Planning Proposal
Lot 711 DP 1128593

Flood Risk Assessment and Surface Water Assessment.

October 2021

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1.0 BACKGROUND AND SCOPE

1.1. Background

Southeast Engineering and Environmental have been engaged to address flooding and potential surface water impact for the Planning Proposal at Lot 711 DP 1128593 (the Site).

The Planning Proposal is for the rezoning of the Site from rural land to rural residential development, to allow a rural subdivision consisting of 13 new lots over the Site.

The development is presented as a Planning Proposal and as such needs to address flooding and potential surface water impacts as outlined by the Department of Planning Industry and the Environment (DPIE) in their Pre-Gateway advice dated 12/3/21.

In relation to flooding a Floodplain Impact Risk Assessment (FIRA) is deemed necessary to assess flood impacts and flood risks on the Site and proposed development.

In relation to surface water management, the development is locate adjacent to the Yokawa River, and drains to the Pambula Estuary which has an associated Estuary and Coastal Zone Management Plan. Potential impacts on the estuary associated with a rural residential subdivision such as sediment in runoff and on-Site effluent management need to be addressed.

This report addresses both of these issues.

1.2. Proposed Development

The proposed development is located approximately 1km south of the residential area of South Pambula on the western side of the Princes Highway (Figure 1.1). Subdivision of Lot 711 DP 1128593 consists of 13 rural residential lots spread over predominantly cleared rural land. Lots range in size from approximately 1ha to 12ha. Lots will be serviced by a public road off the Princes Highway and right of access and emergency access from Summerhill Road (Figure 1.2).

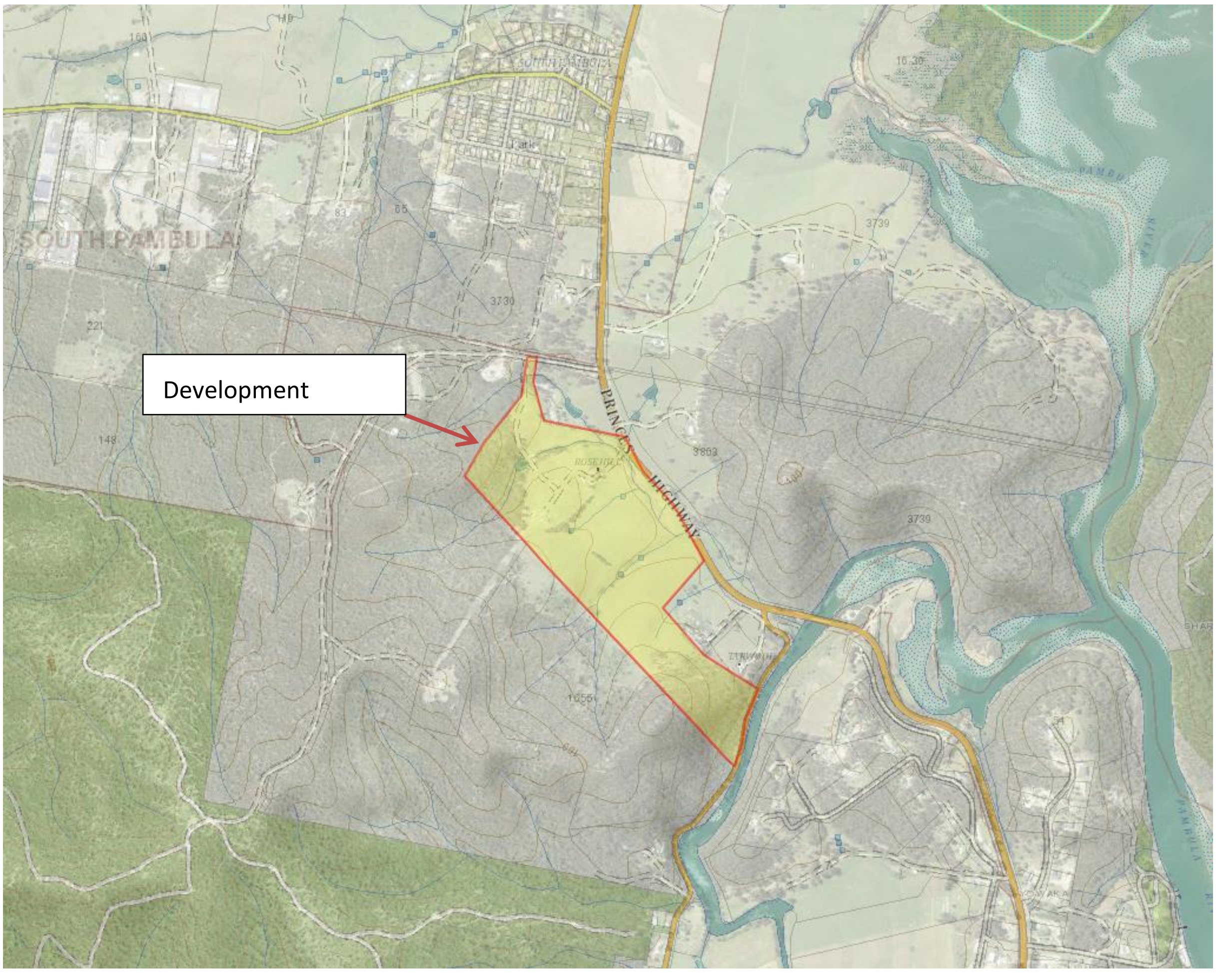

Figure 1.1 Site locality

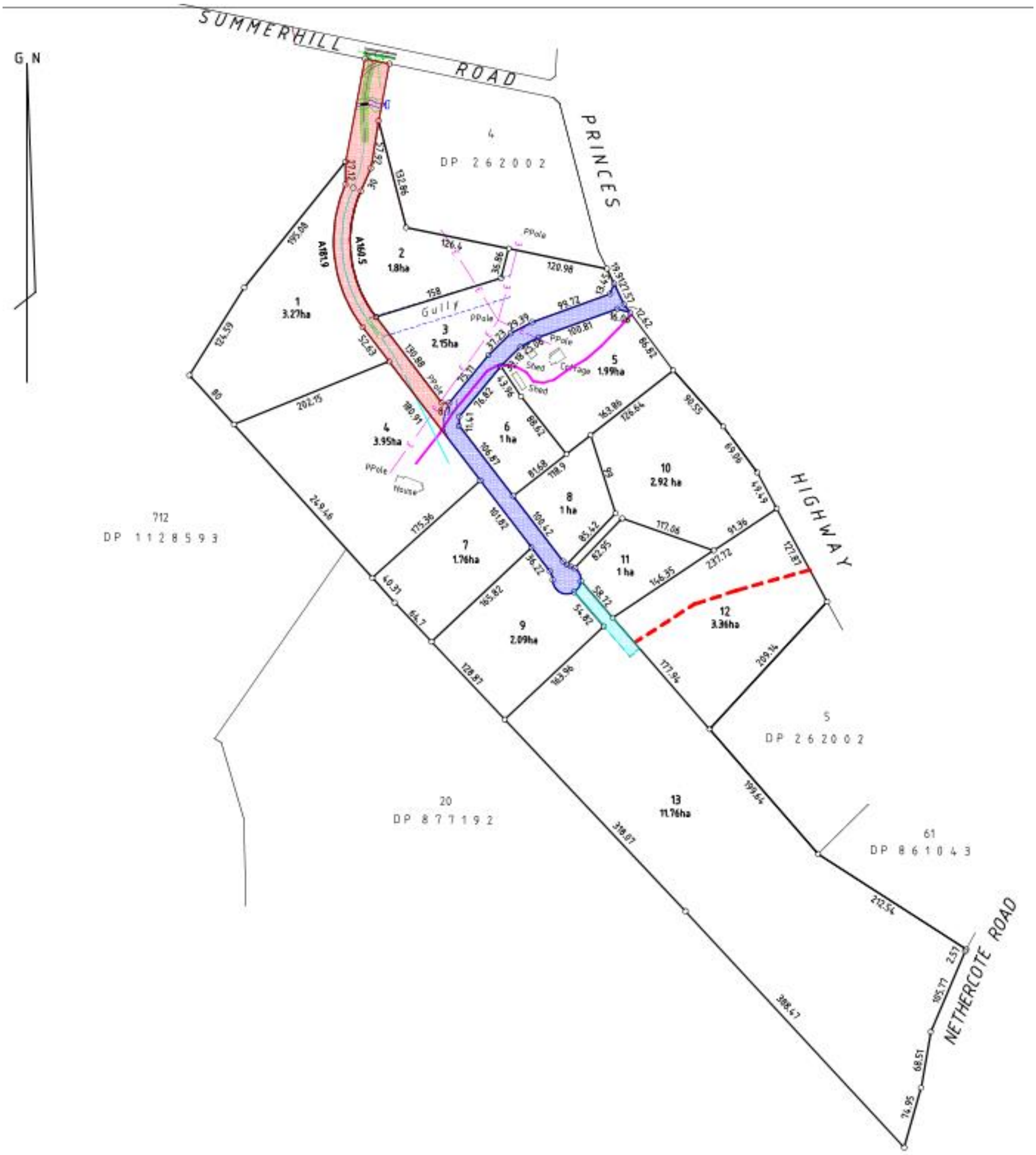

Figure 1.2 Proposed development layout

2.0 SITE HYDROLOGIC, SOIL AND RECEIVING WATER CONDITIONS

2.1. Catchments and drainage

The Site is situated on undulating hillsides, predominantly facing east. A number of unnamed watercourses run through the development Site that ultimately drain to the Yowaka River, and then the Pambula estuary (Figure 2.1). These watercourses collect runoff from the Site, from forested areas further west and from catchments to the east of the Princes Highway via culvert connections. There are three main external upstream catchments draining to the Site; referred to as catchments 3.4, 3.3 and 3.0, with areas 27, 41 and 40ha respectively, as well as smaller internal catchments and about 20ha draining to the Site from the east.

Watercourses within the Site are generally well vegetated and stable. A significant portion of the external catchments, particularly upstream of the Site are forested and will remain so.

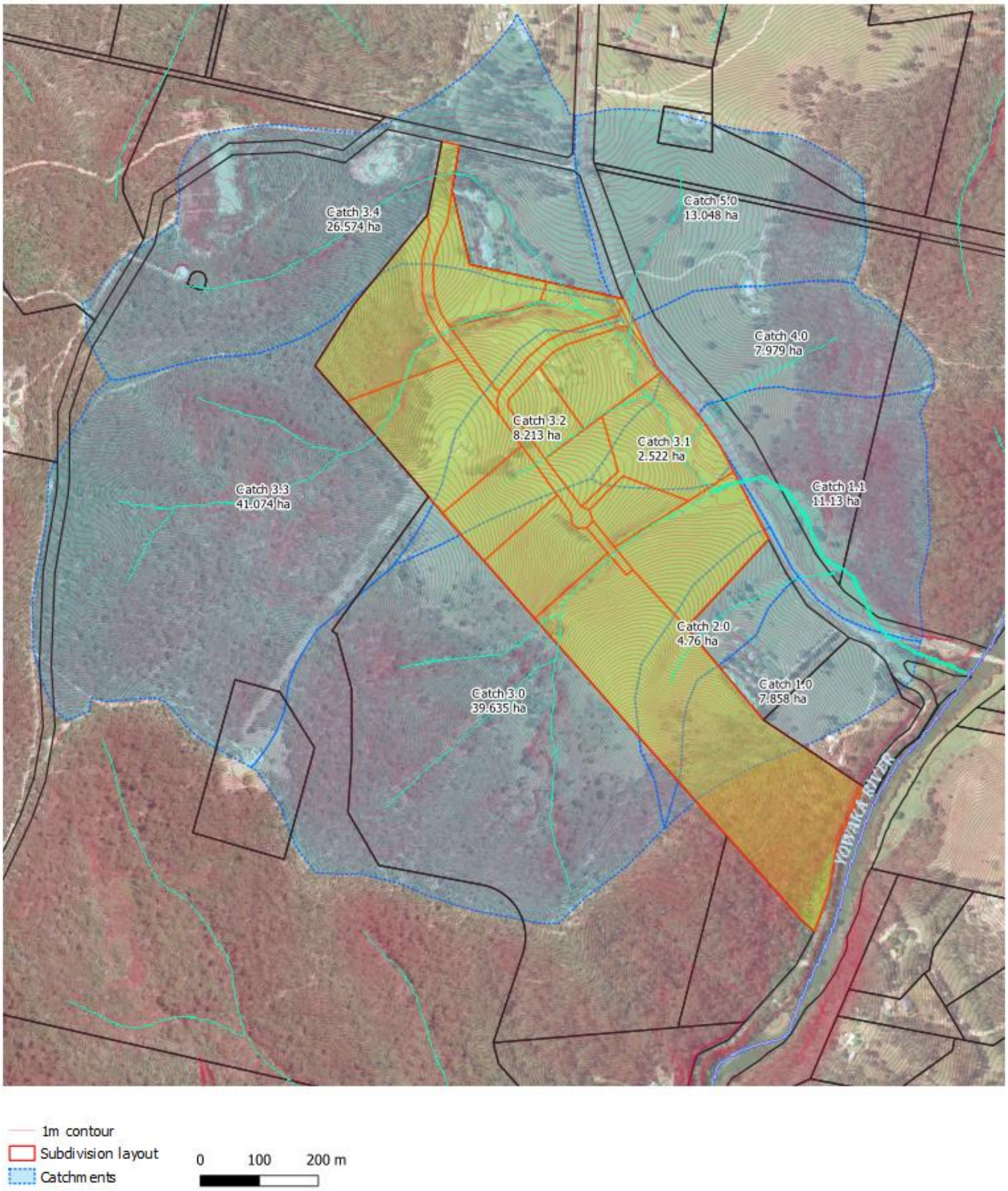

Figure 2.1 Site and drainage catchments

2.2. Site soil characteristics

Soil landscape mapping accessed from https://www.environment.nsw.gov.au/eSpade2Webapp shows two soil landscapes across the Site. The bulk of the Site is classified as the Bald Hills (bh) soil landscape with a small section of the Bournda (bo) soil landscape in the north west corner of the Site (Figure 2.2).

The Bald Hills landscape is characterised by a basalt geology, with moderately deep and moderately well drained chocolate soils to between 20-150cm deep. These soils landscapes are generally well suited to grazing, and have low limitations for earthworks. Surface soils and sub soils are moderately suited for septic absorption, although more stony areas present a restriction.

The Bournda landscape is characterized by a ryolite geology, with shallow lithosols over well drained yellow podzolic soils. These soils have moderate limitations for earthworks. Soils are not well suited for septic absorption due to restricted drainage.

2.3. Receiving environment

Stormwater discharge from the development Site is located about 350m upstream of the Yowaka River and the Pambula estuary. The Coastal Zone Management Plan (CZMP) for the Pambula Lake Estuary (BMT WBM, 2015) summarises the threats and associated management actions that are necessary to protect the environmental and economic values of the estuary. Key threats identified in the CZMP relating to this development include:

- Unsealed roads in the catchment contributing sediment
- Stormwater and sewage discharges contributing nutrients, pathogens and sediment
- On-Site sewage leachate contributing nutrients and pathogens.

High priority actions identified in the CZMP that relate to this proposed rural residential development include:

- Fencing of riparian areas and revegetation of these areas
- Assessment and management of unsealed roads.

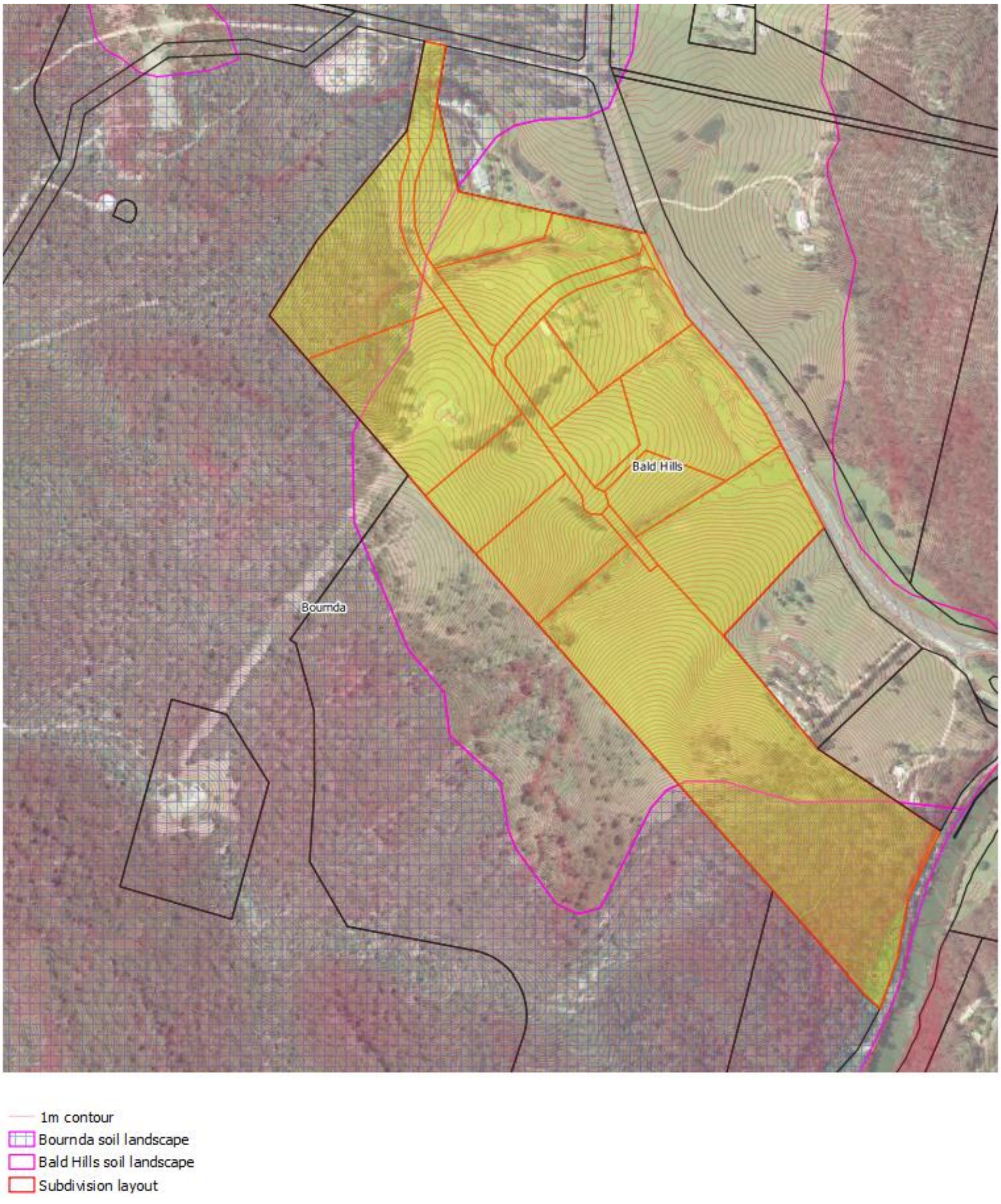

Figure 2.2 Site soils and slopes

3.0 MODELLING HYDROLOGIC AND HYDRAULIC BEHVIOUR

3.1. Method Summary

The purpose of this investigation is to gain an understanding of flood risk at the Site to inform the planning proposal and development components such as crossings and access. In order to do this, a combination of a rainfall runoff routing model (XP RAFTS) and 2D direct rainfall hydraulic model (HEC RAS 2D) have been used in conjunction with relevant Australian Rainfall and Runoff (ARR) procedures.

The ARR ensemble approach requires running a considerable number of storm durations and patterns for each rainfall event to determine the critical event for that sub-catchment. To limit the number of direct rainfall 2D model runs, XP RAFTS was used to estimate the critical storm duration and the median storm pattern, this rainfall event was then used in the direct rainfall hydraulic model.

These models were also compared with the Regional Flood Frequency Estimation (RFFE) Model included in Australian Rainfall and Runoff and accessed at https://rffe.arr-software.org/. This model is a tool that collates nearby gauged flows and compares gauged data and catchment characteristics with the catchment in question to provide an indication of the range of peak flows to be expected based on historical data.

3.2. Modelling assumptions

3.2.1. ARR data and IFD information

Storm patterns, losses and pre-burst rainfall depths were downloaded from the ARR data hub website. IFD data was downloaded from the Bureau of Meteorology (BOM) website.

Storm losses for both the XP RAFTS model and the direct rainfall 2D model were estimated by subtracting the NSW specific transformational pre-burst rainfall from the ARR storm losses.

Downloaded ARR and BOM data is contained in Appendix A.

3.2.2. XP RAFTS

Assumptions and inputs:

- PERN roughness (Manning's) – 0.035
- Slope – varies (Based on DEM surface slope analysis)
- Impervious – 0%

3.2.3. HEC RAS 2D

Assumptions and inputs:

- Surface roughness (Manning's) – 0.06
- Surface terrain is based on a 1m DEM from NSW spatial services website
- Model surface resolution is a 5m grid. Break lines have been used to pick up roads and crossings around the Site
- Modelled using the diffuse wave equation
- Downstream boundary condition is the Yowaka River. A constant flood level of 5m AHD is assumed. This is approximately the 1% AEP flood level in the Yowaka River.

3.3. Model comparison and peak flow results

XP RAFTS model results show that the critical rainfall durations are between 20 to 30 minutes over the main sub catchments within the Site. The rainfall pattern used in the HEC RAS model was the critical event over the development Site.

Model results have been compared both at the end of catchment 3.3 and catchment 1.0. Table 3.1 and Figure 3.1 outline the results for a range of events modelled for the rainfall runoff model (XP RAFTS), rainfall on grid model (HEC 2D) and regional gauged data. The 2D rainfall on grid model results correspond roughly with the XP RAFTS runoff routing model. The RFFE values for the overall Site are significantly higher than the other model results, with the 5th percentile roughly matching the XP RAFTS and HEC 2D results. When analyzing to an average rainfall intensity to produce the median 1% AEP flow reported from the RFFE, this corresponds to an average rainfall intensity of about 340mm/h, well above the 1% AEP intensity expected for this type of catchment when compared with the BOM IFD data for the Site. This would seem to be an anomaly in the RFFE estimate, and is confirmed when reviewing the RFFE flow v. catchment area figure (Figure 3.2 Site and comparative catchments used in RFF (Note high flow for the catchment size relative to other recorded sites)Figure 3.2) which shows a high flow for the catchment size relative to other recorded sites.

Table 3.1 Comparison of peak flows for rainfall events for Catchment 3.3.

AEP (%)	Catchment Location	Critical storm duration	ARR Storm rainfall pattern	Flow (m^3/s)		
				(RAFTS)	HEC 2D	RFFE (median)
1	1.0	20min	5845	48.14	49.91	105
	3.3			13.26	15.01	-
5	1.0	25min	5886	28.98	20.84	54.4
	3.3			7.50	7.19	-

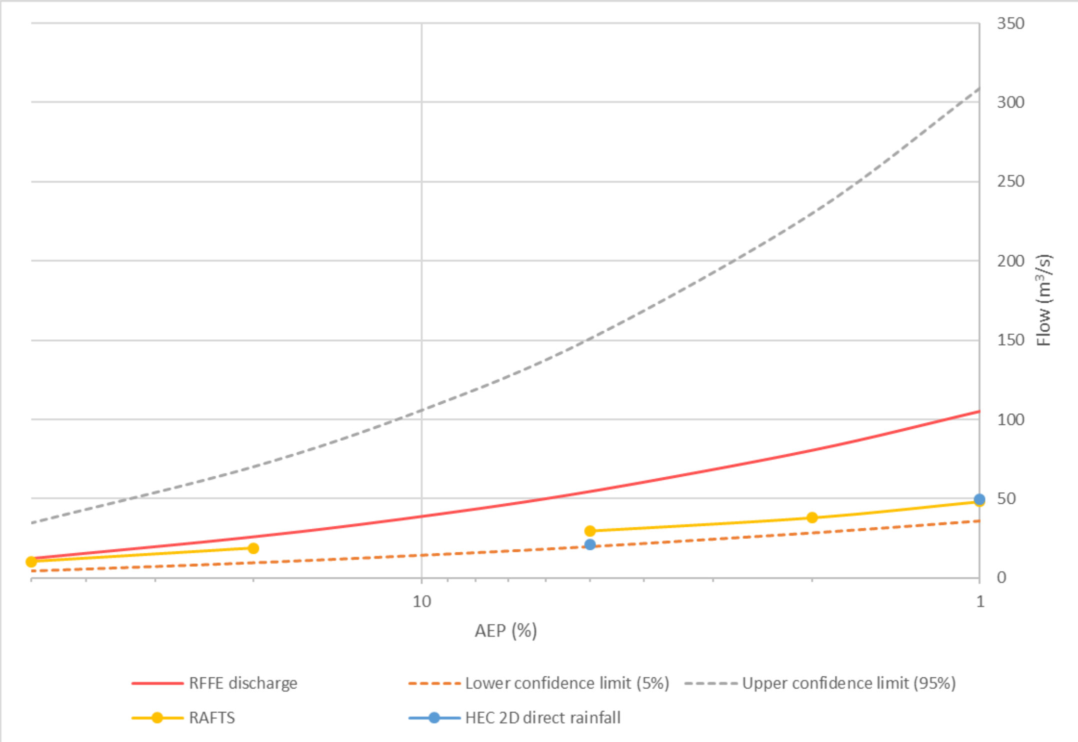

Figure 3.1 Comparison of design event flow rates from RAFTS, HEC 2D and RFFE tool at downstream end of Catchment 1.0.

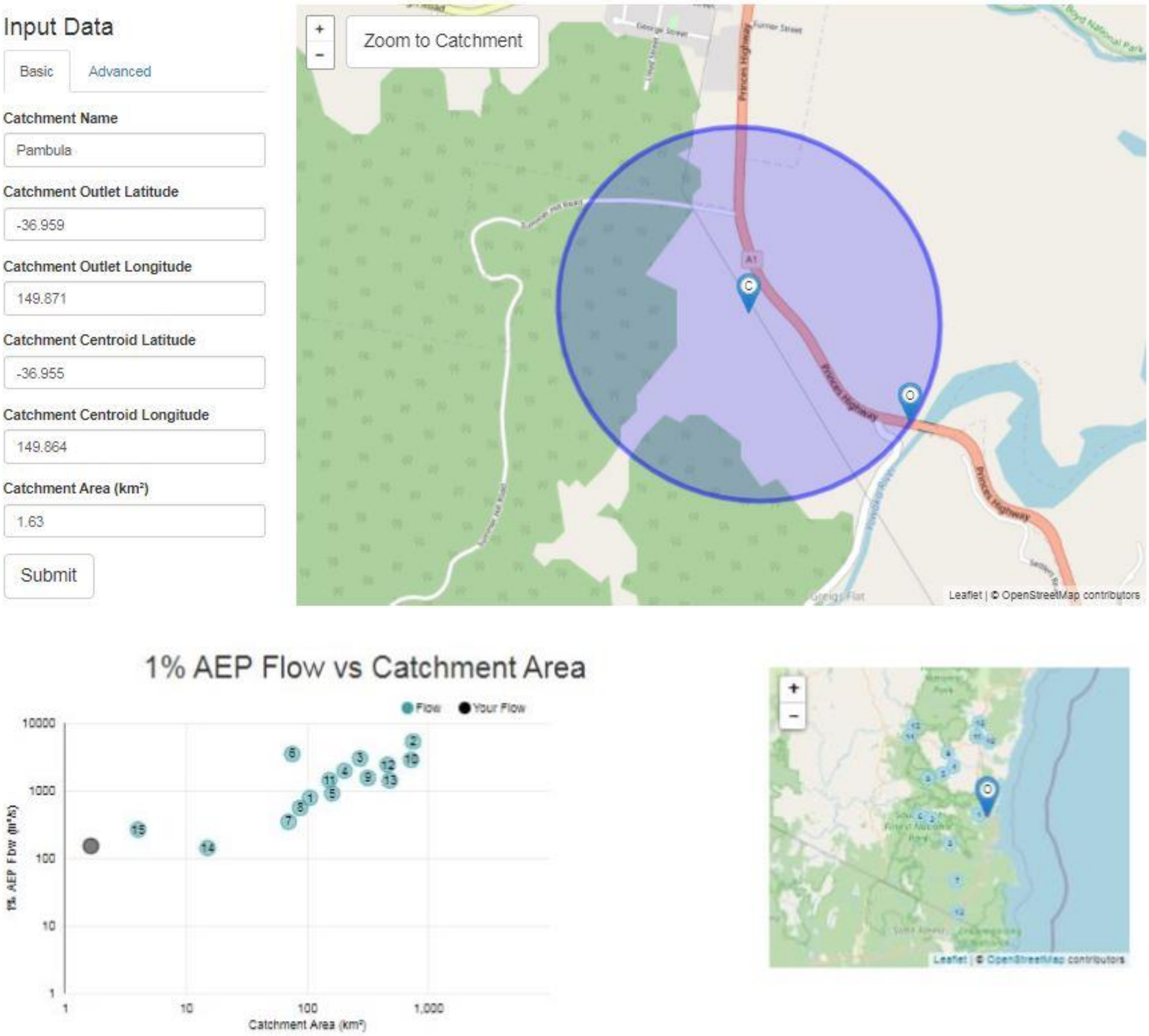

Figure 3.2 Site and comparative catchments used in RFF (Note high flow for the catchment size relative to other recorded sites)

3.4. 2D surface flow model results

Detailed maps showing flood depths, water level contours and velocities over the development area provided in Appendix B. Figure 3.3 provides an indication of the 1% AEP extent of flooding in the vicinity of the Site.

Flood flows are generally well confined to the watercourses on the Site, with limited overbank flows occurring immediately upstream of obstructions such as existing road crossings. These areas are also associated with deeper flows.

Flow velocities in the 1% AEP event are generally between 1-2.5 m/s with localised areas, generally downstream of crossings where velocities increase. High and extreme hazard areas are confined to the watercourse areas.

Flood hazard is defined be the following:

Extreme – v>3.0m/s or d>1.2m

High – v x d > 0.6

Low/Safe – v x d <0.6 or d < 0.2m or v < 0.5m/s

As shown in Figure 3.3 there is sufficient area on each lot to construct development outside of flood affected areas.

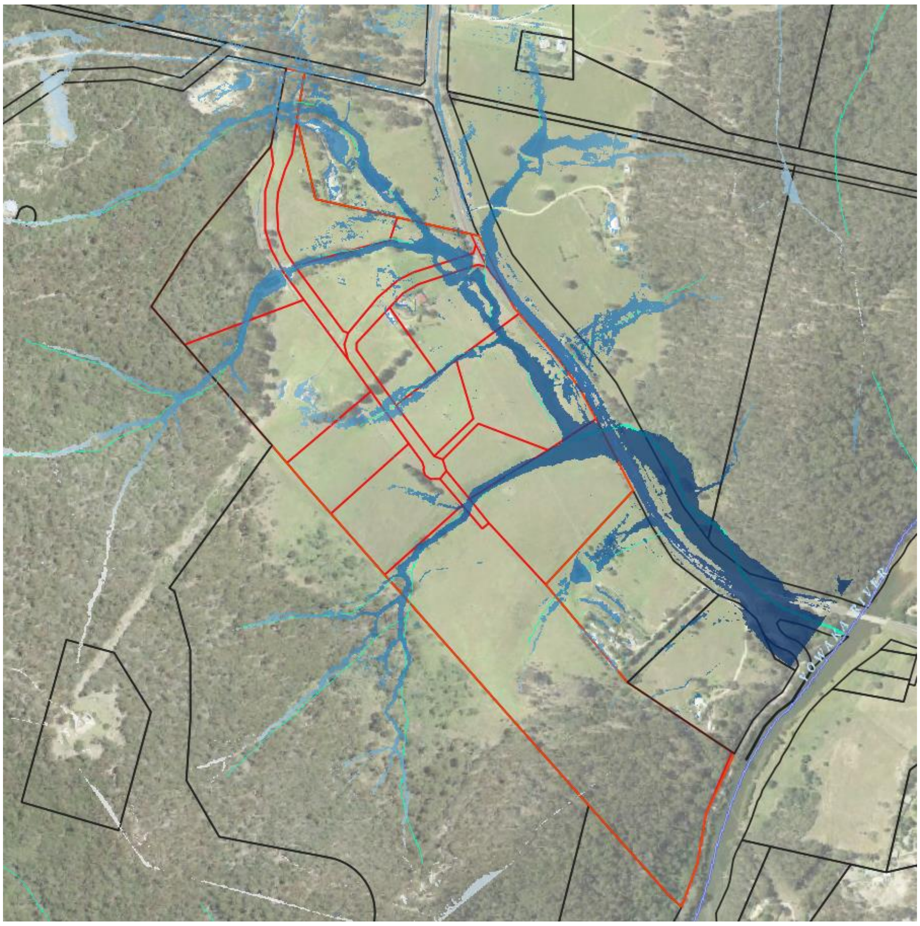

Figure 3.3: 1% AEP Flood Extents

4.0 FLOOD RISK FOR THE DEVELOPMENT

4.1. Site Access and Crossings

Proposed Site access points are shown in Figure 4.1. The main access to the Site is from the Princes Highway (crossing C). This will require upgrading the crossing to provide flood free access in a 1% AEP event. This is likely to be achieved using multiple box culverts. Significant crossings will also be required at Sites A, B and E. A smaller crossing will be required at crossing D. Estimated design flows as well as stream order and crossing type are listed in Table 4.1 below.

Table 4.1 Crossing specifications

Crossing location	**1% AEP flow (m^3/s)**	**Stream order**	**Crossing type**
A	4.13	1	Culvert
B	13.02	2	Culvert
C	24.70	2	Culvert/Bridge
D	1.98	1	Culvert
E	12.60	2	Culvert

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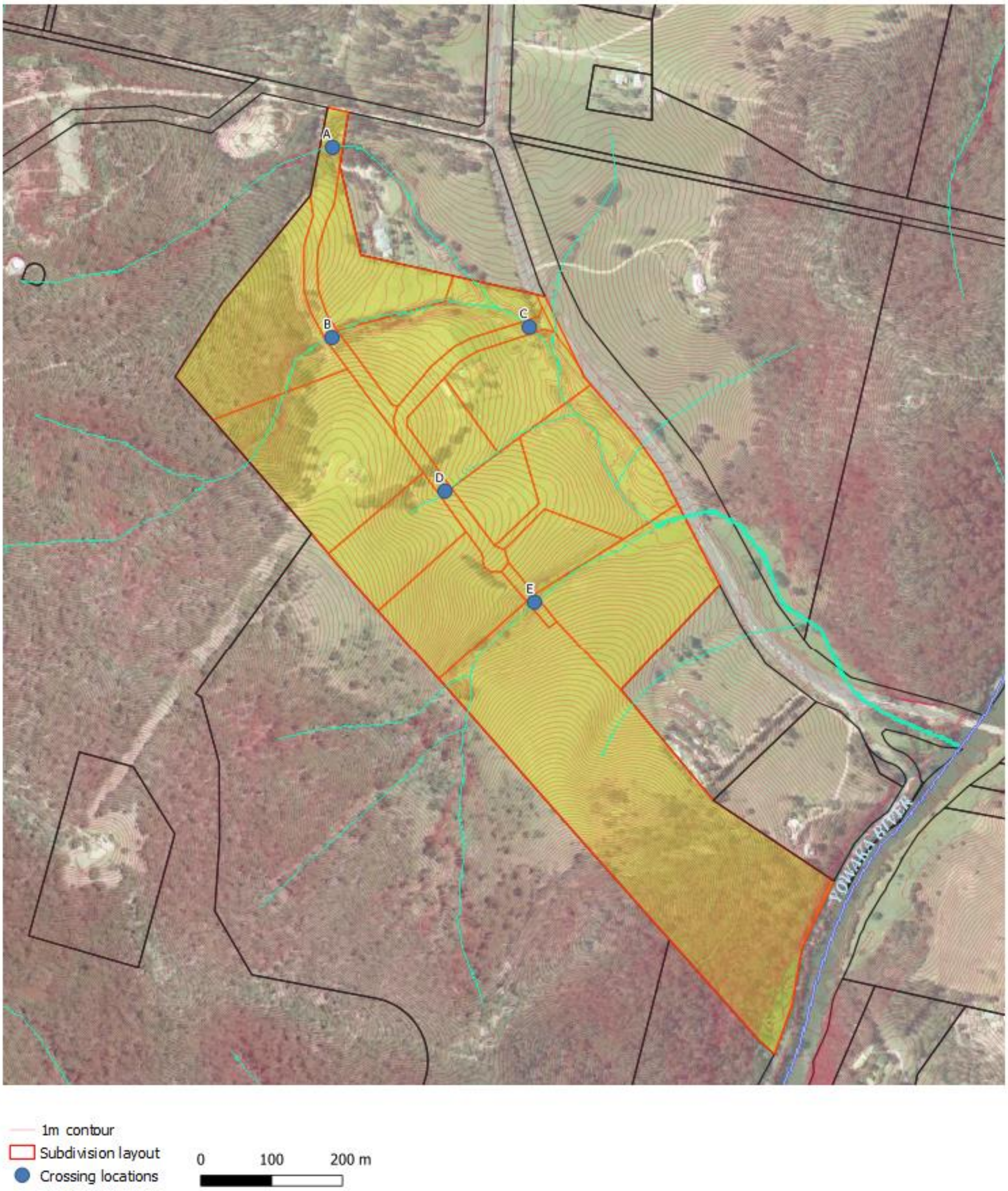

Figure 4.1 Site access and crossings

4.2. Flood planning levels and lot development

13 lots are proposed at the Site, with the smallest lot being 1ha. Given the highly confined nature of the watercourses, the undulating nature of the Site and the lot areas, there is more than sufficient space above the Flood Planning Levels (FPL) to develop buildings on each proposed lot. Building areas should be a minimum 0.5m above the 1% AEP flood levels at the Site.

4.3. Extreme events (PMF) and climate change impacts

The PMF event for the Site has not been modelled as planning around these events is focused on critical infrastructure, not low density rural residential development. Should a PMF event occur given the relatively small nature of the Site catchments crossings may be overtopped for a short period. It is not necessary, or economically feasible to provide access to the development or access within the development for the PMF event.

The Site is located above any potential sea level rise impacts. Over time, rainfall intensity is generally predicted to increase given the increased moisture holding capacity of the warming atmosphere, however given the high spatial and temporal variability of rainfall the change in intensity is difficult to predict using climate models (Evans et al, 2014). It is recommended that Council select an appropriate percentage increase in intensity and this be applied to crossing designs.

5.0 SURFACE WATER IMPACTS AND MANAGEMENT

5.1. Potential impacts

The increase in the number of Lots creates an associated increase in impervious surfaces. Increased impervious surfaces have the effect of increasing runoff volume, and potentially increasing flows, particularly for smaller, more frequent events.

The development will create temporary disturbance of the landscape associated with road and services construction and building construction. This has the potential to increase erosion and entrainment of sediment from the Site.

The development will require on-Site wastewater management systems for the effluent generated by the new lots. If these systems are incorrectly sized, sited or constructed there is potential for untreated or partially treated effluent to leave the Site, particularly during wet weather.

5.2. Hydrologic modifications

At the lot scale, new houses and associated infrastructure will increase impervious surfaces. However, given there is no mains water supply is proposed large rainwater tanks will be installed, mitigating the impact of additional roof areas.

A comparison of peak flows for the 50% AEP event at the downstream end of catchment 3.0 allowing for a 5% increase in impervious percentage over the entire catchment area (additional 5.76ha of impervious area) results in no real change in catchment flows for the critical 50% AEP event. This is likely due to the new impervious areas discharging runoff slightly faster compared to being previously pervious and the associated disaggregation of local hydrographs

Given the majority of the catchment areas for the watercourse on the Site are forested, and will remain so, the small increase in impervious surfaces associated with the additional 11 new building areas (there are 2 existing houses and associated buildings) is unlikely to have an impact on watercourse geomorphology.

Table 5.1 Comparison of 50% AEP flows at catchment 3.0

Location	**Flow (m^3/s)**	
	0% impervious	**5% Impervious**
Catchment 3.0 (1.5h storm, pattern 6024)	8.84	8.82

5.3. Construction management

Suspended solids loads and concentrations leaving the Site have the potential to increase, particularly during access and service construction where there is potential for large exposed surfaces. Surface slopes on the Site increase this potential for, in particular where access roads have steep longitudinal grades. Site soils of the Bald Hills landscape are generally well suited to earthworks given their depth, moderate permeability and cohesive nature.

Detailed soil and water management plans will need to be prepared as a condition of access and service construction. Particular reference should be made to the following:

- *Managing Urban Stormwater: Soils and construction - Volume 1 (Landcom, 2004)*
- *Managing Urban Stormwater, Soils and Construction, Volume 2A Installation of Services (DECC, 2008)*
- *Managing Urban stormwater: soils and construction - Volume 2C, unsealed roads (*DECC, 2008)

5.4. Riparian and watercourse protection

New crossings and crossing upgrades will be necessary. Crossings over watercourses on the Site are either first or second order streams and can be accommodated using culverts. These crossings will require concurrence from the Natural Resources Access Regulator (NRAR) as they will be considered works on waterfront land under the Water Management Act 2000. These crossings will should comply with:

- *Guidelines for riparian corridors on waterfront land (DPI, 2012)*

Other works within 40m of watercourses on the Site may also require concurrence from NRAR. It is recommended that core riparian zones be established, where feasible, 10 to 20m from the top of bank and these areas fenced and revegetated.

5.5. Lot scale water quality management

Rainwater tanks will buffer the impacts of additional roof areas as outlined above. Other changes to the Site such as paved areas and land use may contribute more runoff as well as associated suspended solids and nutrients. The lack of a direct connection and discharge via a stormwater system to receiving waters along with Site landscaping and the buffers between proposed built areas and watercourses significantly mitigates these potential pollutant sources. It is unlikely there will be any significant long term change to stormwater runoff quality associated with development at the proposed lot scale.

Disposal of effluent on-Site presents an additional nutrient, BOD and pathogen loads on each lot. A wastewater land capability assessment has been carried out by Martens and Associates for the planning proposal, and this report concludes that;

> *'…the Site is able to adequately provide disposal of effluent for the development of the density proposed'*

This is consistent with the soil landscapes present over most of the Site.

6.0 CONCLUSION AND RECOMMENDATIONS

6.1. Flooding

The generally incised nature of watercourses on the Site and relatively small catchments means that there is sufficient area to develop away from flood prone areas.
Access within and into and out of the Site will require upgraded and new watercourse crossings. These will need to be designed in accordance with Bega Valley Shire Council's design standards and will require concurrence from NRAR.

6.2. Water quality

The primary risk to receiving waters is possible suspended solids loads migrating from the Site, particularly during construction.

Long term stormwater quality and quantity impacts associated with this rural residential development are unlikely to be noticeable given the development density and available buffers to receiving waters.

As suggested in the Coastal Zone Management Plan for the Pambula Lake Estuary, it is recommended that riparian protections be considered for the watercourses running through the development including:

- Fencing off a core riparian zone of at least 10m from the creek edge, keeping access practicalities into consideration.
- Providing stock access watering points

REFERENCES

DECC, (2008), *Managing Urban stormwater: soils and construction - vol 2A, installation of services*

DECC, (2008), *Managing Urban stormwater: soils and construction - volume 2C, unsealed roads*

Evans JP, Argüeso D, Olson R, Di Luca A. (2014) *NARCliM extreme precipitation indices report. NARCliM Technical Note 6.* Sydney, Australia: Report to the NSW Office of Environment and Heritage,

Lambert, (2019), *Australian Rainfall and Runoff, Book 6, Flood Hydraulics*

Landcom (2004), *Managing Urban stormwater: soils and construction - vol 1*

APPENDIX A – FLOOD MODEL OUTPUT

Subdivision layout

1% AEP Flood depths

1% Flood depth

- 0.00999832
- 0.3986985384
- 0.7873987568
- 1.1760989752
- 1.5647991936
- 1.953499412
- 2.3421996304
- 2.700999832
- 3

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1% AEP Flood hazard

Subdivision layout

Hazard_LBTest.Terrain.Merged surface2

- Low
- High
- Extreme

0 100 200 m

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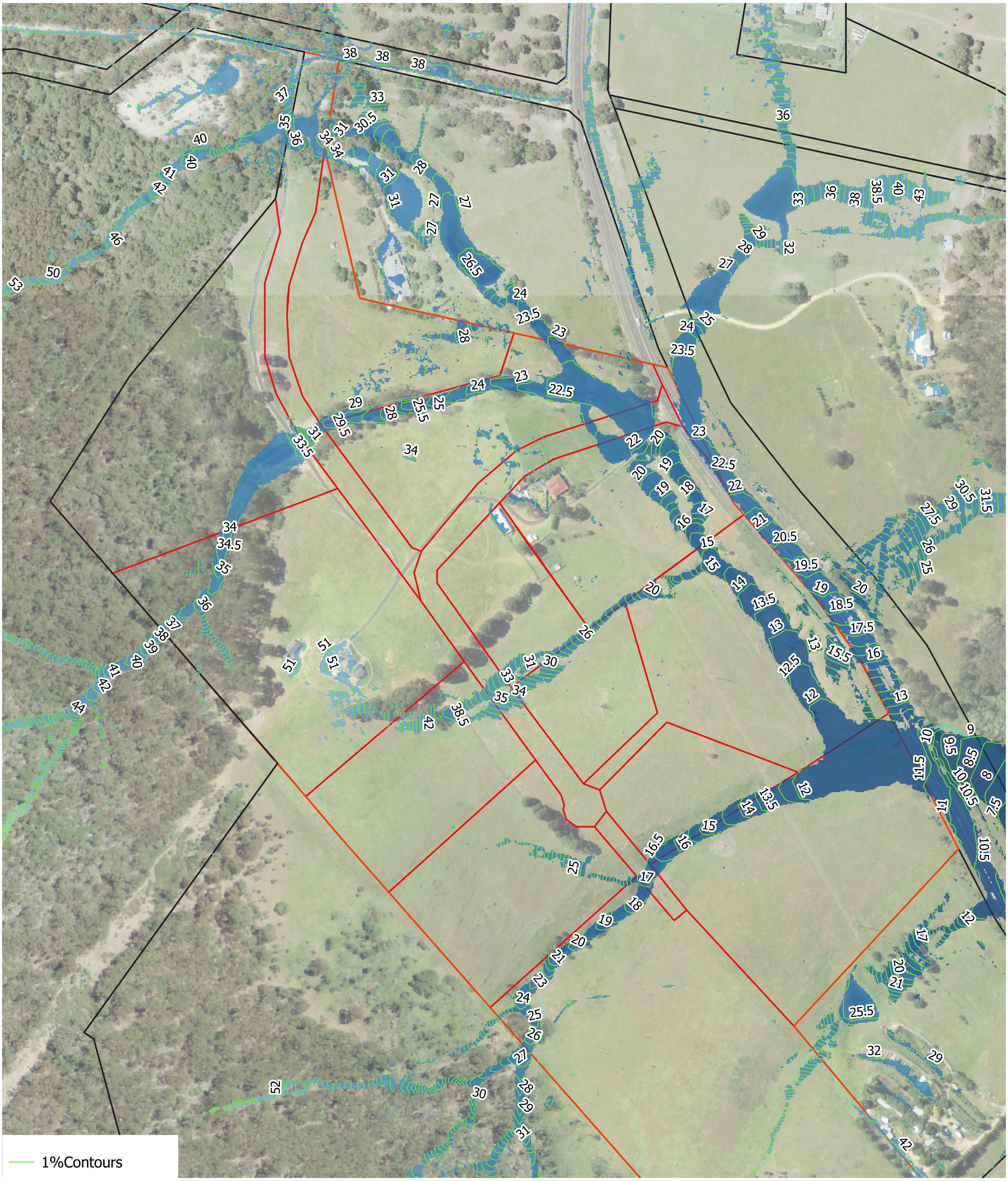

Water surface elevations

- 5
- 17.35
- 29.7
- 42.05
- 54.4
- 66.75
- 79.1
- 90.5
- 100
- Subdivision layout

0 100 200 m

1% AEP Flood levels and extents.

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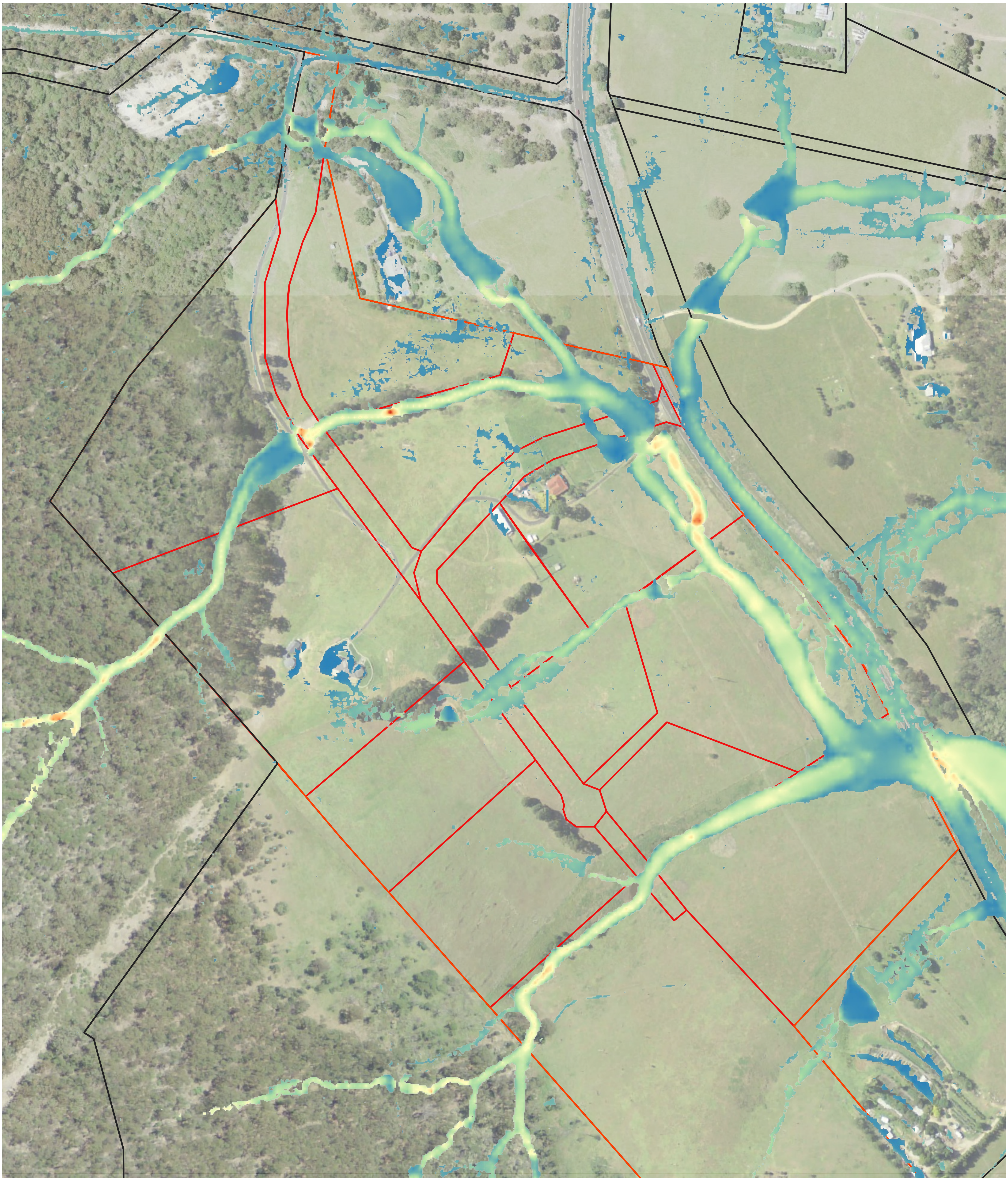

1% AEP Flood velocity

Subdivision layout

Velocity (Max).Terrain.Merged surface2

0

1.25

2.5

3.75

5

0 100 200 m

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