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Our Ref: DJW: L.T2227.002.docx

27 April 2022
Providence Asset Group
Suite 704, 97-99 Bathurst Street
Sydney NSW 2000
Attention: Jeremy Every

Dear Jeremy

RE: FLOOD IMPACT ASSESSMENT FOR PROPOSED SOLAR FARM AT LOT 2 DP707260 AND LOT 1 DP705438, ROSEDALE ROAD, ASHLEY NSW

Background

Torrent Consulting was engaged by Providence Asset Group to undertake a Flood Impact Assessment to assist in the DA process for the proposed solar farm at Lot 2 DP707260 and Lot 1 DP705438 Rosedale Road, Ashley, NSW (the Site) as presented in Figure 1. It is understood that Moree Plains Shire Council (MPSC) has identified the site as being at risk of flooding, with flood waters from Marshalls Ponds Creek escaping the watercourse alignment and spilling over Rosedale Road.

The Site is located on the right floodplain of Marshalls Ponds Creek, just to the north of Ashley. Marshalls Ponds Creek flows into Carole Creek around 5 km downstream of Ashley and forms part of the broader Gwydir River system. The catchment area of Marshalls Ponds Creek is around 350 km^2, however, it can receive additional flood flow contributions from the Gwydir River, which has a contributing catchment area of almost 13 000 km^2. The local floodplain topography is presented in Figure 2, in which the floodplain is shown to grade in a north-westerly direction. The channels of Marshalls Ponds and Carole Creeks are evident, as is the presence of agricultural floodplain modification.

The Gwydir River system is important for primary production and the floodplain has been heavily modified for agricultural purposes. This includes irrigation infrastructure, large dam storages and protective levee embankments. These inland rural floodplains are managed by the NSW DPE to maintain important floodways and ensure appropriate agricultural development.

There is a detailed legal instrument “Floodplain Management Plan for the Gwydir Valley Floodplain 2016” that covers the region and includes specific rules for development within four management zones labelled A to D (A being the most restrictive). The approximate extent of the flood management zones around Ashley and the Site is presented in Figure 3. This shows that the lease area of the Site is located within Zone B. There is also a floodway (Zone A) that traverses the eastern corner of the Site.

Model Development

Design flood hydrology in these inland floodplain environments is extremely challenging. The large rural floodplain studies that typically cover these regions often do not explicitly assess design flood conditions, but instead use historic floods for planning and management purposes. For the Gwydir Valley the Feb 2012 event is used for this purpose, with the smaller Jan 2004 event being used to define the floodway extents.

A TUFLOW model of the Marshalls Ponds Creek floodplain has been developed for this assessment to better understand the flood risk in and around the Site and to enable a flood impact assessment to be undertaken. The model covers Marshalls Ponds Creek and the surrounding floodplain between the Newell

Highway and the confluence with Carole Creek. Representation of Carole Creek and the associated floodplain is provided between the Gwydir River offtake and a location around 7 km downstream of the Marshalls Ponds Creek confluence, as presented in Figure 4.

The model utilised the Geoscience Australia the NSW Spatial Services LiDAR data products, downloaded via the ELVIS Foundation Spatial Data portal to define the floodplain topography. Most of the modelled area is covered by both datasets, with the GA product being captured in 2013 and the Spatial Services product being captured in 2020. The GA LiDAR provides a better representation of overall floodplain elevations, as there is a much greater impact of vegetation evident in the Spatial Services LiDAR. However, the details of the creek channel geometry are generally better represented within the Spatial Services product. Therefore, a composite Digital Elevation Model (DEM) was produced, comprising the lowest elevation of the two datasets within each 1 m horizontal grid cell. A horizontal grid cell resolution of 8 m was adopted in the TUFLOW model, with the sub-grid sampling routine being implemented at a 2 m resolution.

There are numerous embankment features within the floodplain that act as hydraulic controls. Large areas of agriculture that are protected by embankments are free from flood inundation and so these areas were excluded from the TUFLOW model extent. Within the modelled extent the embankment crests were reinforced as breaklines using the Z Shape functionality, with elevation data extracted from the LiDAR DEMs. Estimated structure representations are provided for the required cross-drainage locations.

The TUFLOW model boundaries were configured to simulate the conditions of the February 2012 flood event. Inflow hydrograph data was obtained from the Water NSW online data portal and was modified to provide consistency with the flood flow distribution of the Gwydir Valley FMP. The 2012 flood event at Ashley is dual-peaked, with each being a similar flood height. The first peak is from the Marshalls Ponds Creek catchment, with the second being flows from Carole Creek and additional spills from the Gwydir River.

The modelled hydraulic roughness values were adjusted to provide a match to the recorded flood levels at the gauge locations. The adopted values are presented in Table 1.

Table 1 – Modelled Hydraulic Roughness Values

Surface Type	Manning's 'n'
Cleared floodplain	0.045
Vegetated floodplain	0.120
Marshalls Ponds Ck channel	0.030
Carole Ck channel	0.045
Downstream creek channels	0.070

Simulated Flood Conditions

The TUFLOW hydraulic model was simulated (using the HPC solver) for the February 2012 flood condition. The 2012 flood is estimated within the Gwydir Valley Floodplain Management Plan (FMP) as being around a 4% AEP design flood equivalent. A representative 1% AEP flood condition was also simulated by increasing the 2012 flood flows by around 74%. This is based on the peak flood flows at Gravesend in the FMP for the 1955 event, which is estimated as being of a 1% AEP design equivalent.

Figure 5 presents the modelled peak flood depths and levels at the Site for the 2012 flood event, with those for the 1% AEP event presented in Figure 6.

Figure 7 presents the modelled flood hazard conditions at the Site for the 2012 flood event, with those for the 1% AEP event presented in Figure 8. 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.

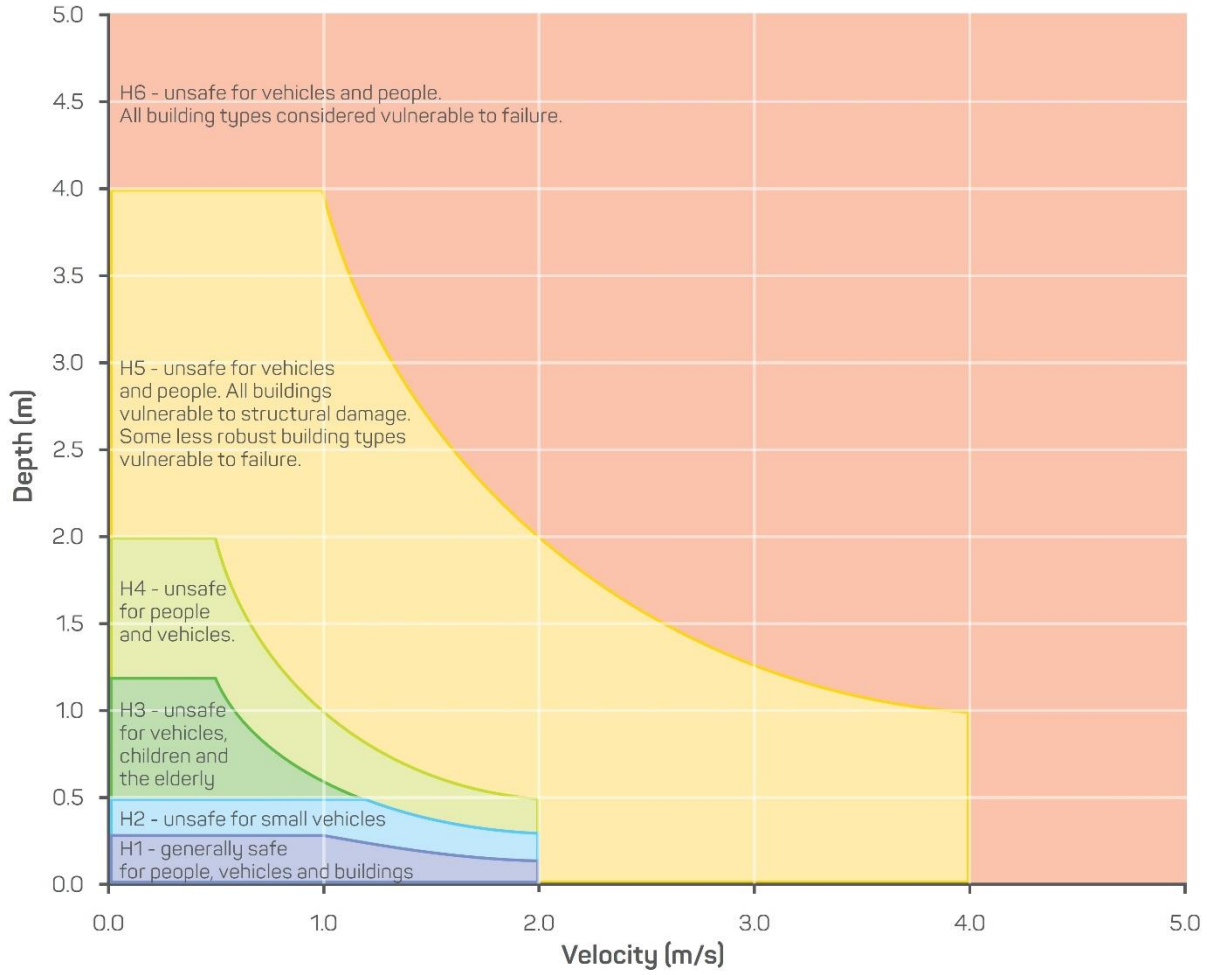
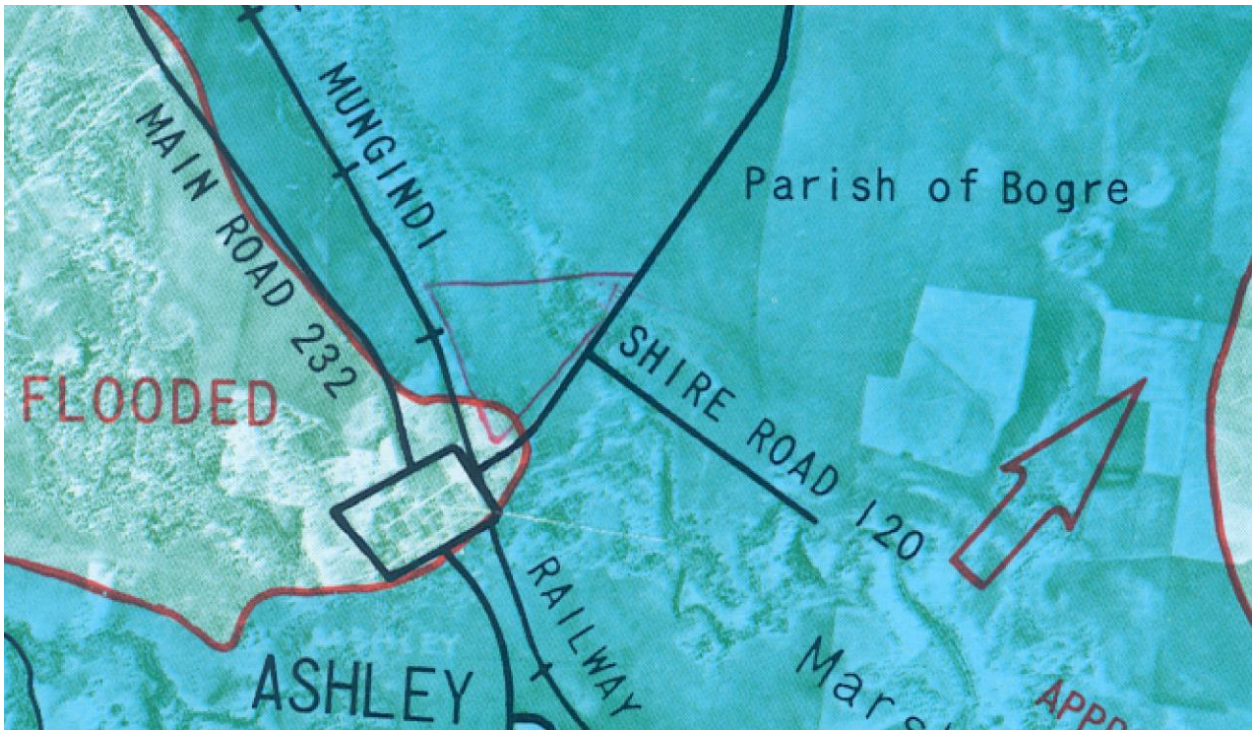


Chart 1 – General Flood Hazard Vulnerability Curves (AIDR, 2017)

The flood hazard mapping is useful for providing context to the nature of the modelled flood risk and to identify potential constraints for 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 modelled flood conditions show that whilst the Site is flood-affected, this is limited to the far eastern corner, in the area identified as a floodway by the FMP. The proposed lease area for the solar farm is flood-free.

The Site was identified as being potentially subject to flood inundation by MPSC, with a flood extent map provided to Providence Asset Group, as presented in Insert 1. It is not certain which flood is depicted in the map; however, it is assumed to be the 1955 flood event, which is the largest in recorded history within the Shire.



Insert 1 – Flood Extent Map

The flooding experienced during the 1955 event is expected to be similar to that modelled in the 1% AEP flood condition. However, whilst broadly consistent (both show a significant breakout north from Marshalls Ponds Creek to the east of Ashley), there are localised differences, particularly in the inundation at the Site. There are a few reasons that explain these differences, including:

- Construction of Copeton Dam (which began in 1968) now regulates 55% of inflows to the region
- The dam, coinciding river regulation and flooplain works have resulted in significant reductions in high flows in the Lower Gwydir, with large floods being reduced in size
- Potential raising of the Rosedale Road embankment through successive works
- Difficulties in distinguishing between the extent of riverine breakout flood flows and local floodplain runoff.

The modelling of mainstream flooding of Marshalls Ponds Creek and Gwydir River breakouts indicates that very rare to extreme flood conditions (i.e. significantly rarer than a 1% AEP) would be required to potentially inundate the Site. Flooding at the Site would be limited to shallow and low hazard flood inundation, most likely from local floodplain runoff downstream of Rosedale Road. To demonstrate these flood conditions a local 1% AEP rainfall condition was simulated in TUFLOW, in accordance with the ARR 2019 guidelines. This identified the 4.5-hour to 6-hour duration rainfall events as producing critical flood conditions at the Site, from the local upstream catchment area of around 1.5 km^2, with a peak flow of just over 8 m^3/s.

The modelled flood depth and level conditions for the 1% AEP local catchment rainfall are presented in Figure 9, with the resultant flood hazard classification presented in Figure 10. These confirm the expected

shallow and low hazard flood conditions, given the relatively small contributing catchment area and flat topography.

Flood Impact Assessment

Potential flooding at the Site does not present a significant risk to either life or property and specific measures to manage surface water (beyond those detailed within the civil design plans for stormwater management) are not required.

In addition to the management of flood risk exposure of the proposed development, the potential for off-site flood impacts to the existing baseline flood conditions also need to be considered to avoid adverse impacts to neighbouring property and infrastructure. The details contained in the site plan (210748 - CIV - Ashley Solar Farm - BASE.dwg) were incorporated into the TUFLOW model to assess the potential flood impacts. Assumptions include:

- application of a 50% blockage to flow around the perimeter fencing
- application of a 2% blockage to flow through the PV tracker arrays to account for the piles (PV modules raised above the flood surface).
- raising of the gravel hardstand construction laydown and Site access road to the levels indicated by the design surface contours
- raising above the floodplain of all internal site infrastructure other than the PV trackers
- incorporation of the proposed site stormwater detention basin, bund and swale.

The TUFLOW model was refined to a 2 m horizontal grid cell resolution for the purposes of simulating pre- and post-development local catchment runoff. This enables the scale of the proposed stormwater management works to be adequately represented.

The 1% AEP local catchment runoff event was then re-simulated, and the results compared to the baseline results to identify potential flood impacts.

The results of the flood impact assessment are presented in Figure 11 for the modelled peak flood level impacts and in Figure 12 for the flood velocity impacts. The results show a negligible impact to the modelled peak flood velocities, with only minor and localised impacts to the modelled peak flood levels.

The proposed hardstand area elevated the critical infrastructure of the solar farm above the local overland flow paths, with site runoff being directed into the proposed detention basin. As depicted in the civil plans, overland surface flows from the west will be redirected around the hardstand laydown area. This results in some minor local increase to the modelled peak flood levels, which then dissipates with no implications across the broader floodplain. All impacts are contained well within the Site boundary.

Conclusion

Torrent Consulting was engaged to undertake a Flood Impact Assessment to assist in the DA process for the proposed solar farm at Lot 2 DP707260 and Lot 1 DP705438 Rosedale Road, Ashley, NSW.

This assessment has included development of a TUFLOW model for the Marshalls Ponds Creek and associated Gwydir River breakout floodplain and has simulated the February 2012 flood event and a representative 1% AEP design flood condition.

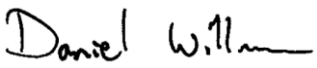
Flood mapping has been produced that shows that the proposed solar farm is compatible with the flood hazard of the land at the 1% AEP event. Potential flooding at the Site does not present a significant risk to either life or property and specific measures to manage surface water (beyond those detailed within the civil design plans for stormwater management) are not required.

The results of the flood impact assessment show a negligible impact to the existing peak flood level and velocity conditions.

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 1 2 km

approx. scale

Figure: 1

Revision: A

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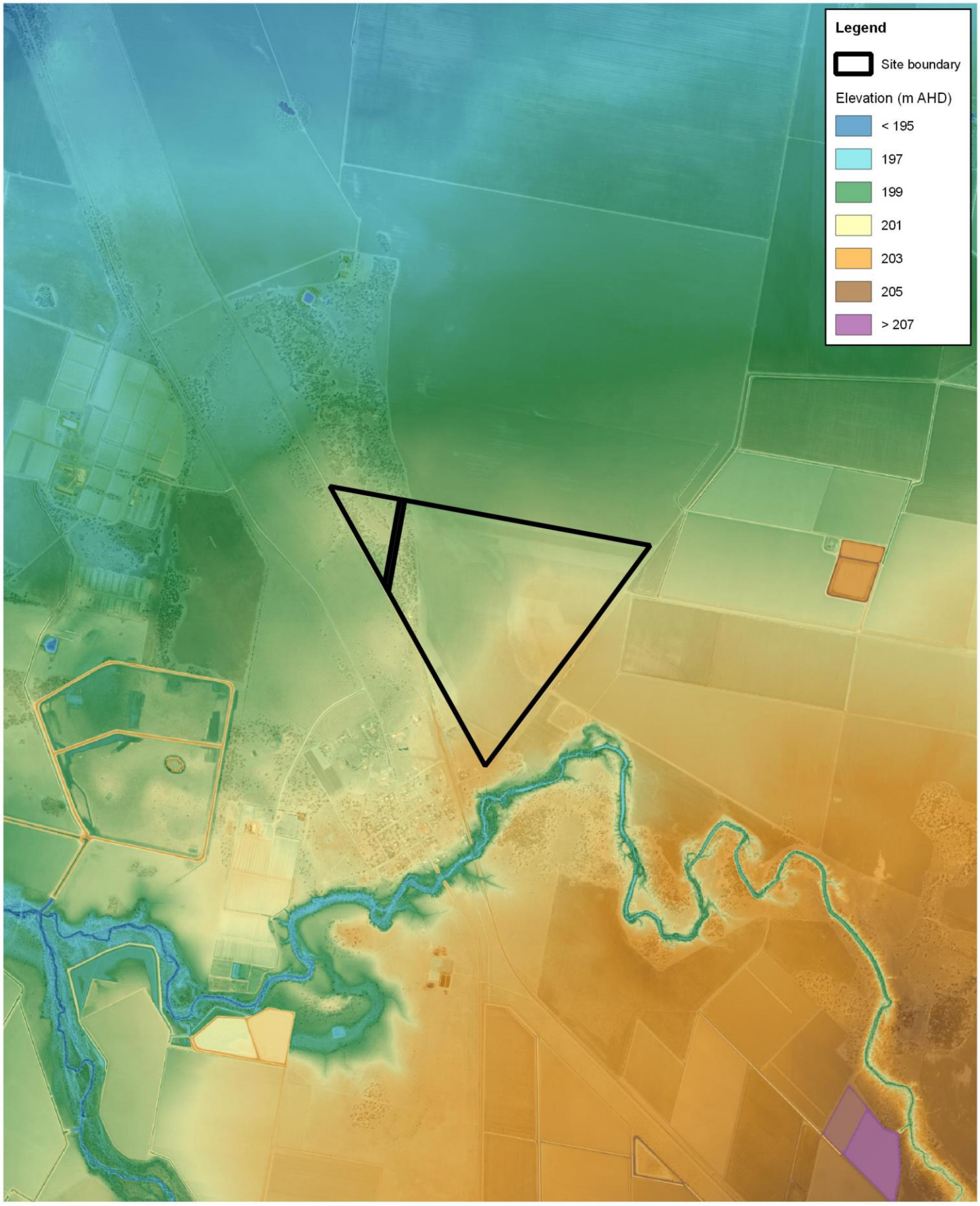

Title:

Local Floodplain Topography

0 1 2 km

approx. scale

Figure: 2

Revision: A

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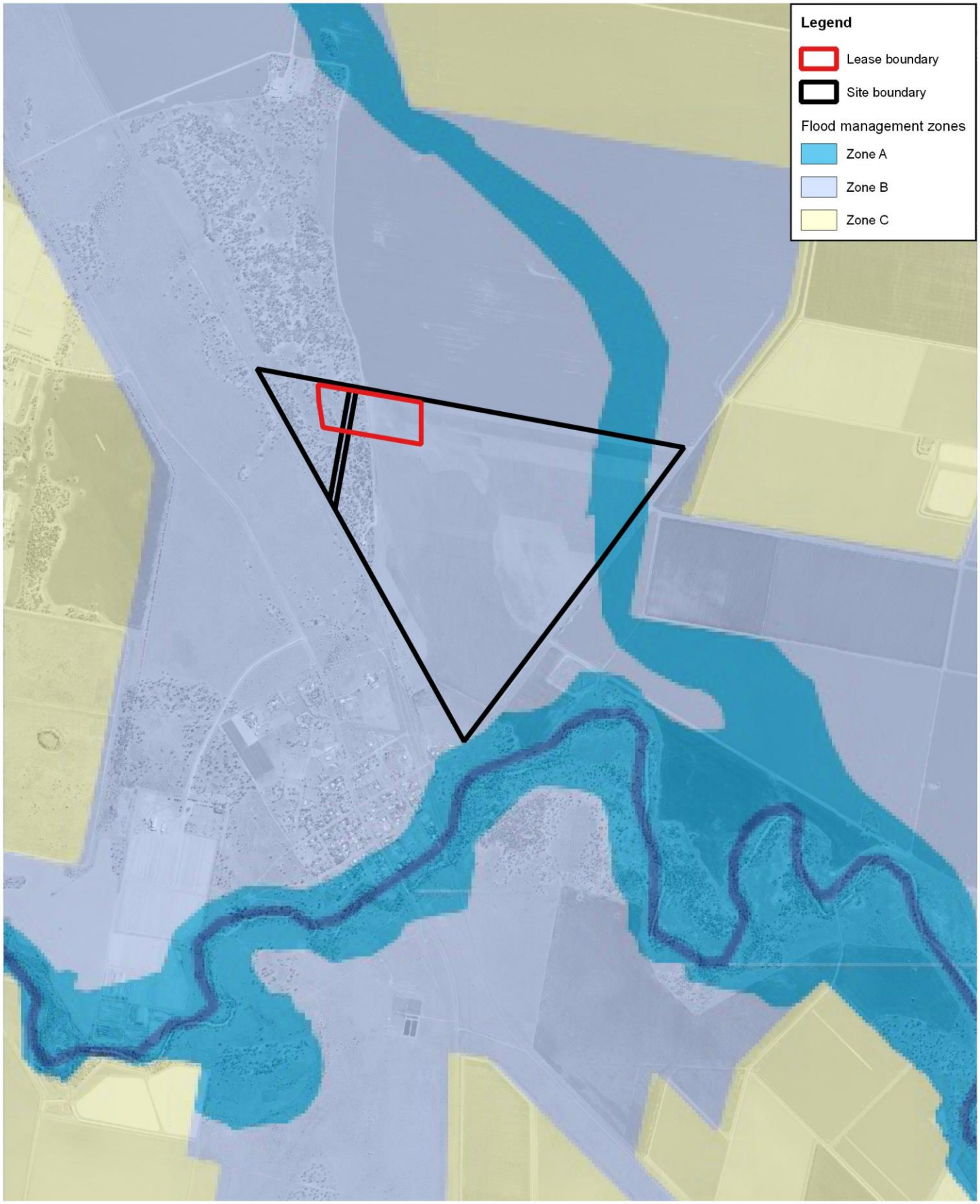

Title:

Gwydir Valley Floodplain Management Plan
Flood Management Zones

0 0.8 1.6 km

approx. scale

Figure: 3

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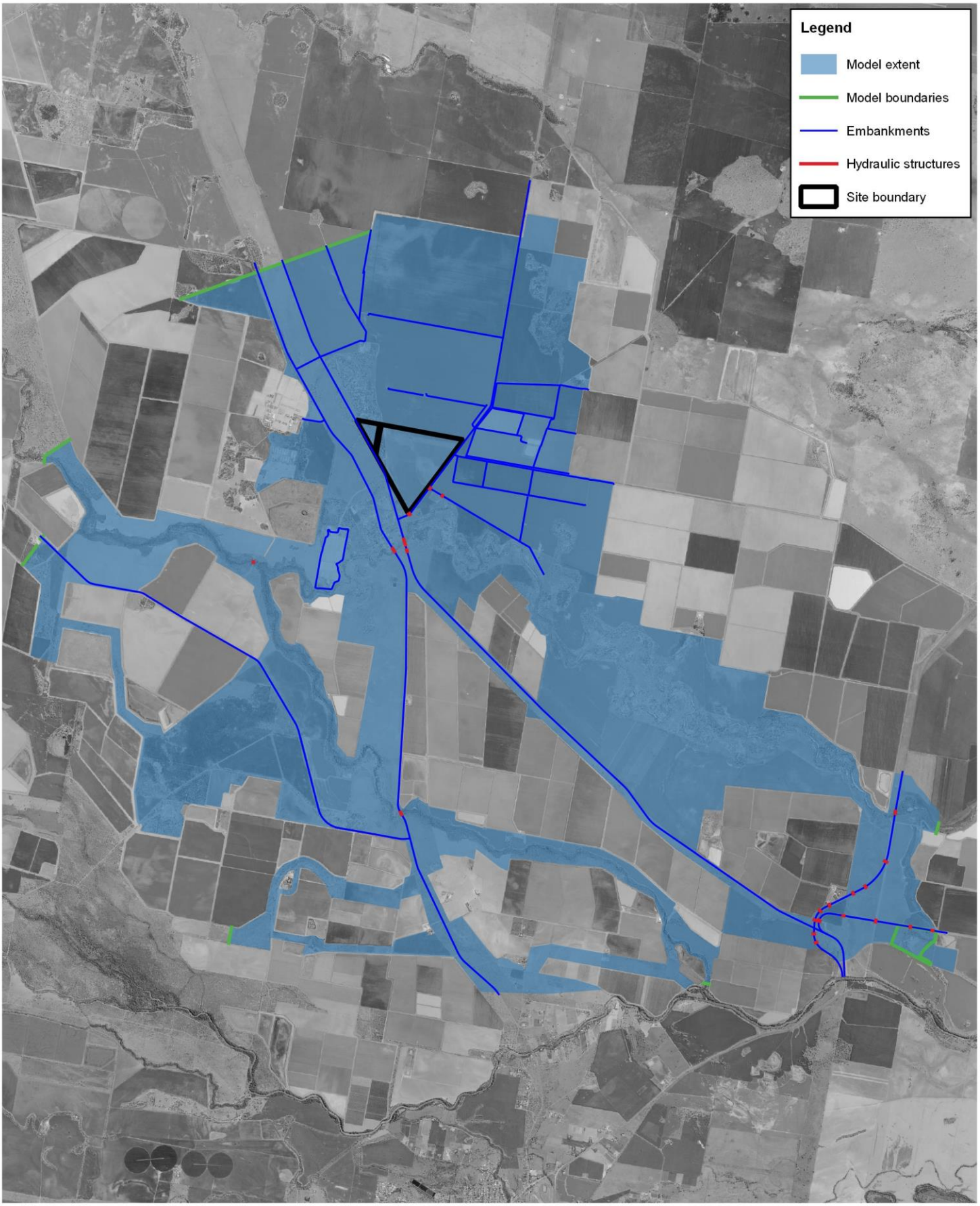

Title:

TUFLOW Model Configuration

0 3 6 km

approx. scale

Figure: 4

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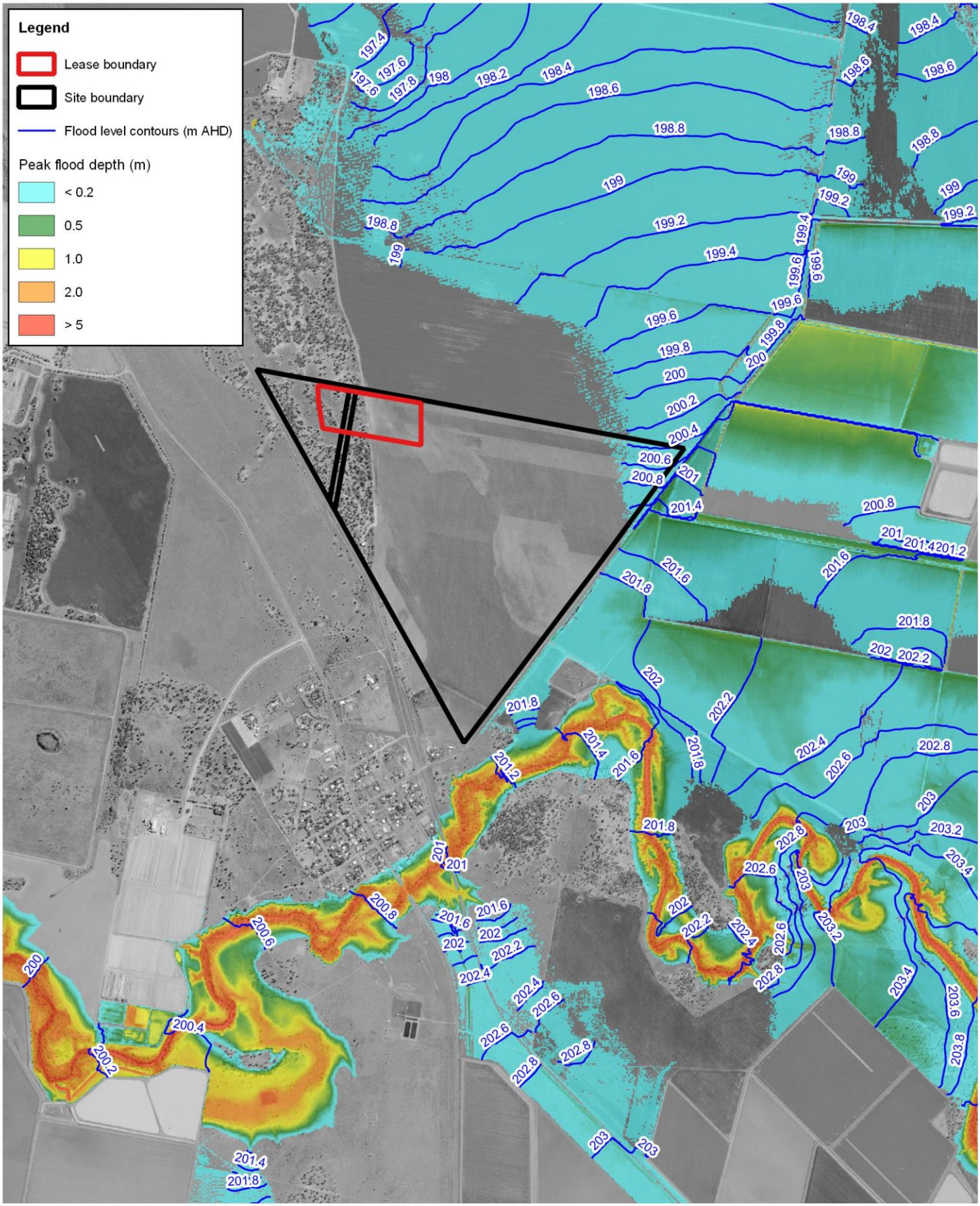

Title:

Modelled February 2012 Flood Conditions

0 0.8 1.6 km

approx. scale

Figure: 5

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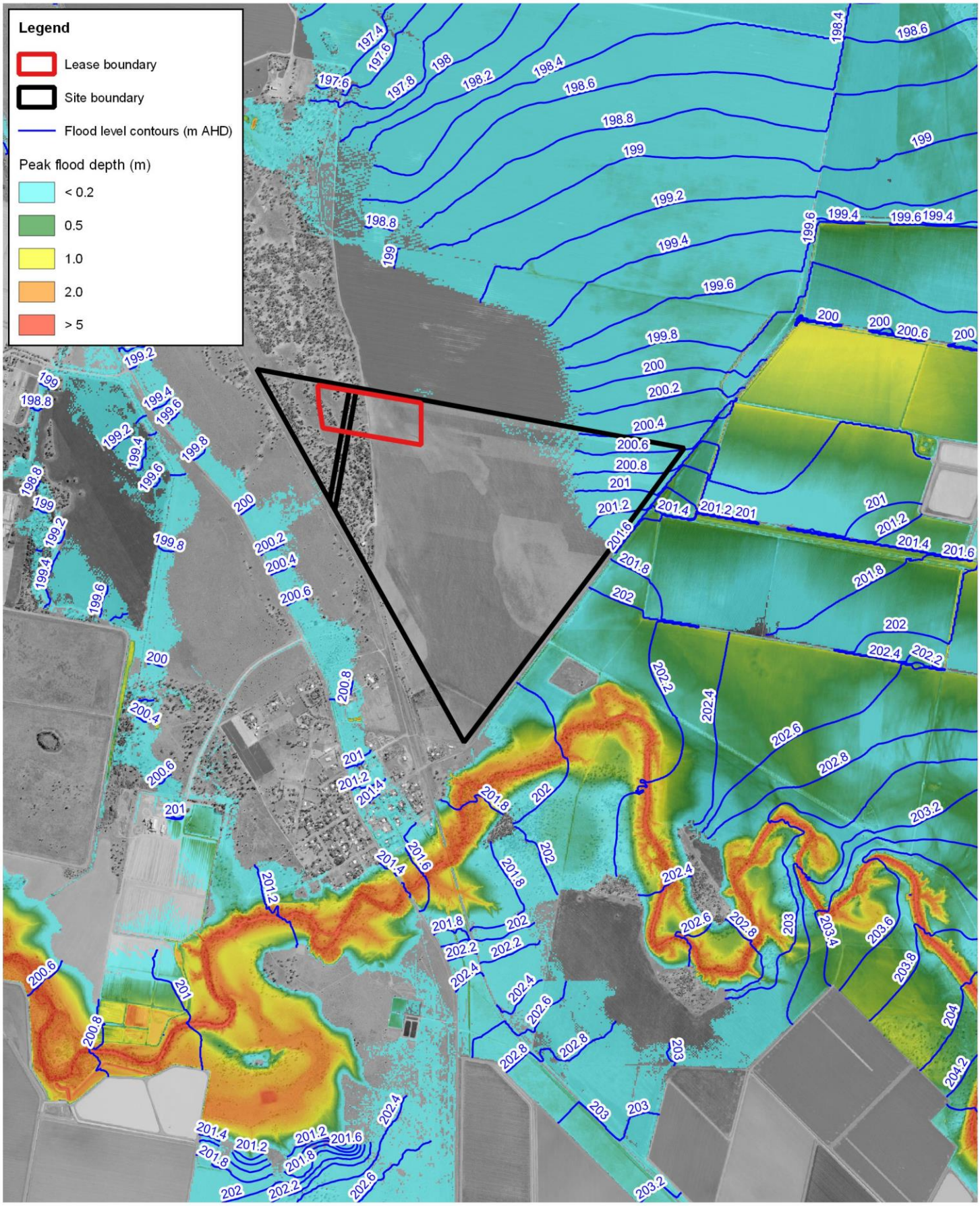

Title:

Modelled 1% AEP Flood Conditions

0 0.8 1.6 km

approx. scale

Figure: 6

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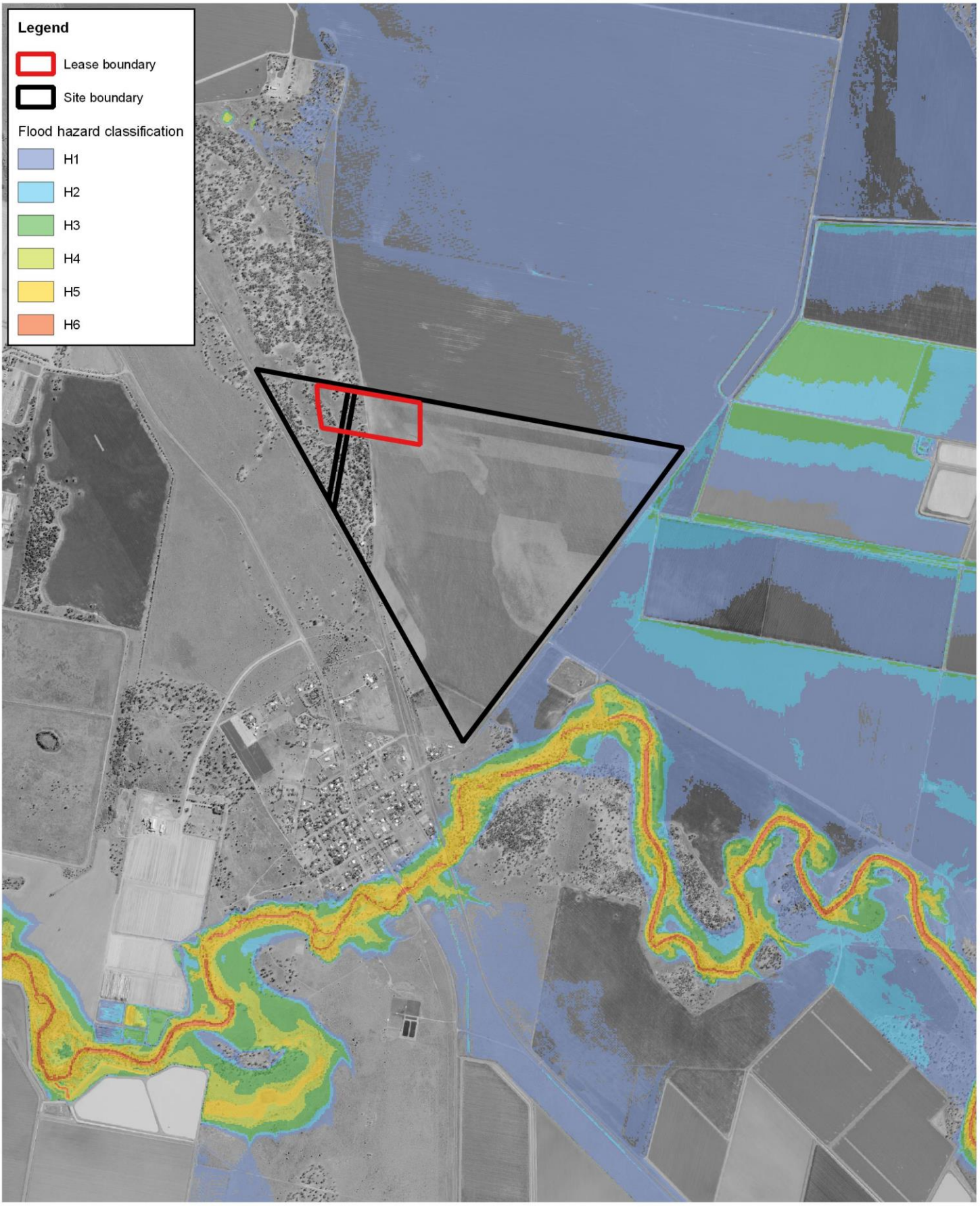

Title:

Modelled February 2012 Flood Hazard

0 0.8 1.6 km

approx. scale

Figure: 7

Revision: A

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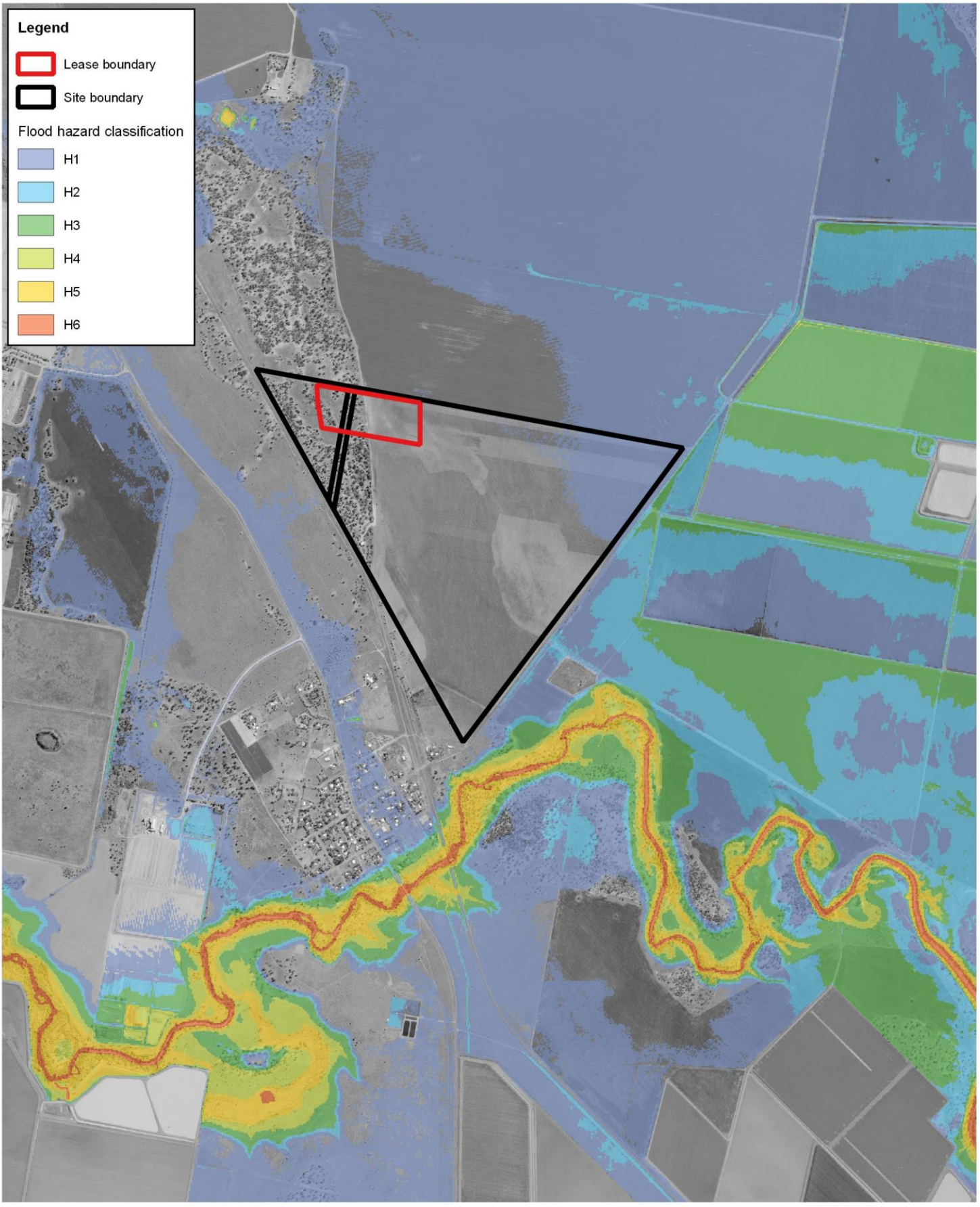

Title:

Modelled 1% AEP Flood Hazard

0 0.8 1.6 km

approx. scale

Figure: 8

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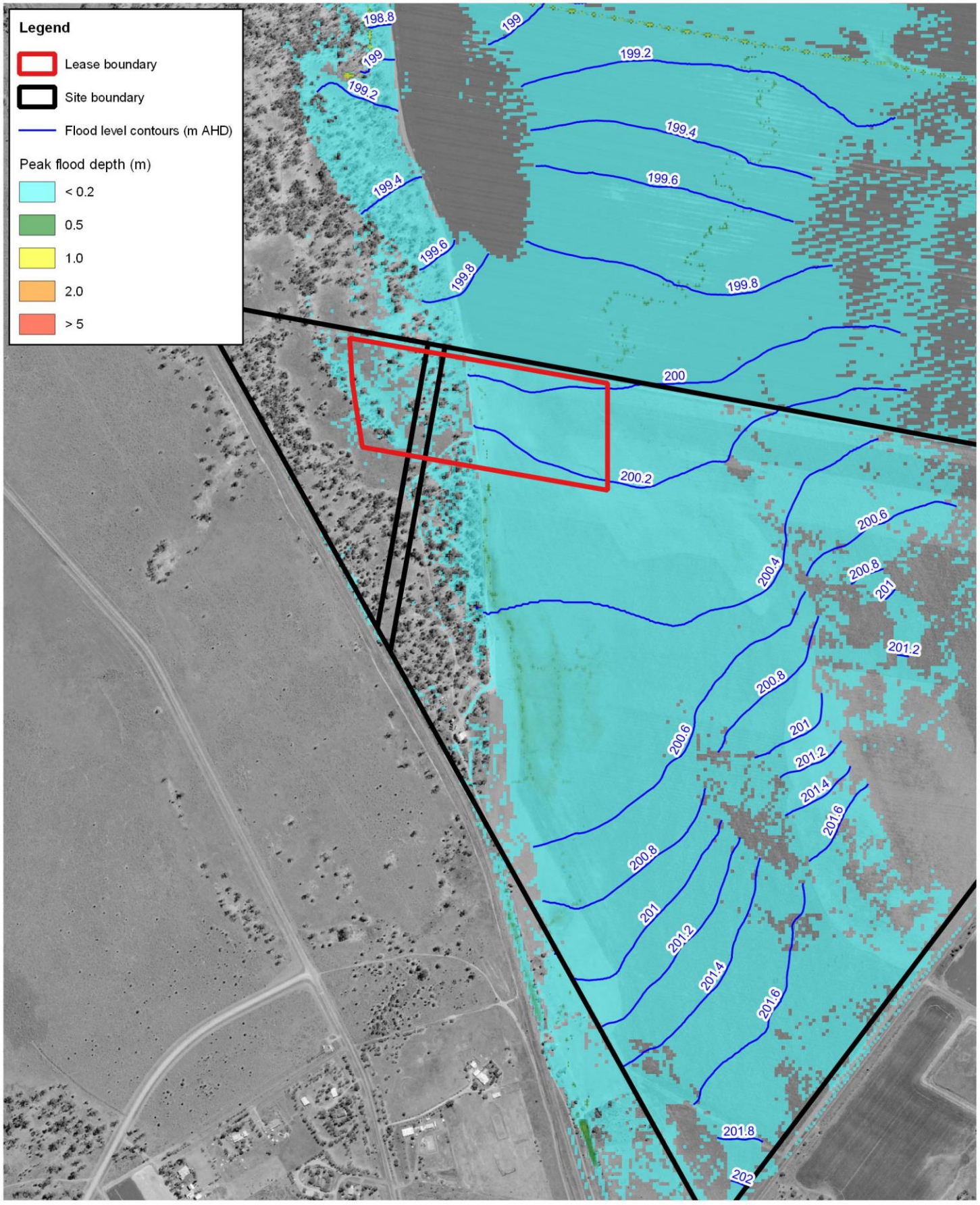

Title:

Modelled 1% AEP Flood Conditions
Local Catchment Rainfall

0 300 600 m

approx. scale

Figure: 9

Revision: A

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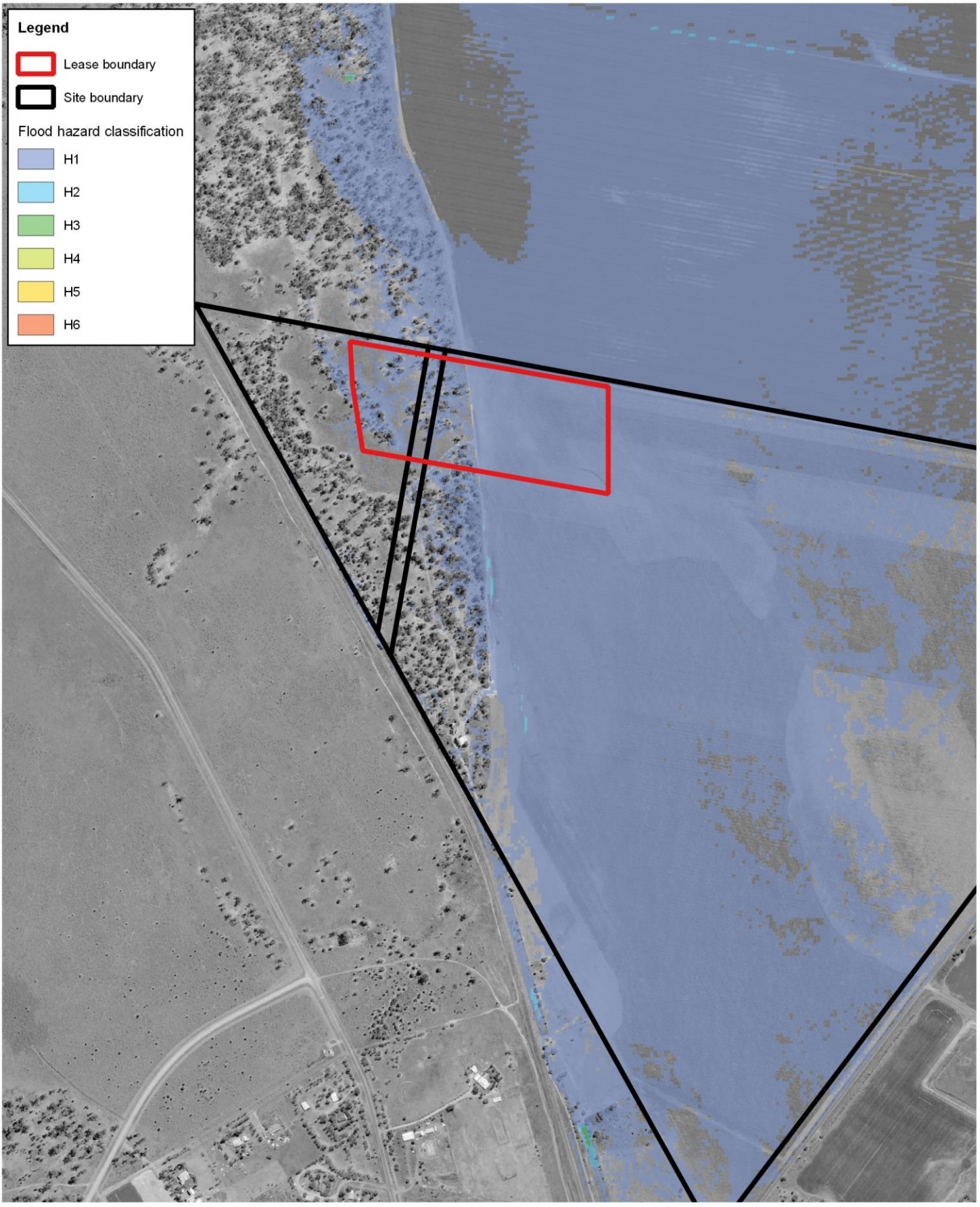

Title:

Modelled 1% AEP Flood Hazard
Local Catchment Rainfall

0 300 600 m

approx. scale

Figure: 10

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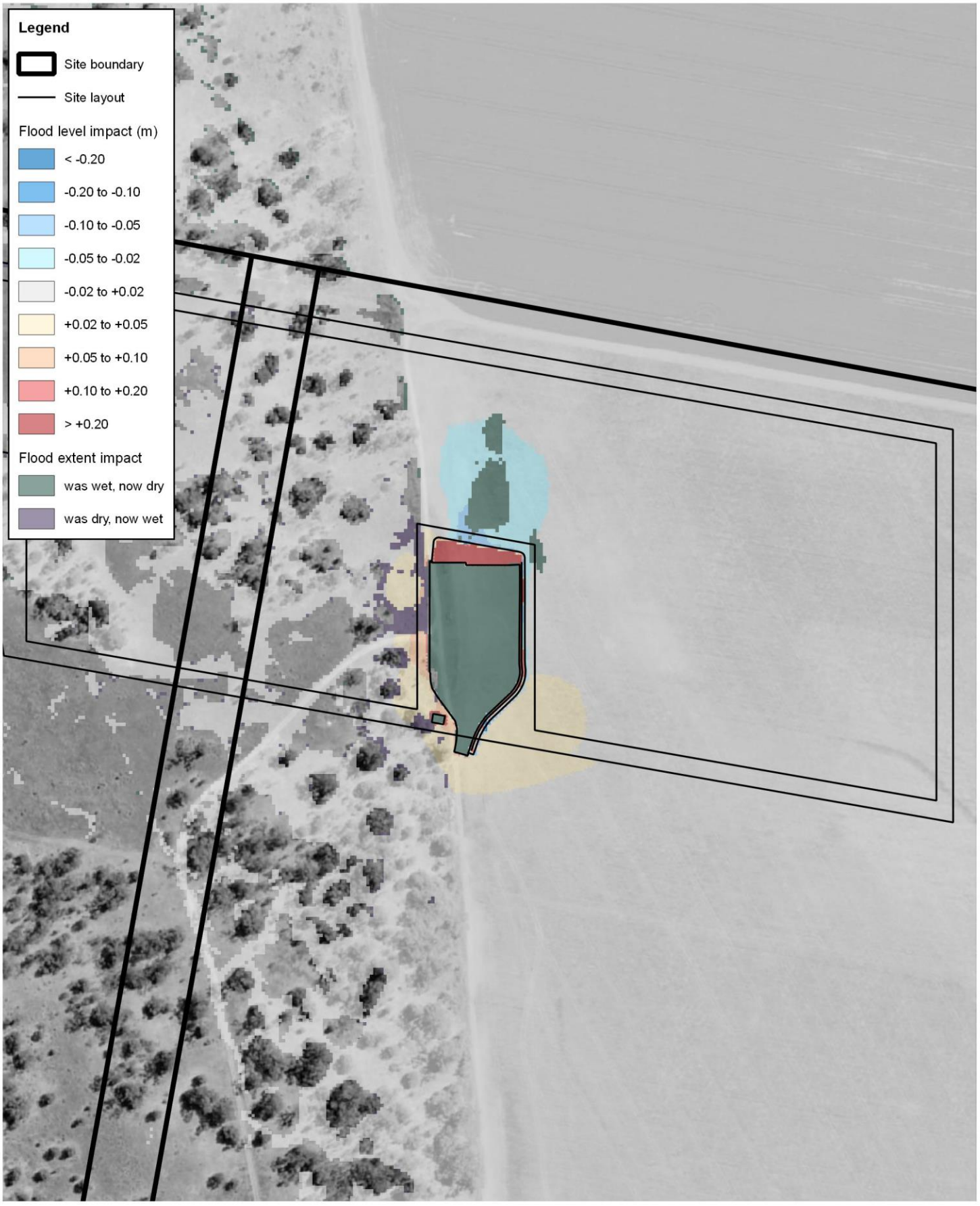

Title:

Modelled 1% AEP Flood Level Impact
Local Catchment Rainfall

0 80 160 m

approx. scale

Figure: 11

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Title:

Modelled 1% AEP Flood Velocity Impact
Local Catchment Rainfall

0 80 160 m

approx. scale

Figure: 12

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