NORTHROP

CIVIL

Flood Impact and Risk Assessment

for

Camp Kurrajong Scout Facility, Wagga Wagga

for Adapt Project Management Pty Ltd

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Contents

Figures

Tables

Acronyms

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARR	Australian Rainfall and Runoff
DCP	Development Control Plan
DP	Deposited Plan
FPL	Flood Planning Level
FRMSP	Flood Risk Management Study and Plan
LEP	Local Environmental Plan
LGA	Local Government Area
m	Measure of length / height / distance (metres)
m AHD	Meters above Australian High Datum
m^3/s	Measure of flow rate (cubic metres per second)
NSW	New South Wales
PMF	Probable Maximum Flood

Introduction

Northrop Consulting Engineers have prepared a Flood Impact and Risk Assessment Report for the proposed upgrades to Camp Kurrajong Scout Facility at 759 Oura Road, Eunanoreenya, herein referred as “the subject site”.

The purpose of this study is to respond to a Council RFI, reproduced below.

> *The site is identified as flood prone land and is within flood planning area. The subject site is subject to flooding in 1% AEP and in PMF flood event. It is noted that the application proposes to address the impact of flooding by constructing the proposed buildings with a floor level 500mm above the 1% AEP level. This alone does not adequately address the potential impacts of the development with respect to flooding. Whilst the use is existing, the proposal will result in an intensification of the use of the site and a potential increase in risk to life and property in flood events. The application is required to address in detail the objectives and matters for consideration under Clause 5.21 of the LEP2010. In addition to this, the application shall also address the relevant objectives and controls under Section 4.2 of the DCP 2010. It is recommended that these provisions be addressed by a qualified planning consultant with relevant experience in floodplain land use planning.*

This study has reviewed the existing flooding behaviour in the vicinity of the subject site, assess whether the development is likely to impact flood behaviour, examine potential existing and developed flood risks, and assess the compliance of the proposed development with Council’s flood related Development Controls.

Included in this report is assessment methodology, flood behaviour, summary of flood risks, flood emergency response strategy, and an outline of Council compliance.

Legislation, Policies and Guidelines

This assessment has been prepared with consideration to the following legislation, policies, and guidelines.

- Wagga Wagga Local Environmental Plan 2010 (LEP 2010).
- Wagga Wagga Development Control Plan 2010 (DCP 2010).
- Australian Rainfall and Runoff 2019 (AR&R 2019).
- NSW Flood Prone Land Policy.
- NSW Government Flood Risk Management Manual (2023).

Locality and Proposed Development

Subject Site

The subject site is located at 759 Oura Road, Eunanoreenya and is otherwise known as Lot 3 and 179 DP 751405, and Lot 7004 DP 1069230.

The elevations on-site range from approximately 182.5m AHD to 184m AHD. There is sparse wooded vegetation across the lots.

An aerial photo of the subject site is presented overleaf in Figure 1.

The Proposed Development

The proposed development includes removal of a number of buildings, construction of a new accommodation facility and hall, and new on-grade carparking and access roads.

A summary of the proposed changes is included overleaf in Figure 2.

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Legend

Subject Site

Figure 1

Aerial

Camp Kurrajong Scouts

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
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Legend

- Subject Site
- Existing Buildings to be Demolished
- Existing Buildings to Remain
- Proposed New Structures
- New Roads and Paths

Figure 2

Proposed Development

Camp Kurrajong Scouts

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
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Methodology

This report has been prepared using the following methodology:

- Desktop review of previous flood studies and emergency response documentation.
- Liaison with Council to obtain flood levels.
- Summary of existing flood behaviour.
- Review of architectural and civil drawings to determine any likely impacts on flood behaviour.
- Identify and summarise any flood risks in both the existing and developed cases.
- Review the Wagga Wagga Local Flood Plan and target gauge warning times to formulate a flood emergency response strategy.
- Assess the proposed development against Council requirements.

Flood Behaviour

Flood information has been provided by Wagga Wagga City Council from the 2018 Wagga Wagga Revised Murrumbidgee River Floodplain Risk Management Study and Plan (prepared by WMA Water), herein referred to as the FRMSP.

Flooding of the site occurs from overtopping of the Murrumbidgee River over Oura Road travelling from south-west to north-east. Maximum flood levels adjacent to the proposed new buildings are presented below in Table 1.

Selected flood levels adjacent to the proposed new buildings is presented overleaf in Figure 3.

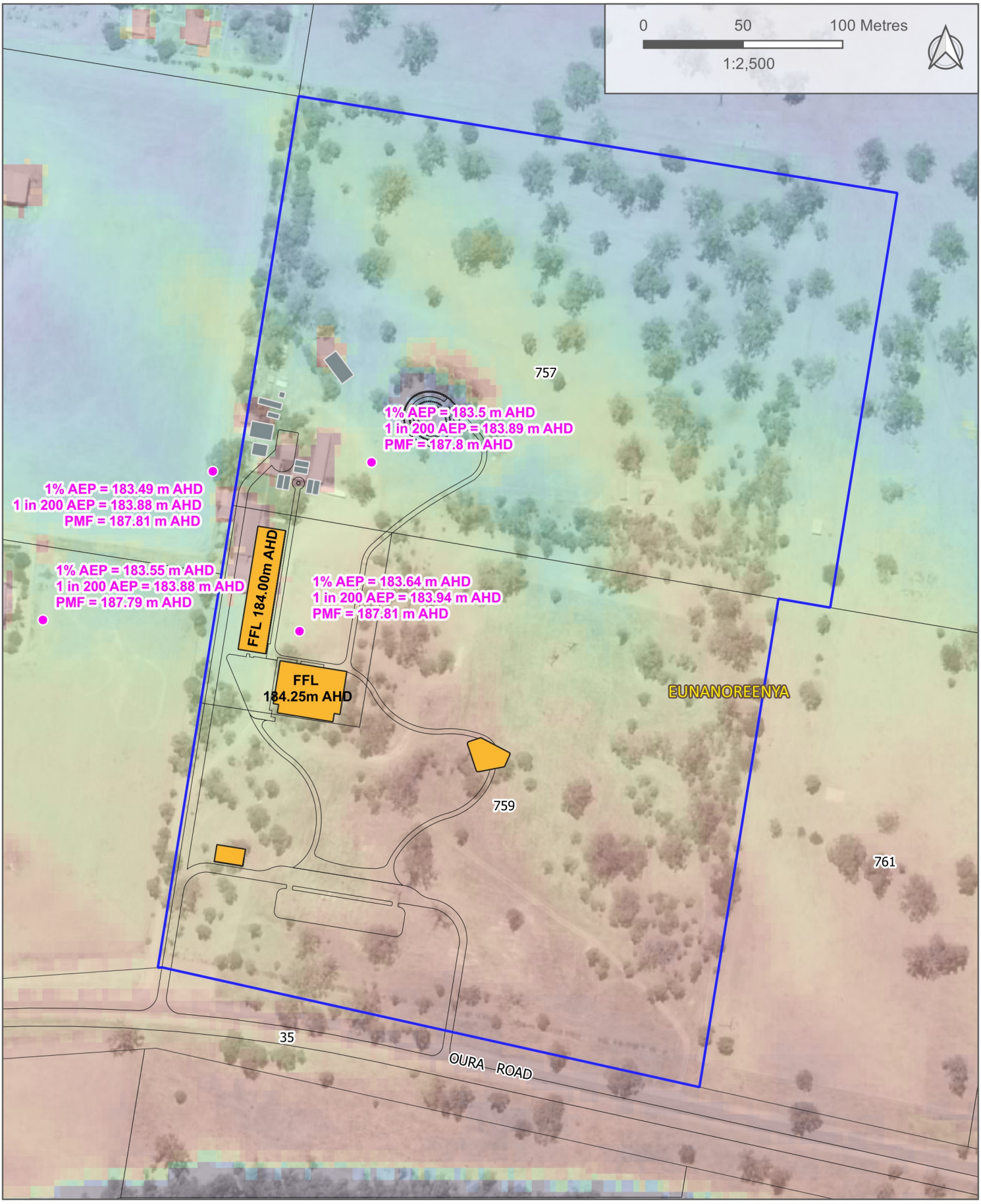
Flood characteristics from the 10% AEP to the PMF are presented overleaf in Figure 4 to Figure 12.

Table 1 - Flood levels

Event	Level (m AHD)
10% AEP	Not flooded
5% AEP	183.11
1% AEP	183.64
1 in 200 AEP	183.94
PMF	187.81

For reference, the floor level of the proposed hall is 184.25m AHD, and the new accommodation building is 184.00m AHD.

The rate of rise of flood waters is largely dependent on the event given the large upstream catchment. The rate of rise is expected to be over several hours. Furthermore, the BoM targets between 12 hours and 30 hours for warning prior to event peak based on their service level specification (http://www.bom.gov.au/nsw/NSW_SLS_Current.pdf). This is reflected in the response to 2010 and 2012 flooding. (https://wagga.nsw.gov.au/__data/assets/pdf_file/0006/79386/Appendix-K-Dec-2010-and-March-2012-Flood-Warnings-and-Evacuation-Warnings-Orders-for-Wagga-Wagga.pdf).



Legend

- Subject Site
- Existing Buildings to Remain
- Proposed New Structures
- New Roads and Paths

Elevation (m AHD)

- 184
- 182
- Flood Points

Figure 3

Flood Elevation

Camp Kurrajong Scouts

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
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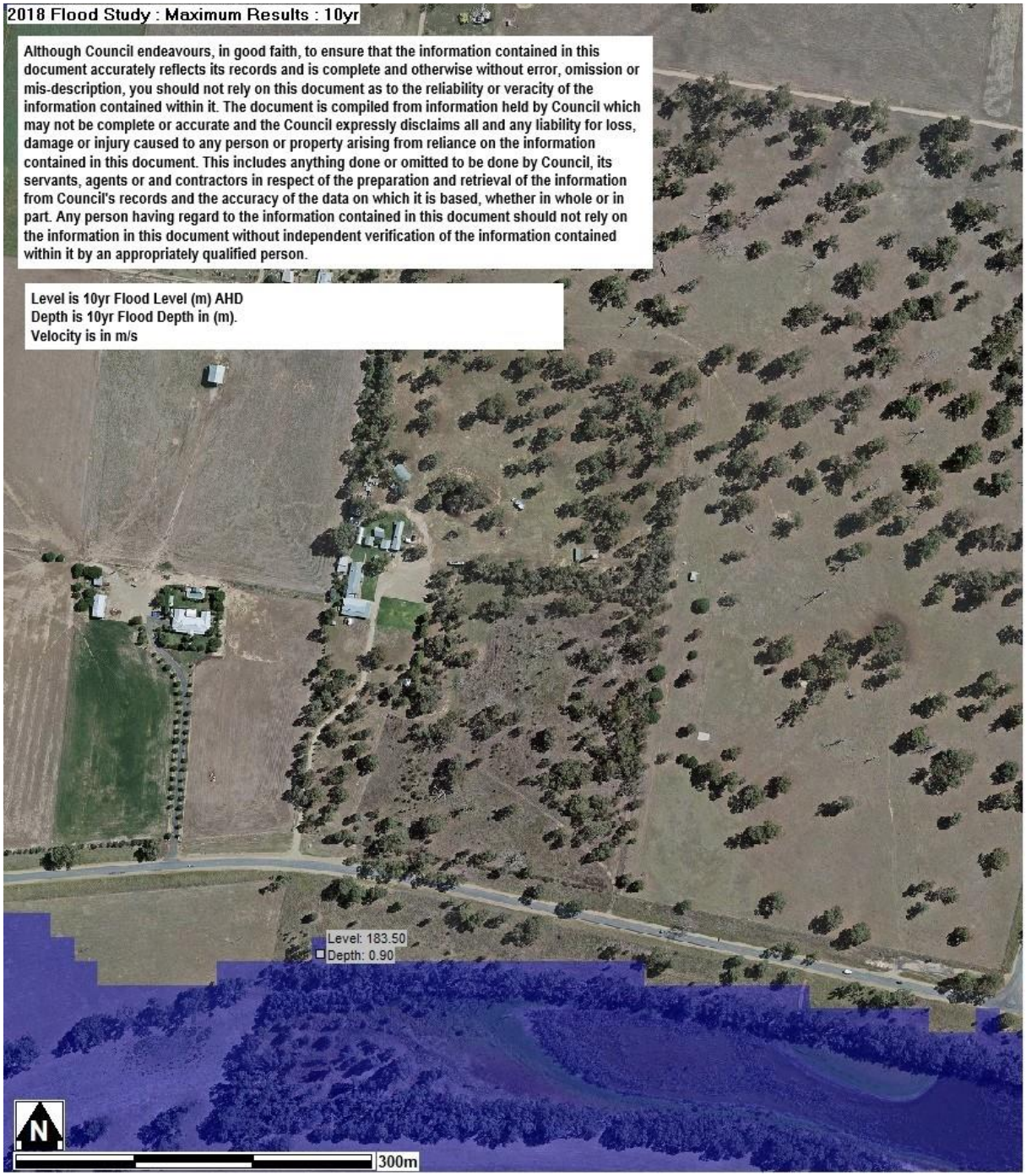

Figure 4 - 10% AEP Flood Depth and Level

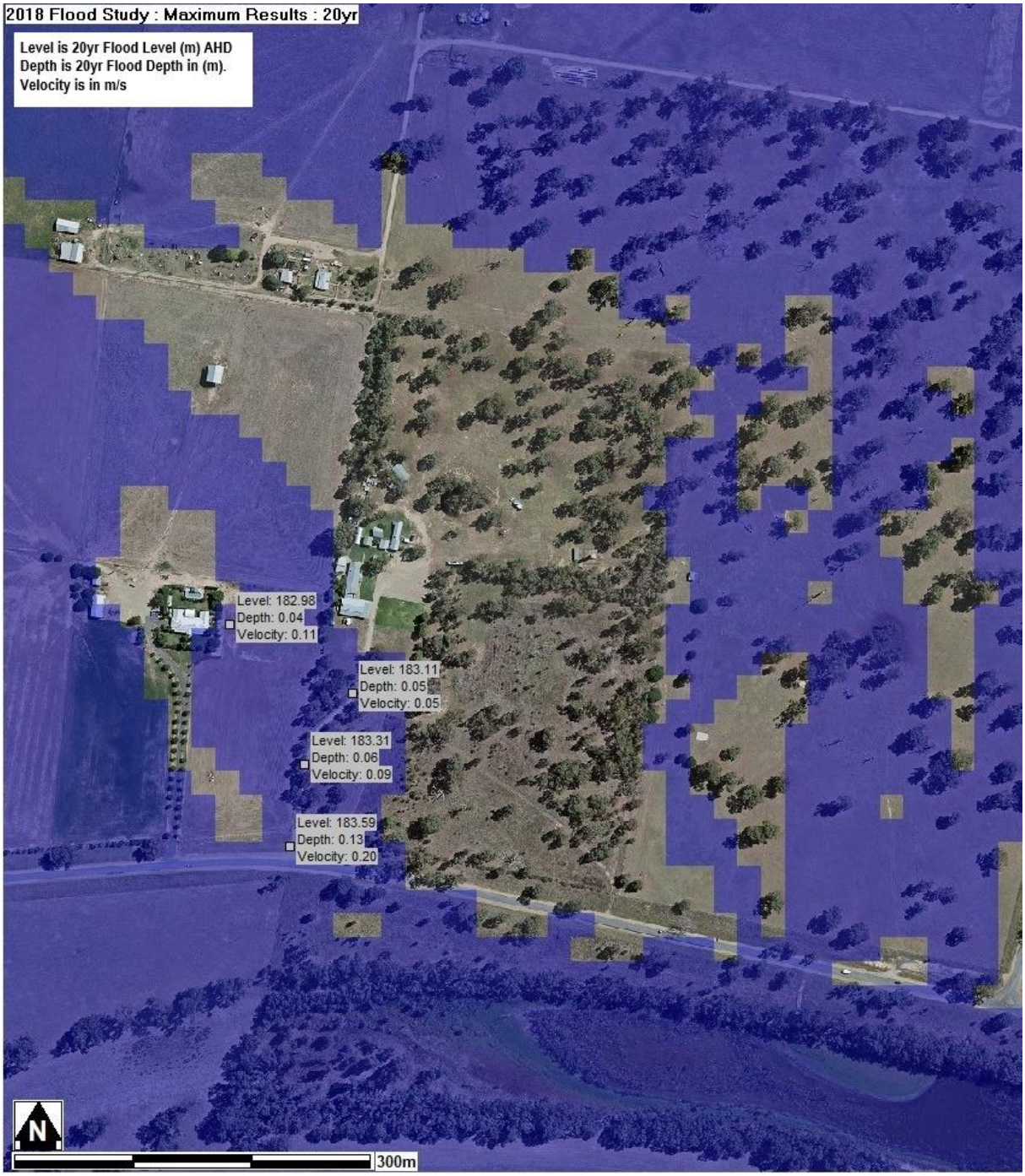

Figure 5 - 5% AEP Depth, Level and Velocity

Figure 6 - 2% AEP Depth, Level and Velocity

Figure 7 - 1% AEP Depth, Level and Velocity

Figure 8 - 1 in 200 AEP Depth and Level

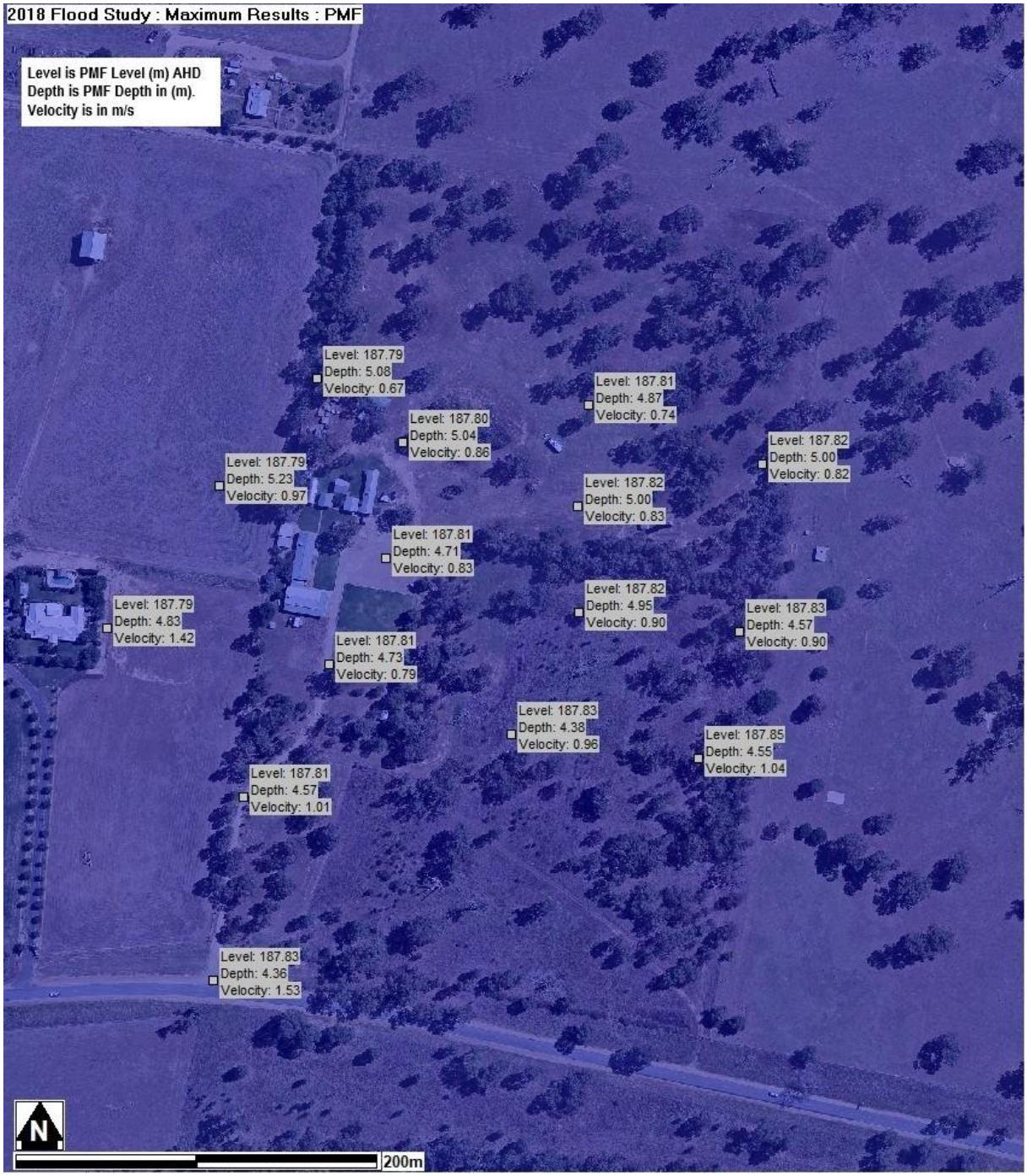

Figure 9 - PMF Depth, Level and Velocity

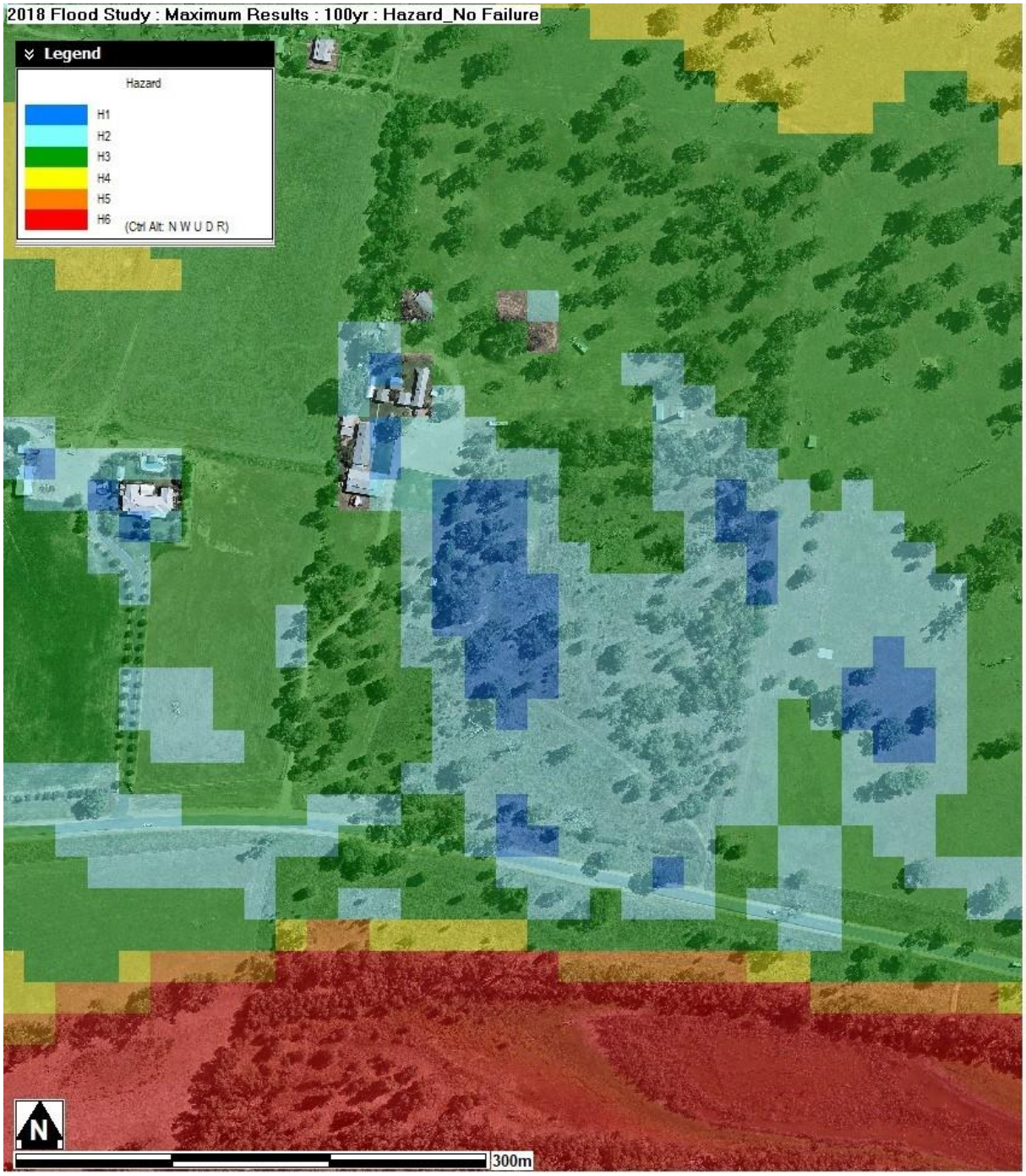

Figure 10 - 1% AEP Hazard

Figure 11 - PMF Hazard

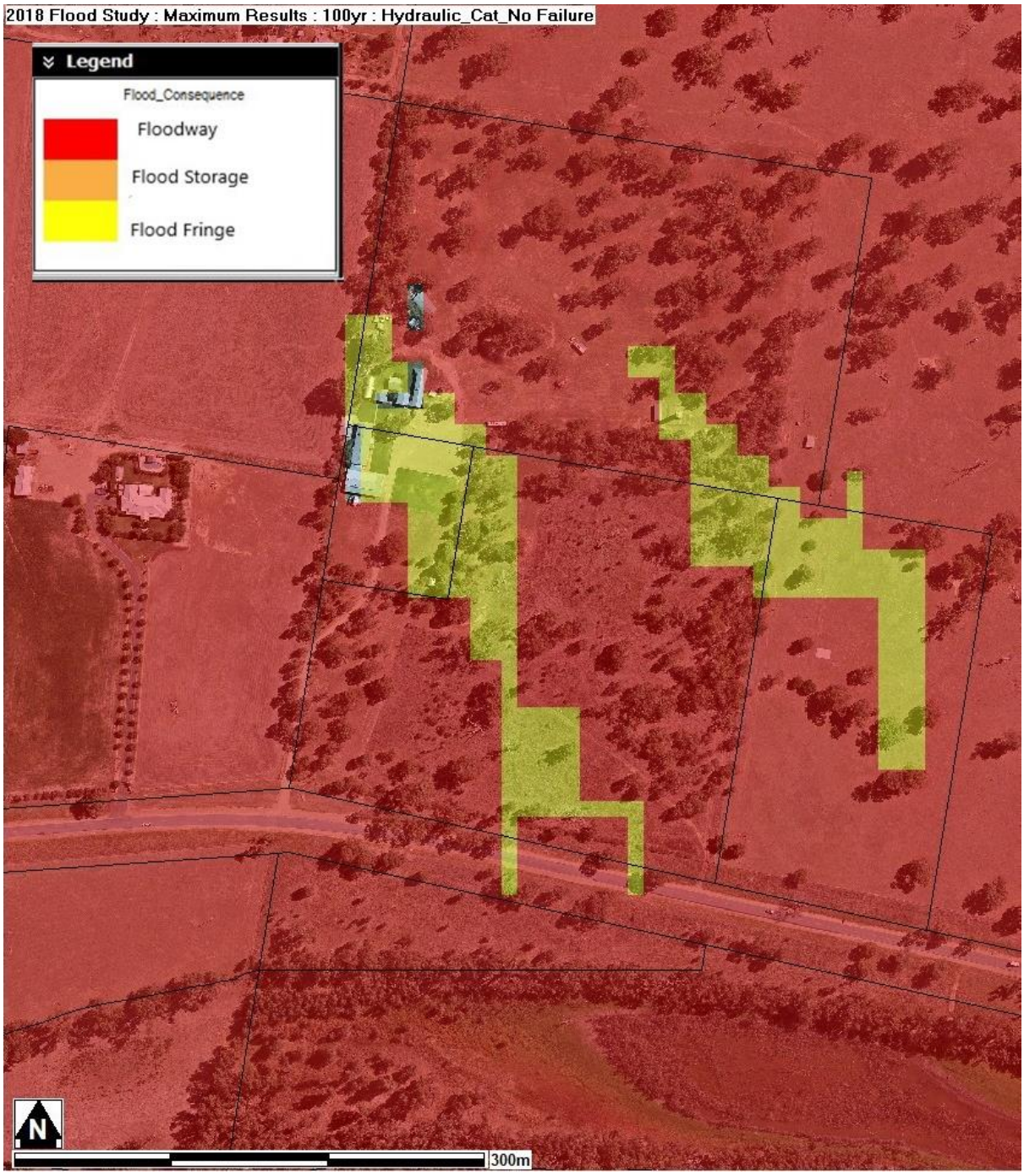

Figure 12 - Hydraulic categories

Flood Risk

Flood Hazard

Categories for flood hazard are presented below in Figure 13.

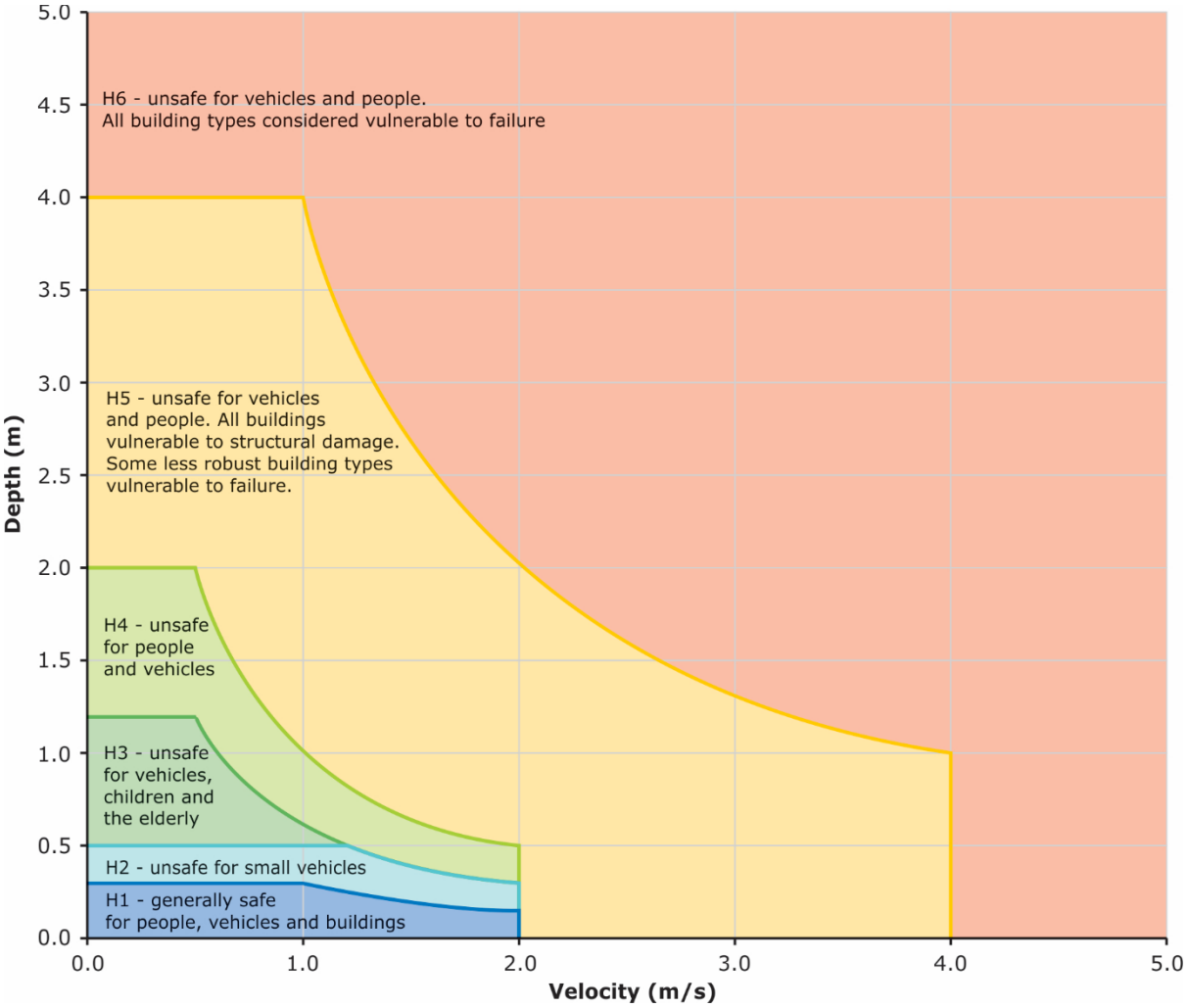

Figure 13 - ARR Hazard Categories

The flood hazard across the site in the 1% AEP is low to moderate, with H1 to H3 hazard categories. A H3 hazard category is generally considered unsafe for vehicles, and for pedestrians who are children and the elderly.

In the PMF, the flood hazard in high H6 across the majority of the site. This indicates unsafe conditions for all vehicles and people, with all structures considered vulnerable to failure.

Existing Risk

The following potential risks from the flood hazard were identified in the existing condition - presented below in **Table 2**.

Table 2 - Existing flood risk analysis

Item	Likelihood	Consequence	Risk Rating
Illness due to contact with contaminated floodwater	Unlikely	Minor	Low
Risk to property - Structural damage	Rare to very rare	Major	High
Risk to property – internal damage due to over floor flooding	Unlikely	Moderate	Medium
Risk to life - Loss of life	Extremely rare	Major	Low

Developed and Residual Risk

Mitigation measures proposed in the design, and potential mitigation measures that could be implemented during operation are presented below in **Table 3**.

Table 3 - Mitigation Measures

Item	Mitigation Measures
Illness due to contact with contaminated floodwater	This risk is noted as unlikely due to the centre being closed and evacuated prior to a flood event. Emergency response measures will act to mitigate this risk.
Risk to property - Structural damage	Through reconstruction of aging buildings, the likelihood of structural damage is expected to be reduced.
Risk to property – internal damage due to over floor flooding	New floor levels have been set above the 1% AEP plus 500mm in the hall and 1% AEP plus 360mm (above the 1 in 200 AEP) in the accommodation. These increases in flood level reduce the risk through reducing the likelihood.
Risk to life - Loss of life	The likelihood of loss of life is expected to be reduced through implementation of a Flood Emergency Response Plan. Principles of any response plan centres around - awareness, preparation, and appropriate response. In this case the applicant will be occupying the development which means they have control over awareness and preparation. Furthermore, the site is located upstream of the Wagga Wagga gauge with greater than 24 hours warning time expected prior to a flood peak.

Following implementation of the proposed mitigation measures, the residual developed risk analysis is presented below in **Table 4**. A risk matrix showing the existing and residual risk comparison is presented in **Table 5.**

Table 4 – Developed residual risk analysis

Item	Likelihood	Consequence	Risk Rating
Illness due to contact with contaminated floodwater	Unlikely	Minor	Low
Risk to property - Structural damage	Extremely rare	Moderate	Low
Risk to property – internal damage due to over floor flooding	Rare to very rare	Moderate	Medium
Loss of life	Extremely rare	Major	Low

Table 5 - Risk matrix

Likelihood	AEP Range	Consequence				
	(%)	Insignificant	Minor	Moderate	Major	Catastrophic
Likely	>10					
Unlikely	1 to 10		**Floodwater (E + D)**	Internal damage (E)		
Rare to very rare	0.01 to 1			Internal damage (D)	Structural damage (E)	
Extremely rare	<0.01			**Structural damage (D)**	**Loss of life (E + D)**	

Note: Developed risk (D) Existing risk (E)

Risk: Very low Low Medium High Extreme

Flood Emergency Response Strategy

Flood Warning

The BoM targets greater than 24 hours warning for events which are likely to affect the site as identified by their service level specification (referenced above). A range of warning products are available from the BoM (http://www.bom.gov.au/water/floods/floodWarningServices.shtml) and SES (https://www.ses.nsw.gov.au/about-us/our-warnings/) including the following.

- BoM Severe Weather Warning
- BoM Flood Watch
- BoM Flood Warning
- SES Advice
- SES Watch and Act
- SES Emergency Warning

Strategy

The following flood emergency response strategy is proposed to manage the risk to life. This should be formalised as a flood emergency response plan prior to occupation.

- **Preparation**. Nominate flood response personnel and understand the available warning products and triggers for response.
- **Cancel Operations if Flooding Forecast**. This eliminates the risk of people trying to access the site or attempting evacuation during extreme weather.
- **Perform Early Evacuation if Site Occupied.** Monitor weather warnings and if major flood expected at the Wagga Wagga gauge. Evacuate early to high ground.
- **Follow Directions of Emergency Services Personnel**. If emergency services attend site, follow their direction.
- **Recovery.** Inspect buildings and infrastructure and remediate, if required.

Council Compliance

LEP

This report has been prepared generally in accordance with LEP Clause 5.21. The below Table 6 outlines the development response to these items.

Table 6 - LEP Requirements

Requirement	Response
(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,	The risk to property is managed by suspending the new buildings above the 1 in 200 AEP. Risk to life is managed through the flood response strategy proposed. We note that whilst the capacity of the facility has increased and this could be considered intensification of use, the use of the site is intermittent which means occupants are less likely to want to stay in place if flooding is predicted.
(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,	The development is rebuilding existing and is therefore compatible with the flood function. No change to the existing site use is proposed. The development has generally been located in flood fringe with minor encroachments into the floodway.
(c) to avoid adverse or cumulative impacts on flood behaviour and the environment,	The development suspends the proposed new buildings and only proposes minor regrading for the carparking and road upgrades. Therefore adverse and cumulative impacts are not expected.
(d) to enable the safe occupation and efficient evacuation of people in the event of a flood.	The development matches the same access arrangements as existing to facilitate evacuation in advance of a very rare to extreme flood event.
(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 development is rebuilding existing and is therefore compatible with the flood function. The development has generally been located in flood fringe with minor encroachments into the floodway.
(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the	The development suspends the proposed new buildings and only proposes minor regrading for the carparking and road upgrades. We do not

Requirement	Response
potential flood affectation of other development or properties, and	expect the development will have a significant adverse impact on other properties.
(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 development matches the same access arrangements as existing to facilitate evacuation in advance of a very rare to extreme flood event.
(d) incorporates appropriate measures to manage risk to life in the event of a flood, and	A Flood Emergency Response Strategy has been proposed to manage the risk to life.
(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses.	The development suspends the proposed new buildings and only proposes minor regrading for the carparking and road upgrades. Sediment and erosion control measures are proposed for construction, and stormwater management measures are proposed for operation which are likely to adequately manage the potential impacts on the environment.
(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,	Consideration has been given to the 1 in 200 AEP which is commonly used as a proxy for climate change, with finished floor levels of the buildings set above this level.
(b) the intended design and scale of buildings resulting from the development,	The buildings are reconstructed generally in the same area as existing and to a slightly larger scale.
(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,	A Flood Emergency Response Strategy has been proposed to manage the risk to life.
(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.	The buildings have potential to be removed in the future if required.

DCP Requirements

Development Control Plan 2010 (DCP 2010) Part A requirements and responses have been summarised in Table 7 below.

The development has been assessed against the “Development on the rural floodplain (High flood risk area)” provisions.

The high risk has been determined based on the majority of the site being classified as “floodway” with a small section of flood fringe around the existing development.

Table 7 – DCP Requirements

Requirement	Response
C20 - Industrial and high impact commercial uses are unsuitable for development on the rural flood plain (high risk area).	These uses are not proposed as part of this development.
C21 - Seniors living housing is not suitable on the rural flood plain (high flood risk area).	This use is not proposed as part of this development.
C22 - Existing dwellings can be replaced but if in a “high hazard” area must be relocated to a location where the overall flood risk is less (being of lower hazard and/or better access) if available on the property.	Hazard in the 1% AEP is H3 or less. Generally, the development locates new structures around the existing development which is generally located within a small section of “Flood Fringe”. We believe this is the most suitable location for development on the subject site.
C23 - Additions to existing habitable dwellings are to be limited to 50m² where the existing floor level is subject to flooding	The development does not add additional dwellings.
C24 - For new dwellings the depth of water for vehicular access is not to exceed 300mm during the 1 in 100 yr flood event.	The development does not add new dwellings and the access to the site is an existing condition.
C25 - Development on the rural flood plain (high risk area) is to comply with the provisions of Table 4.2.5.	The development has been address against “Residential” provisions and these requirements are reproduced below.
Floor Levels	
• All new habitable development to have floor levels greater than the 100yr ARI flood level, plus freeboard. • Additions to existing habitable dwellings not to exceed 50m² (where the existing floor level is subject to flooding). • House raising and flood proofing is encouraged for existing developments below the 100yr flood level. • New development is to be consistent with flood hazard and evacuation needs.	The floor level of the accommodation building has been set with 360mm freeboard to the 1% AEP and is above the 1 in 200 AEP flood level. The new hall has a level above the 1% AEP plus 500mm and the 1 in 200 AEP.
Structural soundness	
• Engineers report to certify that any new structure can withstand the forces of	The velocities and depths in the 1% AEP are reasonably low, and we expect the flood forces

Requirement	Response
floodwater, debris and buoyancy up to and including the 100yr ARI (excludes sheds less than 20m²) • Fencing construction and materials are to allow flood waters to equalise on either side	will be accounted for using standard structural engineering practice. We request this item is included as a condition of consent.
Flood affectation	
• Engineers report or suitable certification required to certify that the development will not increase flood affectation elsewhere	The proposed buildings are suspended above the 1% AEP flood level and replacing buildings located generally in the same spot. We do not believe the development will cause significant adverse impacts on neighbouring properties.
Evacuation	
• A Flood Plan is required and is to make provision for evacuation of employees and storage of materials above the 100yr ARI flood level, plus freeboard. • Flood evacuation access is not to be worse than for the old building being replaced. • Habitable developments to be sited to provide best evacuation access where conditions allow.	A Flood Emergency Response Strategy is proposed to evacuate early should inundation of the site be likely. The BoM targets 24 hours of warning prior to very rare to extreme peaks at the Wagga Wagga gauge which we believe is adequate time to coordinate an evacuation of the site. Furthermore, the site has overland escape route in the 1% AEP, and temporary overland refuge area on high trapped perimeter in the PMF should evacuation not be completed in time. These categories are noted in the FRMSP (https://wagga.nsw.gov.au/__data/assets/pdf_file/0007/79369/Figure-16.pdf, and https://wagga.nsw.gov.au/__data/assets/pdf_file/0008/79370/Figure-17.pdf)
Management and design	
• Developments are encouraged to provide a flood free area. • Parts of building below the 100yr flood level, plus freeboard to be constructed from flood compatible materials.	It is not feasible to provide a flood free area on this site. We consider it is feasible to construct the new buildings with flood compatible materials below the 1% AEP plus 500mm and request this is included as a condition of consent.

Conclusion

Northrop Consulting Engineers were engaged by Adapt Project Management Pty Ltd to prepare a Flood Impact and Risk Assessment report for the proposed Camp Kurrajong Scout Facility at 759 Oura Road, Eunanoreenya.

This study has reviewed the existing flood behaviour in the vicinity of the subject site, the likely flood impact of the proposed development, as well as the development compliance with respect to Council's flood related development controls.

The following was concluded.

- The proposed development is not expected to result in a significant adverse flood impact in the adjacent properties through suspended new buildings.
- Risks to property can be managed through selection of floor levels above the 1 in 200 AEP.
- Residual risk to life can be managed through the emergency response strategy proposed.

We commend our findings to Council for their review. Should you have any queries regarding this correspondence, please feel free to contact the undersigned on (02) 4943 1777.

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Limitation Statement

Northrop Consulting Engineers Pty Ltd (Northrop) has been retained to prepare this report based on specific instructions, scope of work and purpose pursuant to a contract with its client. It has been prepared in accordance with the usual care and thoroughness of the consulting profession for the use by Adapt Project Management Pty Ltd. The report is based on generally accepted practices and standards applicable to the scope of work at the time it was prepared. No other warranty, express or implied, is made as to the professional advice included in this report.

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Document Register

Rev	Status	Prepared	Approved	Admin	Date
A	Approval	GB	GB	ZJ	9 May 2024