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Our Ref: DJW: L.T2299.004.docx

27 February 2024
Gresford Park Land Managers
c/o Perception Planning
PO Box 107
Clarence Town NSW 2321
Attention: Ashlee Rutherford

Dear Ashlee

RE: FLOOD RISK ASSESSMENT FOR PROPOSED DEVELOPMENT AT EAST GRESFORD SHOWGROUND, 29 PARK STREET, EAST GRESFORD NSW

Background

Torrent Consulting was engaged to undertake a Flood Risk Assessment to assist in the DA process for the proposed development at East Gresford Showground, 29 Park Street, East Gresford NSW (the Site). It is understood that Dungog Shire Council has requested a flood study to determine the 1% AEP flood level at the Site and confirm that proposed structures are suitably located for flood planning purposes. The potential risks associated with the proposed use of the Site were also assessed in the context of Council's specified planning controls for development within the floodplain.

The Site is located on the right bank of the Allyn River, on the eastern edge of East Gresford, around 14 km upstream of the Paterson River confluence, as presented in Figure 1. The Allyn River rises in the southern Barrington Tops and has a catchment area of around 285 km² upstream of the Site. The upper catchment topography is characterised by steep terrain and narrow valleys giving way to a broader undulating floodplain at the Site, as presented in Figure 2.

This assessment includes the development of a TUFLOW model to simulate the flood hydrology and hydraulics of the contributing catchment at the Site. An existing WaterNSW gauge around 29 km upstream of the Site at Halton was used for the calibration of hydraulic roughness of the Allyn River channel and in validation of design flood flows.

The modelling provides a platform to assess the existing flood risk profile at the Site, including a detailed understanding of the local flood depths, velocities, and hazards.

Model Development

For this assessment, a TUFLOW hydrologic model was developed covering the Allyn River catchment upstream of the Site, at which the contributing catchment area is around 285 km^2. The model utilised the NSW Spatial Services LiDAR data product, downloaded via the ELVIS Foundation Spatial Data portal to define the catchment topography.

The Digital Elevation Model (DEM) was pre-processed using GIS-based terrain analysis techniques to remove sinks within the grid and create a hydrologically corrected DEM. This prevents the initial loss of catchment rainfall to artificial trapped storages. A 40 m model grid cell resolution was adopted, with sub-grid sampling from a 10 m resolution DEM.

Land use coverage in the catchment was separated into cleared and vegetated areas using aerial imagery, with an 'n' value of 0.06 and 0.12 applied, respectively.

The downstream boundary of the model was configured as a stage-discharge relationship, automatically generated within the model, adopting a hydraulic gradient of 0.3%.

A more detailed TUFLOW model, as presented in Figure 3, was developed covering the Allyn River from around 3 km upstream of the Site to around 3 km downstream of the Site. The model was constructed using a 4 m grid cell resolution and implemented a 2 m sub-grid sampling routine, with elevations defined using a 2 m horizontal grid cell resolution LiDAR DEM. The Allyn River channel was reinforced to ensure proper representation of the channel bed, and two bridges were represented with a 2D layered flow constriction.

Model inflow boundaries were extracted from the hydrological model. The adopted downstream boundary and Manning's 'n' roughness are consistent with those of the hydrological model. However, a Manning's 'n' value of 0.04 was used for in-channel flows, based on calibration to the observed in-channel rating curve at the Halton gauge.

The TUFLOW model was used to simulate the catchment rainfall-runoff process, utilising the ensemble storm method outlined in the ARR 2019 guidelines.

Flood Modelling and Mapping

The TUFLOW model of the local catchment was divided into upper and lower sections to better represent the spatial variation in design rainfall and rainfall losses. Catchment runoff was simulated (using the HPC solver) for the full range of design rainfall events for storm durations ranging from 6 hours to 24 hours. The design rainfall depths were sourced from the BoM IFD (Intensity Frequency Duration) portal. An Areal Reduction Factor (ARF) was applied to the design point rainfall for each rainfall event, ranging from around 0.83 to 0.95 (6-hour to 24-hour) for the 1% AEP event. Design rainfall losses considered the recent NSW-specific guidance and initial losses of 5 mm to 15 mm were adopted, with a continuing loss of 1.7 mm/h and 1.3 mm/h for the upper and lower catchments, respectively.

The ensemble method involves the simulation of ten rainfall temporal patterns for each design event magnitude and duration, with the average condition of the ten being adopted for design purposes. The TUFLOW model simulations were analysed at the Site to identify the critical storm duration, i.e. that which produces the peak flood flow for each design event magnitude. The 12-hour duration was identified as being critical for all events up to a 0.2% AEP.

A Flood Frequency Analysis (FFA) was undertaken to define the peak design flood flows based on historic data recorded at the WaterNSW gauge at Halton. A separate hydrological model was developed for the Allyn River catchment upstream of the gauge to assess the model performance in the estimation of design peak flood flows from the rainfall-runoff process, against the observed catchment response.

Table 1 presents the modelled and observed peak design flows at the Halton gauge. The modelled peak flows are around 15% higher than those estimated from the FFA, which is a reasonable consistency. Given that there is uncertainty associated with both methods, the modelled design flood conditions were adopted without further adjustment.

Table 1 – Modelled and Observed Peak Design Flood Flows at Halton

Design Event	Modelled Flow (m^3/s)	Observed Flow (m^3/s)
20% AEP	320	280
10% AEP	440	380
5% AEP	550	470
2% AEP	670	600
1% AEP	800	690

For the simulation of the PMF (Probable Maximum Flood) condition the Generalised Short Duration Method (GSDM) published by the BoM was adopted. The critical duration of the PMF is typically shorter than that of the standard design flood events. The 5-hour duration was found to provide the critical condition at the Site for the PMF event.

Table 2 presents the modelled peak design flows at the Site.

Table 2 – Modelled Peak Design Flood Flows at the Site

Design Event	Flow (m^3/s)
20% AEP	430
10% AEP	540
5% AEP	650
2% AEP	820
1% AEP	960
0.5% AEP	1080
0.2% AEP	1270
PMF	7760

Flood Risk Mapping

Design flood flow hydrographs from the hydrologic modelling were simulated in the detailed TUFLOW hydraulic model to derive design flood conditions at the Site.

The modelled peak flood extents for the 5% AEP, 1% AEP and PMF events are presented in Figure 4, together with the proposed Site layout. Figure 5, Figure 6, and Figure 7 are presented for additional flooding context and show the modelled peak flood depths and peak flood level contours for the 5% AEP, 1% AEP and PMF events, respectively.

Figure 8, Figure 9, and Figure 10 present the flood hazard classification at the Site for the 5% AEP, 1% AEP and PMF events, respectively. The flood hazards have been determined in accordance with Guideline 7-3 of the Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia (AIDR, 2017). This produces a six-tier hazard classification, based on modelled flood depths, velocities and velocity-depth product. The hazard classes relate directly to the potential risk posed to people, vehicles, and buildings, as presented in Chart 1.

The flood hazard mapping is useful for providing context to the nature of the modelled flood risk and to identify potential constraints for development of the Site with regards to floodplain risk management.

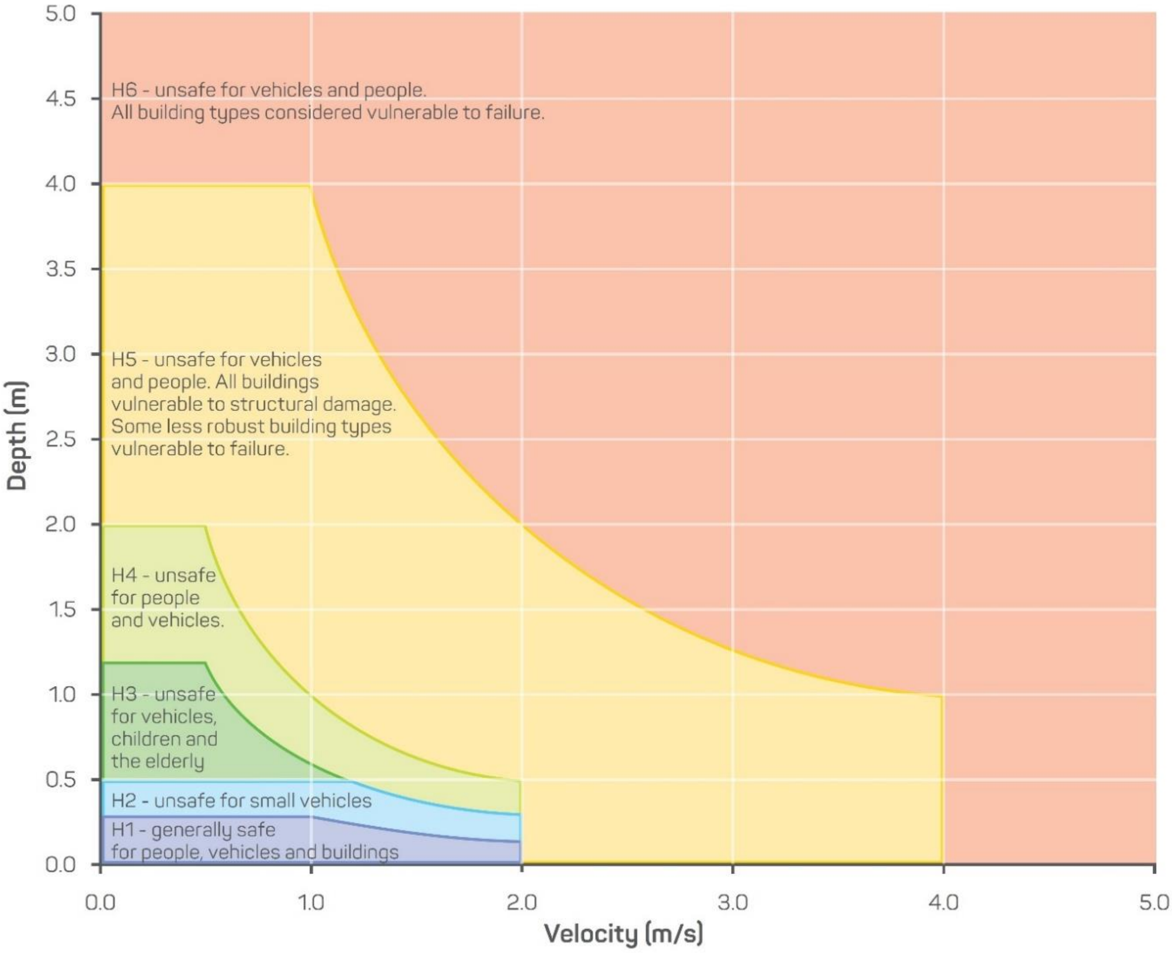


Chart 1 – General Flood Hazard Vulnerability Curves (AIDR, 2017)

Flood Risk Management

The principal consideration of good practice floodplain risk management is to ensure compatibility of the proposed development with the flood hazard of the land, including the risk to life and risk to property. Requirements within a Council's LEP (Local Environment Plan) and DCP (Development Control Plan) typically consider the management of flood risk, with the application of an FPL (Flood Planning Level) being the principal control measure.

Dungog Shire Council nominates an FPL at the 1% AEP flood level plus a 0.5 m freeboard, which is consistent with standard practice. Due to the hydraulic gradient across the Site, the 1% AEP level ranges between 42.9 m AHD and 44.1 m AHD, with a corresponding FPL between 43.4 m AHD and 44.6 m AHD.

Council's document Dungog Development Control Plan No. 1 Part C.8- Managing Our Floodplains defines three Floodplain Risk Management Zones according to the corresponding flood risk as follows:

- Floodway/High Hazard area – Classified as Floodway or flood storage in a flood study or has depth > 4 m in 1% AEP event. Areas which are responsible for conveyance of flood water or temporary storage of floodwater during an event. Change in these areas has the potential to affect flood levels and flood behaviour.

- Flood fringe - Part of flood planning area outside of the Floodway which is between the Flood Planning Level and the High Hazard area.
- Outer Floodplain - Remaining part of the Flood Planning area which is above the Flood Planning Level but below the PMF.

Figure 11 presents the extent of the three management zones and the specific development at the Site. An unpowered camping area is within the flood fringe, while a powered camping area and parking area are within the outer floodplain. Two unpowered camping areas are located outside of the Floodplain Risk Management Zone.

Schedule 2 of the DCP document presents a matrix of Flood Planning Controls within each zone according to the land use category, with a residential land use considered appropriate for this development due to the provision of camping accommodation.

The following planning controls are specified for residential development within the flood fringe:

- Floor levels (excluding non-habitable residential floorspace) to be equal to or greater than the FPL and other floor levels equal to or greater than the FPL. Construction in Floodway not permitted.
- All structures to have flood compatible building components below or at the FPL.
- Engineers certificate to confirm any structure subject to a flood up to and including the 1% AEP or 0.2% AEP (as applicable) flood level can withstand the force of flood water, debris, and buoyancy.
- The impact of the development on flood affection elsewhere to be considered. The development must not obstruct or divert flood waters to or from neighbouring properties.
- Consideration required regarding an appropriate flood evacuation strategy & pedestrian / vehicular access route for both before and during a flood.
- S5.10.7 certificates to notify of applicability of this DCP
- Flood plan required where floor levels are below the design floor level.
- Applicant to Demonstrate that there is an area where goods may be stored above the FPL during floods.
- Applicant to provide controls where necessary to prevent the discharge of pollution during floods, including compliance with Councils On-site Sewage Development Assessment Framework.

The following planning controls are specified for residential development within the outer floodplain:

- S5.10.7 certificates to notify of applicability of this DCP.

For residential areas, no development is admissible within a floodway.

There are no buildings proposed within the flood fringe, therefore planning controls applicable to floor levels and building design are not applicable to this development.

Due to the passive nature of the development within the flood fringe, it is not expected to impact local flood conditions.

Due to the rarity of an event required to inundate camping areas, it is unlikely that campers will be present when inundation occurs. However, if evacuation is required, rising access to flood free land within the Site and to the town centre of East Gresford via Gresford Road is available. This inherently manages the risk to life from flooding to an acceptable level.

The applicants should ensure the relevant information is updated within the Online 10.7 Planning Certificate Service to ensure the appropriate flood planning controls for the Site are readily identifiable upon application for a section 10.7 Planning Certificate.

Conclusion

Torrent Consulting was engaged to undertake a Flood Risk Assessment to assist in the DA process for the proposed subdivision of 29 Park Street (Lot 1, DP 11562, Lot 17, DP 39791, and Lot 7002, DP 96464), East Gresford NSW.

This assessment has included development of a TUFLOW model for the Allyn River catchment upstream of the Site and has simulated design flood conditions in accordance with the ARR 2019 guidelines, specifically the ensemble method for design flood hydrology.

A hydraulic model of the floodplain surrounding the Site was developed and simulated for the design flood events, with the resultant flood mapping used to define the three Floodplain Risk Management Zones identified by Council.

Some development locations at the Site are located within the flood fringe and outer floodplain, however there are no specific requirements with respect to proposed structures within the Site.

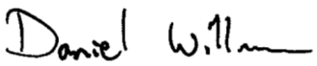
Rising access is readily available to flood free areas within the Site and to East Gresford, inherently managing the risk to life from flooding to an acceptable level.

The Online 10.7 Planning Certificate Service should be updated to identify the flood planning controls applicable to the Site.

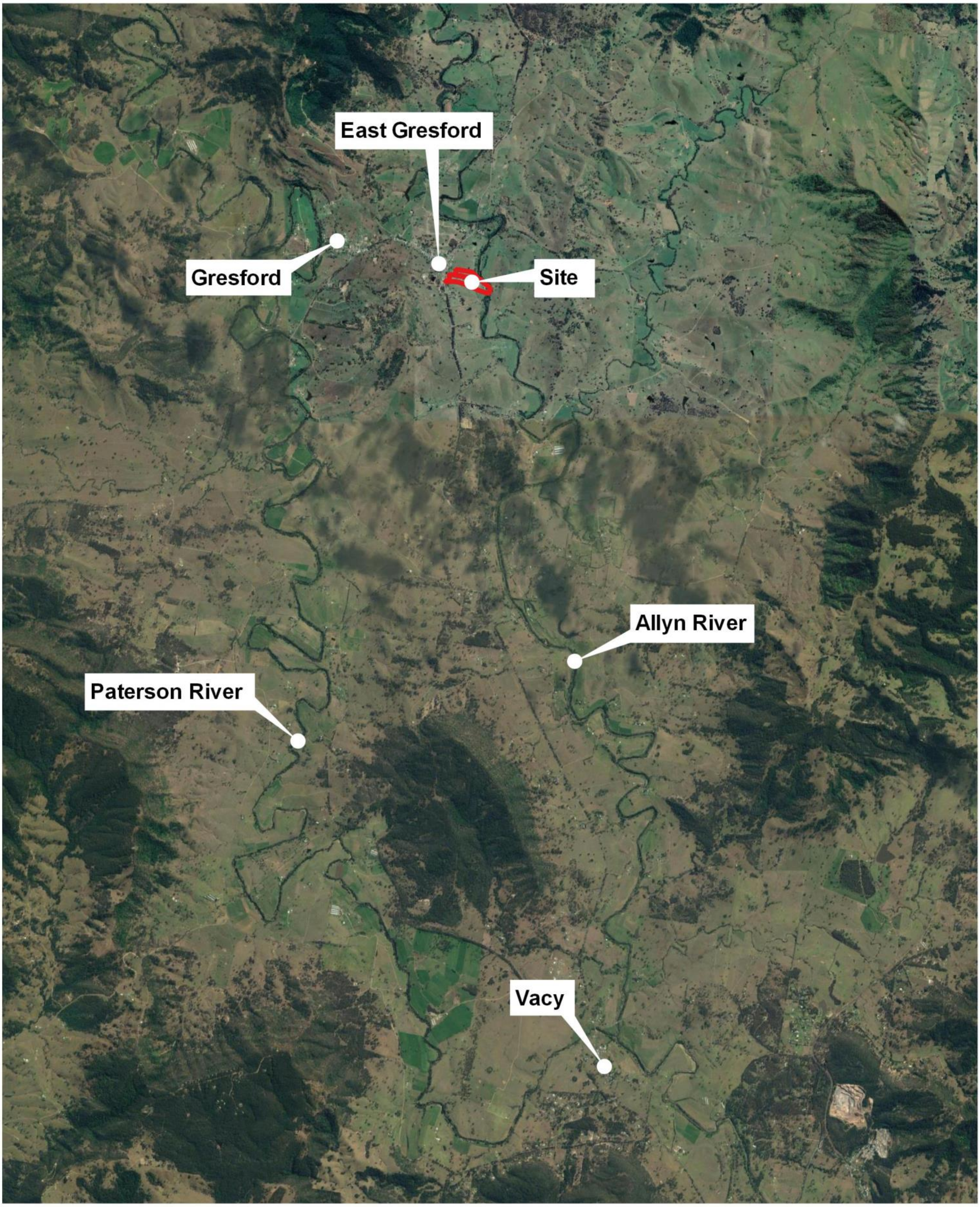
We trust that this report meets your requirements. For further information or clarification please contact the undersigned.

Yours faithfully

Torrent Consulting



Dan Williams
Director



Title:

Study Locality

0 2 4 km

approx. scale

Figure:	1	*Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.*
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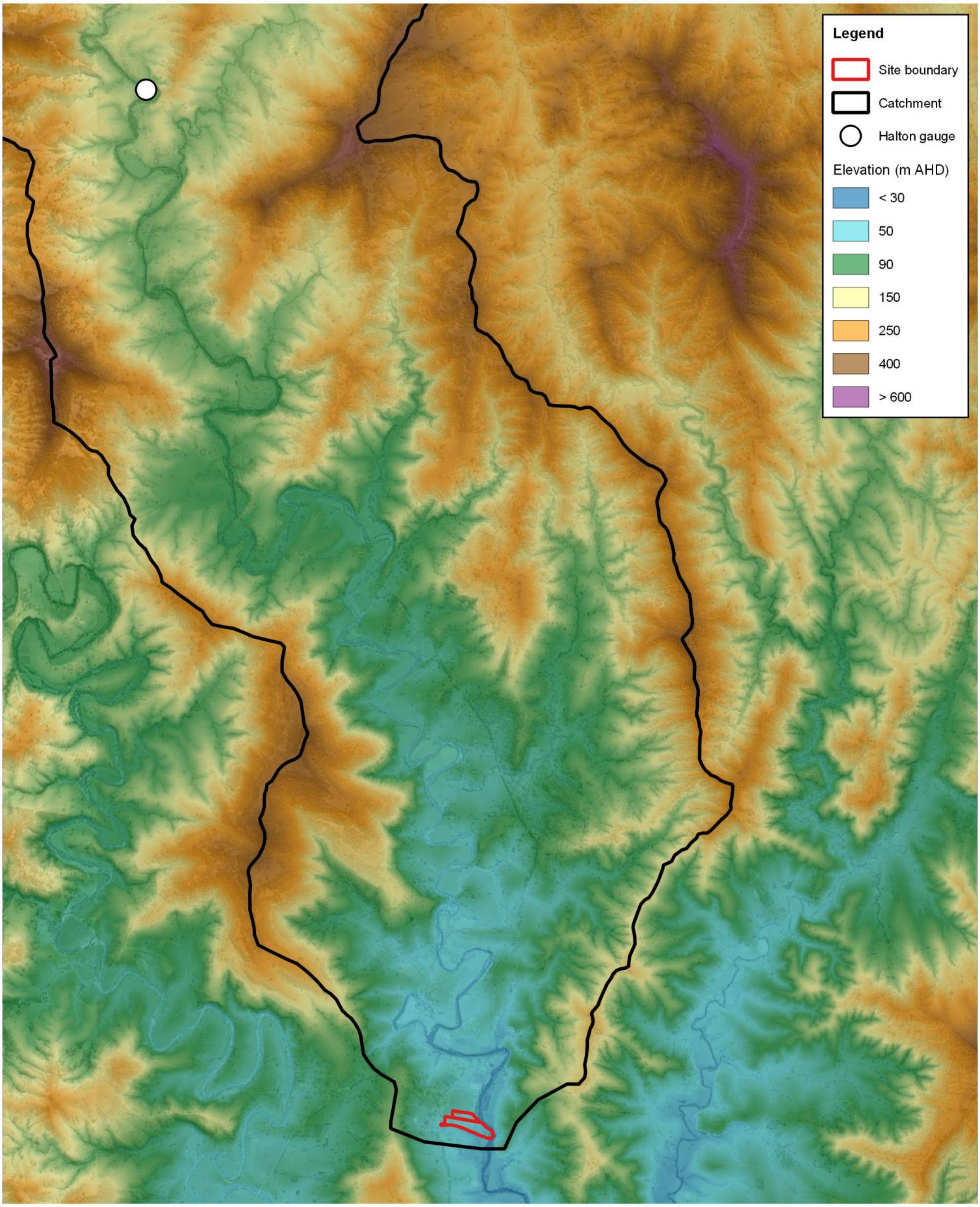

Title:

Local Catchment Topography

0 1,000 2,000 m

approx. scale

Figure:	2
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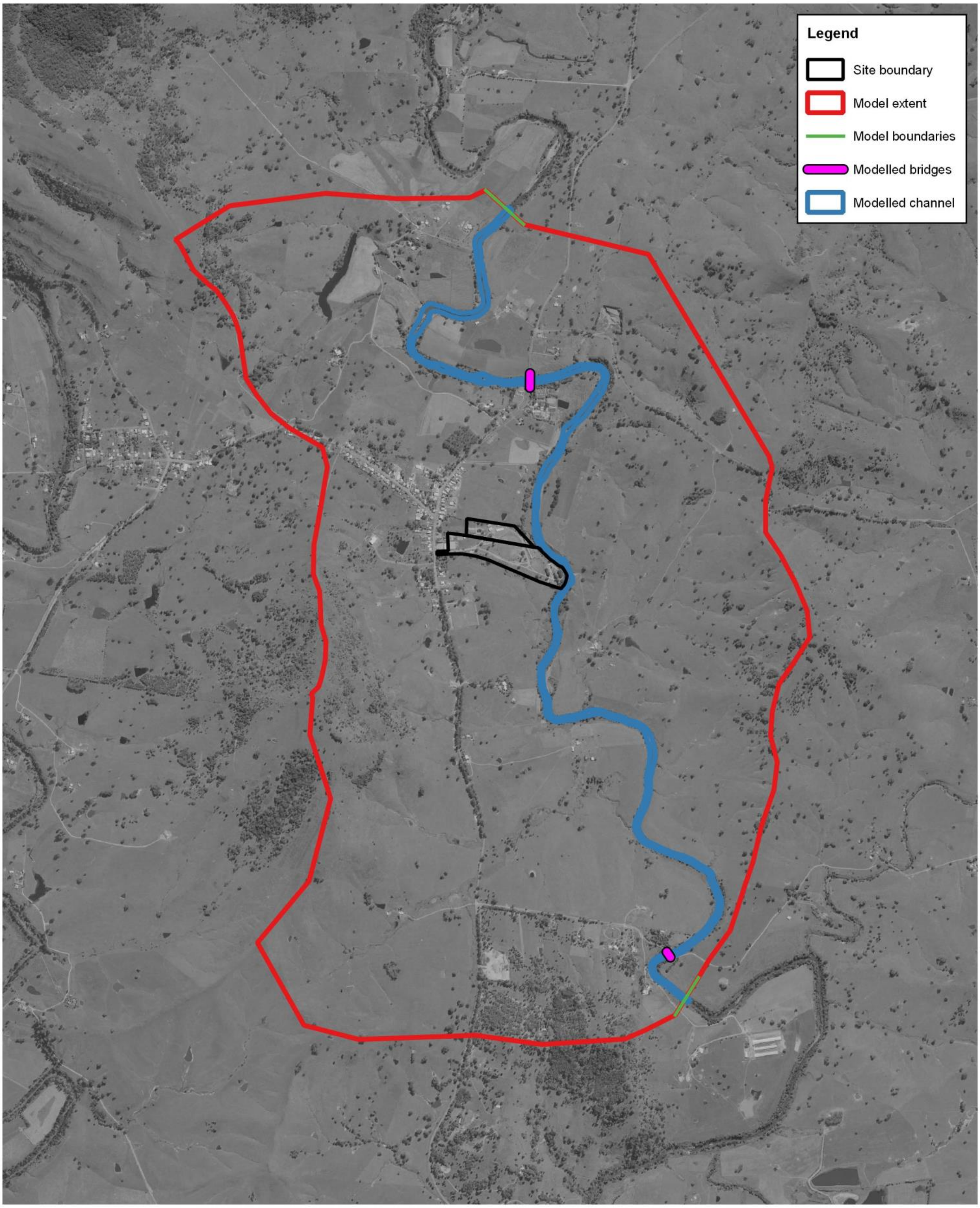

Title:

TUFLOW Model Components

0 0.7 1.4 km

approx. scale

Figure: 3

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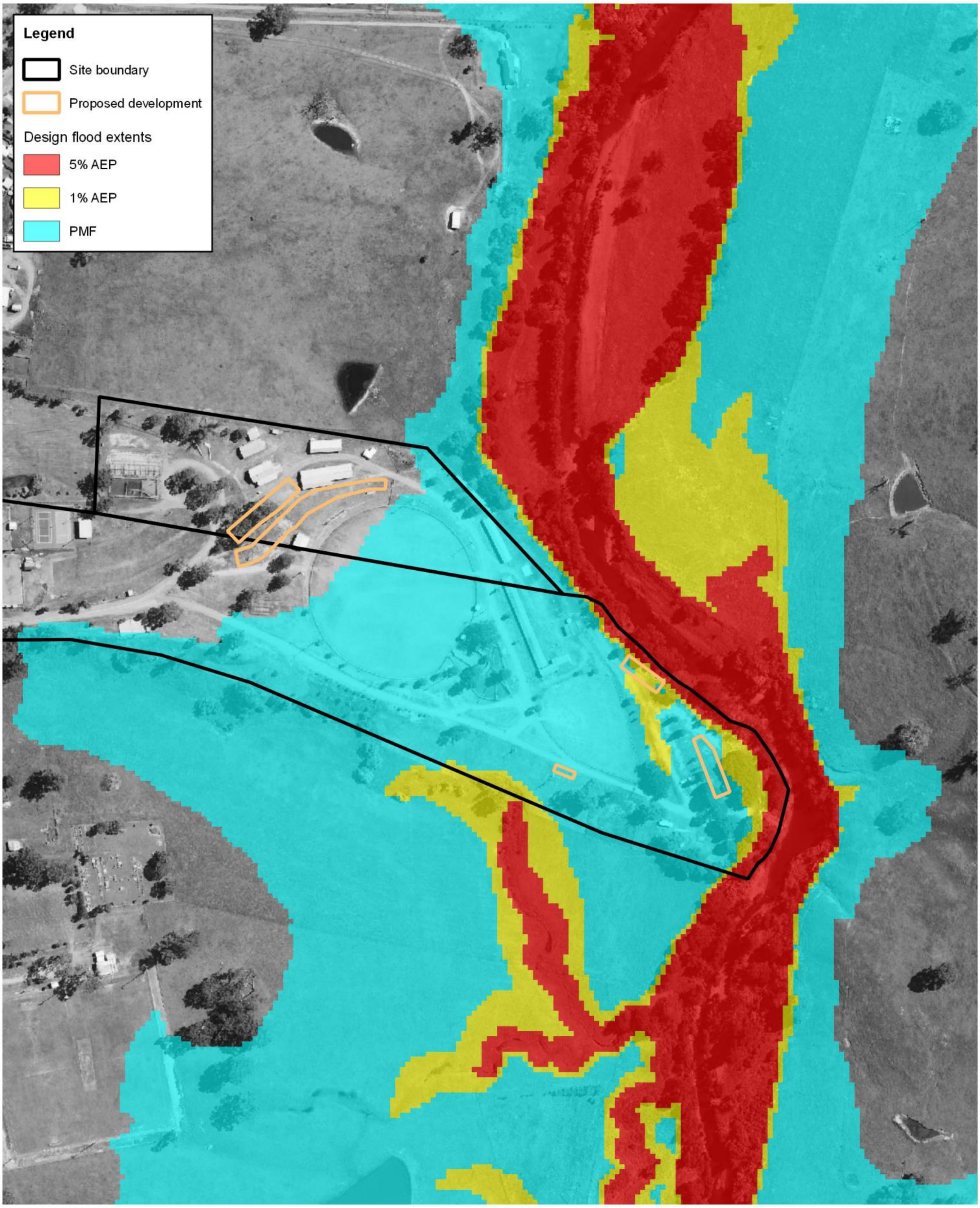

Title:

Modelled Flood Extents and Site Layout

0 100 200 m

approx. scale

Figure: **4**

Revision: **B**

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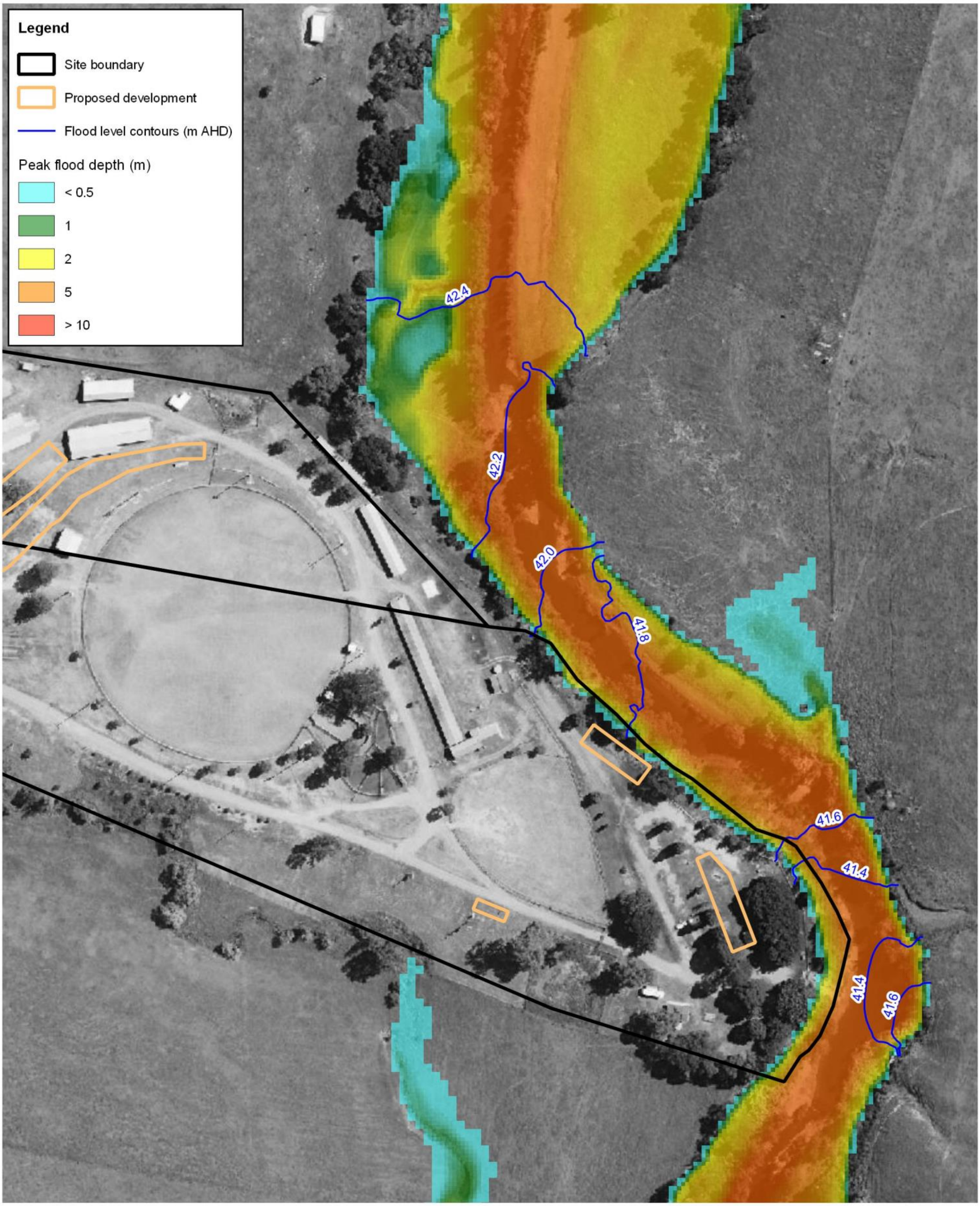

Title:

Modelled 5% AEP Flood Depths and Levels

0 60 120 m

approx. scale

Figure: 5

Revision: B

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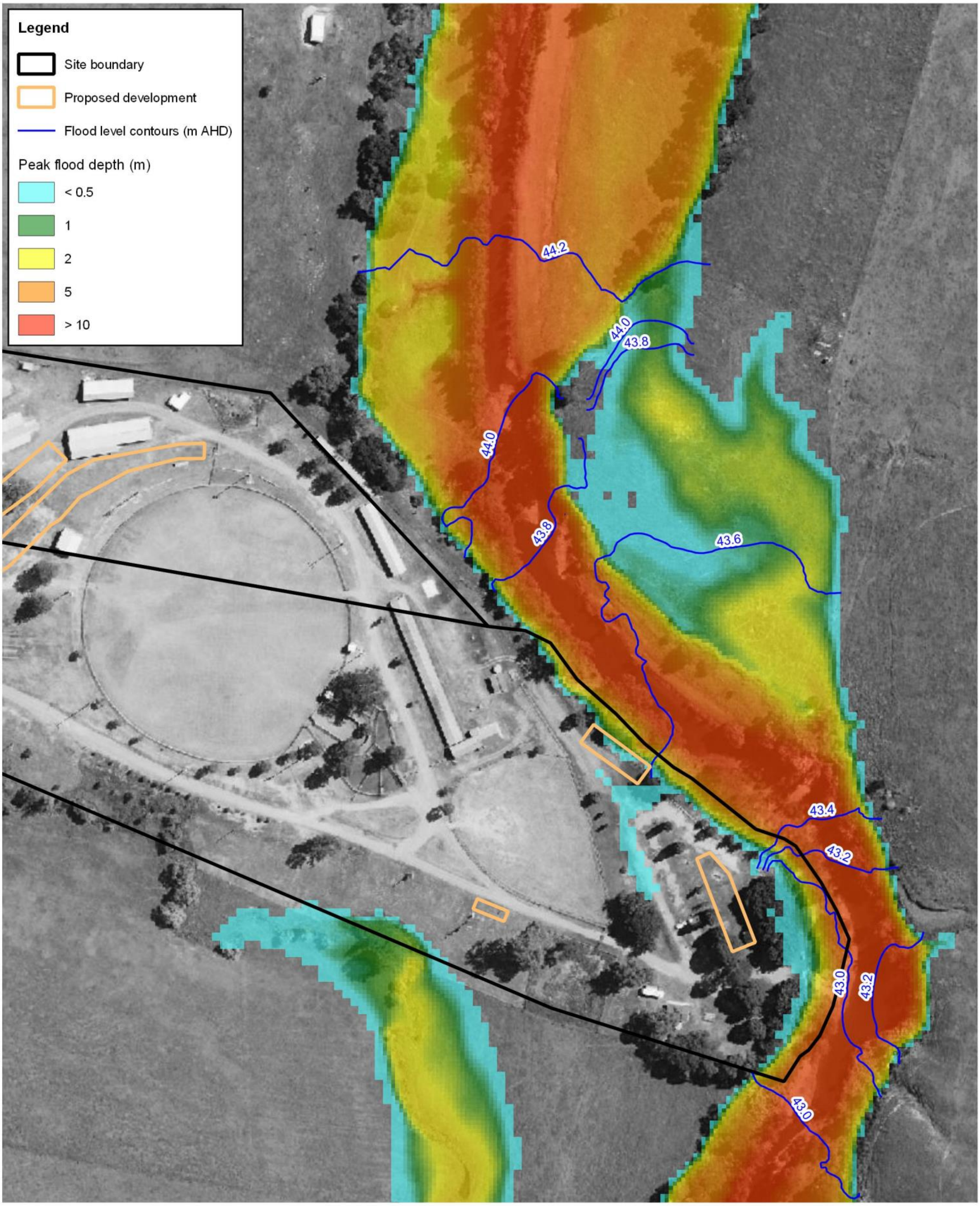

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Modelled 1% AEP Flood Depths and Levels

0 60 120 m

approx. scale

Figure: **6**

Revision: **B**

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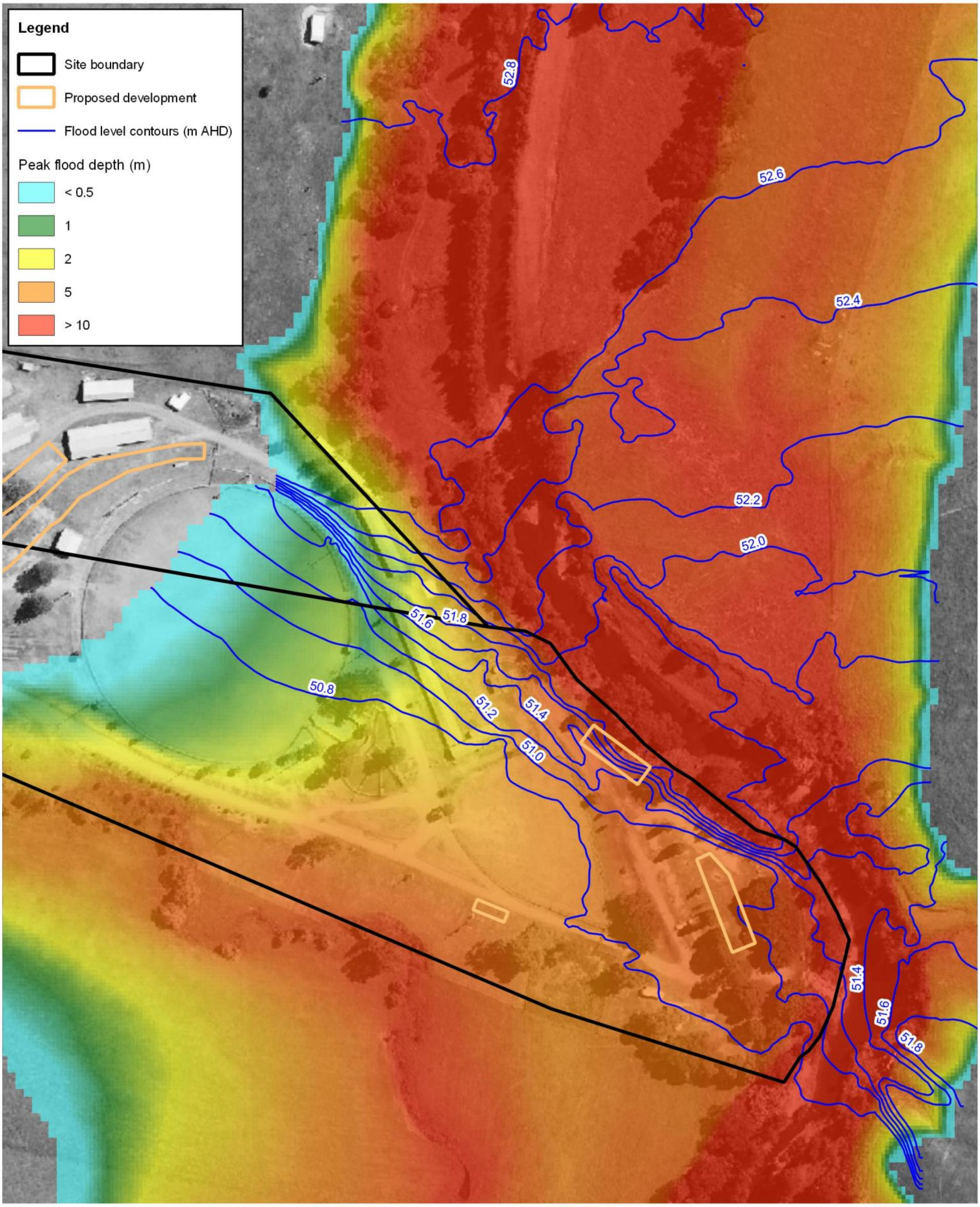

Title:

Modelled PMF Flood Depths and Levels

Figure: 7

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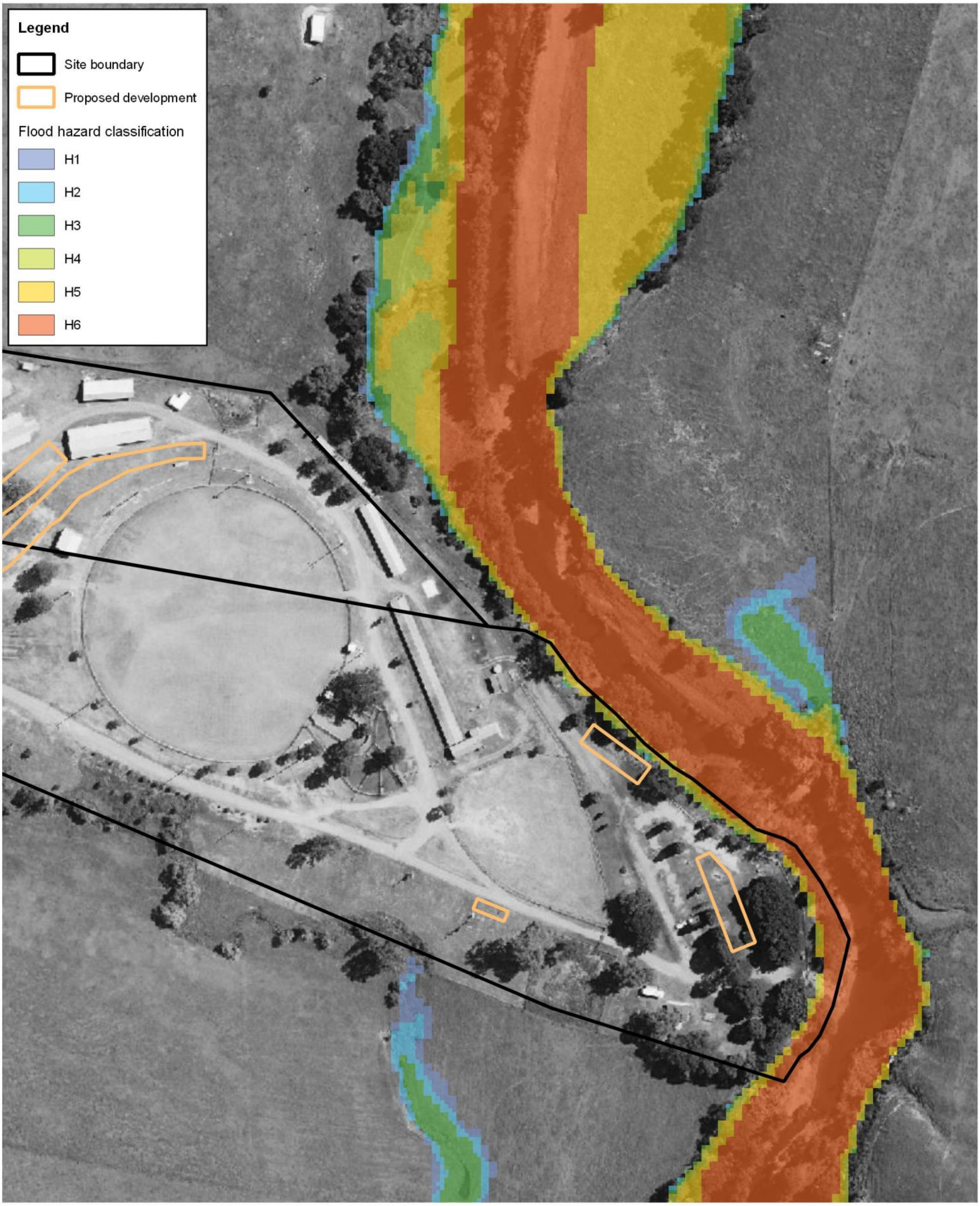

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5% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **8**

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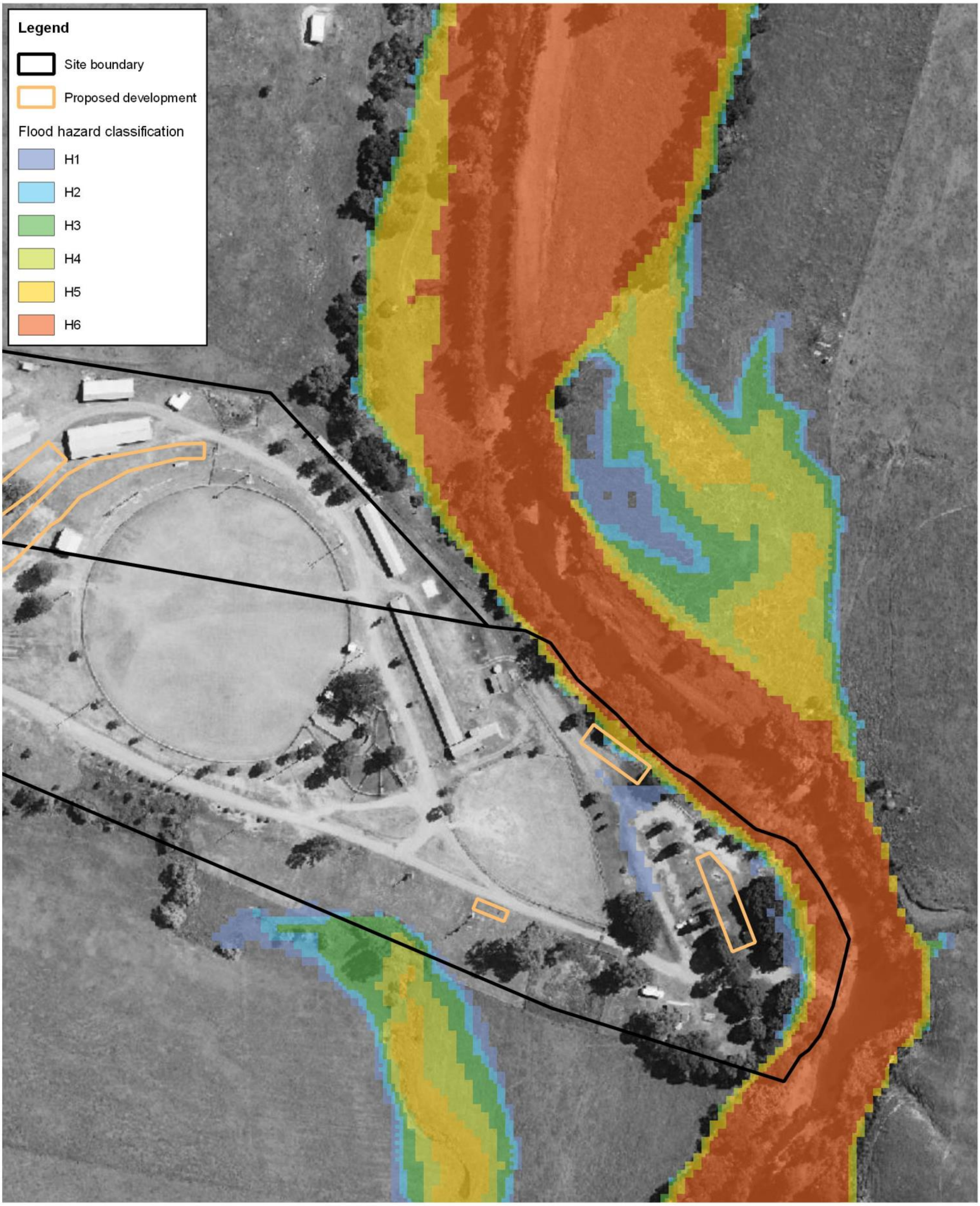

Title:

1% AEP Flood Hazard Classification

0 60 120 m

approx. scale

Figure: **9**

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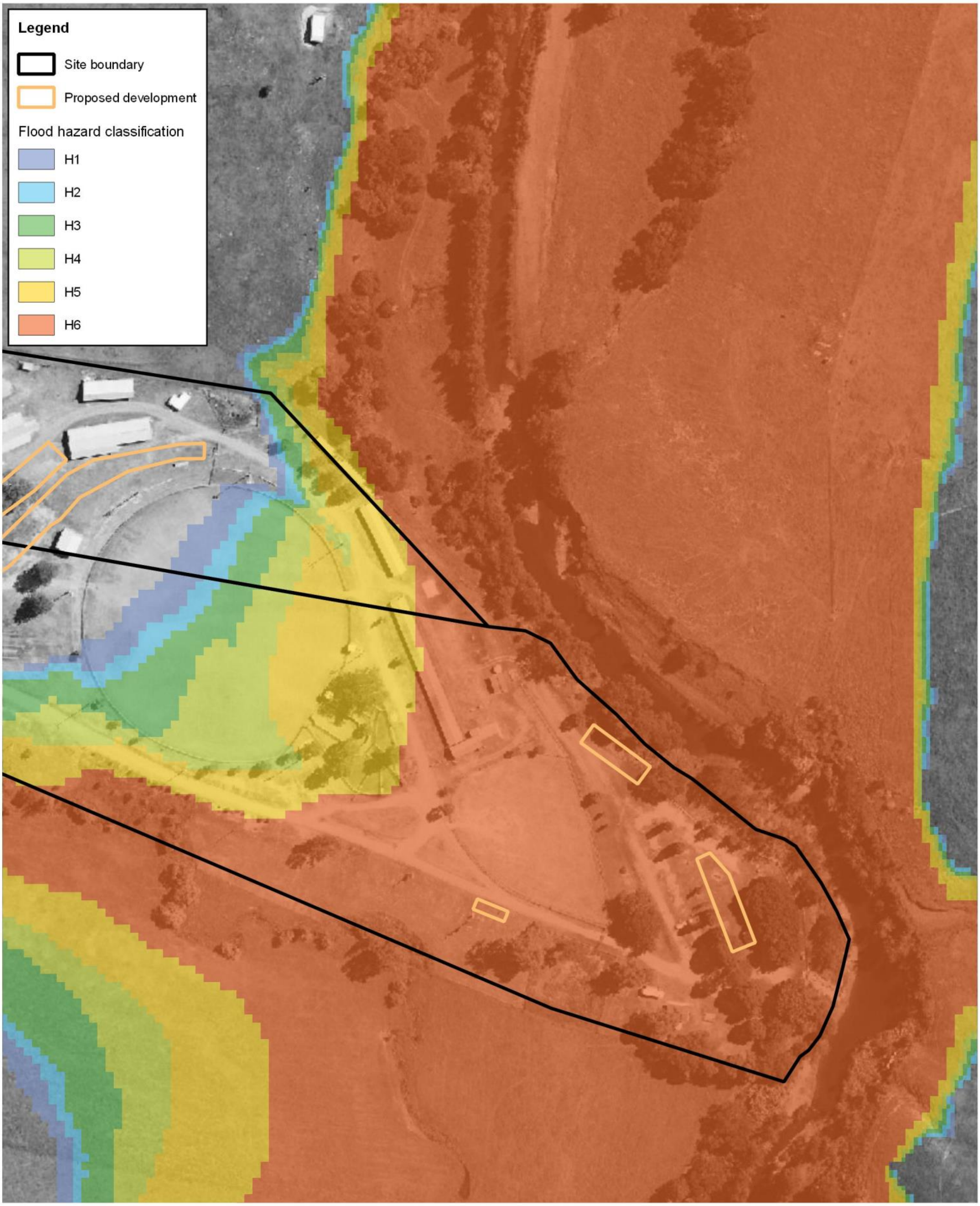

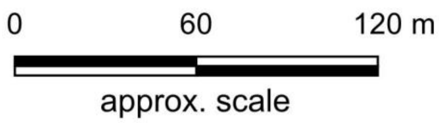

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PMF Flood Hazard Classification

Figure: **10**

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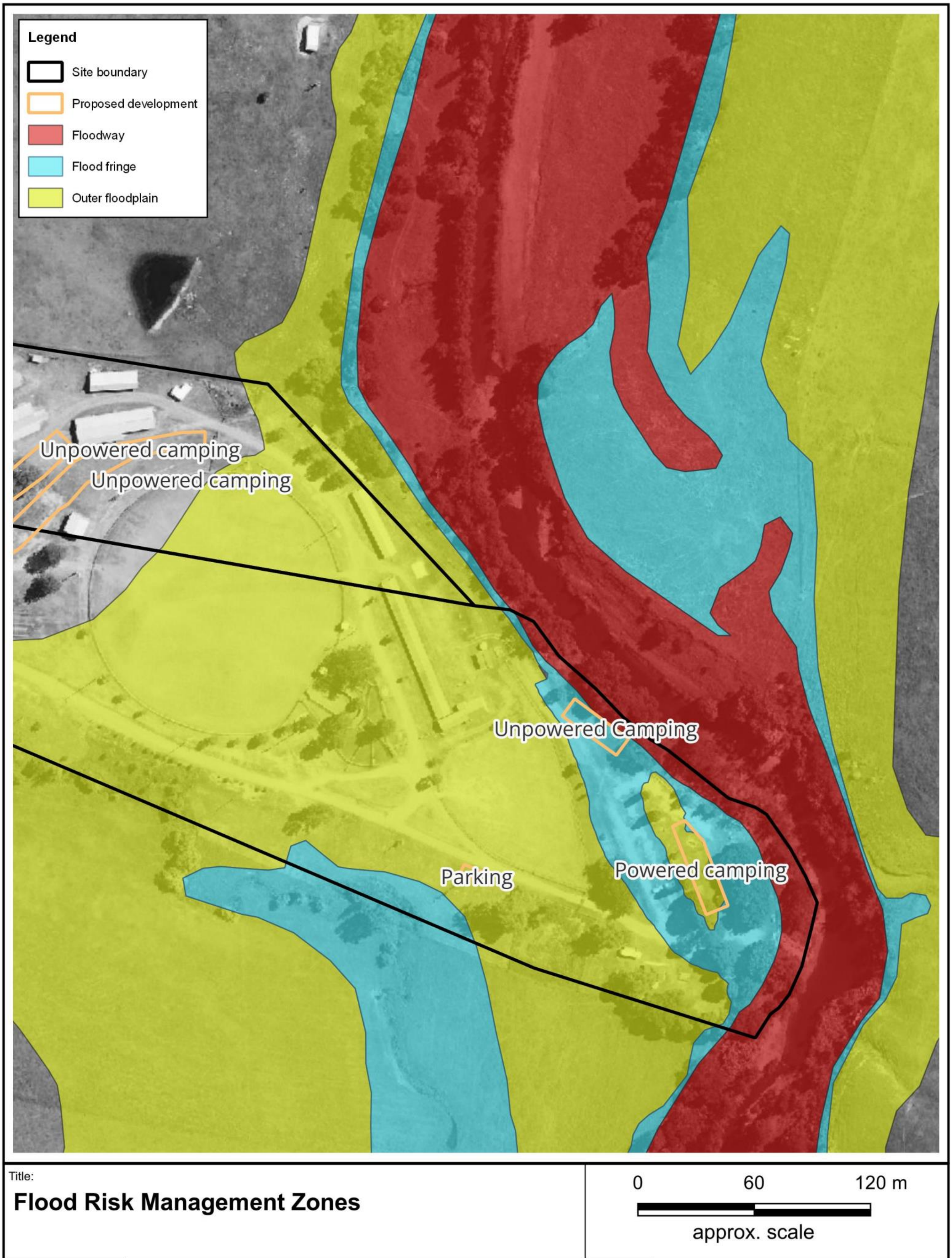

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Flood Risk Management Zones

Figure: **11**

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