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Our Ref: DJW: L.T2351.002.docx

27 July 2023
Brad Lantry c/o Perception Planning
PO Box 107
Clarence Town NSW 2321
Attention: Cameron Ashe

Dear Cameron

RE: FLOOD IMPACT ASSESSMENT FOR PROPOSED COMMERCIAL DEVELOPMENT AT 12-14 DAY STREET, EAST MAITLAND NSW

Background

Torrent Consulting was engaged to undertake a Flood Impact Assessment to assist in the DA process for the proposed commercial development at 12-14 Day Street, East Maitland, NSW (the Site). It is understood that a flood report is required by Maitland City Council, as per the requirements of the Maitland DCP.

The Site is located at the edge of the right floodplain of the Hunter River, immediately upstream of the railway embankment at East Maitland Station, as presented in Figure 1. The topography of the local floodplain is undulating and characterised by roadways, housing, and the raised embankment of the adjacent railway line, as presented in Figure 2.

Design flood information is contained within the Hunter River Branxton to Green Rocks Flood Study (WMA Water, 2010) and the Hunter River Floodplain Risk Management Study and Plan (WMA Water, 2015). Information within these studies was used to summarise the existing flood conditions and risks in the context of the Site and the proposed development.

The assessment also utilises a TUFLOW model of the Lower Hunter River to simulate design flood conditions consistent with those of the existing flood study. This model provides a platform to assess the potential flood impacts associated with the proposed building and carpark. It also enables a more detailed understanding of the local flood velocities and hazards under both existing and the proposed post-construction conditions.

As a new commercial building is proposed at the Site, an assessment of the required Flood Emergency Response was also undertaken to assist with the completion of a Flood Emergency Response Plan (FERP) in relation to flood risk, warning, and evacuation.

Model Development

A TUFLOW model of the Hunter, Williams and Paterson Rivers has been developed by Torrent Consulting. The model covers the entire floodplain of the Lower Hunter River downstream to the river mouth at the Tasman Sea, including upstream to Luskintyre on the Hunter River, Vacy on the Paterson River and Glen Martin on the Williams River, as presented in Figure 3.

The Site location is sensitive due to the proximity to a cross drainage structure through the rail embankment. Further, the detail of the proposed works is at a scale not fully represented by the existing

TUFLOW model, which is at a 20 m grid cell resolution. Therefore, the recent Quadtree functionality of TUFLOW that enables a variable model grid mesh resolution was utilised allowing a horizontal grid cell resolution of 5 m to be modelled within and surrounding the Site.

Modelled flood levels within the floodplain to the south of the Hunter River at Maitland were different to flood levels modelled for Council's adopted flood study. Therefore, local inflows were scaled to provide flood levels at the Site that are consistent with the adopted study. The design flood conditions were modelled for the 20% AEP, 10% AEP, 5% AEP, 2% AEP, 1% AEP and 0.5% AEP events.

The catchment area of the Hunter River covers some 22 000 km^2, with the Paterson and Williams Rivers contributing around 1200 km^2 and 1300 km^2 respectively. The modelled area encompasses some 750 km^2.

The model utilised the NSW Spatial Services LiDAR data product, downloaded via the ELVIS Foundation Spatial Data portal to define the floodplain topography. The model was constructed using a 20 m grid cell resolution, sampling elevations from the LiDAR data. The modelled floodplain contains numerous embankments that function as hydraulic controls and are of too small a scale to be adequately captured by the 20 m grid cell model resolution. Therefore, a network of breaklines was digitised along some 820 km of embankments and the underlying LiDAR data interrogated to populate the breaklines with the elevations of the embankment crests. These were then incorporated into the TUFLOW model using the Z Shape representation, which modifies model cell elevations to match those of the breaklines.

A total of 26 floodplain mound constructions were identified as having been constructed since the LiDAR data was captured in 2012-13, using available aerial imagery in Google Earth. The approximate extent of these mounds was identified from the imagery and incorporated into the TUFLOW model with assumed mound heights being adopted to raise them above the 1% AEP flood level.

The Hunter River Hydrographic Survey (May 2005) was used to provide representative channel cross-section information of the lower Hunter, Paterson and Williams Rivers. An appropriate channel topography was incorporated into the model, with a full 2D representation of both channel and floodplain. Aerial imagery was used to define separate surface materials for areas of cleared floodplain, river channel and remnant vegetation. Modelling of key hydraulic structures within the study area is also included for the Fullerton Cove and Salt Ash floodgates and culverts under Nelson Bay Road.

Many estuarine vegetation communities are not well penetrated, and are subsequently poorly filtered in, the LiDAR data product. These include areas of mangroves, saltmarsh, phragmites, rank grassland, wet heath, and other swampy habitats. The modelled floodplain elevations in these areas have therefore had an elevation correction adjustment applied to the LiDAR data. Vegetation across the Hunter Estuary has been treated in the TUFLOW model, with LiDAR elevations being lowered between 0.2 m and 0.6 m, depending on vegetation cover. The extent of the modified LiDAR elevations is presented in Figure 3.

The upstream model inflow boundaries on the Hunter, Paterson and Williams Rivers were developed using information contained in the Hunter River Branxton to Green Rocks Flood Study (WMA Water, 2010), the Paterson River Flood Study Vacy to Hinton (WMA Water, 2017) and the Williams River Flood Study (BMT WBM, 2009) respectively. Local hydrological inputs for the 750 km^2 of model area were also accounted for, although they are not overly important for the derivation of the design flood conditions. The downstream boundary of the model was configured as a tidal cycle with a peak water level of 1.1 m AHD, which is approximately an annual peak condition.

The model was calibrated to provide consistency with the Hunter River Branxton to Green Rocks Flood Study and the Williamtown – Salt Ash Floodplain Risk Management Study through iterative adjustment of the Manning's 'n' roughness parameters for the digitised land use materials. The adopted Manning's 'n' values are provided in Table 1.

The TUFLOW model produced results at Maitland that closely match those of the Hunter River Branxton to Green Rocks Flood Study. Consistent results at Raymond Terrace were harder to achieve and were found to be significantly influenced by total inflow volumes more-so than peak flow rates alone.

Design flood levels at Oakhampton are driven principally by peak flows (with variations in volume effectively negligible). Flood levels at Oakhampton were consistent with the previous study within the Hunter River channel, however local differences were modelled within the floodplain at the Site. This report does not aim to redefine the flood levels adopted by Council, but the model does provide a suitable representation of flood conditions for the purpose of an impact assessment.

Flood Frequency Analysis (FFA) undertaken for the Hunter River Branxton to Green Rocks Flood Study and the Singleton Floodplain Risk Management Study (BMT, 2020) provide similar estimates of design flood flows for the Hunter River, which provides a good level of confidence in those estimates. The derivation of design flood flow estimates through FFA at Raymond Terrace is less certain, due to a shorter period of continuous record and a lack of a site rating curve. Using FLIKE to derive probabilistic estimates of design peak flows, the results for the rarer events were found to vary significantly depending on the assumptions made for data entry of historic flood thresholds. This is because there is less than 40 years of continuous record and the largest flood events all occurred before this period.

Table 1 – Adopted Manning's 'n' Values

Surface Material	Manning's 'n'
Cleared floodplain	0.040
Hunter River channel u/s Morpeth	0.030
Hunter River channel Morpeth to Raymond Terrace	0.025
Hunter River channel d/s Raymond Terrace	0.020
Paterson River channel	0.045
Williams River channel	0.025
Remnant vegetation	0.120
Mangroves	0.150

Rainfall-runoff modelling was undertaken for the entire Hunter River catchment using methods outlined in ARR 2019 to assist in establishing suitable design flow conditions at Raymond Terrace, specifically the relationship between modelled peak flow conditions at Oakhampton and Raymond Terrace. With flows on the Hunter River dominating volumes at Raymond Terrace, establishing a relationship between design flows at Oakhampton and expected design flows at Raymond Terrace provides a useful tool for validating design flood levels at Raymond Terrace. The Hunter River catchment rainfall-runoff modelling found the critical duration at Oakhampton to be 48 hours, whereas it was the 72-hour duration at Raymond Terrace – indicative of the additional reliance on overall flood volume to maintain peak flows and levels. Table 2 presents the design flows at Oakhampton and the estimated equivalent design flow condition at Raymond Terrace.

Table 2 – Hunter River Design Peak Flows (m^3/s)

Design Event	Oakhampton	Raymond Terrace
20% AEP	1700	1400
10% AEP	2600	2300
5% AEP	3800	3200
2% AEP	5800	4700
1% AEP	8000	6300
0.5% AEP	10 300	7900
0.2% AEP	13 500	10 200

Ultimately, design flow estimates were adopted from the FLIKE FFA for the 20% AEP and 10% AEP events and from the rainfall-runoff modelling analysis for the rarer flood events. Table 2 presents the design flows at Oakhampton and the estimated equivalent design flow condition at Raymond Terrace. A comparison of the adopted design flows at Raymond Terrace with the 90% confidence interval determined using FLIKE is presented in Chart 1.

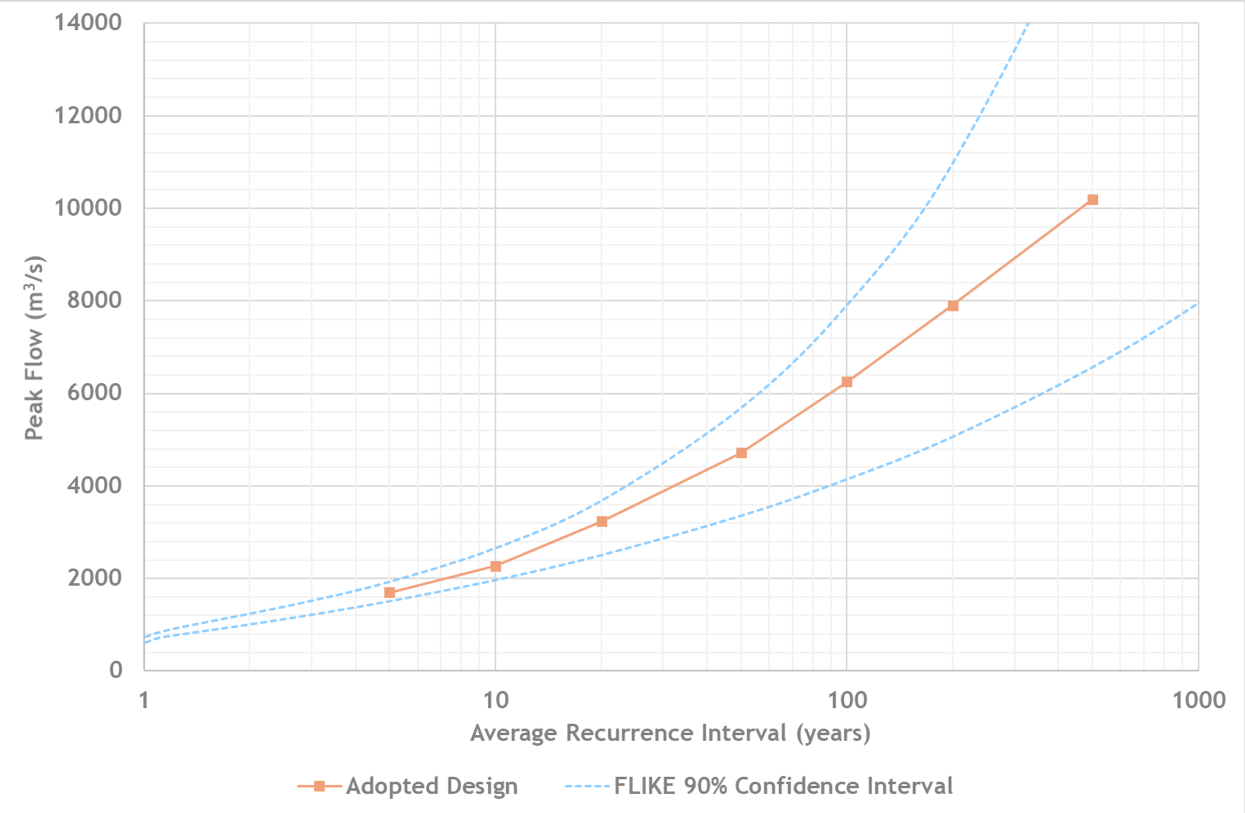


Chart 1 – Adopted Design Flood Flows at Raymond Terrace

Design flood flow hydrographs for the Hunter, Williams and Paterson Rivers were simulated in the TUFLOW model and the volumes of the flood recession were adjusted until the required peak flow conditions at Raymond Terrace were matched. The resultant peak flood levels at the Raymond Terrace gauge are presented in Table 3, together with those established for the Williamtown – Salt Ash Floodplain Risk Management Study. The overall consistency between the two is good and is well within the bounds of uncertainty of the FFA at Raymond Terrace.

Table 3 – Design Flood Levels at Raymond Terrace

Design Event	This Assessment	BMT WBM (2017)
20% AEP	2.6	2.2
10% AEP	2.9	3.0
5% AEP	3.3	3.3
2% AEP	4.0	4.1
1% AEP	4.7	4.8
0.5% AEP	5.3	5.2
0.2% AEP	6.1	N/A

Flood Modelling and Mapping

The adopted flood mapping shows that the Site is not impacted by flooding until the 1% AEP event. Therefore, the TUFLOW model was simulated (using the HPC solver) for the 1% AEP and 0.5% AEP events to define baseline flood conditions for the purposes of assessing flood risk and as the basis for subsequent flood impact assessment. The Extreme Flood event was also simulated. The modelled peak flood levels at the Site are summarised in Table 4.

The modelled peak flood extents for the 1% AEP, 0.5% AEP and Extreme events are presented in Figure 4. 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 1% AEP, 0.5% AEP and Extreme events, respectively.

Table 4 – Modelled Peak Design Flood Levels

Design Event	Flood Level (m AHD)
1% AEP	9.7
0.5% AEP	10.7
Extreme	11.1

Flood Risk Management

The flood hazard conditions at the Site were assessed to determine the risk to property and risk to life exposure of the proposed development. Appropriate flood risk management measures were identified in accordance with Council's DCP, LEP, and the NSW Floodplain Development Manual.

Figure 8, Figure 9, and Figure 10 present the flood hazard classification at the Site for the 1% AEP, 0.5% AEP and Extreme Flood 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 2.

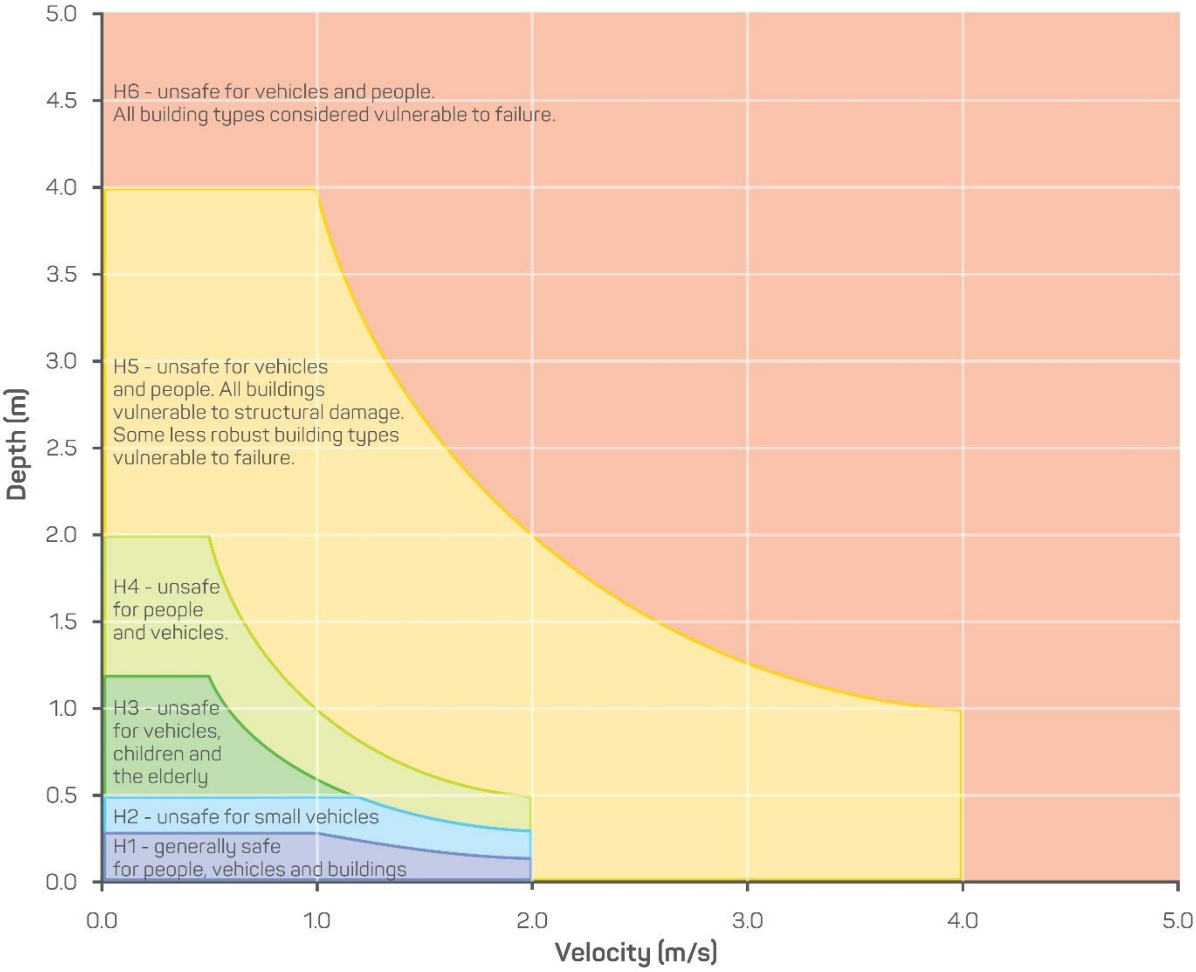


Chart 2 – General Flood Hazard Vulnerability Curves (AIDR, 2017)

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

The objective of the management of risk to property is to minimise the damages that would be incurred in the event of a flood. This includes potential damage to future building structures and their contents. Risk to property is typically managed to the 1% AEP design flood event, which is around 9.7 m AHD as shown on Council's existing flood mapping. A corresponding Flood Planning Level (FPL) of 10.2 m AHD is therefore appropriate for the Site, being the 1% AEP flood level plus 0.5 m freeboard.

The modelled flood levels at the Site are consistent with Council's adopted flood levels, therefore the model results provide a good representation of the flood hazard conditions for the purpose of risk analysis in this report.

Council make provision for development below the FPL subject to appropriate controls as outlined in the DCP B.3 – Hunter River Floodplain and require adequate information to assess the impact of the proposal on flood behaviour, the environment, flood affectation and risk to life and property before development approval can be granted.

The flood hazard mapping for the 1% AEP event presented in Figure 8 shows that the Site is impacted by a maximum H4 hazard, which presents a moderate risk to life and property. This is principally depth-driven, as modelled velocities across the Site at the 1% AEP event are less than 0.1 m/s.

It is proposed to construct the lower floor level at 9.7 m AHD, which is at the Council nominated 1% AEP level, and the mezzanine level at 12.75 m AHD, which is above the Council nominated FPL. The lower level should not be used for 'habitable' purposes as defined by Council, therefore should not be dedicated office space or used for storage of valuable items. The mezzanine can be used for office space and will allow storage of valuable items above the FPL in accordance with Council requirements, inherently reducing the property risk within the habitable part of the building.

Electrical fittings will need to be located above the FPL unless they are on a separate circuit (with earth leakage protection) to the rest of the building.

The design of structural components of the building need to withstand the forces of depth of inundation, buoyancy, and flow velocity (including potential for debris impact) up to the 1% AEP event, for which local post-development flood conditions are at a depth of up to 1.4 m and a velocity of up to 0.1 m/s. This will require Certification by a Structural Engineer.

Parts of the proposed building at or below the FPL shall be constructed in accordance with Table 1: Flood Aware Design Requirements for Residential Development on Flood Prone Land of DCP Section B.3.

The objective of the management of risk to life is to minimise the likelihood of deaths in the event of a flood and is typically considered for flood events rarer than the 1% AEP, up to the PMF (or Extreme Flood). Figure 10 shows that the dwelling is impacted by an H5 hazard at the Extreme event, which would produce high hazard flood conditions on Site. It is therefore essential that occupants are evacuated to flood-free locations prior to an Extreme event occurring. Evacuation is available at the 5% AEP event as required by Council.

Flood Behaviour

The Site is subject to flood inundation from the Hunter River when the capacity of the levee system is exceeded at Maitland. While this occurs at around a 10% AEP flood rarity (on average, once in every ten years), the design flood mapping in the Hunter River Branxton to Green Rocks Flood Study shows that at the 5% AEP event the local floodplain (including the Site) is free from inundation. At the 2% AEP event flooding of the area is only minor and localised and does not directly impact the Site. However, local roads likely become impacted prior to the 1% AEP flood peak. At the 1% AEP event, backwater from the broader floodplain inundates the Site. It is therefore essential that people using the Site are evacuated to flood-free locations prior to this occurring or prevented from accessing the Site beforehand.

Flood Warning

A flood warning system is established for the Hunter River. The BoM incorporates the Maitland (at Belmore Bridge) gauge into its operational flood warning network. Water level data can be accessed at: http://www.bom.gov.au/fwo/IDN60232/IDN60232.061268.plt.shtml for the Maitland gauge. The data presents the current recorded water level at the gauge together with the recorded data over the past five days. The Minor, Moderate and Major flood warning levels are also provided and are summarised in Table 5. The gauge height in metres corresponds to the elevation in metres above Australian Height Datum (AHD).

Table 5 – Flood Warning Levels (m)

Warning Level	Maitland
Minor	5.9
Moderate	8.9
Major	10.5

The Major Flood Level at Belmore Bridge corresponds with around a 10% AEP event (on average, once in every ten years). The Site is not impacted by floodwaters until the 1% AEP, with access to areas outside the floodplain also available prior to this event. Therefore, it is expected that a major flood warning will be in place before inundation of the Site and local roads being cut off by flood waters.

The NSW State Flood Plan (2015) provides a target flood warning time of 24 hours prior to a Major flood event at Maitland. Therefore, sufficient time is available to raise valuable items above the FPL and to evacuate the Site prior to the risk of flood inundation.

The managers of the Site should pay attention to any Flood Watch or Flood Warnings issued by the Australian Bureau of Meteorology (BoM). In the event of a flood emergency response being initiated by the SES, occupants of the Site should follow the instructions given accordingly. This may include an order to evacuate to a designated flood evacuation centre, if required. However, during such an event, State emergency services would likely be stretched, and occupants of the Site should be prepared to respond to a flood emergency without assistance.

To ensure timely flood warning in advance of a required evacuation, the site managers should set themselves up to receive RSS (Really Simple Syndication) feeds from the BoM New South Wales & ACT Warning service. Alerts are automatically provided to subscribed devices when the feed is updated. This can be set up for both home computers and mobile phones and is customisable (refer http://www.bom.gov.au/rss/rss-guide.shtml).

Warnings issued for Maitland can then be monitored, with real-time gauge data available for viewing at http://www.bom.gov.au/fwo/IDN60232/IDN60232.061268.plt.shtml.

The BoM Twitter feed (https://twitter.com/bom_nsw) offers a simpler and more user-friendly interface for the dissemination of official flood warning information. It also relays SES Flood Evacuation Warning and Flood Evacuation Order information, providing all key flood response advice in a single location.

Floods Near Me (# Floods Near Me #) is a flood warning mobile device application that brings together flood related information in NSW and provides the user with tailored warnings.

The Site managers should consider subscribing to the BoM Twitter feed of the Floods Near Me App in addition to, or as an alternative to the RSS service.

Flood Emergency Response

If a Major Flood Warning is issued by the BoM for the Hunter River at Maitland, then businesses operating from the Site should close to prevent access to the Site while the warning is in place. Closure of the Site should be advertised via appropriate means, such as web pages, and social media.

Site managers should arrange to move valuable items above the FPL (if not already located there). However, the protection of property from flooding should always be secondary to the protection of life and so any such activity should be suspended in sufficient time to enable evacuation of people from the Site.

Once a Major Flood Warning has been issued for Maitland it is expected that Council will close local roads in advance of the impending flood inundation. The SES may also issue an Evacuation Order for the area to relocate people from the floodplain. Occupants of the Site should follow any direction given by the SES in that regard.

The Site can be readily evacuated via Day Street to southern areas of East Maitland that are outside the floodplain, with access beyond to the broader regional road network. Some roads may become inundated during the flood event, but evacuation would occur prior to this. If any people evacuating the Site cannot readily access their place of residence or alternative accommodation arrangements, then they should follow the direction of the SES as to the appropriate designated evacuation centres. The nearest evacuation centre to the Site nominated in the Maitland City Local Flood Plan is at Maitland High School.

Business owners in flood-affected areas are encouraged to prepare a Flood Emergency Response Plan (FERP). The Australian Government provides advice and a template for the preparation of an Emergency Management Plan (https://business.gov.au/risk-management/emergency-management/how-to-prepare-an-emergency-management-plan). Most of the content can (and should) be completed by the operator of the business. However, this report provides relevant flood information to support the development of an Emergency Management Plan in relation to flood risk.

Flood Impact Assessment

The detail of the proposed development was provided by Perception Planning and was incorporated into the TUFLOW model. The design flood events were then re-simulated, and the results compared to the baseline results to identify potential flood impacts.

The results of the flood impact assessment, together with the proposed building and site fill, are presented in Figure 11 to Figure 14. Flood impact mapping is presented for the modelled peak flood level and modelled peak flood velocity for the 1% AEP and 0.5% AEP flood events, respectively.

The model results show a negligible impact to the modelled peak flood levels and velocities at the 1% AEP event because the local flood waters are predominantly a non-convective backwater. At the 0.5% AEP event there is greater floodplain convection, with a hydraulic gradient generated as floodplain waters are drawn northwards along the upstream side of the railway embankment to drain through the bridge structure some 200 m away.

The impact of the proposed development locally redirects the 0.5% AEP event flow around the Site, sheltering the neighbouring property to the north, with a reduction in peak flood level and velocity. Where flows are concentrated around the western side of the Site the velocities are locally increased by around 0.3 m/s. However, the resultant peak velocity is still low at around 0.8 m/s and so this does not represent an adverse impact to the risk to property in the affected area. The impact on the risk to life is also negligible, as the area will be evacuated prior to the onset of flooding.

Conclusion

The Site at 12-14 Day Street, East Maitland, NSW requires a Flood Assessment to assist in the approval process for the proposed commercial development.

The flood risk assessment has determined that providing a mezzanine level above the FPL of 10.2 m AHD reduces the likelihood of flood inundation within habitable parts of the proposed building and provides a suitable storage area for valuable items.

Structural design to the 1% AEP flood event needs to consider hydraulic forces to prevent structural damage and will require Certification by a Structural Engineer, with local flood depth and velocity conditions of up to 1.4 m and 0.1 m/s, respectively.

Parts of the proposed building at or below the FPL shall be constructed in accordance with Table 1: Flood Aware Design Requirements for Residential Development on Flood Prone Land of DCP Section B.3.

While the likelihood of flood inundation at the Site is relatively low, expected on average only once every 50 to 100 years, evacuation will be required for a Major Flood event. There is sufficient warning time of at least 24 hours available prior to such an occurrence, readily enabling an effective management of the flood risk.

The appropriate flood emergency response to manage the risk can be summarised as:

- Monitor and subscribe to the BoM Flood Warning service (or alternative feed of this information)
- If a Major Flood Warning is issued for the Hunter River at Maitland, then the Site should be closed and communicated to employees and other potential visitors, accordingly
- Relocation of any valuable items to the mezzanine level prior to the flood warning can be undertaken, but only if sufficient time is available to safely do so – direction to be taken from the SES
- Evacuation of any remaining people from the Site is readily undertaken to flood free areas within East Maitland via Day Street and then beyond to the appropriate destinations, accordingly.

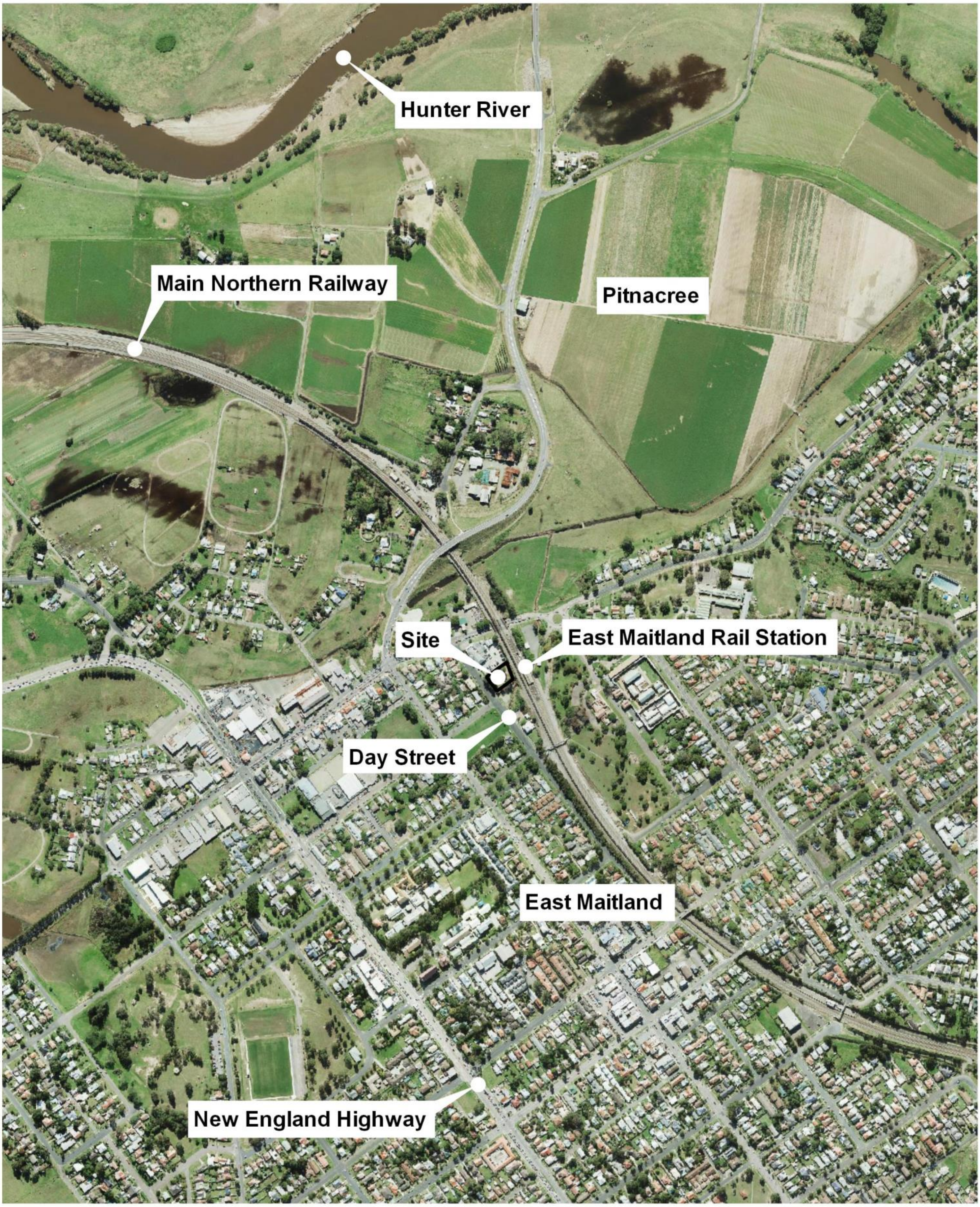
The flood impact assessment has included use of a TUFLOW hydraulic model to simulate design flood conditions at the Site, with the modelled 1% AEP flood conditions maintaining a reasonable consistency with the 1% AEP flood conditions modelled within the Council adopted study. The flood impact assessment has determined that the proposed development does not result in adverse off-site flood impacts.

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

0 200 400 m

approx. scale

Figure: 1

Revision: A

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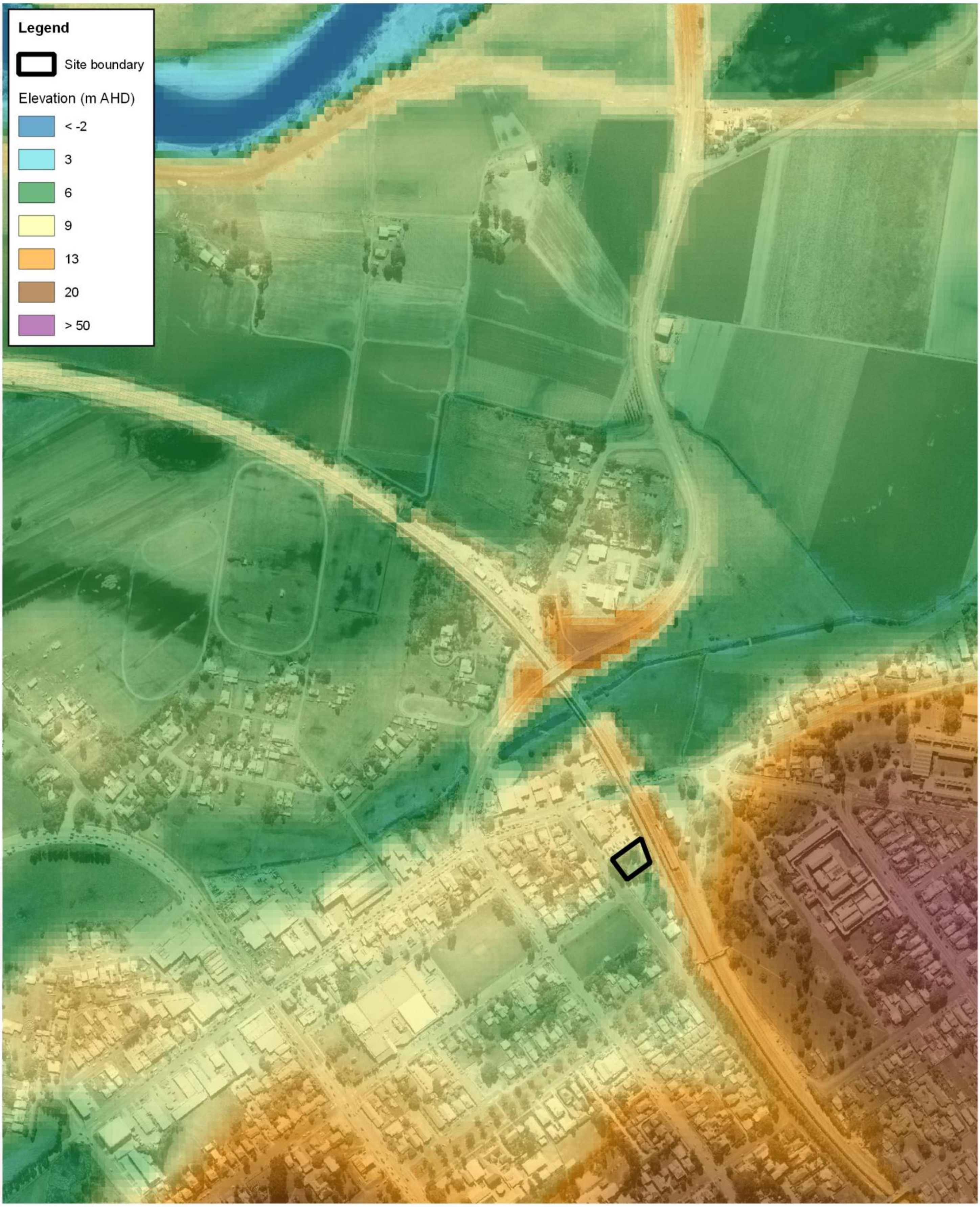

Title:

Local Floodplain Topography

Figure: **2**

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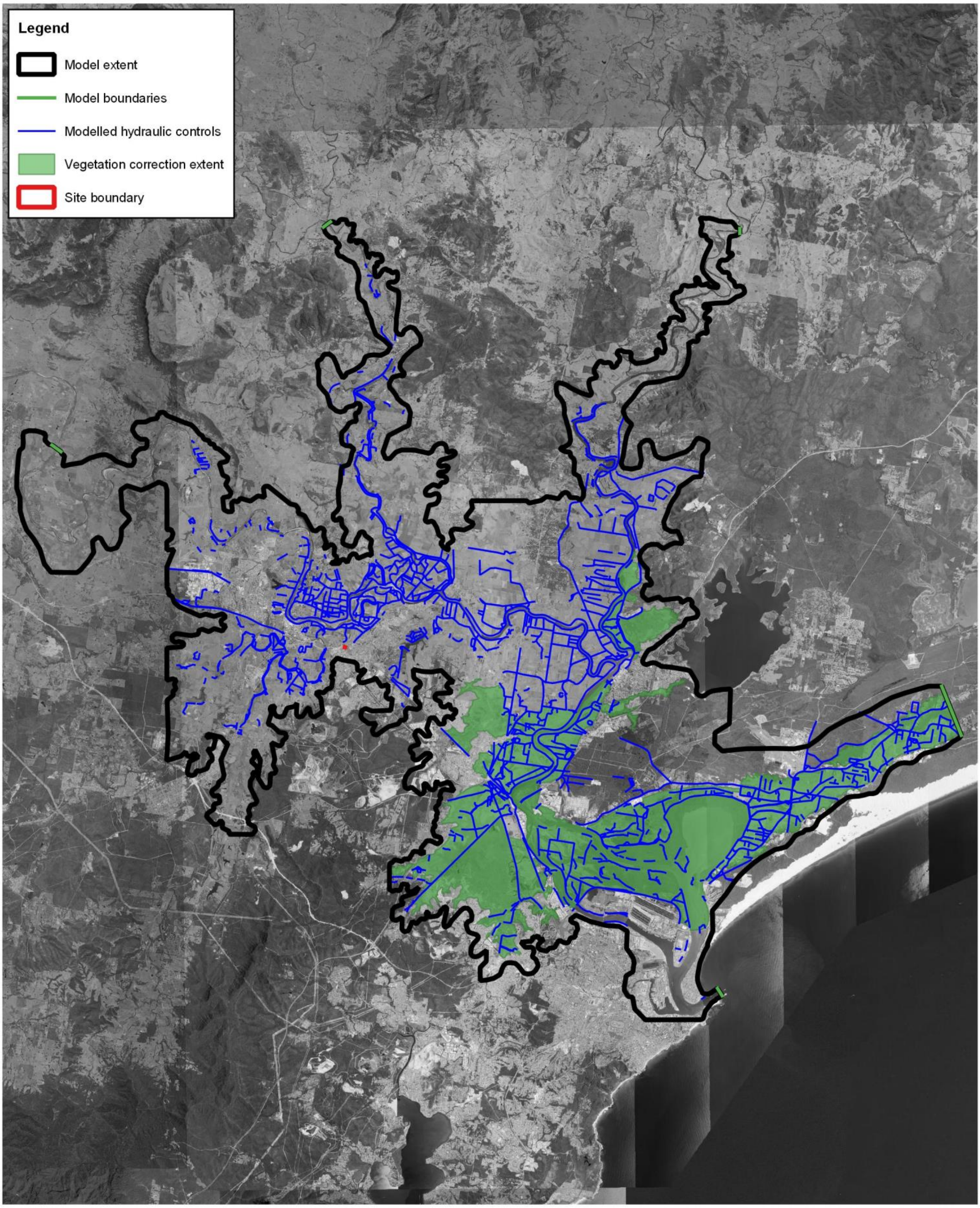

Title:

TUFLOW Model Components

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approx. scale

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Title:

Modelled Design Flood Extents

0 100 200 m

approx. scale

Figure: 4

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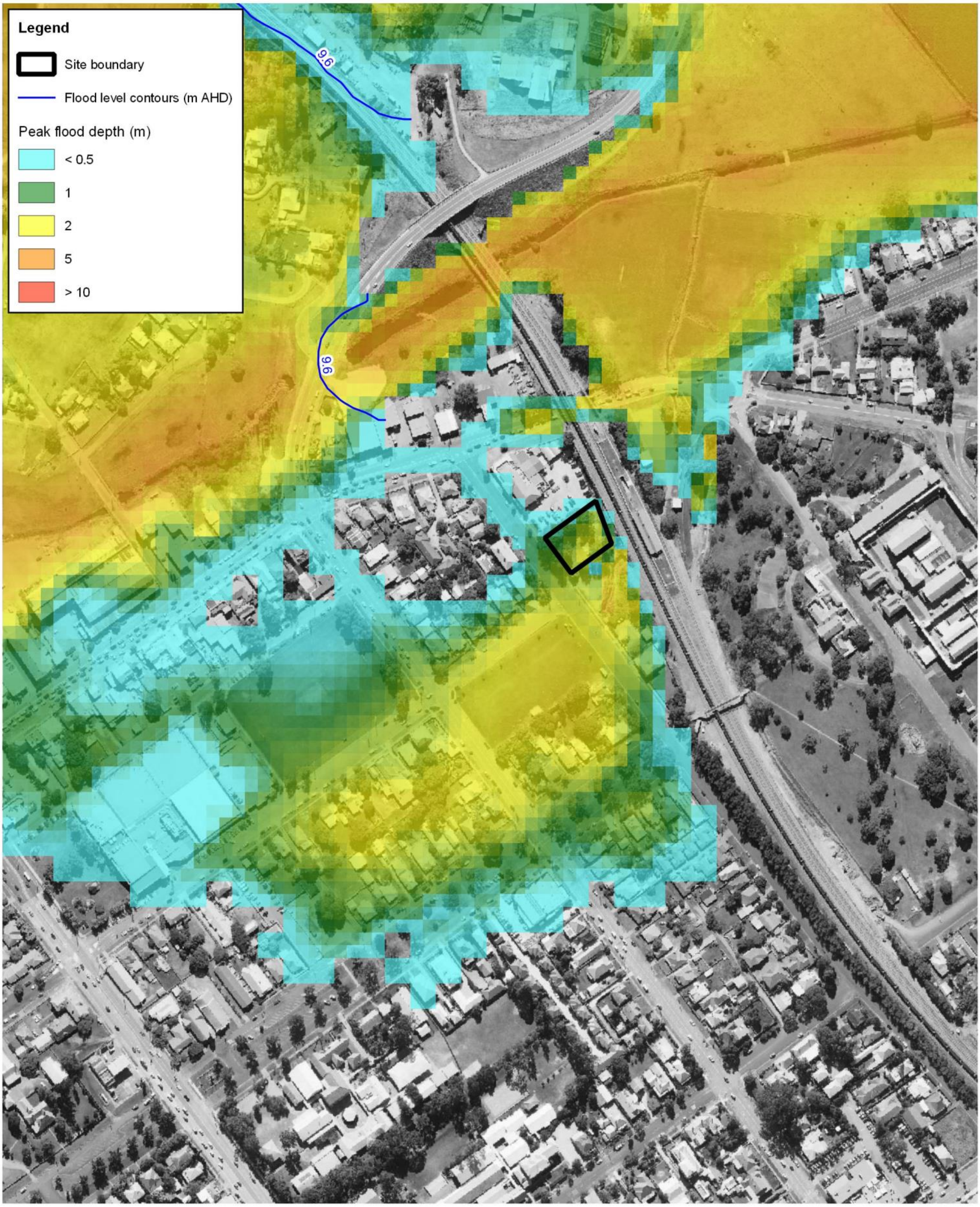

Title:

Modelled 1% AEP Flood Depths

Figure: **5**

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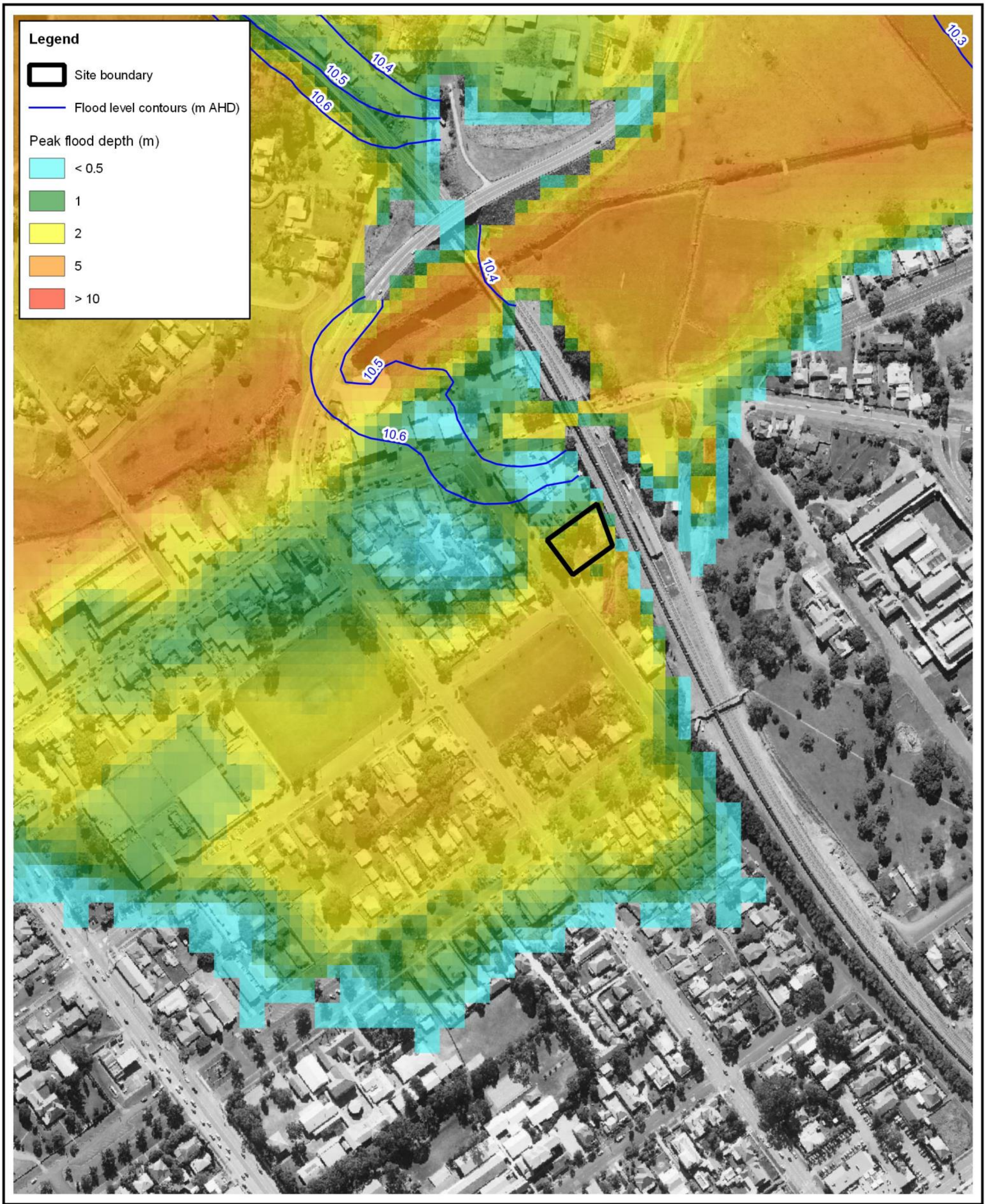

Title:

Modelled 0.5% AEP Flood Depths

0 100 200 m

approx. scale

Figure: **6**

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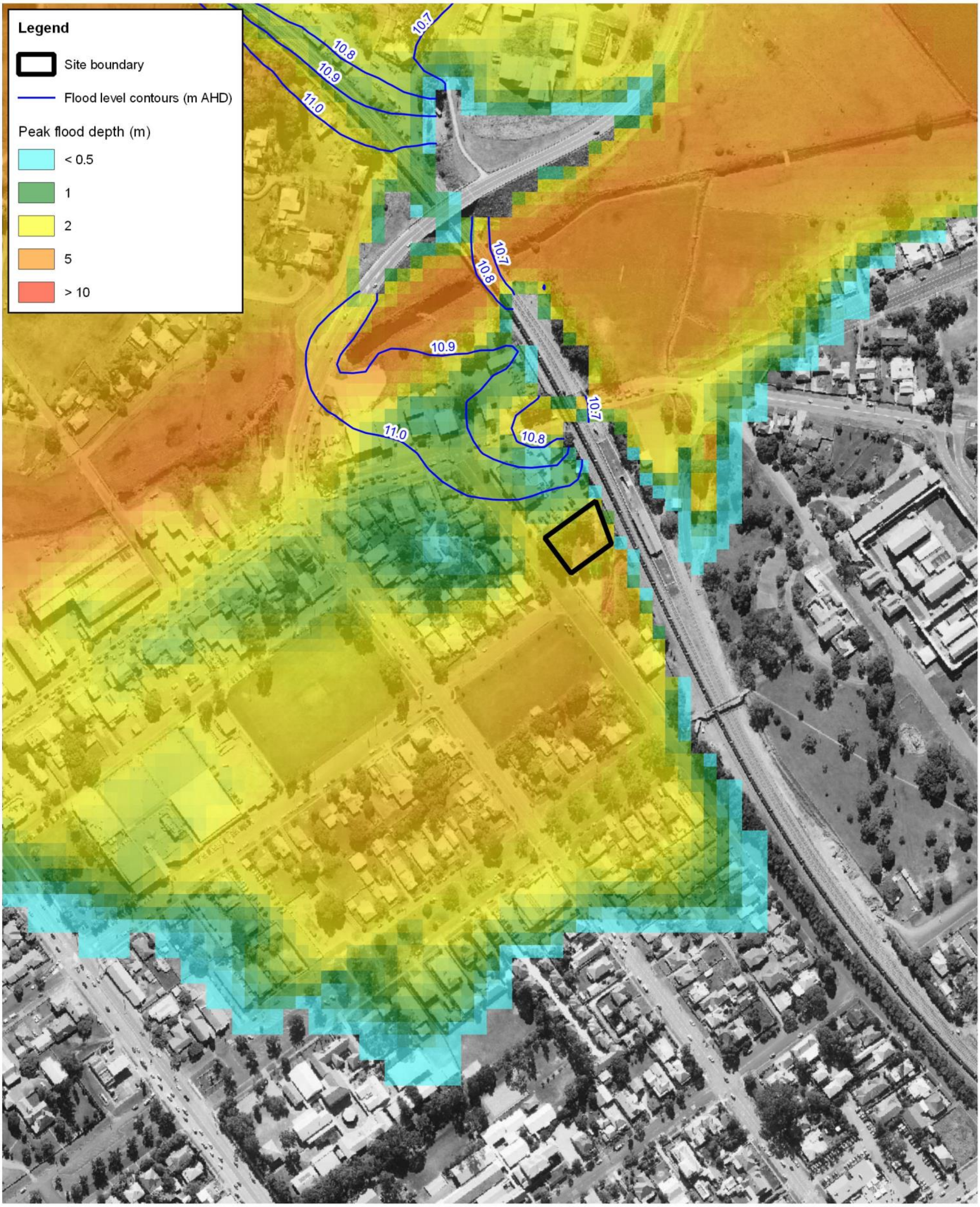

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Modelled Extreme Flood Depths

Figure: **7**

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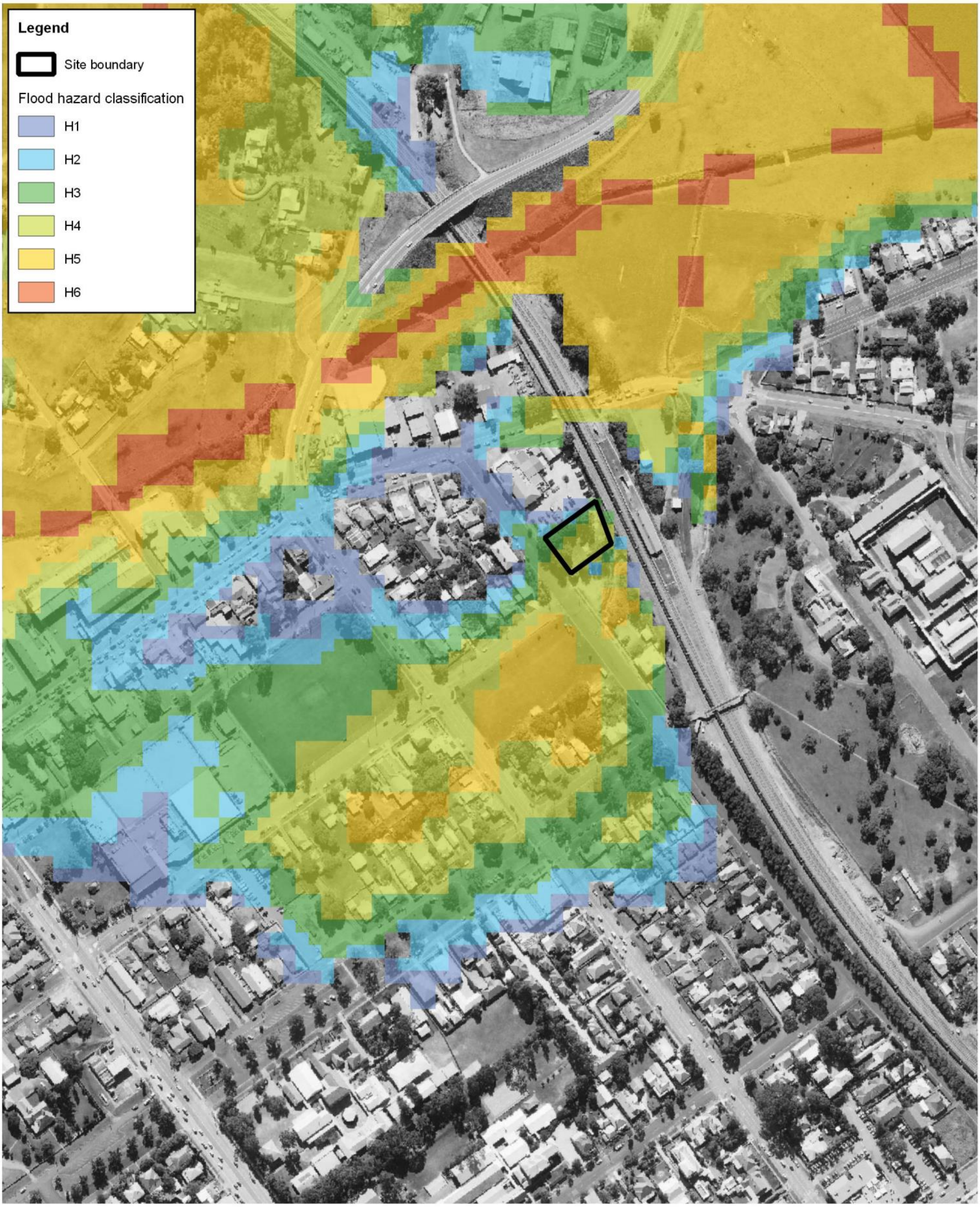

Title:

Modelled 1% AEP Flood Hazard Classification

0 100 200 m

approx. scale

Figure:	8
Revision:	A

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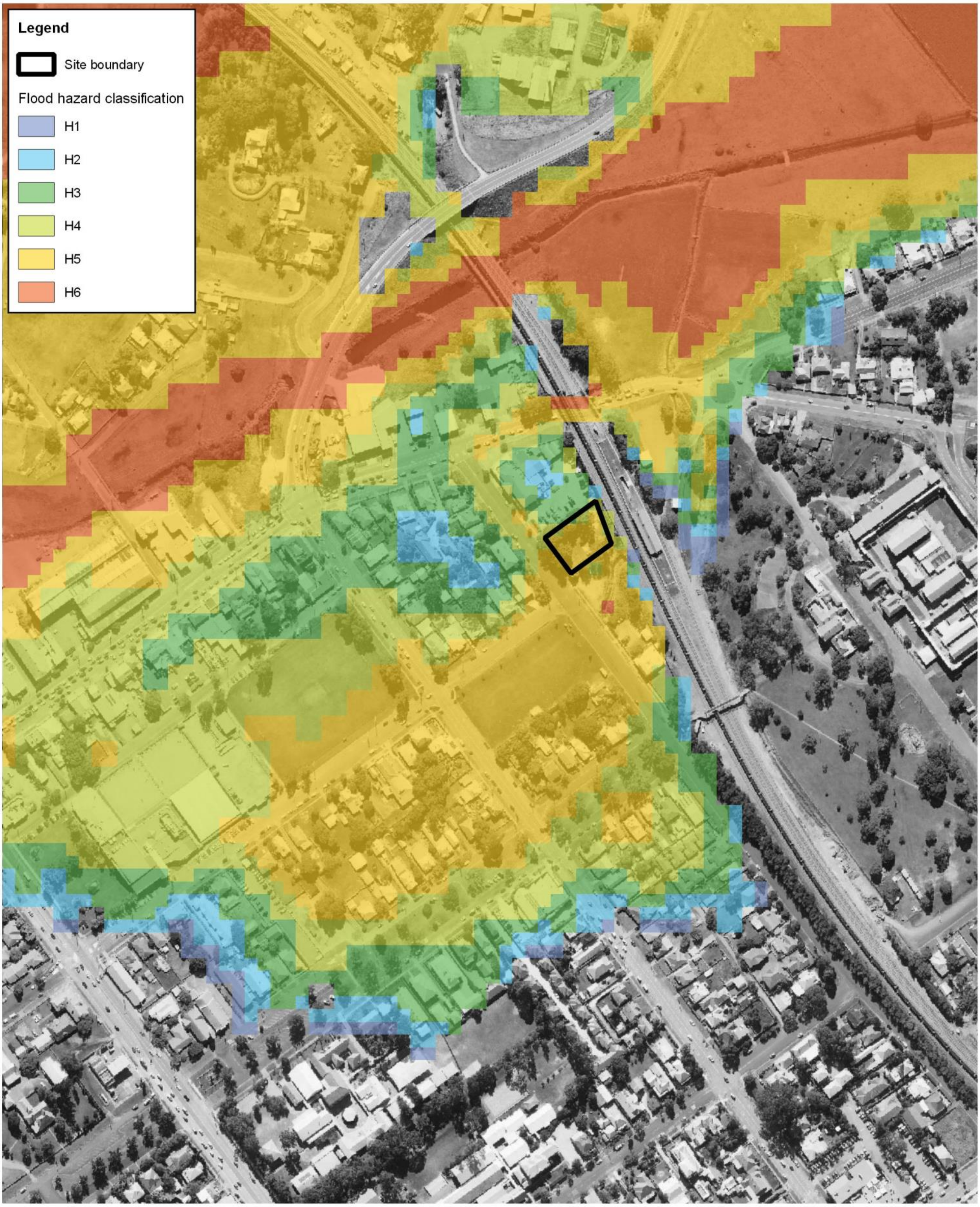
Filepath: Z:\Projects\T2351_Day_St\GIS\T2351_008_230302_100y_hazard.qgz



Title:

Modelled 0.5% AEP Flood Hazard Classification

0 100 200 m

approx. scale

Figure: 9

Revision: A

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Title:

Modelled Extreme Flood Hazard Classification

0 100 200 m

approx. scale

Figure: **10**

Revision: **A**

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Title:

Modelled 1% AEP Peak Flood Level Impact

0 20 40 m

approx. scale

Figure: **11**

Revision: **A**

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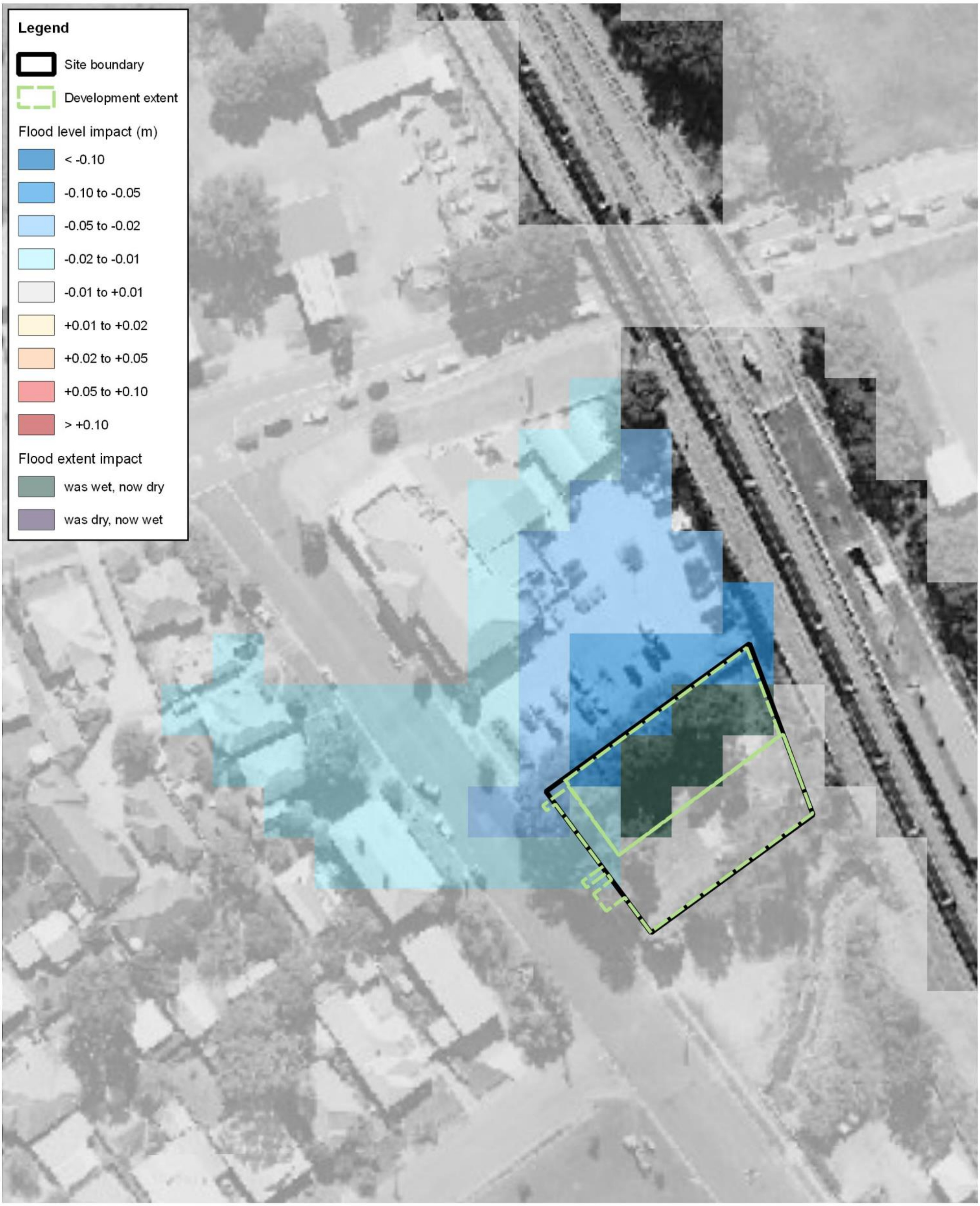
Filepath: Z:\Projects\T2351_Day_St\GIS\T2351_011_230302_100y_h_impact.qgz



Title:

Modelled 0.5% AEP Peak Flood Level Impact

0 20 40 m

approx. scale

Figure:	12
Revision:	A

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Filepath: Z:\Projects\T2351_Day_St\GIS\T2351_012_230302_200y_h_impact.qgz

Title:

Modelled 1% AEP Peak Flood Level Impact

0 20 40 m

approx. scale

Figure: **13**

Revision: **A**

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Title:

Modelled 0.5% AEP Peak Flood Level Impact

Figure: **16**

Revision: **A**

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