.0
22/03:30am	10.1	10.0	99	0.1	1014.5	1014.5	0.0
22/03:00am	10.5	10.3	99	0.1	1014.2	1014.2	0.0
22/02:30am	10.2	10.1	99	0.1	1014.6	1014.6	0.0
22/02:00am	10.7	10.5	99	0.1	1015.0	1015.0	0.0
22/01:30am	10.5	10.3	99	0.1	1015.2	1015.2	0.0
22/01:00am	10.1	10.0	99	0.1	1015.1	1015.1	0.0
22/12:30am	10.3	10.1	99	0.1	1015.0	1015.0	0.0
22/12:00am	11.1	10.9	99	0.1	1014.9	1014.9	0.0
21/11:30pm	11.2	11.0	99	0.1	1015.0	1015.0	0.0
21/11:00pm	11.6	11.4	99	0.1	1014.7	1014.7	0.0
21/10:30pm	11.1	10.9	99	0.1	1015.0	1015.0	0.0
21/10:00pm	11.4	11.1	98	0.2	1015.2	1015.2	0.0

21/09:30pm	12.3	11.8	97	0.3	1015.1	1015.1	0.0
21/09:00pm	13.0	12.4	96	0.3	1015.0	1015.0	0.0
21/08:30pm	13.0	12.2	95	0.4	1014.9	1014.9	0.0
21/08:00pm	13.3	12.4	94	0.5	1014.6	1014.6	0.0
21/07:30pm	13.1	12.3	95	0.4	1014.4	1014.4	0.0
21/07:00pm	13.1	12.3	95	0.4	1014.0	1014.0	0.0
21/06:30pm	13.3	12.7	96	0.3	1013.6	1013.6	0.0
21/06:00pm	13.2	11.6	90	0.9	1013.1	1013.1	0.0
21/05:30pm	14.4	12.6	89	1.0	1012.6	1012.6	0.0
21/05:00pm	14.9	12.9	88	1.1	1012.0	1012.0	0.0
21/04:30pm	15.5	13.2	86	1.3	1012.0	1012.0	0.0
21/04:00pm	16.3	13.2	82	1.7	1011.7	1011.7	0.0
21/03:30pm	16.7	13.0	79	2.1	1011.5	1011.5	0.0
21/03:00pm	17.9	13.8	77	2.3	1011.0	1011.0	0.0
21/02:30pm	17.9	13.4	75	2.5	1010.8	1010.8	0.0

Table 8: Daily Weather Observations for Merimbula (Merimbula, NSW - August 2024 - Daily Weather Observations, n.d.; Merimbula, NSW - July 2024 - Daily Weather Observations, n.d.)

Daily Weather Observations for Merimbula					
Month	Date	Day	Min. Temp (°C)	Max. Temp (°C)	Rain (mm)
July	23	Tu	6.9	20.1	0
	24	We	5.6	17.3	0
	25	Th	7.0	19.5	0.2
	26	Fr	4.6	18.0	0
	27	Sa	0.4	17.0	0
	28	Su	6.6	14.2	0.2
	29	Mo	6.7	13.3	2.4
	30	Tu	7.9	15.5	0
	31	We	7.2	15.5	0
August	1	Th	6.4	15.4	0
	2	Fr	7.0	17.2	0
	3	Sa	3.1	17.1	0
	4	Su	2.7	16.1	0
	5	Mo	5.4	16.3	0
	6	Tu	3.8	17.2	0.2
	7	We	3.8	20.2	0
	8	Th	2.5	17.7	0
	9	Fr	4.5	18.3	0
	10	Sa	3.6	17.2	0.2
	11	Su	4.5	17.5	0
	12	Mo	4.1	18.8	0
	13	Tu	7.7	19.1	0.2
	14	We	7.8	18.3	0.2
	15	Th	6.6	18.9	0
	16	Fr	6.8	18.9	0
	17	Sa	6.5	20.1	0.6
	18	Su	11.4	16.9	0.8
	19	Mo	3.9	16.2	0
	20	Tu	4.4	18.6	0.2
	21	We	8.2	24.8	0
	22	Th	9.7		0

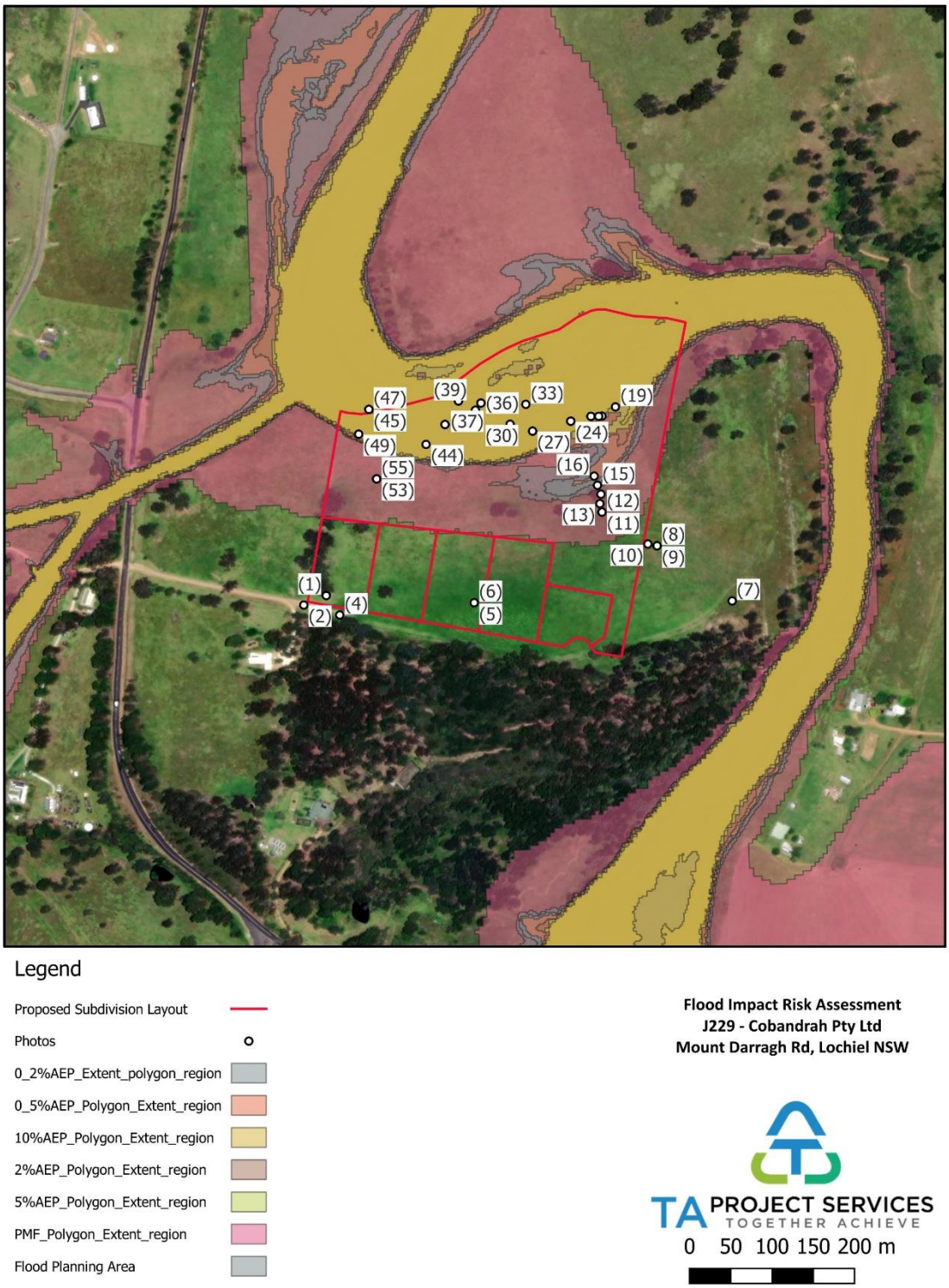


Figure 39: Site Inspection Photo Locations

Figure 40: Photo ID1

Figure 41: Photo ID2

Figure 42: Photo ID3

Figure 43: Photo ID4

Figure 44: Photo ID5

Figure 45: Photo ID6

Figure 46: Photo ID7

Figure 47: Photo ID8

Figure 48: Photo ID9

Figure 49: Photo ID10

Figure 50: Photo ID11

Figure 51: Photo ID12

Figure 52: Photo ID13

Figure 53: Photo ID14

Figure 54: Photo ID15

Figure 55: Photo ID16

Figure 56: Photo ID17

Figure 57: Photo ID18

Figure 58: Photo ID19

Figure 59: Photo ID20

Figure 60: Photo ID21

Figure 61: Photo ID22

Figure 62: Photo ID23

Figure 63: Photo ID24

Figure 64: Photo ID25

Figure 65: Photo ID26

Figure 66: Photo ID27

Figure 67: Photo ID28

Figure 68: Photo ID29

Figure 69: Photo ID30

Figure 70: Photo ID31

Figure 71: Photo ID32

Figure 72: Photo ID33

Figure 73: Photo ID34

Figure 74: Photo ID35

Figure 75: Photo ID36

Figure 76: Photo ID37

Figure 77: Photo ID38

Figure 78: Photo ID39

Figure 79: Photo ID40

Figure 80: Photo ID41

Figure 81: Photo ID42

Figure 82: Photo ID43

Figure 83: Photo ID44

Figure 84: Photo ID45

Figure 85: Photo ID46

Figure 86: Photo ID47

Figure 87: Photo ID48

Figure 88: Photo ID49

Figure 89: Photo ID50

Figure 90: Photo ID51

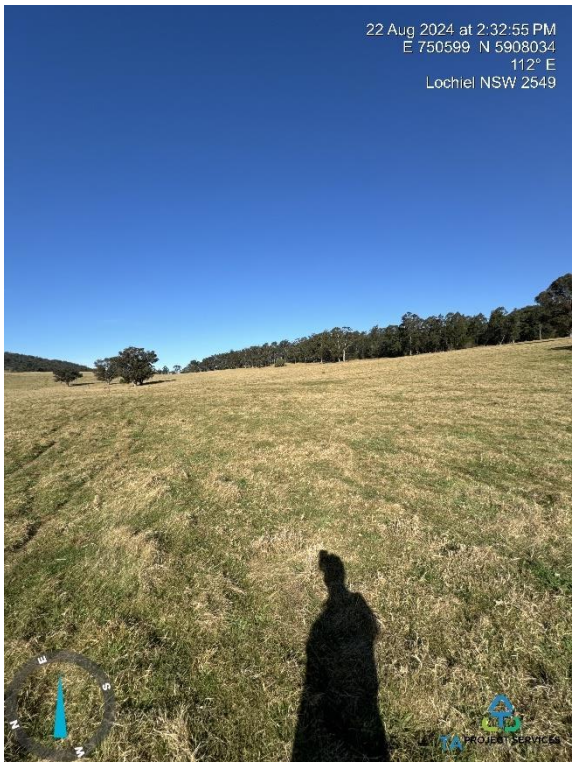


Figure 91: Photo ID52

Figure 92: Photo ID53

Figure 93: Photo ID54

Figure 94: Photo ID55

Figure 95: Photo ID56

10.3. Flood Maps

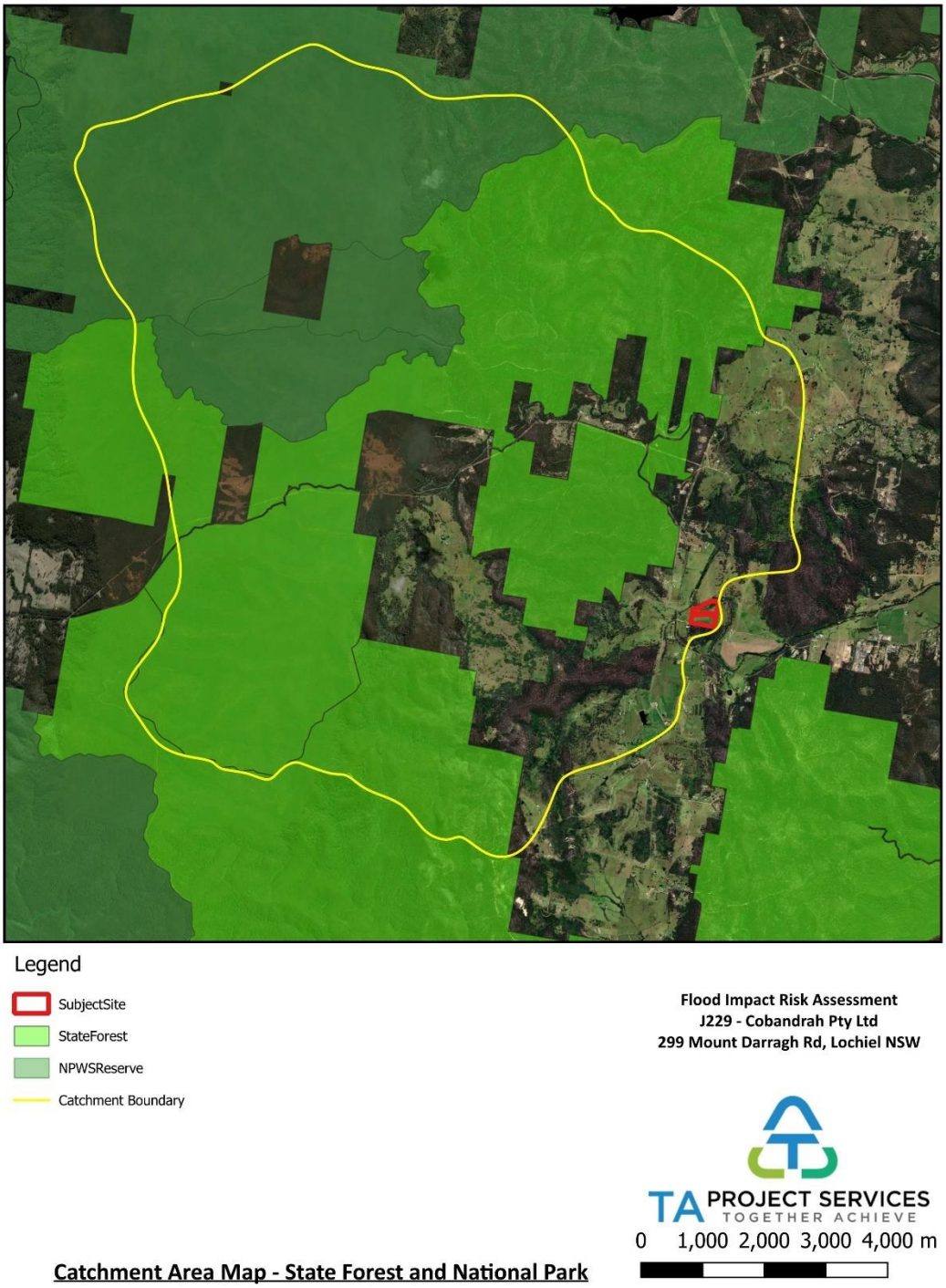


Figure 96: Catchment Boundary with State Forest and National Parks

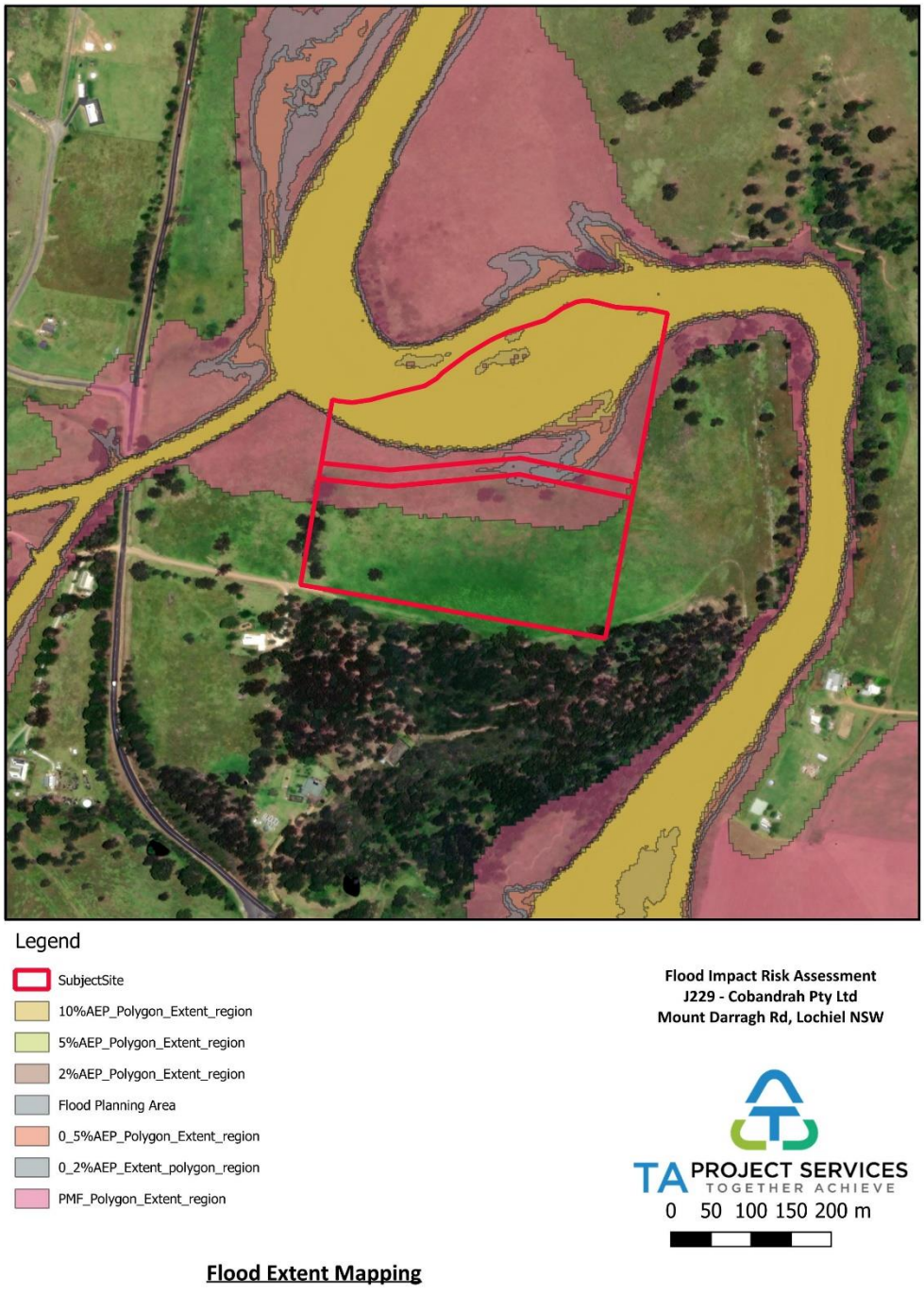


Figure 97: Flood Extent Map

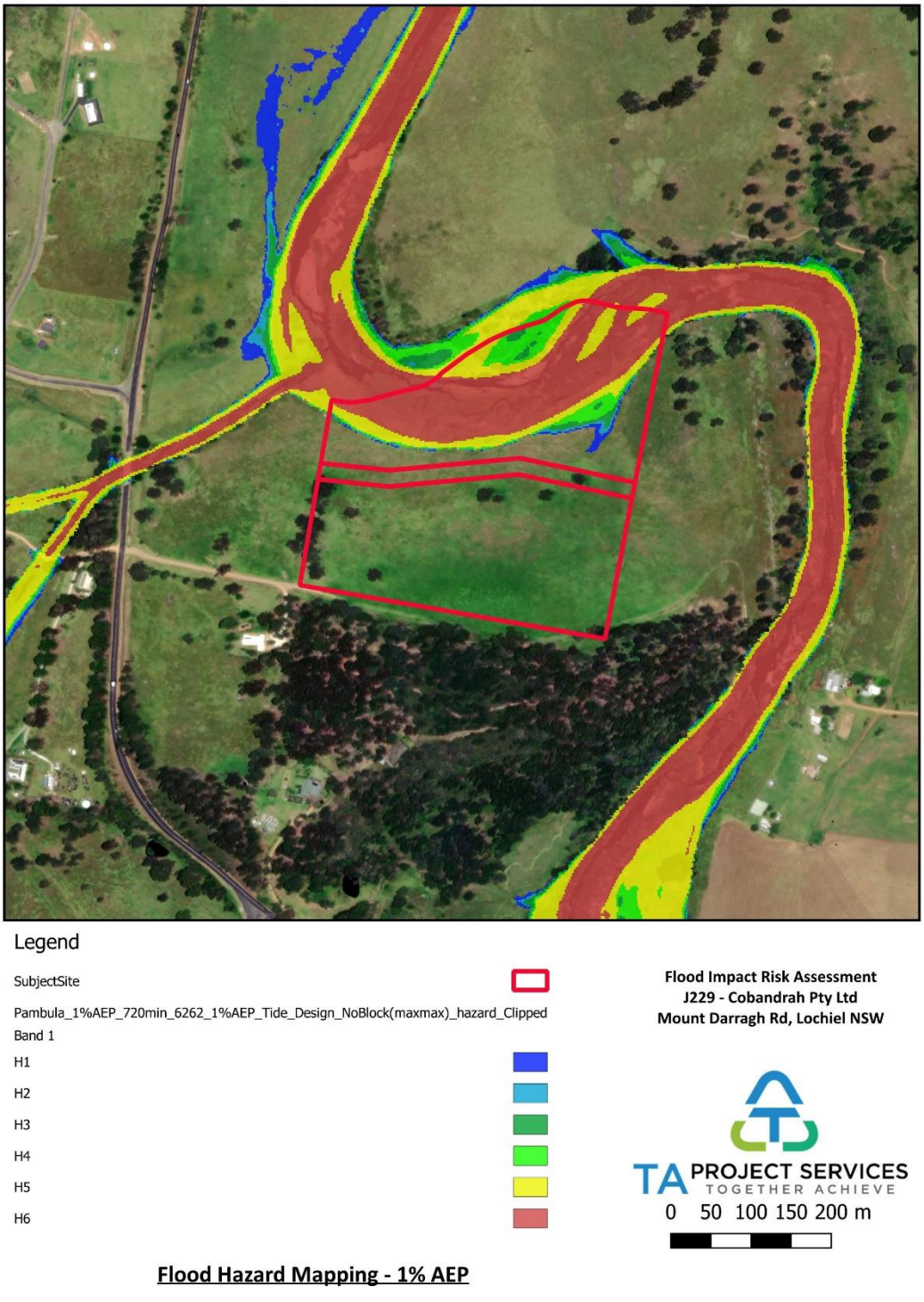


Figure 98: 1% AEP Flood Hazard

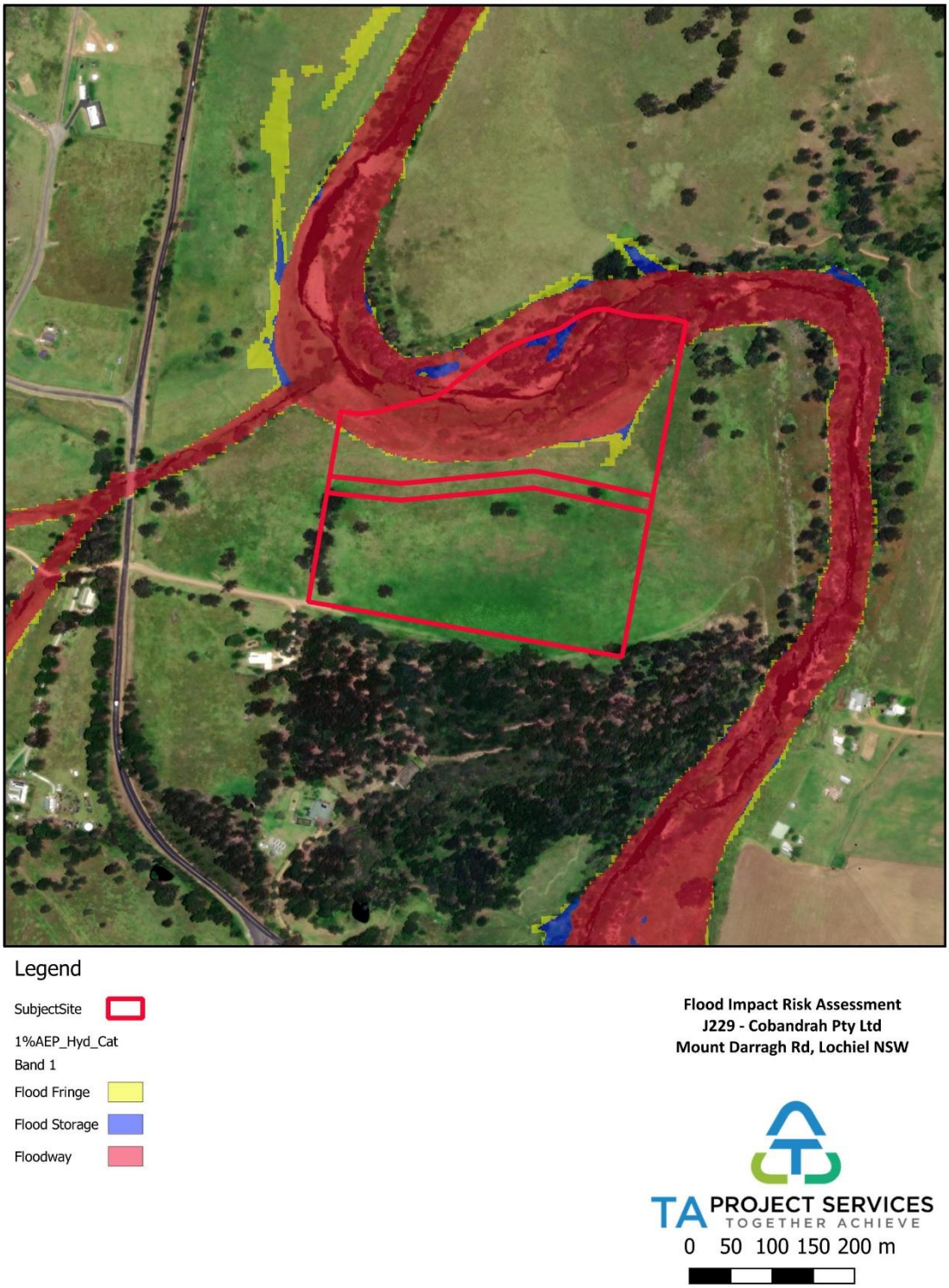


Figure 99: 1% AEP Flood Category

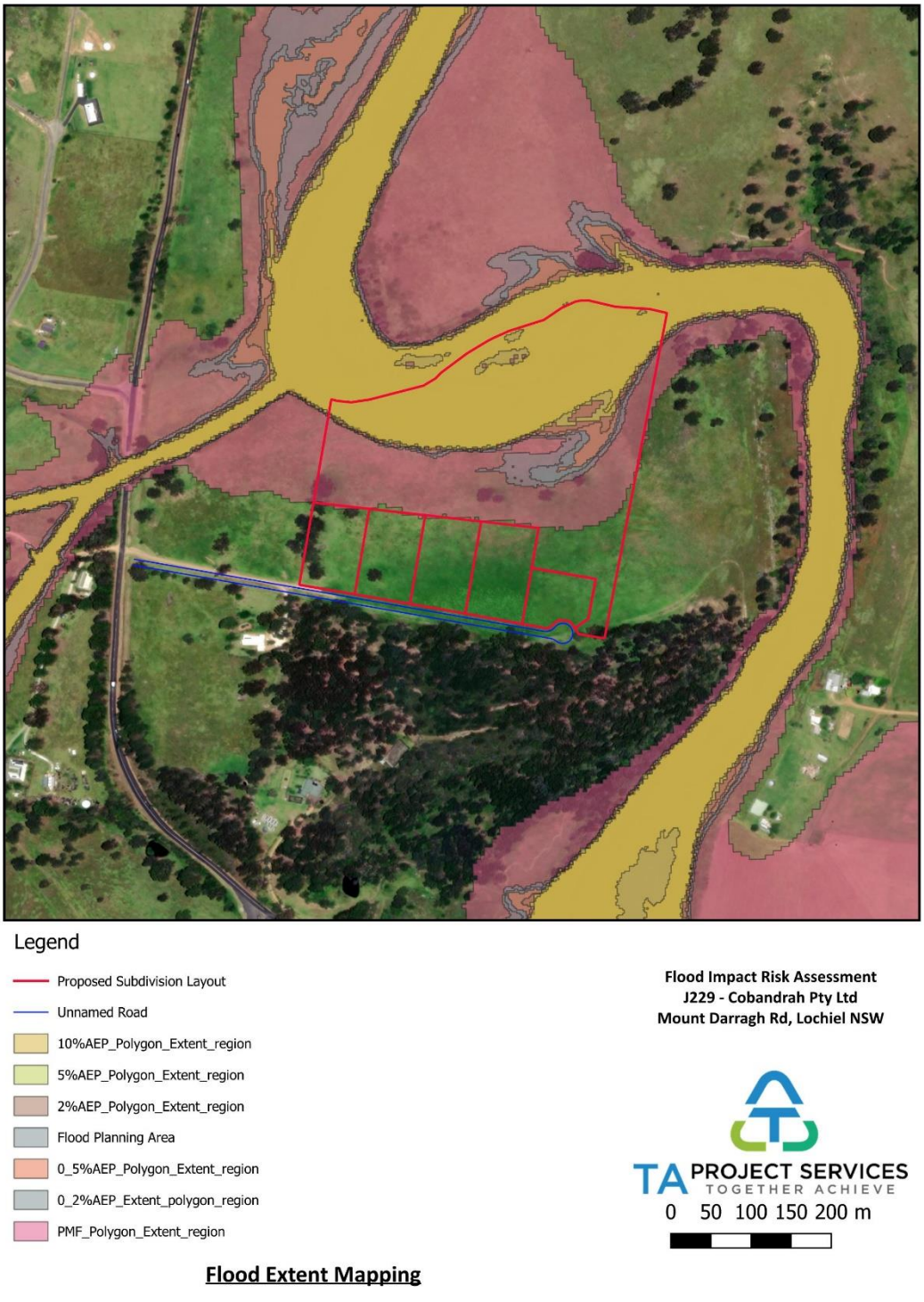
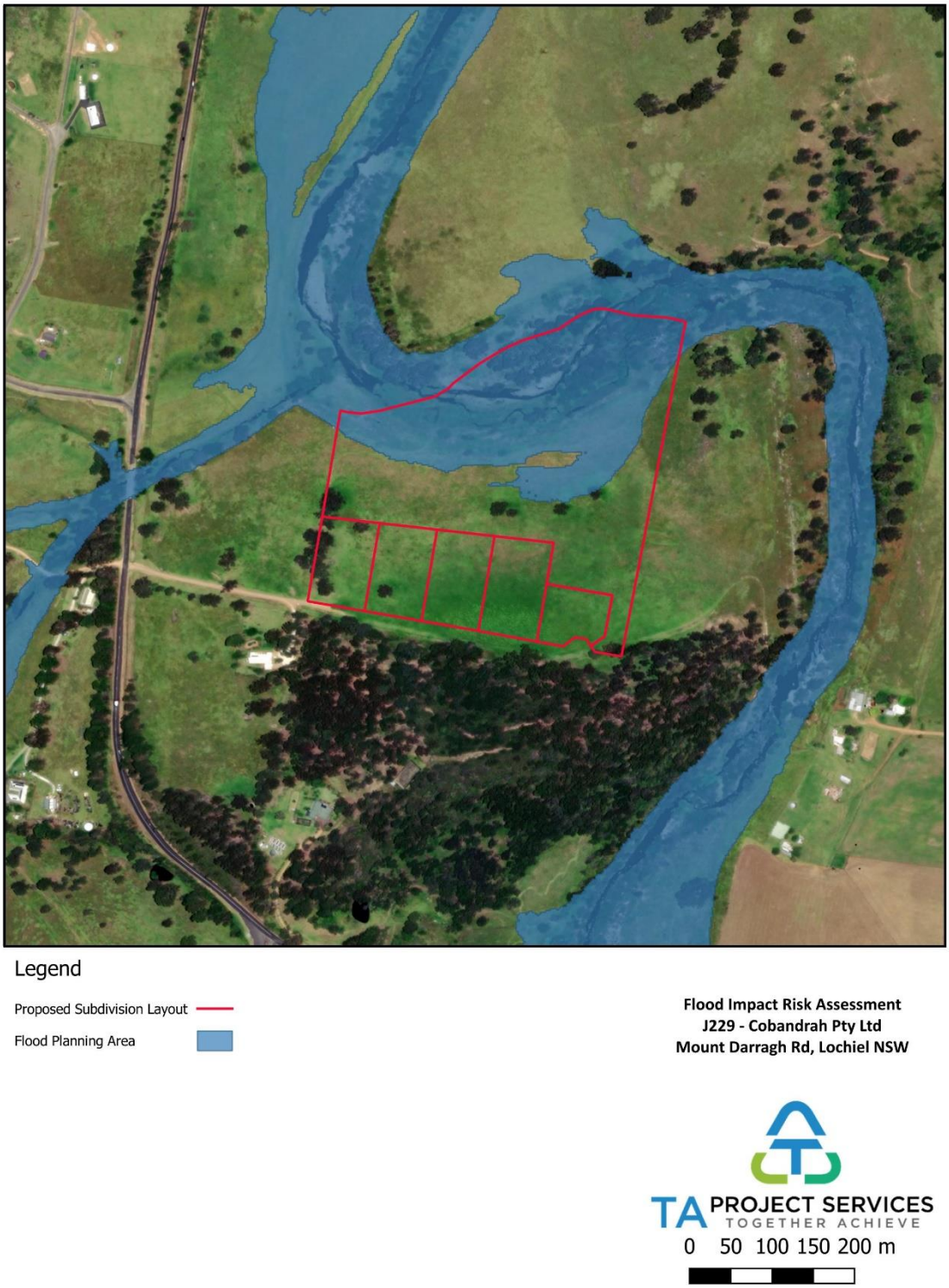


Figure 100: The Unnamed Road Flood Extent Map



Flood Planning Area Mapping

Figure 101: Flood Planning Area Map

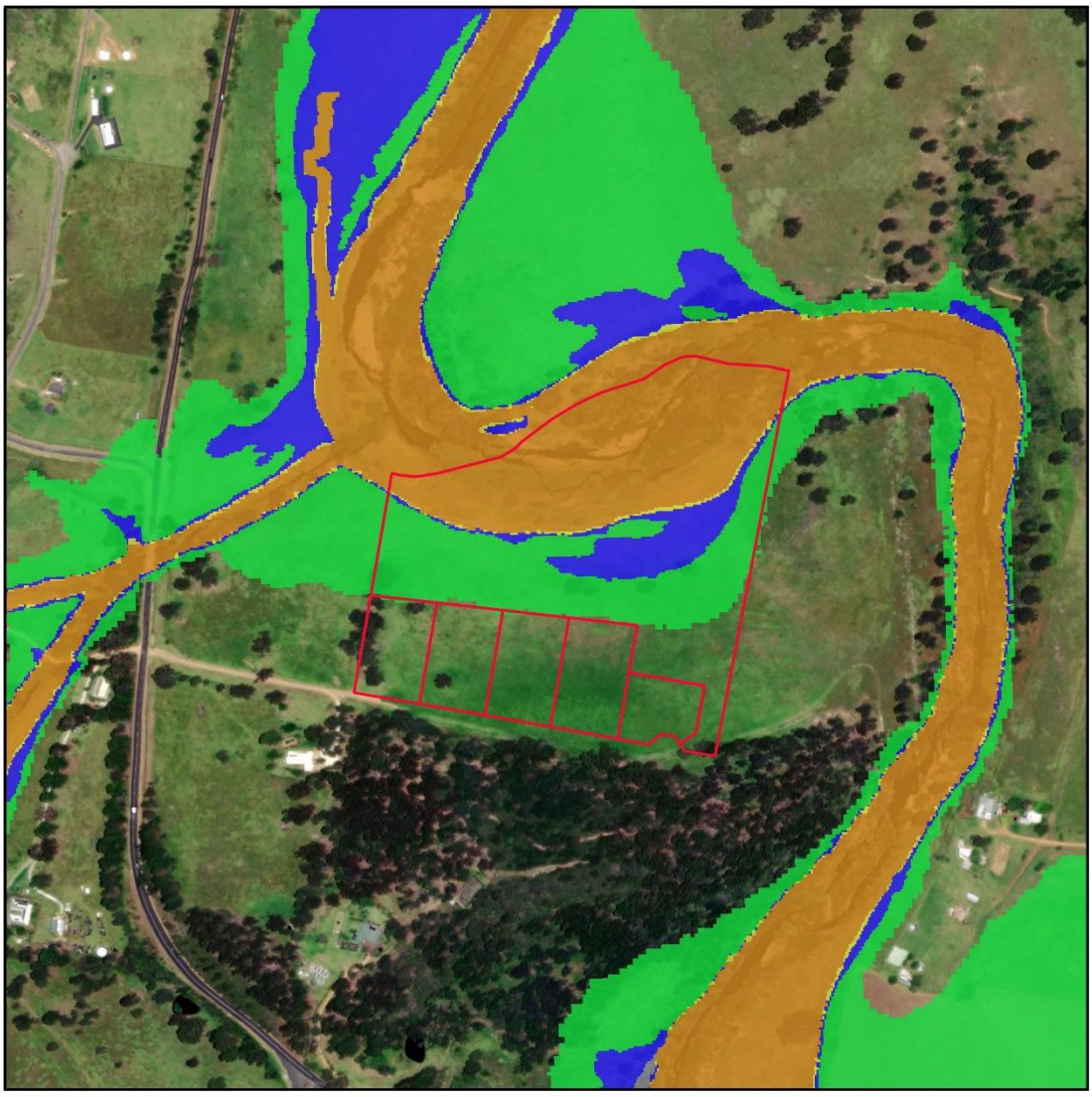


Figure 102: Flood Planning Constraint Category Map

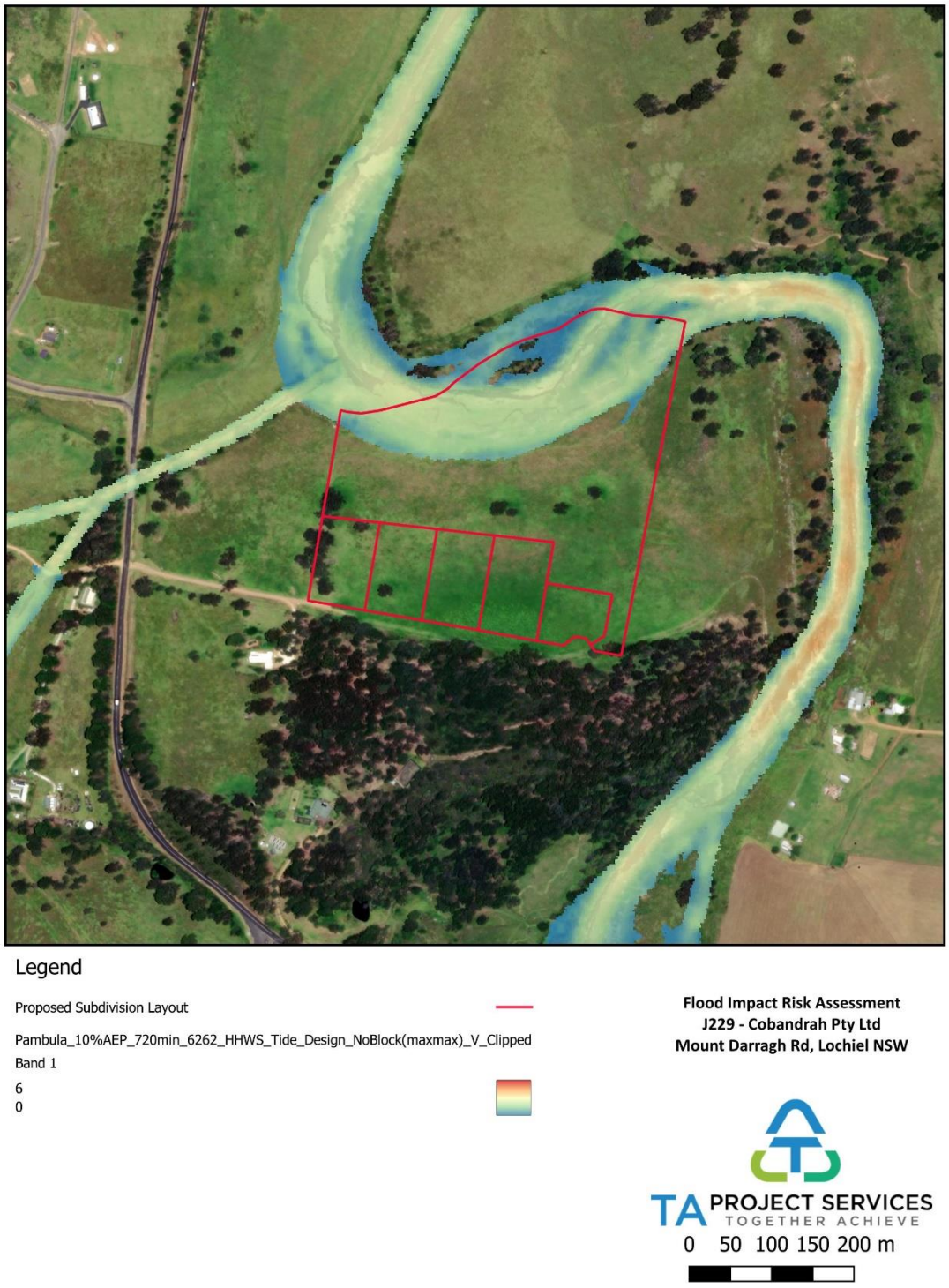


Figure 103: 10% AEP Flood Velocity Map

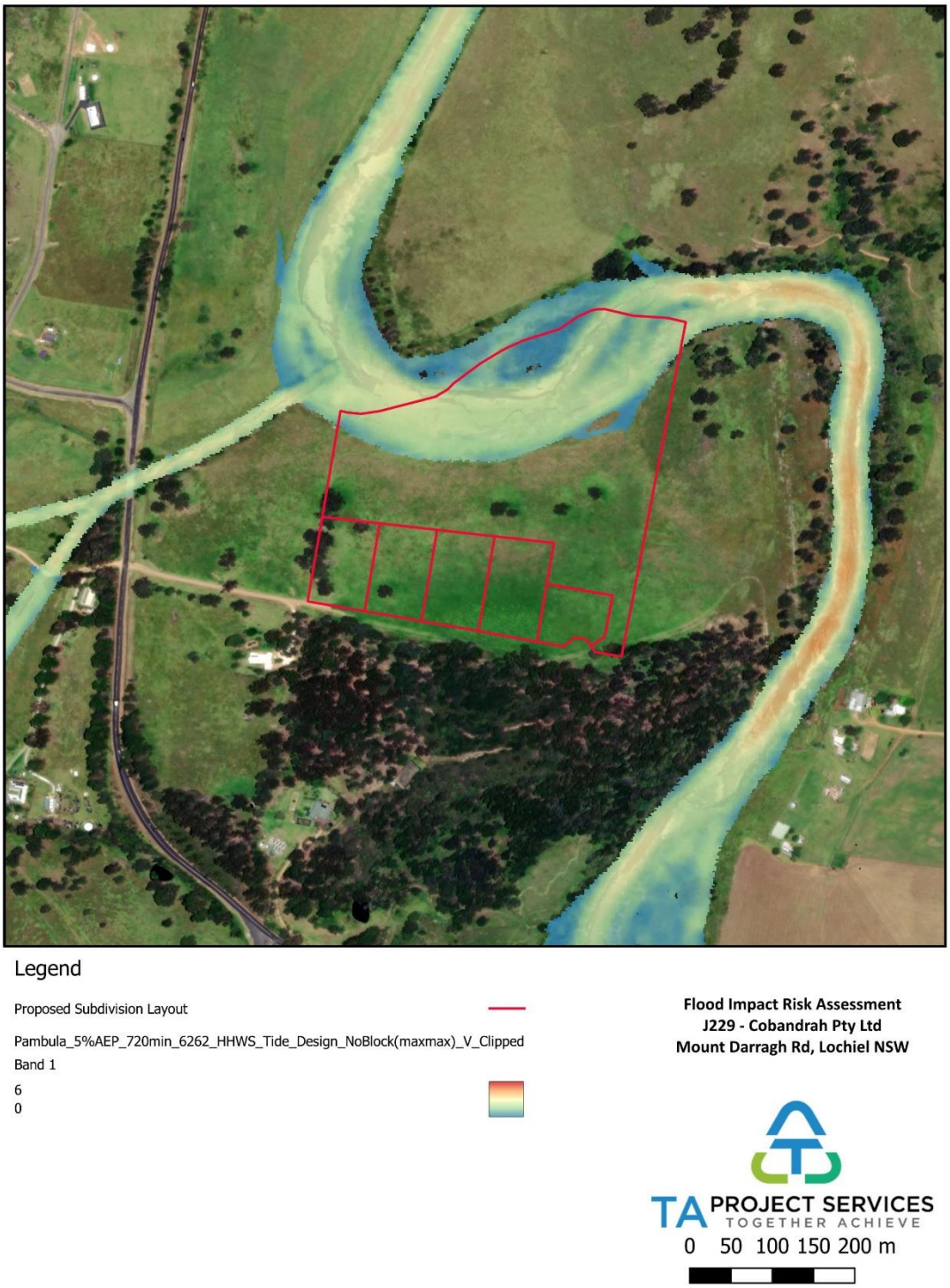


Figure 104: 5% AEP Flood Velocity Map

Figure 105: 2% AEP Flood Velocity Map

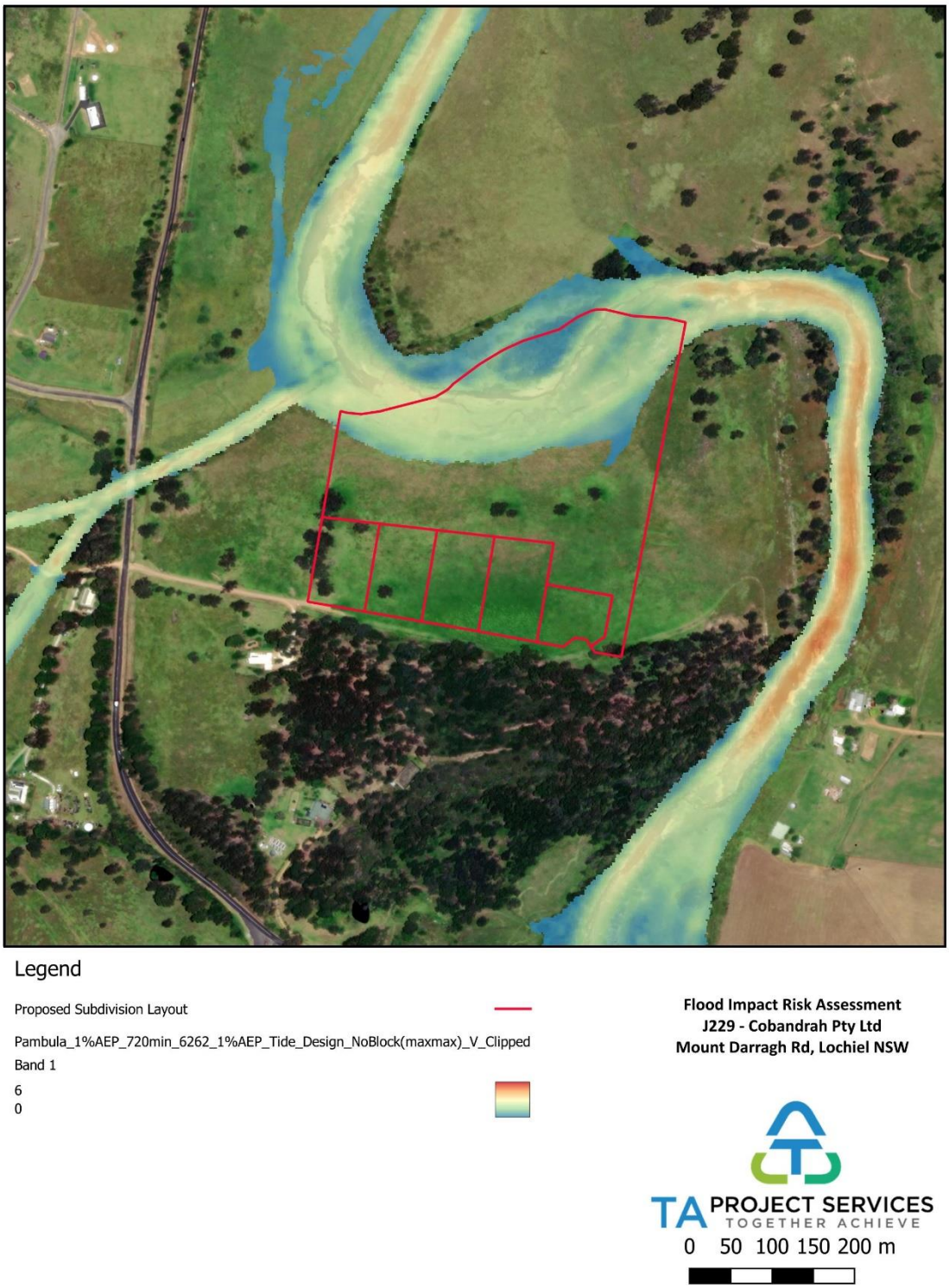


Figure 106: 1% AEP Flood Velocity Map

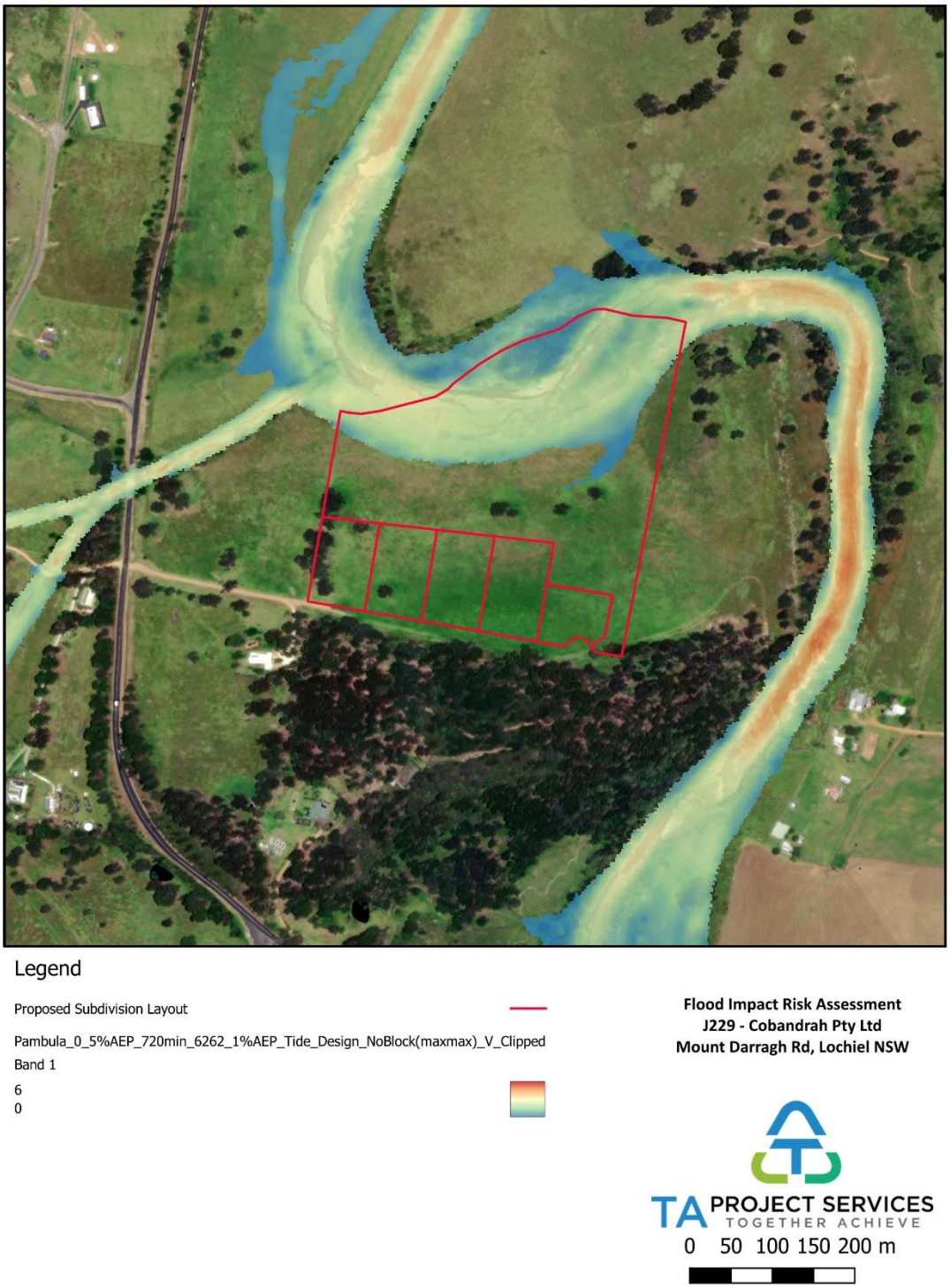


Figure 107: 0.5% AEP Flood Velocity Map

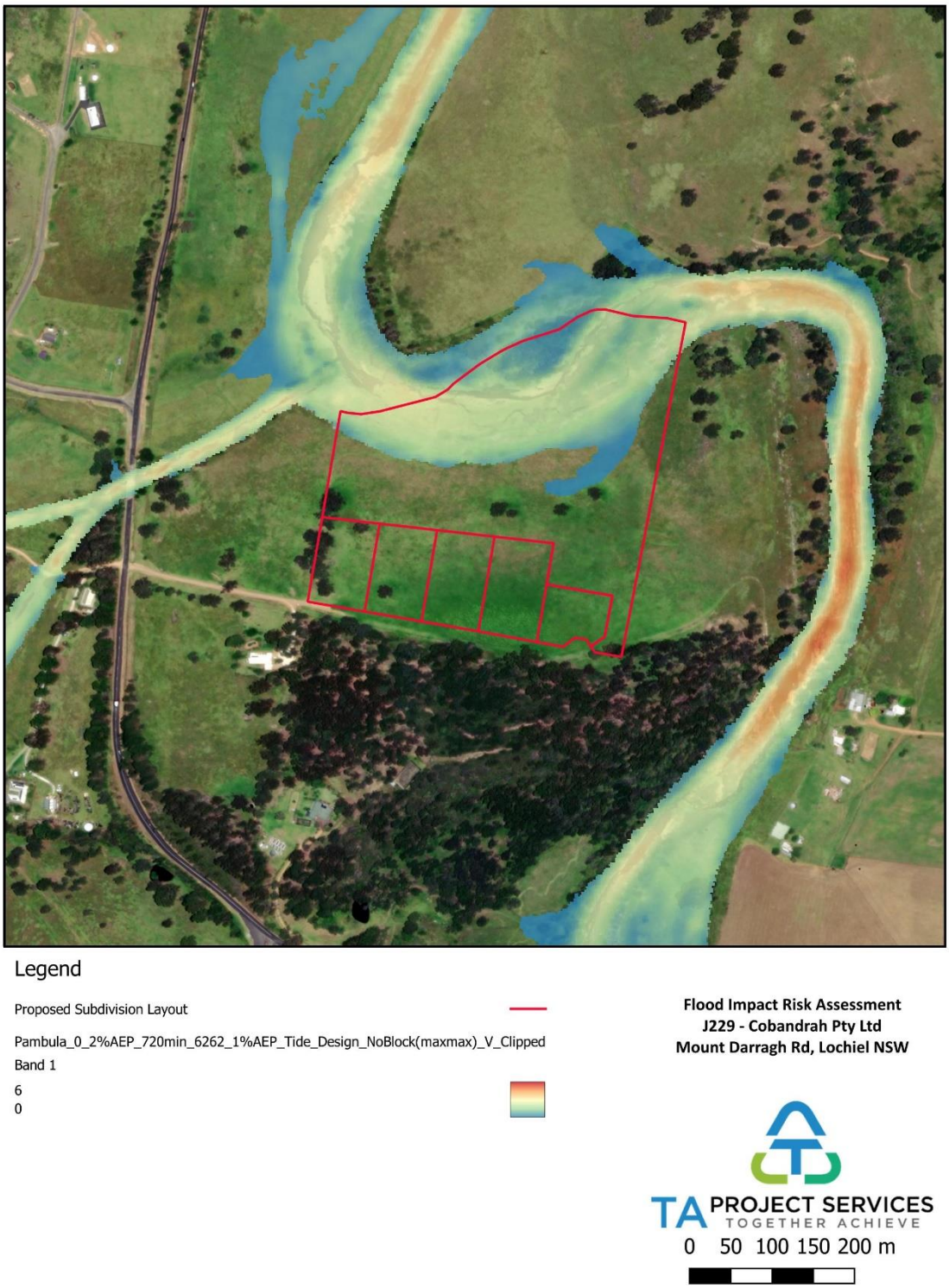


Figure 108: 0.2% AEP Flood Velocity Map

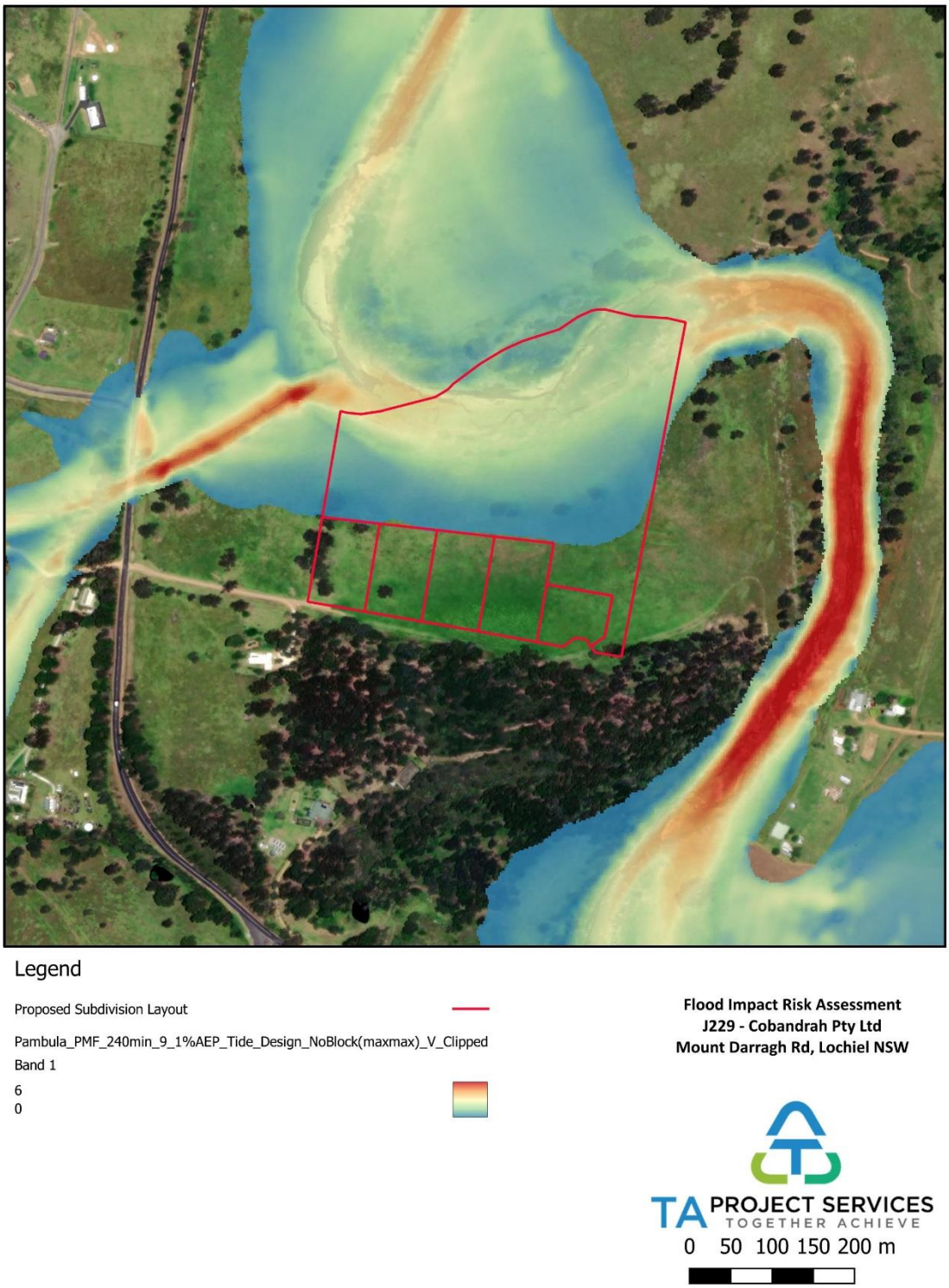


Figure 109: PMF Flood Velocity Map

Figure 110: 10% AEP Flood Depth Map

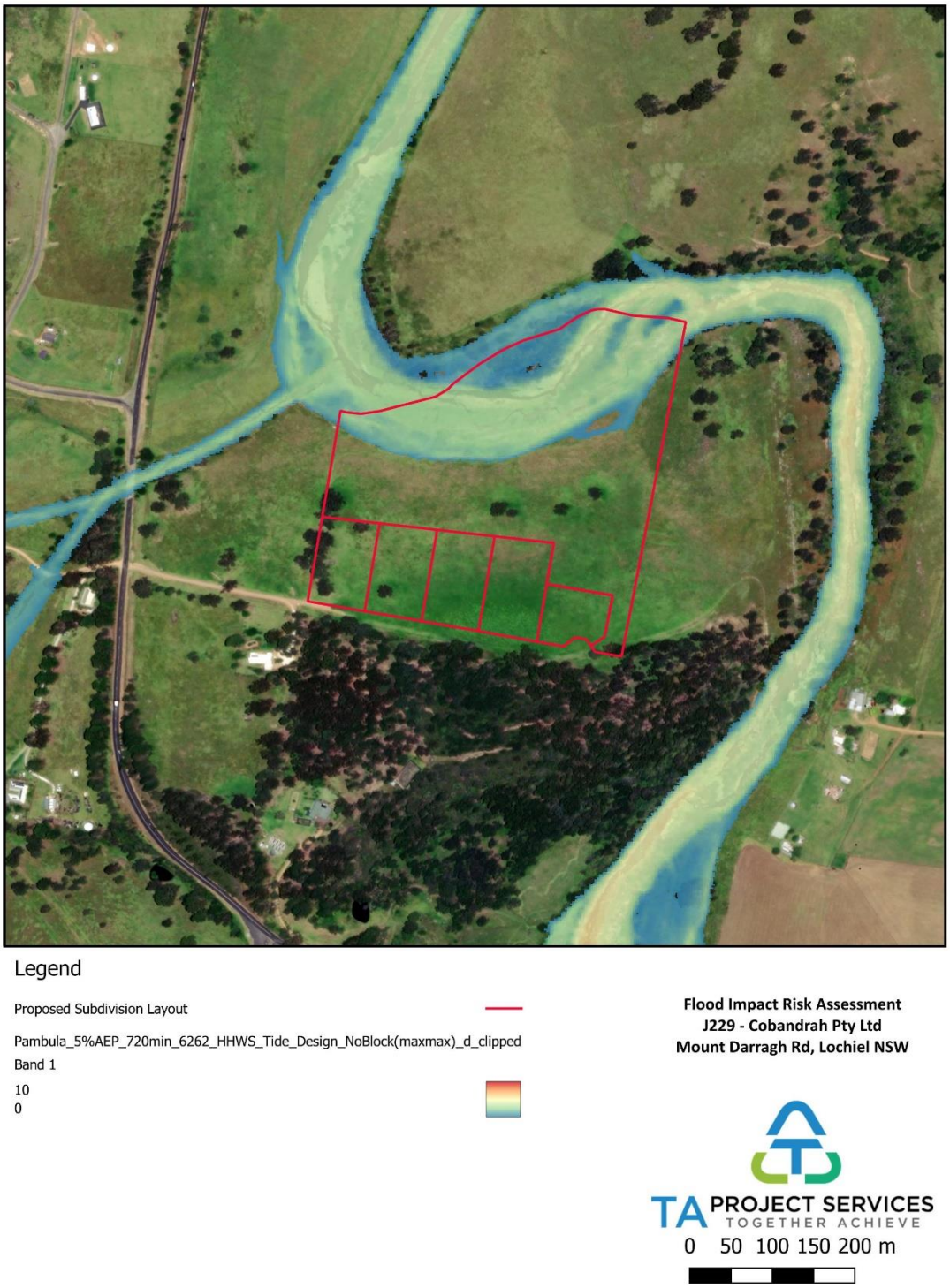


Figure 111: 5% AEP Flood Depth Map

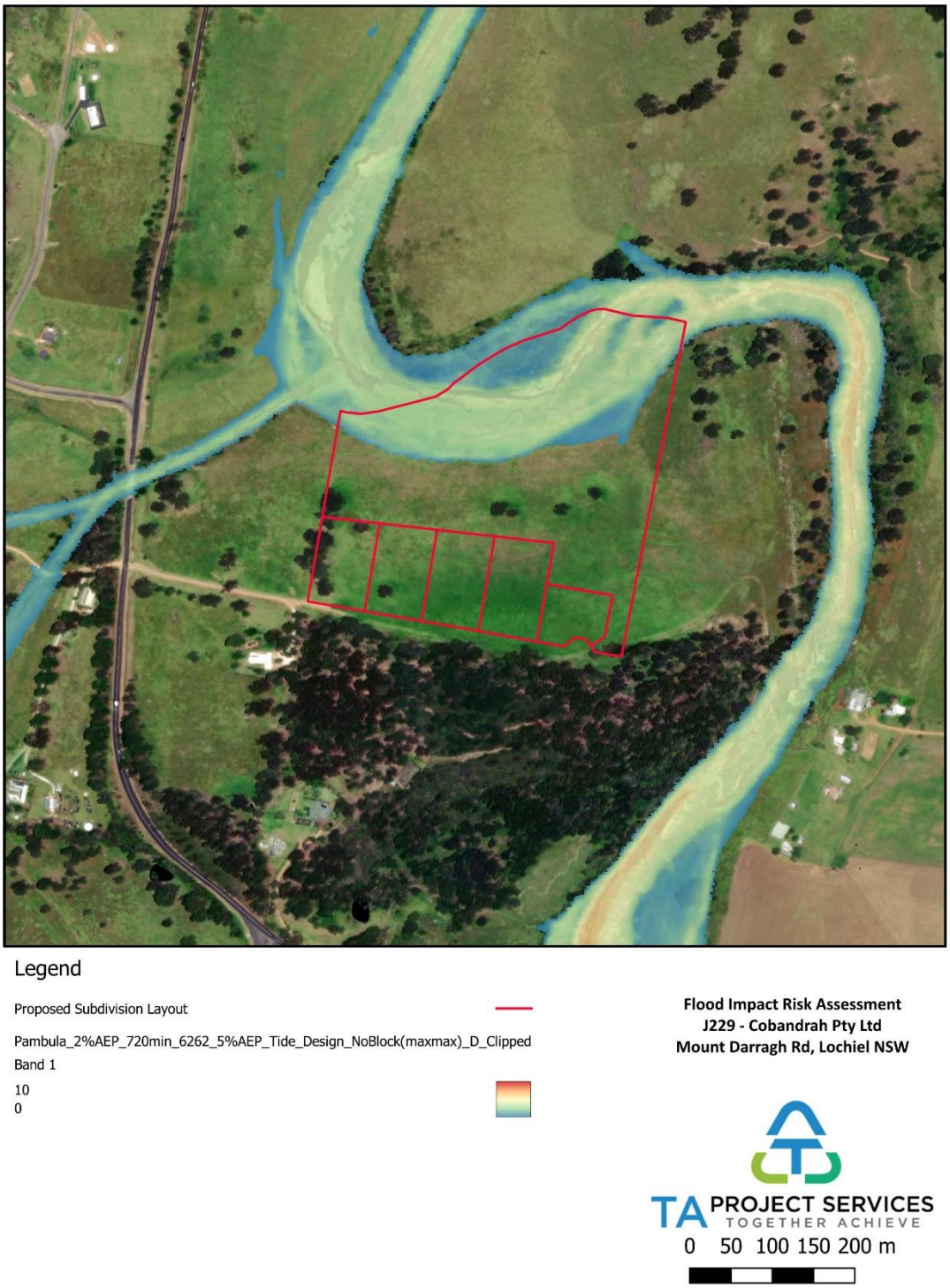


Figure 112: 2% AEP Flood Depth Map

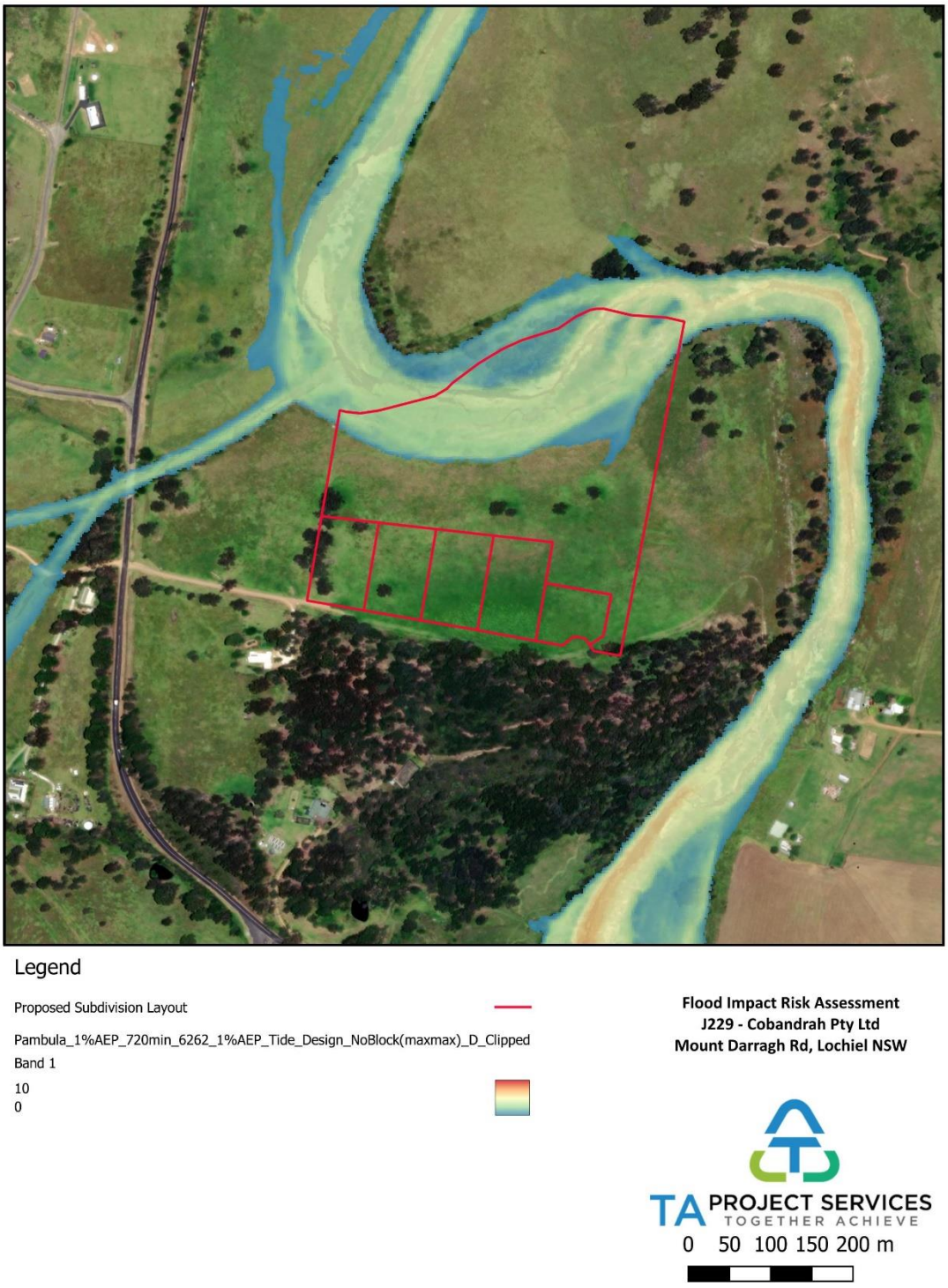


Figure 113: 1% AEP Flood Depth Map

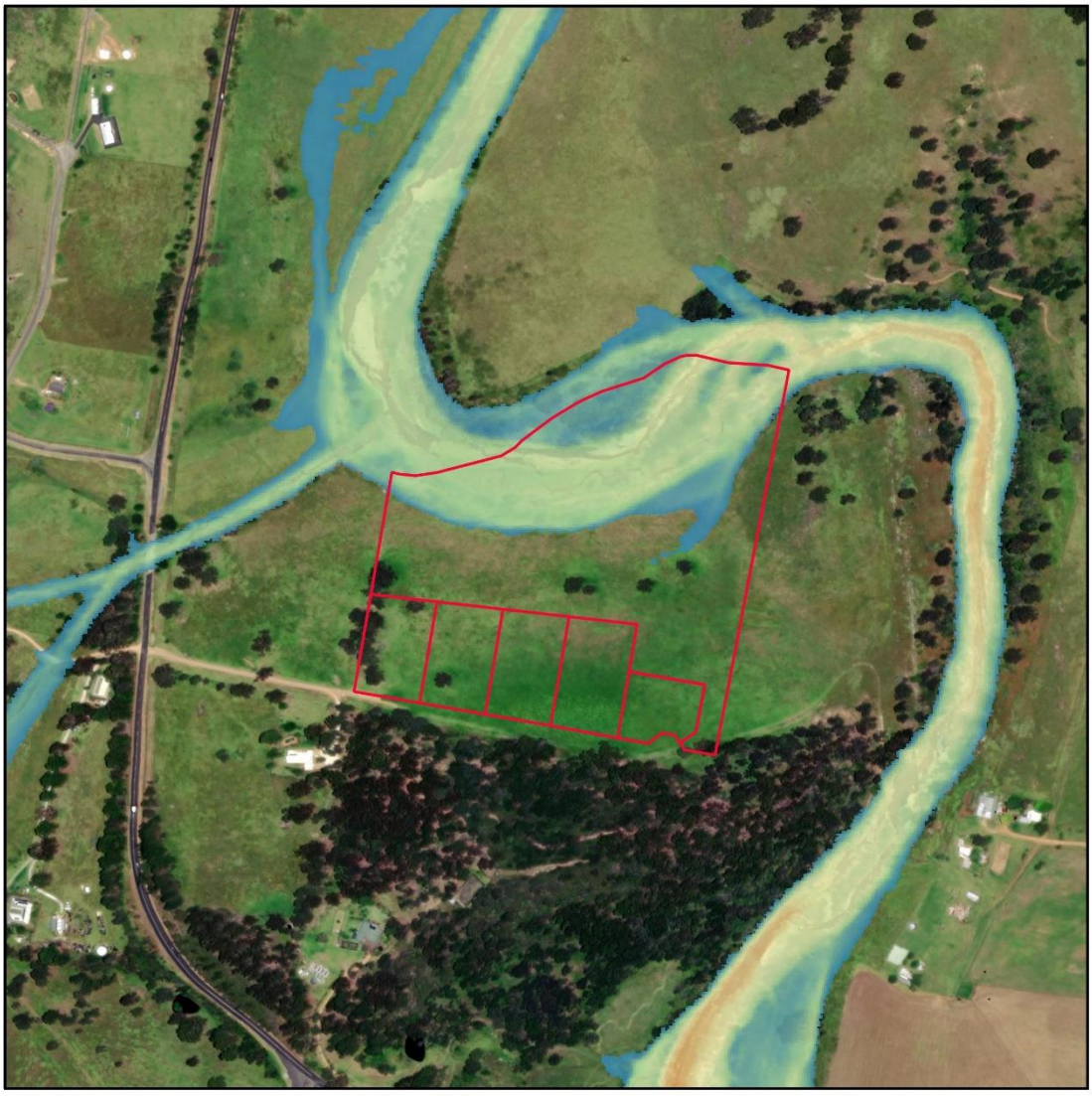


Figure 114: 0.5% AEP Flood Depth Map

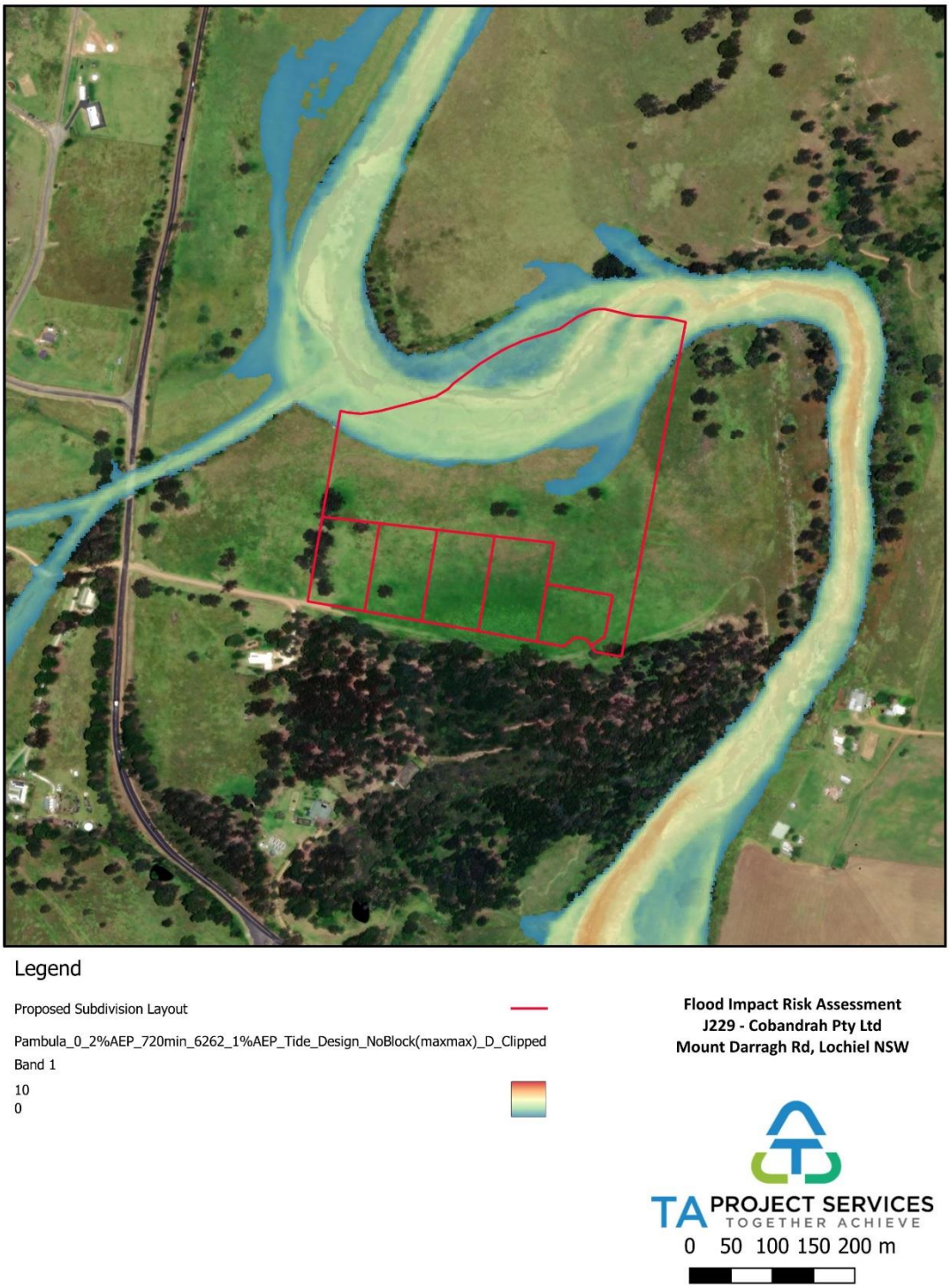


Figure 115: 0.2% AEP Flood Depth Map

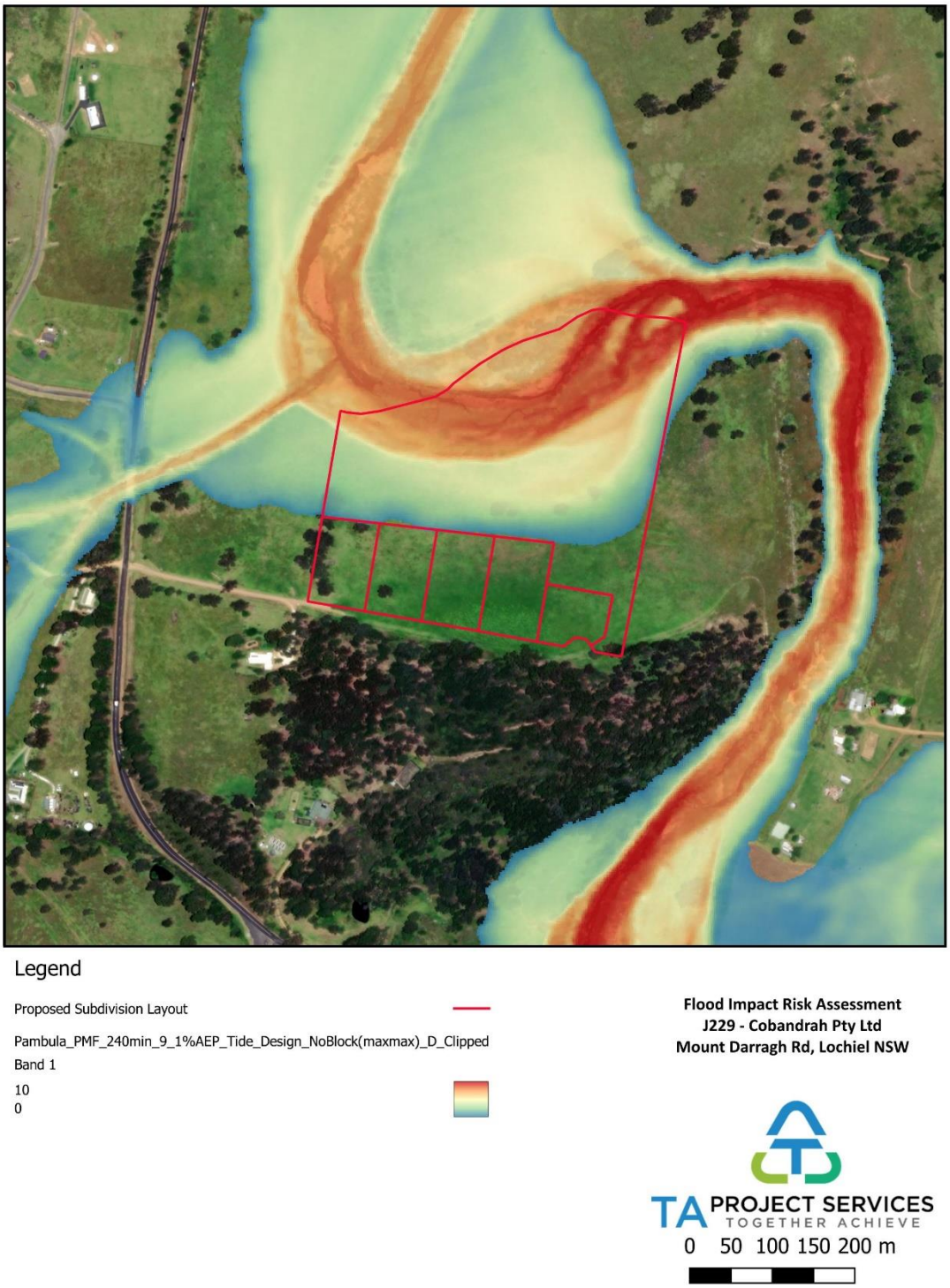


Figure 116: PMF Flood Depth Map

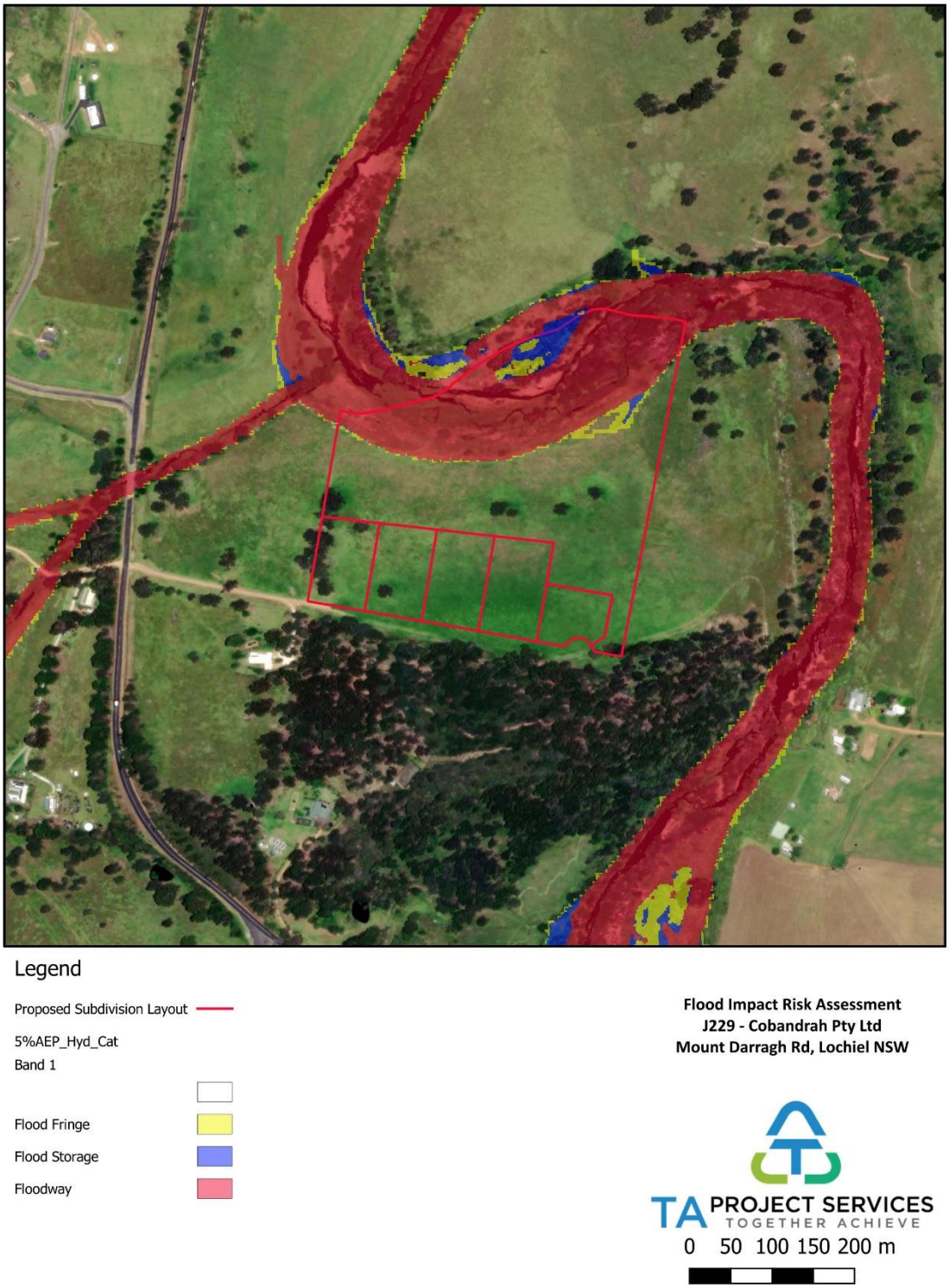


Figure 117: 5% AEP Flood Category Mapping

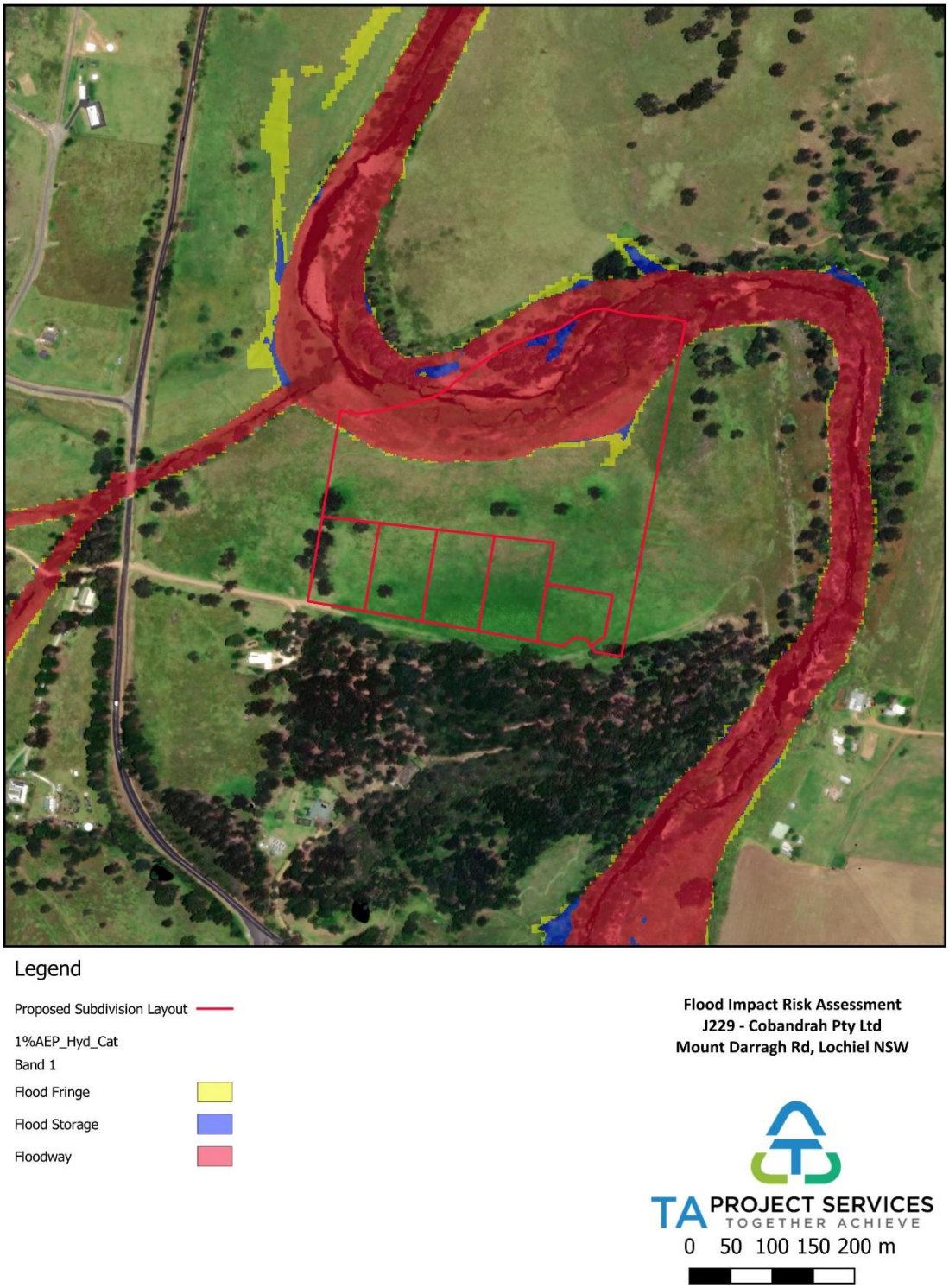


Figure 118: 1% AEP Flood Category Map

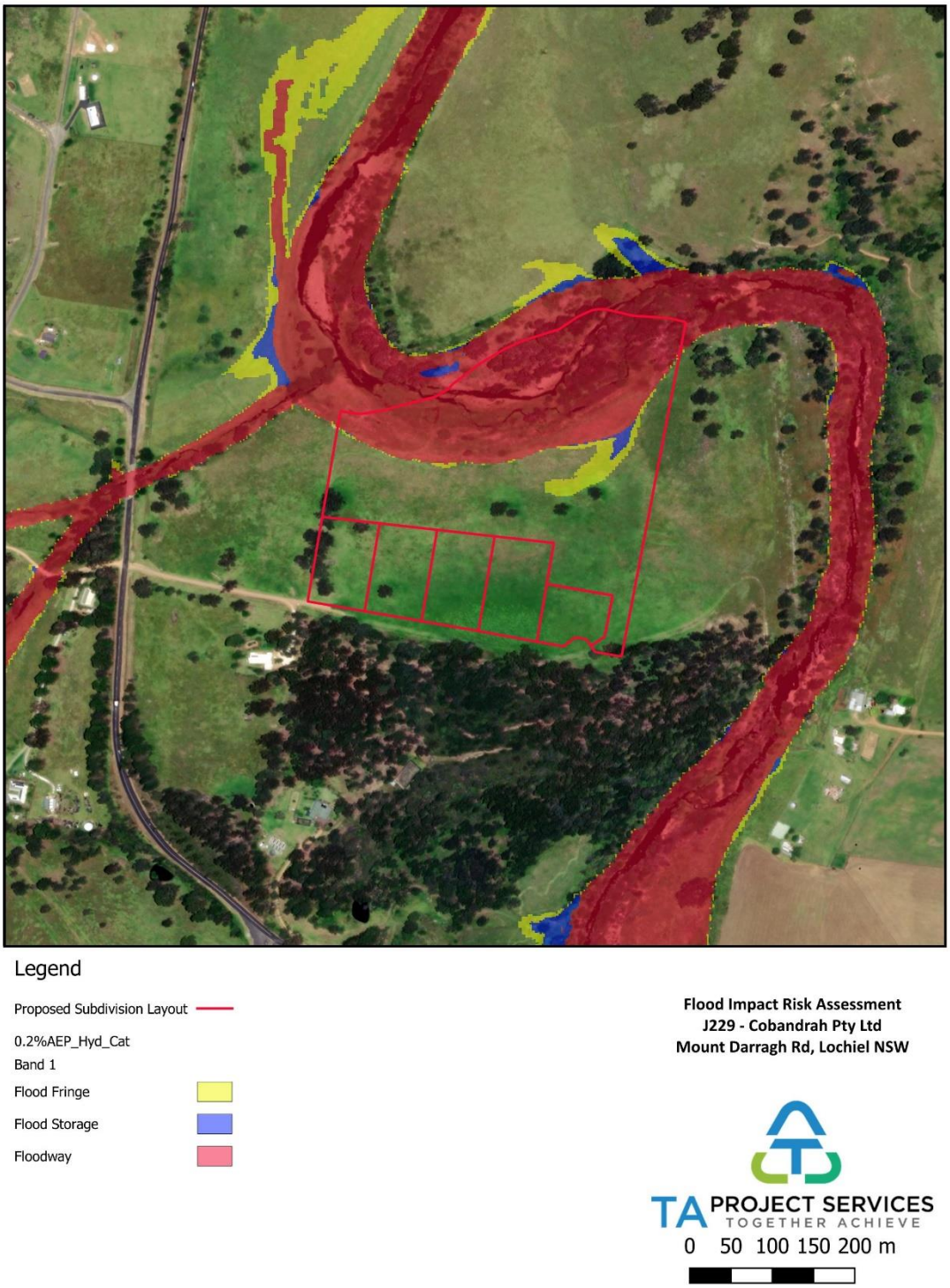


Figure 119: 0.2% AEP Flood Category Map

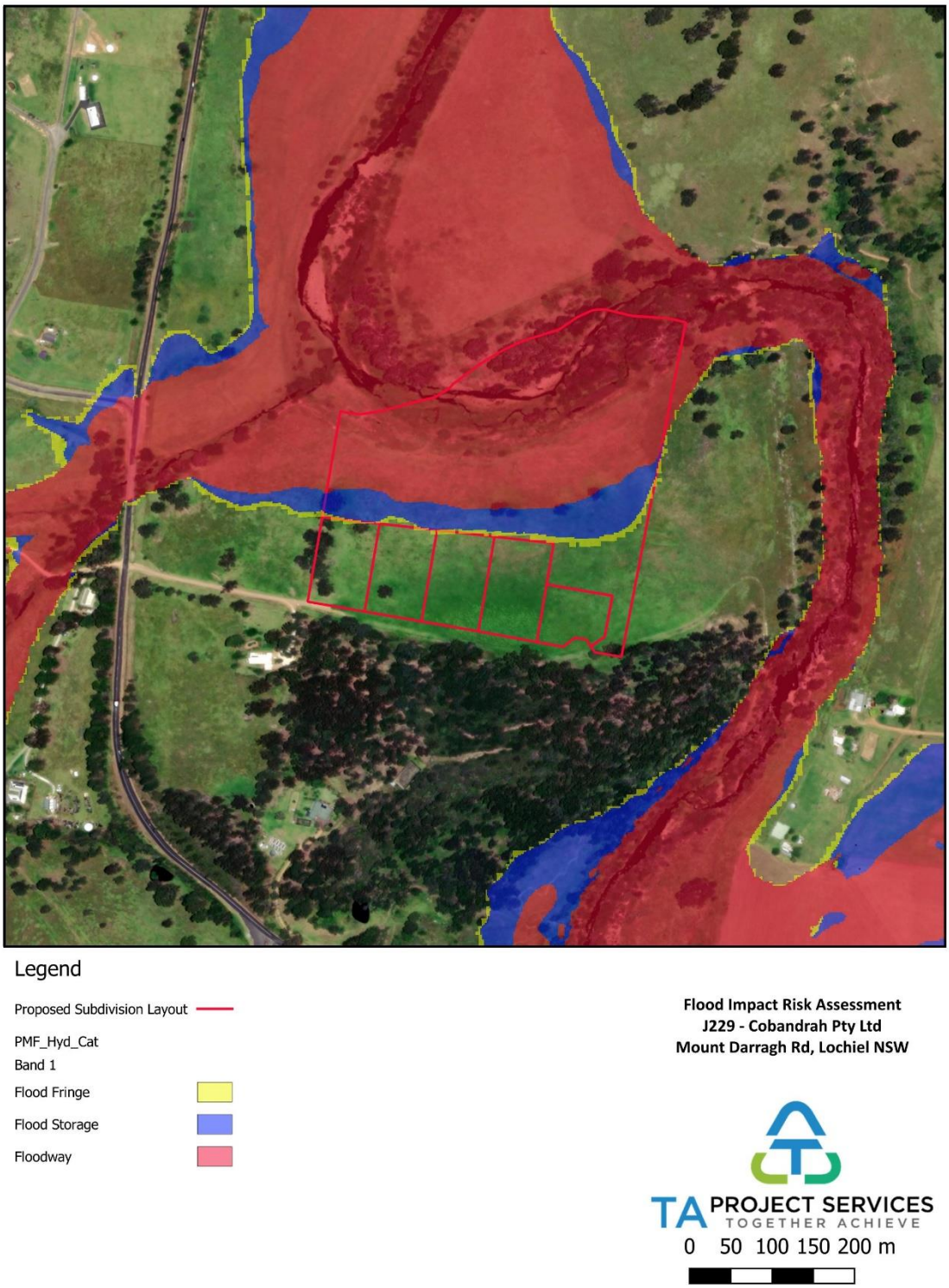


Figure 120: PMF Flood Category Map

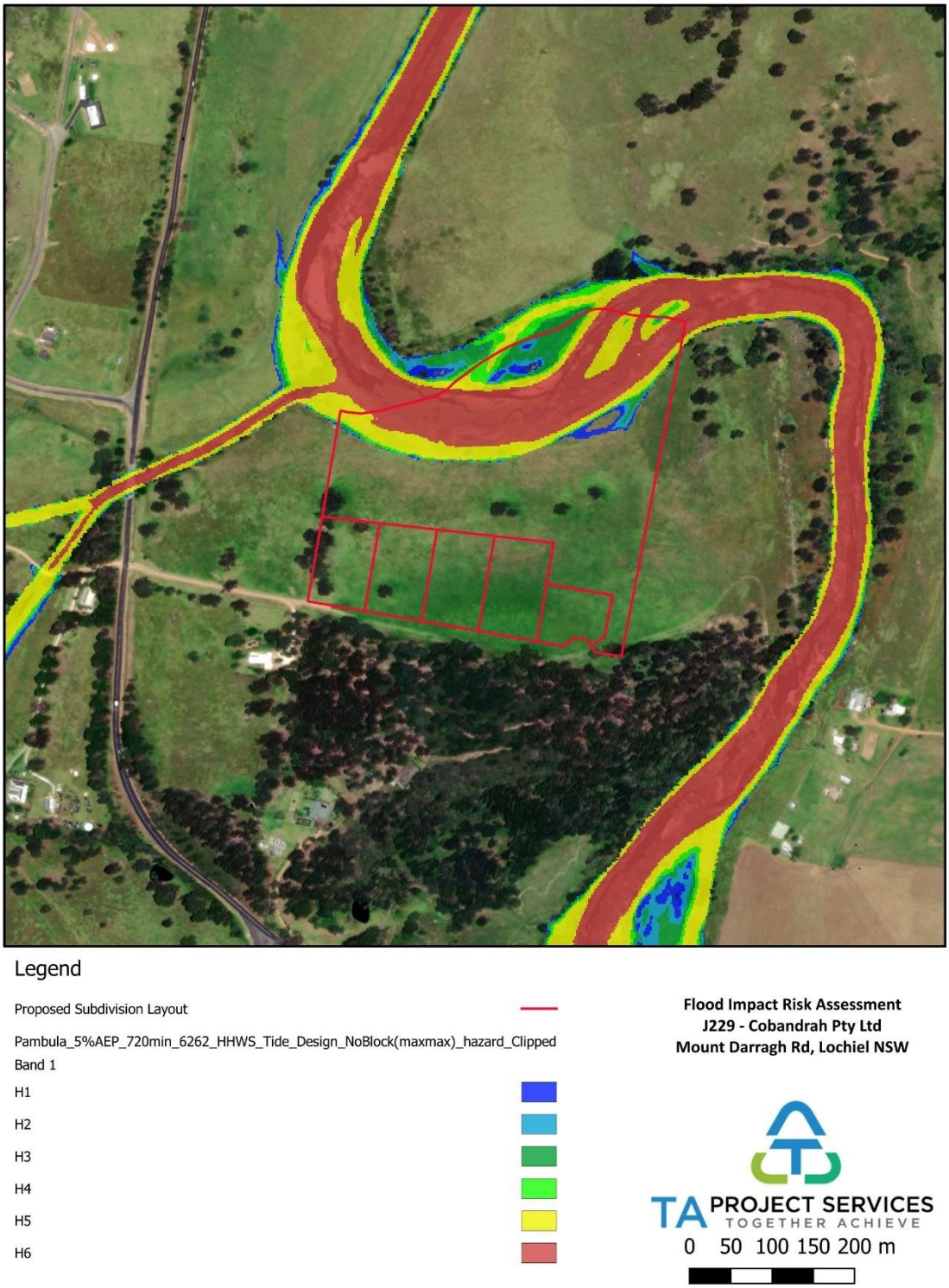


Figure 121: 5% AEP Flood Hazard Mapping

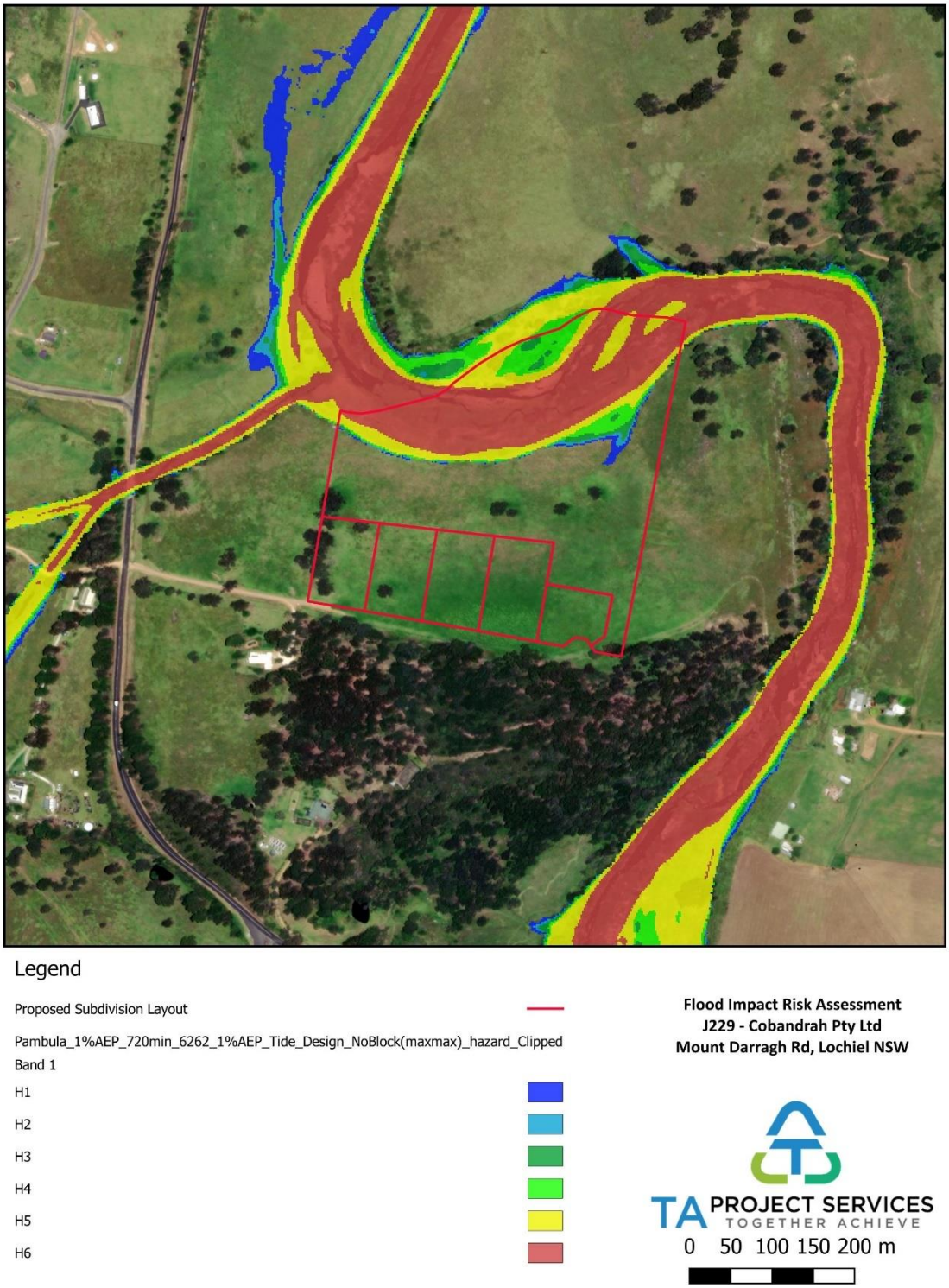


Figure 122: 1% AEP Flood Hazard Mapping

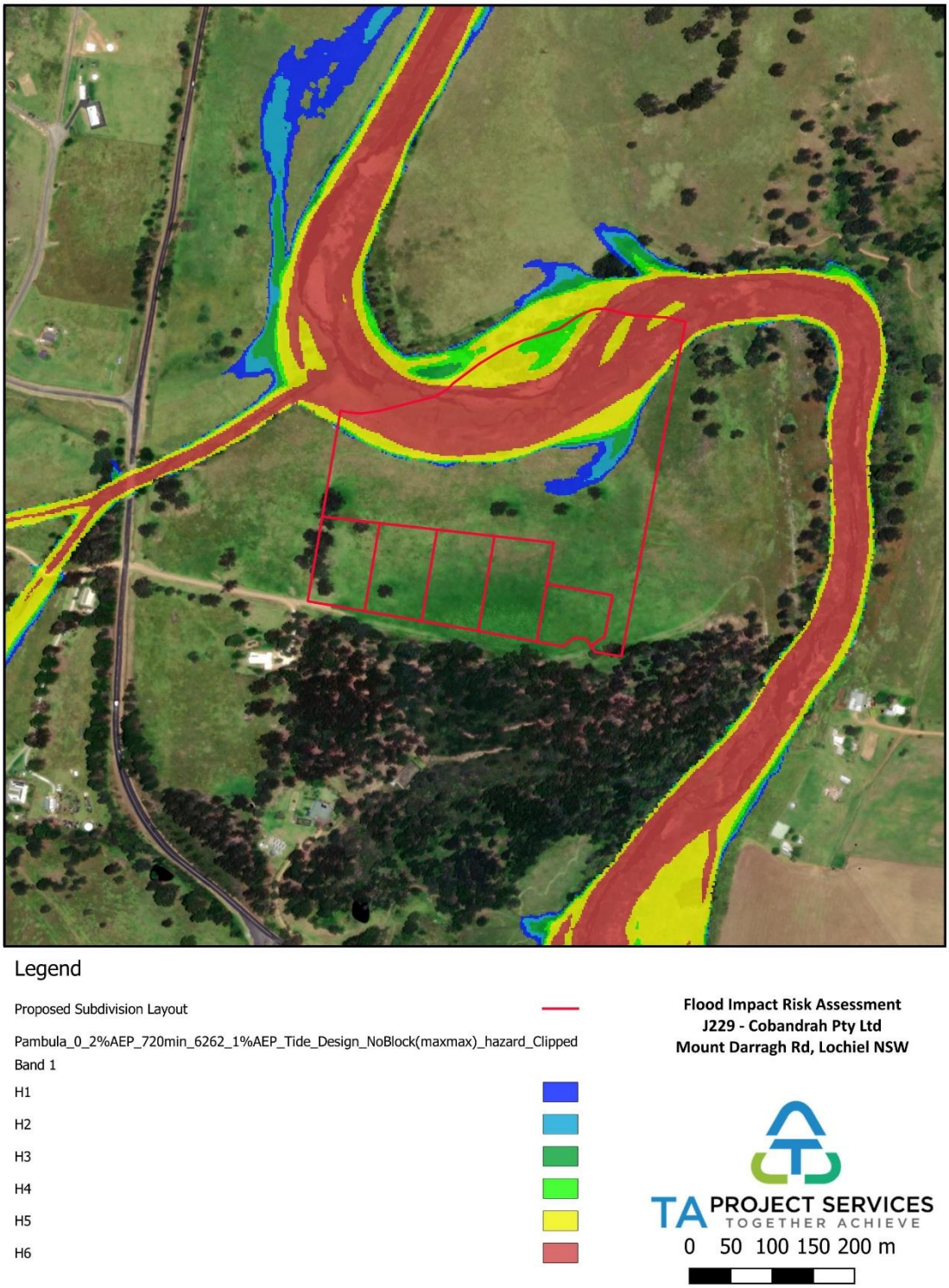


Figure 123: 0.2% AEP Flood Hazard Mapping

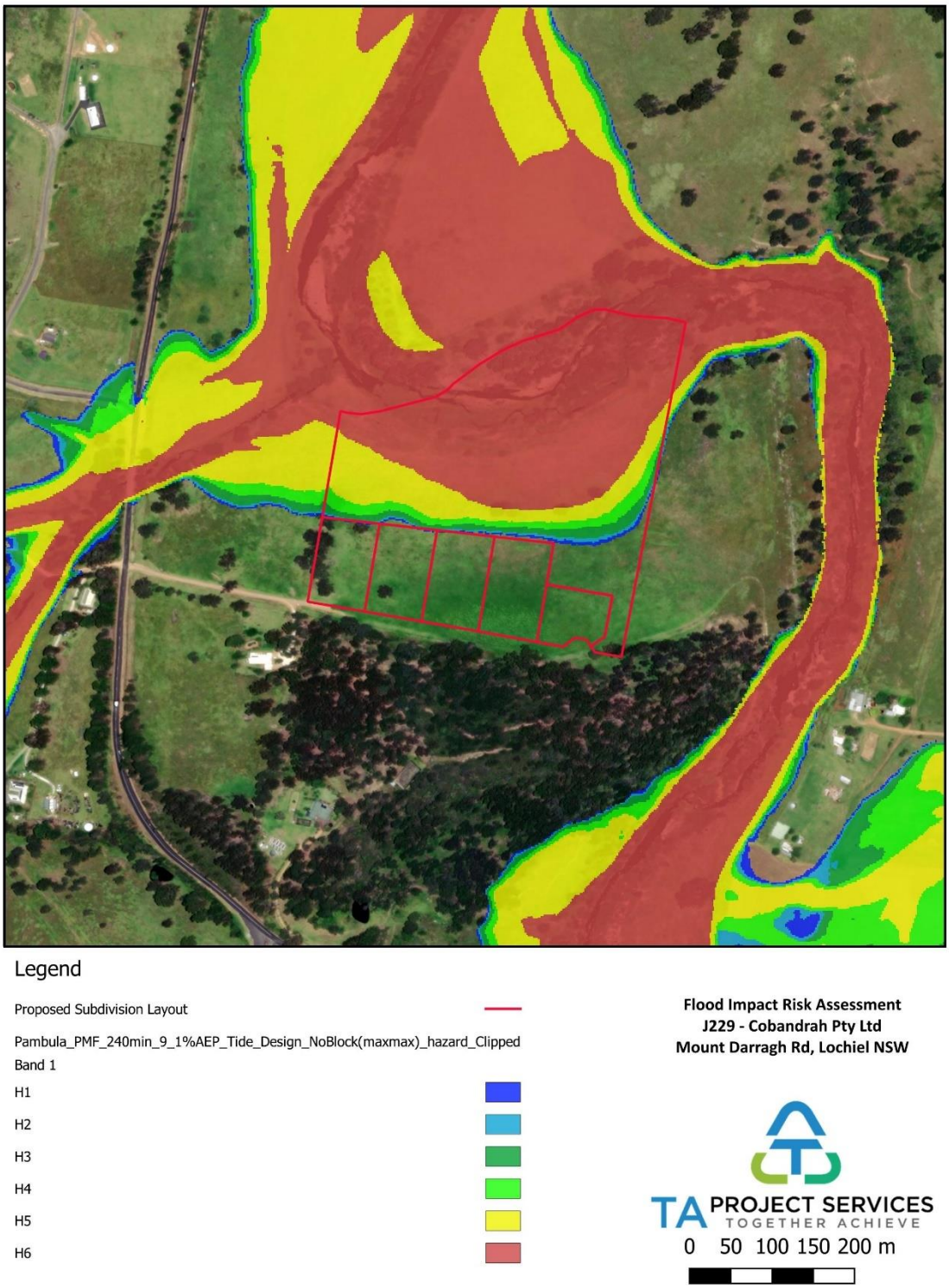


Figure 124: PMF Flood Hazard Mapping