Torrent Consulting Pty Ltd
86 Blanch Street
Shortland NSW 2307

ABN 11 636 418 089

www.torrentconsulting.com.au

Our Ref: DJW: L.T2257.003.docx

9 August 2022
Catalyze Property Consulting Pty Ltd
PO Box 44
Islington NSW 2296
Attention: Craig McGaffin

Dear Craig

RE FLOOD RISK ASSESSMENT FOR PLANNING PROPOSAL AT 16-21 CUSACK PLACE, YASS NSW

Background

Torrent Consulting was engaged to undertake a Flood Risk Assessment to assist in the approval process for the Planning Proposal at 16-21 Cusack Place, Yass NSW (the Site). It is understood that Yass Valley Council has requested a flood assessment, as the existing Flood Study does not cover the Site, but an overland flow path is identified as traversing the Site.

This Site is located at the southern end of Yass, as presented in Figure 1. It is situated at the head of three local catchments, as presented in Figure 2, each of which drain to the Yass River. Much of the Site has no upstream catchment reporting to it, but there is a catchment area of over 20 ha that enters the Site along the southern boundary.

A Preliminary Servicing Strategy has been prepared for the Site by 5QS (218025/A, dated 2 November 2021). The Strategy identified the need to manage the transfer of overland flood flows through the Site, from the southern to northern boundary.

The Yass Floodplain Risk Management Study and Plan (Lyall & Associates, 2021) also identifies the continuation of the overland flood flow path as being a floodway. However, the flood modelling and mapping undertaken to support the study has its upstream limit located around 330 m downstream of the Site. Therefore, a TUFLOW model has been developed for this assessment to provide flood risk mapping along the overland flow path at the Site.

Model Development

For this assessment, a TUFLOW model was developed covering the catchment of the overland flood flow path draining through the Site (as presented in Figure 3), which totals around 0.4 km^2 at the outlet on the northern boundary. The model utilised the NSW Spatial Services LiDAR data to define the floodplain topography and was constructed using a 4 m horizontal grid cell resolution. The sub-grid sampling routine was employed in TUFLOW to represent ground surface elevations at a 2 m horizontal spacing. Land use within the catchment is effectively pastural grassland and was assigned a Manning's 'n' roughness coefficient of 0.05.

There are a few hydraulic structures located within the modelled area and the dimensions of these have been assumed using the available aerial imagery and LiDAR data. The structure details do not have a significant impact on the model results at the Site but have been included for completeness.

The downstream boundary of the model was configured as an automatically generated stage-discharge curve with a slope of 1.2%, around 680 m downstream of the Site at Perry Street. Direct rainfall input was applied to the full modelled area to simulate catchment runoff. The five farm dams located within the modelled area were configured with initial water levels set at the initial point of overtopping of the dam walls.

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

Design Flood Hydrology

The TUFLOW model was simulated (using the HPC solver) for the 10% AEP, 5% AEP and 1% AEP design rainfall events for storm durations ranging from 10 minutes to two hours. The design rainfall depths were sourced from the BoM IFD (Intensity Frequency Duration) portal. Because of the small size of the catchment no areal reduction factor was applied. Design rainfall losses considered the recent NSW-specific guidance. This provided a continuing loss of 1.6 mm/h, with initial losses of around 11 to 12 mm.

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 outlet from the Site to identify the critical storm duration, i.e. that which produces the peak flood flow for each design event magnitude. The 60-minute duration was identified as being critical for the 1% AEP event, with the 90-minute duration being critical for the 10% AEP and 5% AEP events.

For the simulation of the PMF (Probable Maximum Flood) condition the Generalised Short Duration Method (GSDM) published by the BoM was adopted. Events for the 15-minute to 1-hour durations were simulated to determine the critical conditions. This found the Probable Maximum Precipitation (PMP) for the 15-minute duration to be critical, with a rainfall depth of 160 mm (~640 mm/h intensity). The simulated peak design flood flows at the Site are summarised in Table 1.

Table 1 – Modelled Peak Design Flood Flows at the Site

Design Event	Peak Flow (m^3/s)
10% AEP 90-min (3914)	1.8
5% AEP 90-min (3915)	2.3
1% AEP 60-min (3819)	3.5
PMF 15-min (GSDM)	77

Note: contents of parentheses denote the adopted design temporal pattern ID

Baseline Design Flood Conditions

Figure 4 presents the modelled peak flood extents at the Site for the 5% AEP, 1% AEP and PMF events, with the Site boundary shown for context. Figure 5, Figure 6 and Figure 7 are presented for additional context and show the modelled peak flood depths and peak flood level contours for the 5% AEP, 1% AEP and PMF events respectively.

The modelled peak flood depths along the overland flow path through the Site are typically less than 150 mm at the 5% AEP event and less than 200 mm at the 1% AEP event, expect locally within the trapped depression behind the existing access road. At the PMF event the peak flood depths are around 0.8 m. The modelled flood gradient is around 1.3%.

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.

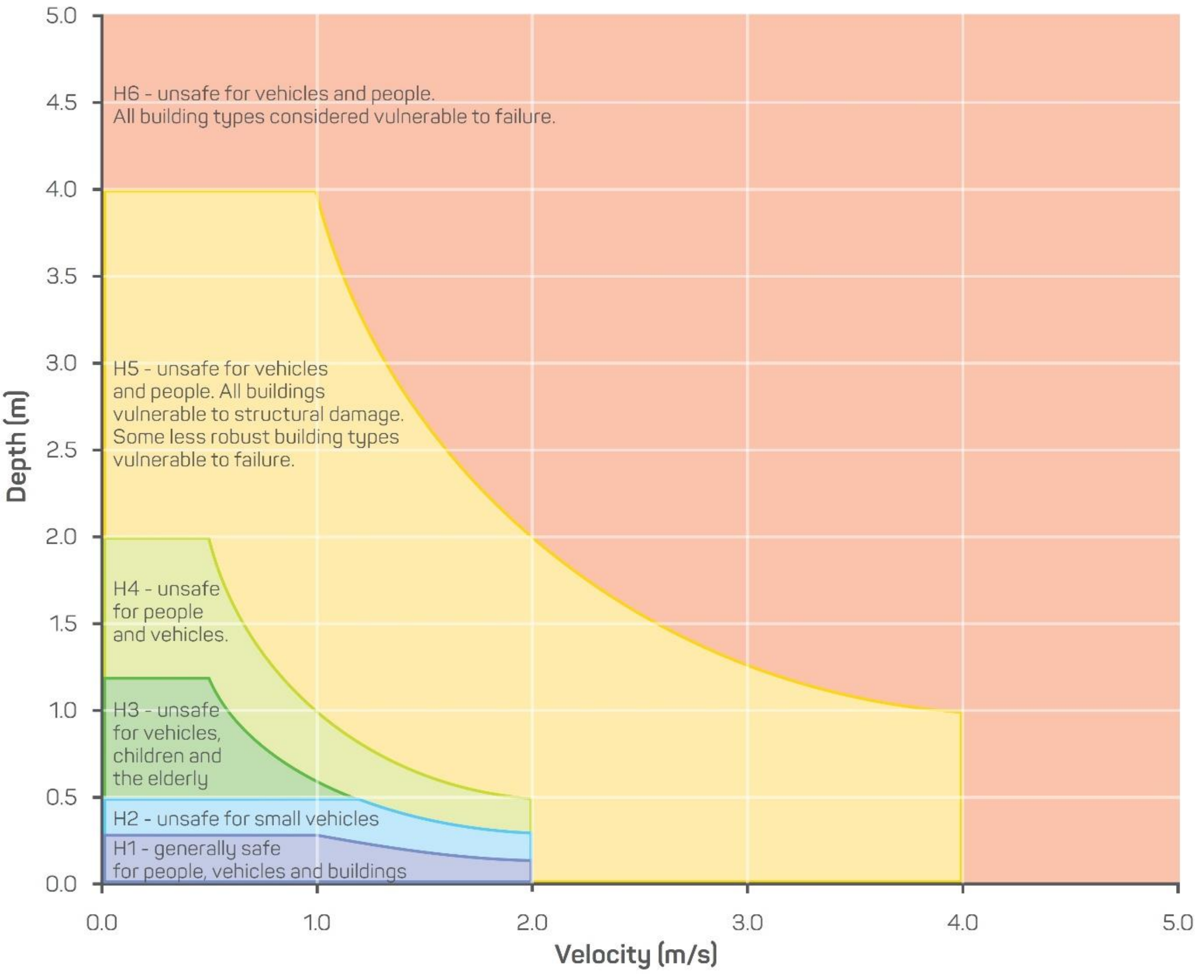


Chart 1 – General Flood Hazard Vulnerability Curves (AIDR, 2017)

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.

At the 1% AEP event the flood hazard within the Site is low and does not present a significant risk to people or property. However, at the PMF event, the combined depth and velocity conditions result in a high hazard that requires management to reduce the risk.

Floodplain Risk Management Considerations

The principal management measure for the risk to property from flooding is the application of a Flood Planning Level, for which the standard for residential property in NSW is 0.5 m above the 1% AEP flood level. However, a reduced freeboard is often considered in the case of overland flood flow paths with only shallow flood depths, such as the one that traverses the Site. A minimum freeboard of 0.3 m is advisable. The resultant Flood Planning Area (FPA) that captures the land within 0.3 m above the 1% AEP flood at the Site is presented in Figure 11 and is consistent with the extent of the H2 or higher flood hazard area at the PMF event.

Excluding residential development from the FPA would effectively manage both the risk to life and risk to property from flooding at the Site. The FPA covers around 2.06 ha of the Site and is typically around 72 m wide. However, local raising of the ground surface through bulk earthworks can serve to manage the flood risk and increase the development yield of the Site.

The TUFLOW model was used to modify the ground surface levels adjacent to the overland flood flow path and contain the floodway within an easement, which was varied in width to determine the resultant flood impacts. An easement width of around 30 m (as shown in Figure 11) was found to contain the floodway with only a limited increase in flood depth. Reducing the modelled easement width from 30 m resulted in an exponential increase in the modelled peak flood depths within the easement. A 30 m easement width results in a 1% AEP flood depth of around 0.2 m and a PMF depth of around 1.0 m.

A fill height of over 0.5 m on residential lots adjacent to the floodway easement would exclude them from the proposed FPL of the 1% AEP plus 0.3 m freeboard. It will also contain the high hazard flood area of the PMF event within the easement, with only low hazard flood conditions within the adjacent lots, as presented in Figure 12.

The construction of a formalised floodway easement will require widening at each end to transition from upstream flood flows entering the Site and downstream flows exiting the Site. The floodway easement concept modelled in this assessment occupies an area of around 1.01 ha, providing an additional 1.05 ha of potentially developable land.

If subdivision of the Site is to include a road crossing of the floodway, then the impacts of that will need to be considered, including the serviceability of the road, cross-drainage provision, potential structure blockage, and increased upstream flood levels impacting the adjacent lots.

Alternatively, a roadway can form the floodway easement. In this case, subsurface stormwater drainage will need to be designed to convey the 10% AEP flood, with the roadway then conveying the 1% AEP flood, as per the minor drainage and major drainage system approach. This design would provide the roadway with a 10% AEP flood immunity and only low hazard flood waters being conveyed within the roadway at the 1% AEP flood event. As per Table 1, the 10% AEP and 1% AEP peak flows are 1.8 m^3/s and 3.5 m^3/s, respectively.

Conclusion

Torrent Consulting was engaged to undertake a Flood Risk Assessment to assist in the approval process for the Planning Proposal at 16-21 Cusack Place, Yass NSW. This assessment has included development of a TUFLOW model for the local catchment and has simulated design flood conditions in accordance with the ARR 2019 guidelines, specifically the ensemble method for design flood hydrology.

Flood hazard mapping has been produced that shows that the Site is of a relatively low flood risk and is suitable for subdivision, as most of the proposed subdivision is outside of the floodplain. The risk to life and risk to property from flooding can be readily managed through application of a 0.3 m freeboard above the 1% AEP flood and the exclusion of residential development from within the resultant FPA. However, local raising of the ground surface through bulk earthworks can serve to manage the flood risk and increase the development yield of the Site.

The construction of a formalised floodway easement of a 30 m width and 0.5 m depth (through the raising of adjacent lots) will contain the FPA and the high hazard flood conditions of a PMF event, providing an additional 1.05 ha of potentially developable land.

If subdivision of the Site is to include a road crossing of the floodway, then the impacts of that will need to be considered, including the serviceability of the road, cross-drainage provision, potential structure blockage, and increased upstream flood levels impacting the adjacent lots.

Alternatively, a roadway can form the floodway easement. In this case, subsurface stormwater drainage will need to be designed to convey the 10% AEP flood, with the roadway then conveying the 1% AEP flood, as per the minor drainage and major drainage system approach. This design would provide the roadway with a 10% AEP flood immunity and only low hazard flood waters being conveyed within the roadway at the 1% AEP flood event. As per Table 1, the 10% AEP and 1% AEP peak flows are 1.8 m^3/s and 3.5 m^3/s, respectively.

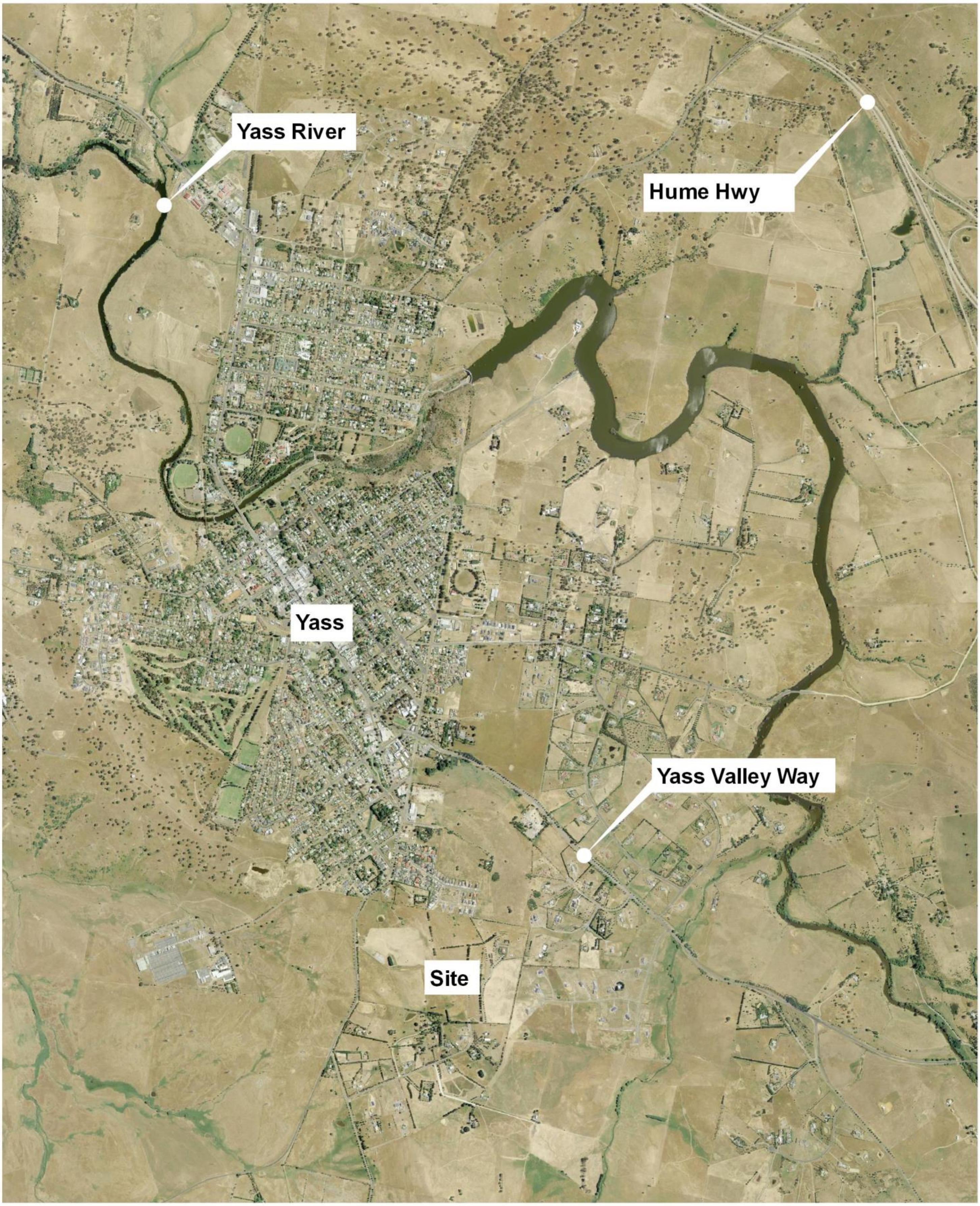
We trust that this report meets your requirements. For further information or clarification please contact the undersigned.

Yours faithfully

Torrent Consulting

Daniel Williams

Dan Williams
Director



Title:

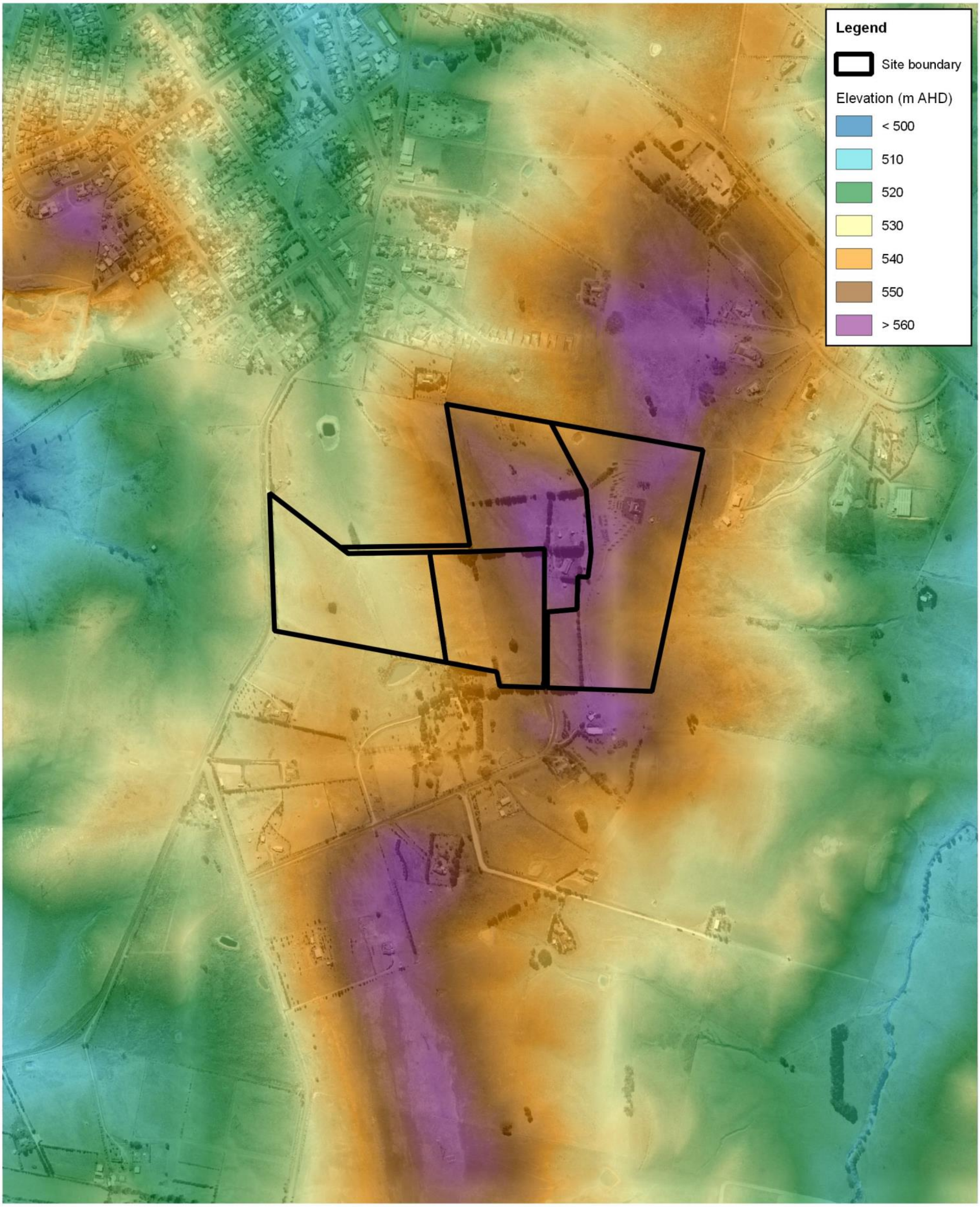
Study Locality

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.*
Revision:	A	

Filepath: \Projects\T2257_Cussack_Pl_FRA\GIS\T2257_001_220728_Locality.qgz

Torrent CONSULTING

www.torrentconsulting.com.au



Title:

Local Catchment Topography

0 300 600 m

approx. scale

Figure: **2**

Revision: **A**

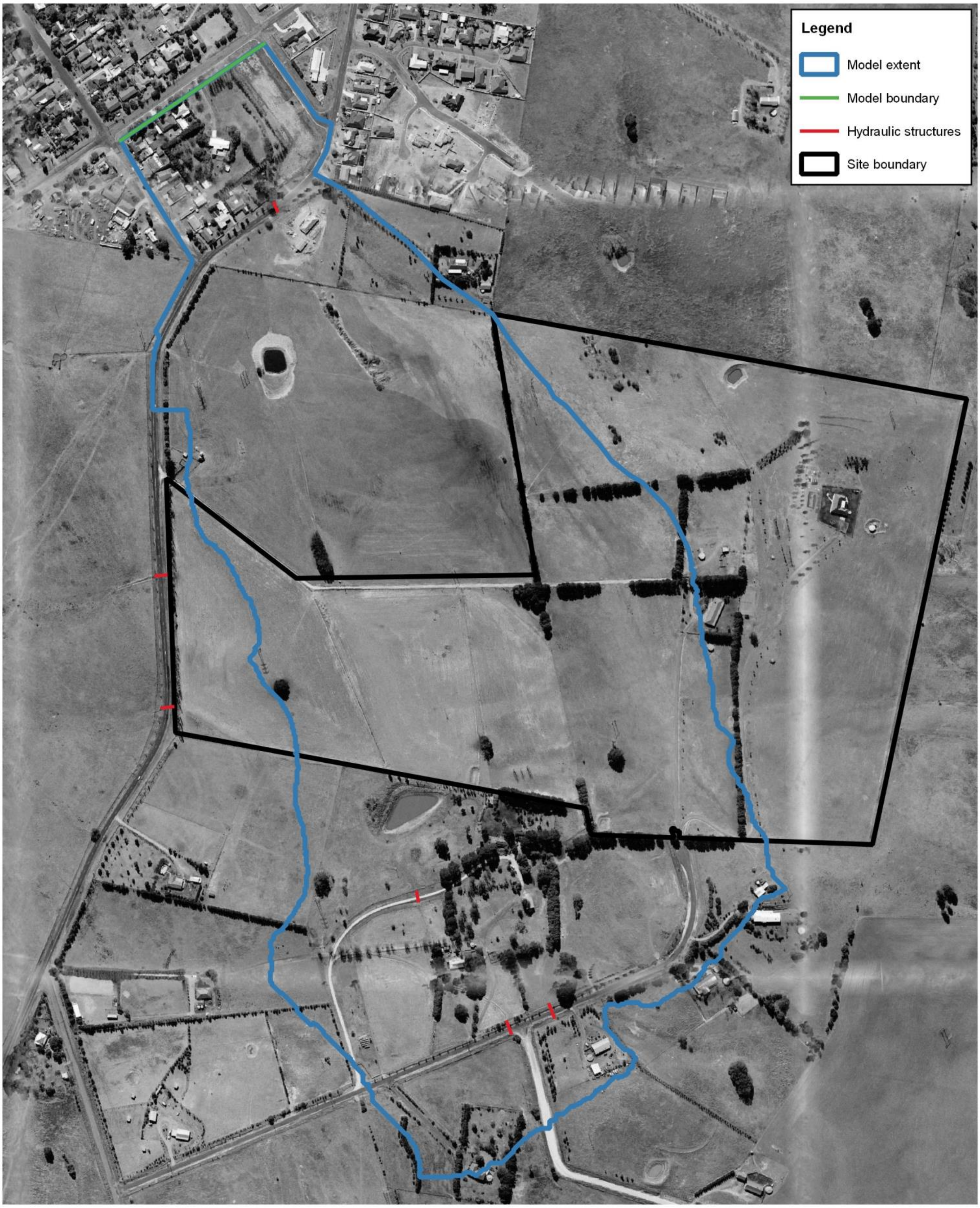
Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or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

N

Torrent CONSULTING

www.torrentconsulting.com.au

Filepath: \Projects\T2257_Cussack_Pl_FRA\GIS\T2257_002_220728_Topography.qgz



Title:

TUFLOW Model Components

0 100 200 m

approx. scale

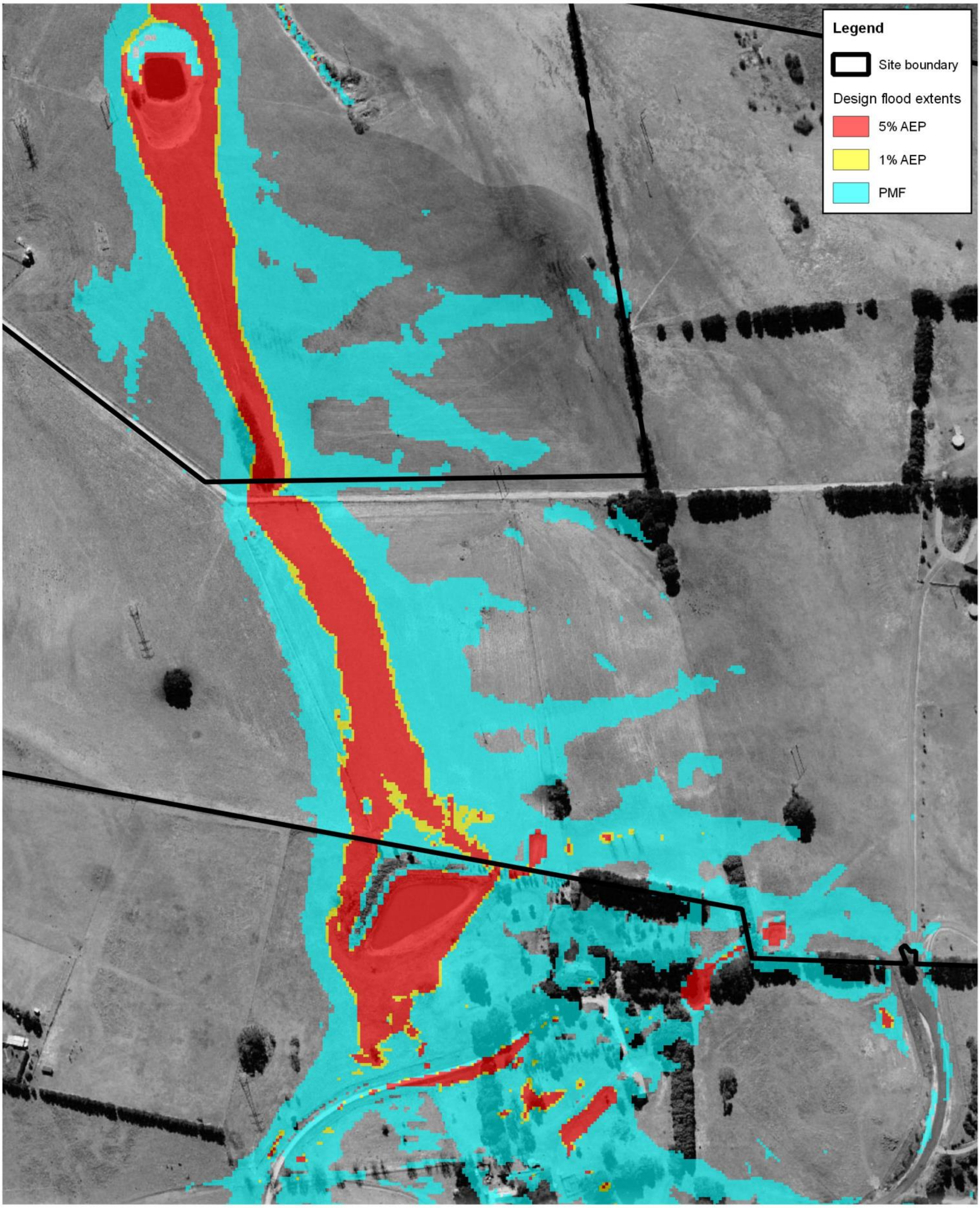
Figure:	3	*Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.*
Revision:	A	

N

Torrent CONSULTING

www.torrentconsulting.com.au

Filepath: \Projects\T2257_Cussack_Pl_FRA\GIS\T2257_003_220728_TUFLOW.qgz



Title:

Modelled Design Flood Extents

Figure: **4**

Revision: **A**

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.

Torrent CONSULTING
www.torrentconsulting.com.au

Filepath: \Projects\T2257_Cussack_Pl_FRA\GIS\T2257_004_220728_Extents.qgz

Title:

Modelled 5% AEP Flood Depths and Levels

0 90 180 m

approx. scale

Figure: 5

Revision: A

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.

N

Torrent CONSULTING

www.torrentconsulting.com.au

Filepath: \Projects\T2257_Cussack_Pl_FRA\GIS\T2257_005_220728_20y_levels.qgz

Title:

Modelled 1% AEP Flood Depths and Levels

0 90 180 m

approx. scale

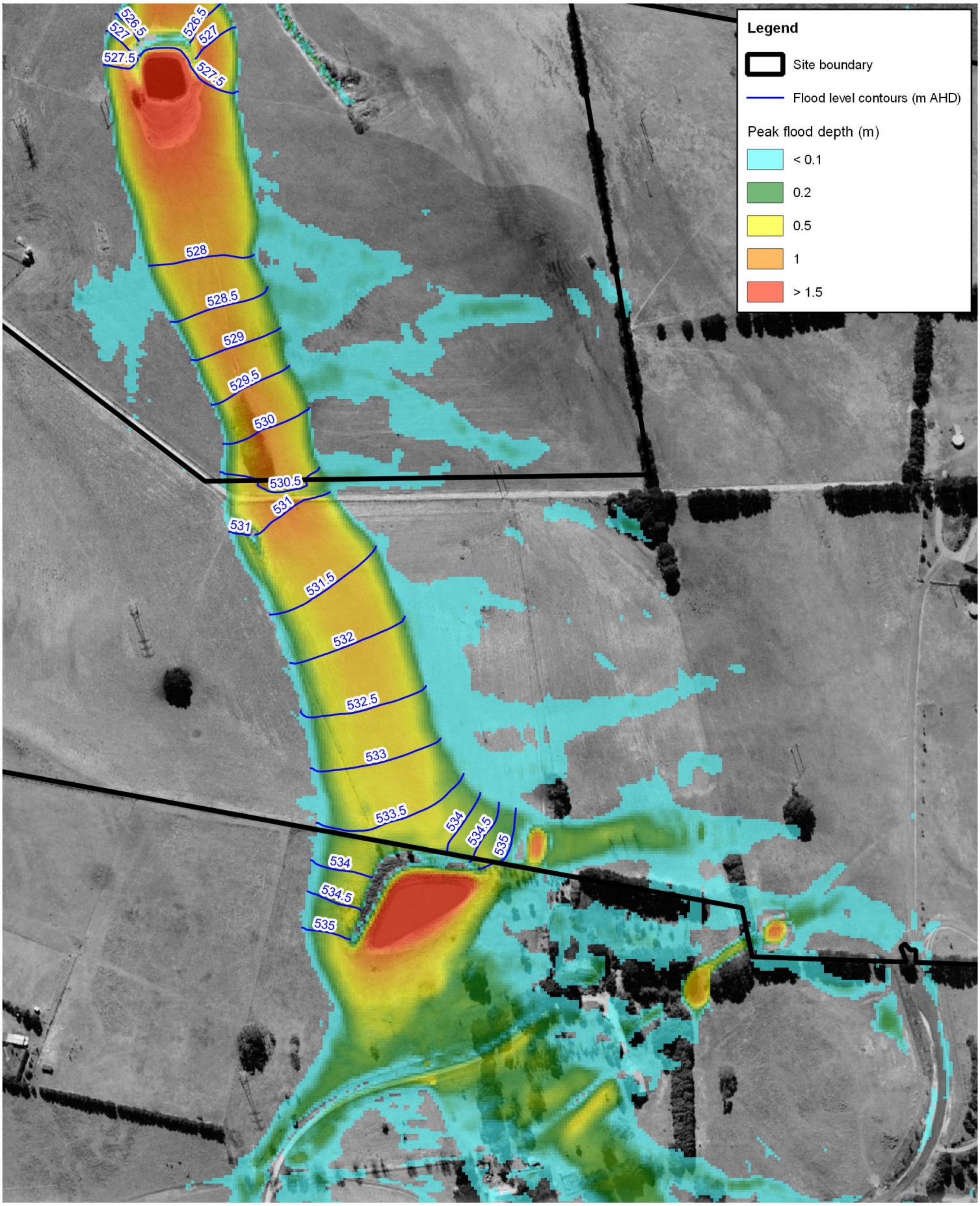
Figure:	**6**	*Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.*
Revision:	**A**	

N

Torrent CONSULTING

www.torrentconsulting.com.au

Filepath: \Projects\T2257_Cussack_Pl_FRA\GIS\T2257_006_220728_100y_levels.qgz



Title:

Modelled PMF Flood Depths and Levels

0 90 180 m

approx. scale

Figure:	7
Revision:	A

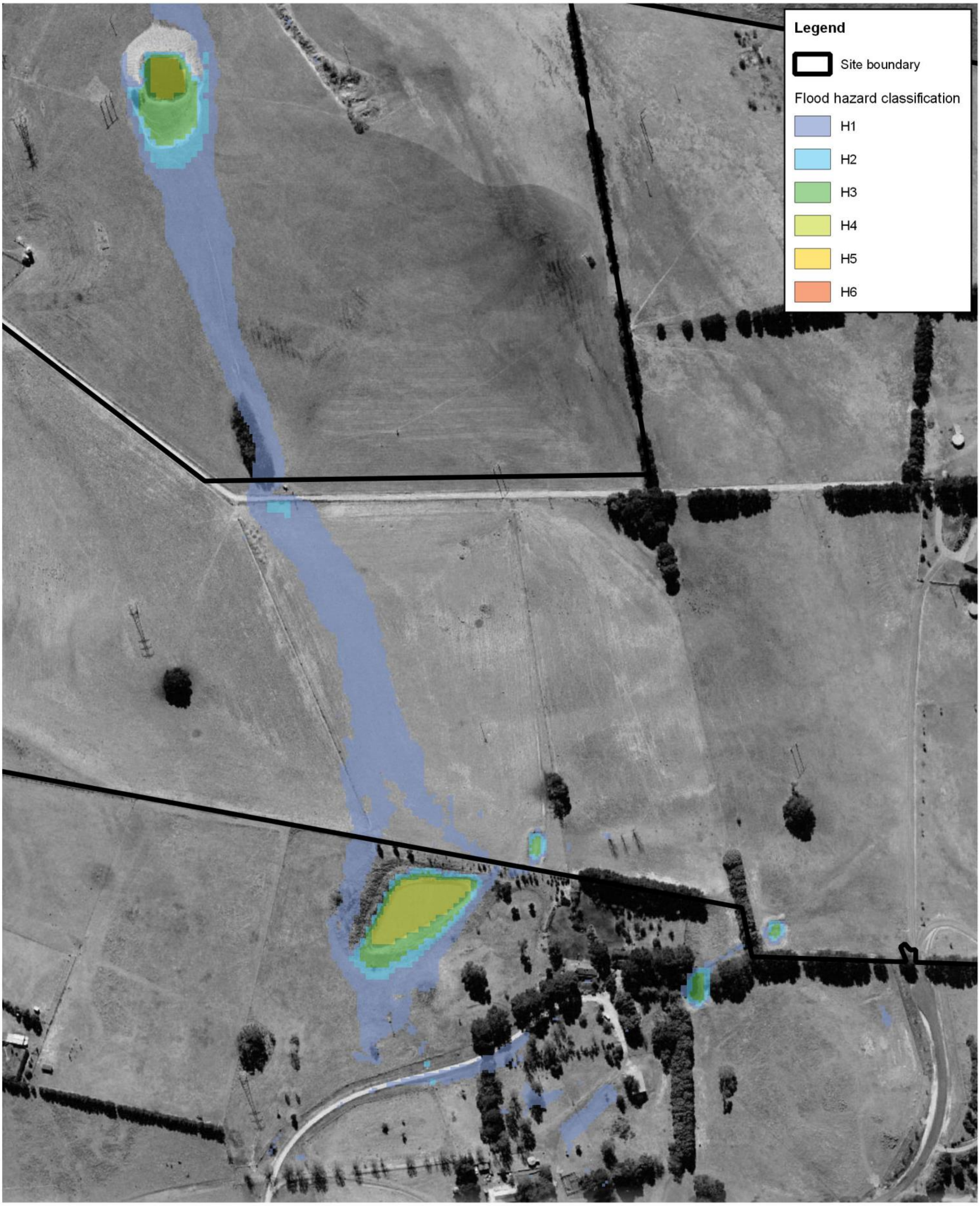
Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or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

N

Torrent CONSULTING

www.torrentconsulting.com.au

Filepath: \Projects\T2257_Cussack_Pl_FRA\GIS\T2257_007_220728_PMF_levels.qgz



Title:

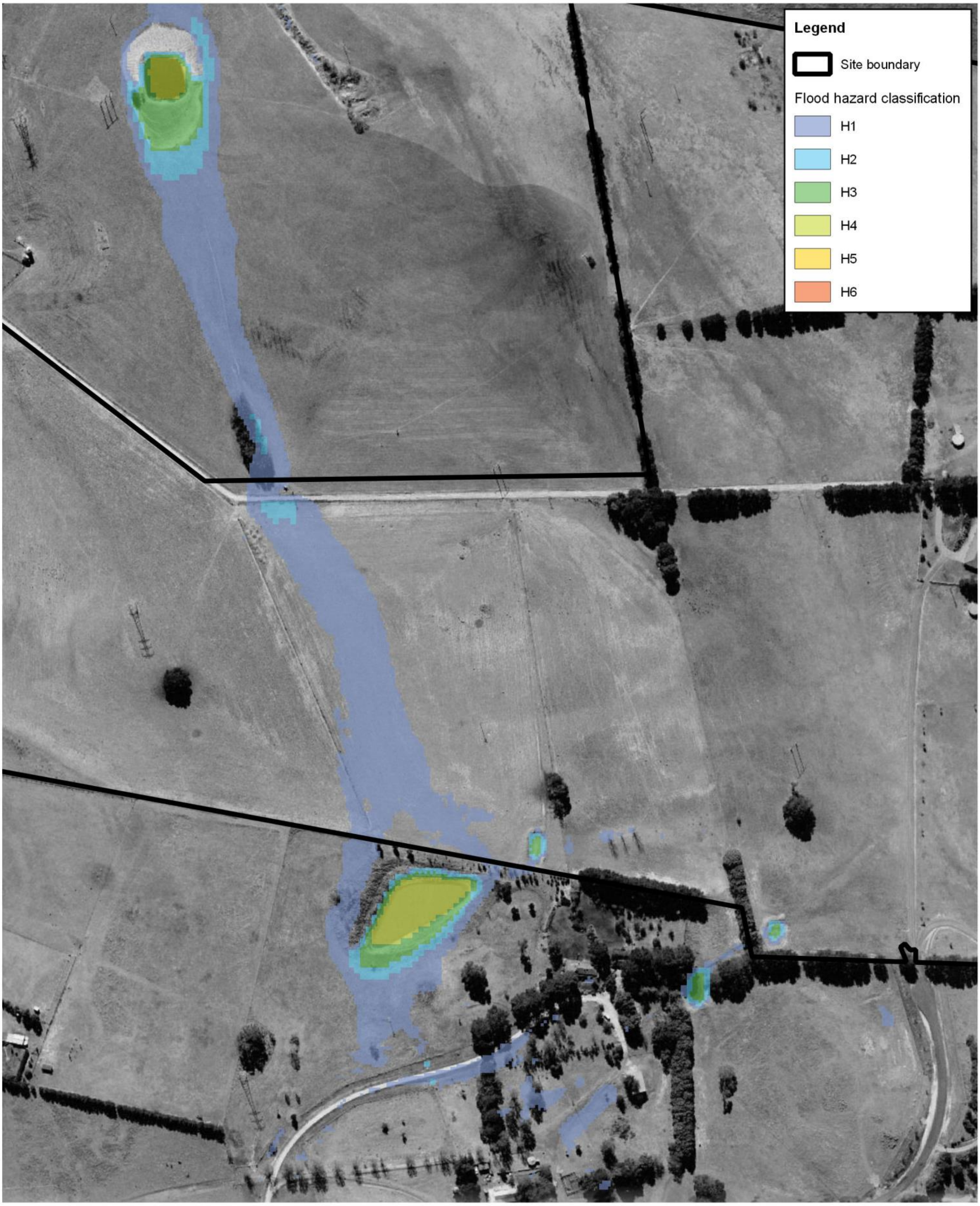
5% AEP Flood Hazard Classification

Figure:	8	*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 guerentees 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.*
Revision:	A	

Filepath: \Projects\T2257_Cussack_Pl_FRA\GIS\T2257_008_220728_20y_hazard.qgz

Torrent CONSULTING

www.torrentconsulting.com.au



Title:

1% AEP Flood Hazard Classification

0 90 180 m

approx. scale

Figure: 9

Revision: A

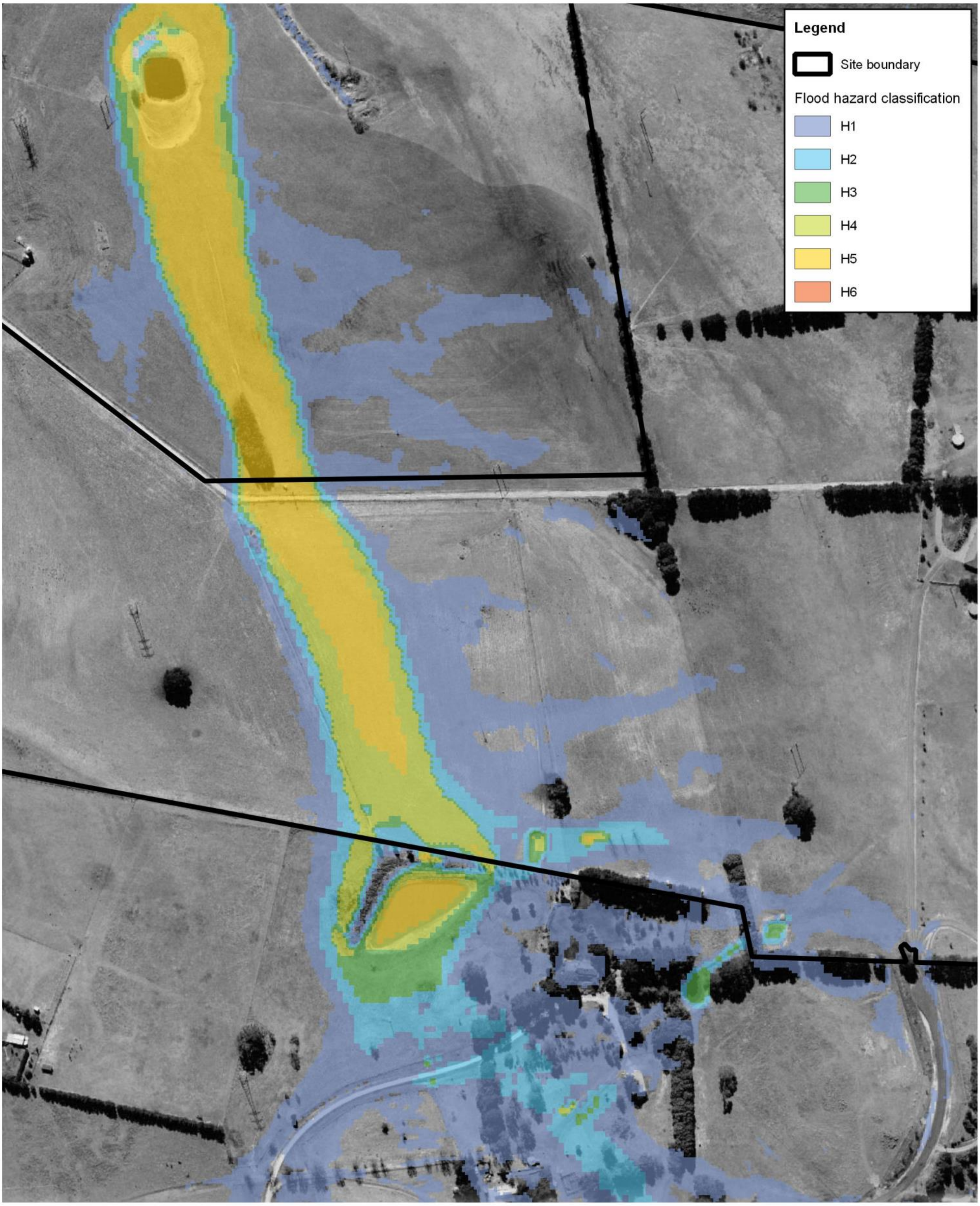
Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or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

N

Torrent CONSULTING

www.torrentconsulting.com.au

Filepath: \Projects\T2257_Cussack_Pl_FRA\GIS\T2257_009_220728_100y_hazard.qgz



Title:

PMF Flood Hazard Classification

0 90 180 m

approx. scale

Figure:	10
Revision:	A

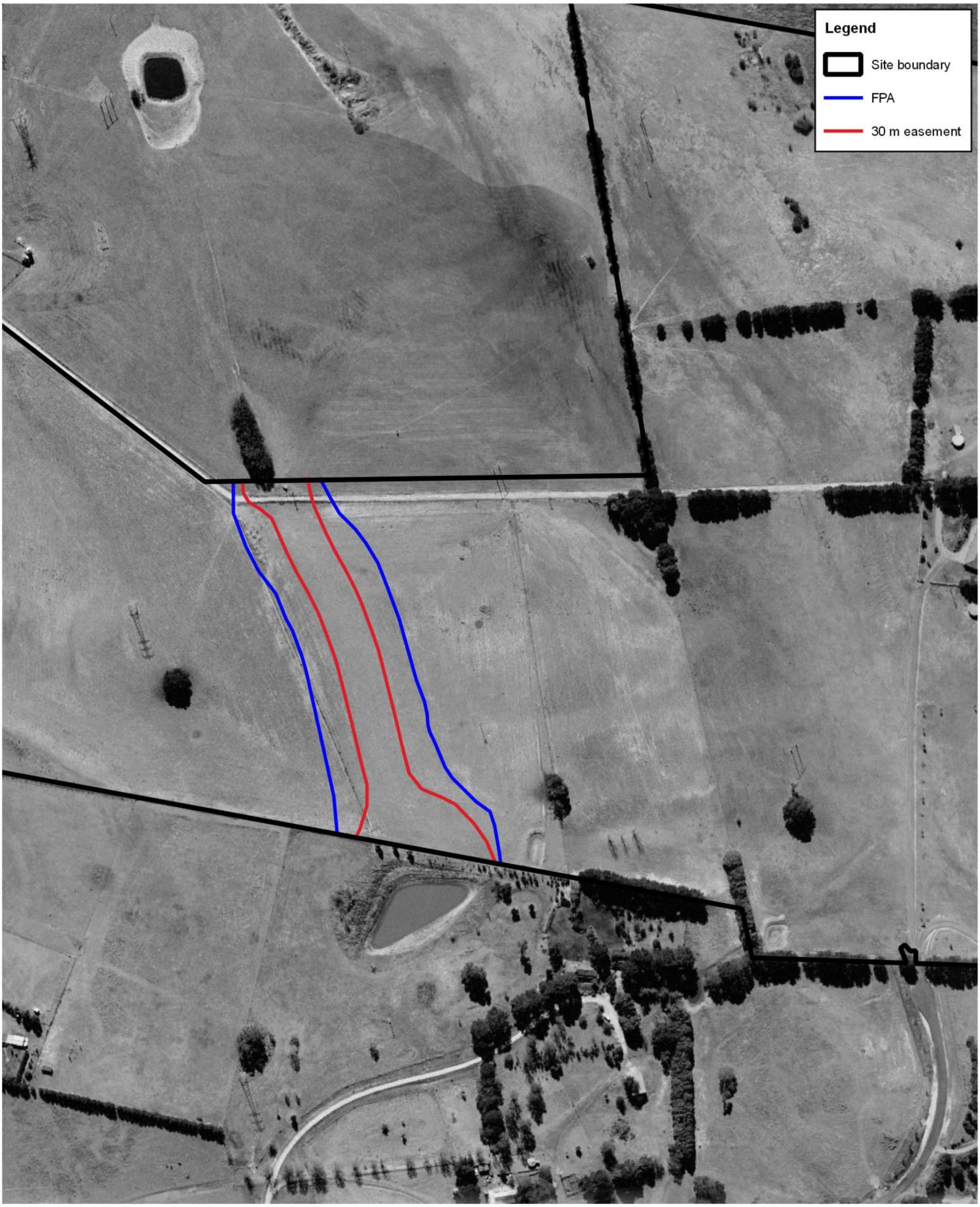
Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or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

N

Torrent CONSULTING

www.torrentconsulting.com.au

Filepath: \Projects\T2257_Cussack_Pl_FRA\GIS\T2257_010_220728_PMF_hazard.qgz



Title:

Flood Risk Management Considerations

0 90 180 m

approx. scale

Figure:	11
Revision:	A

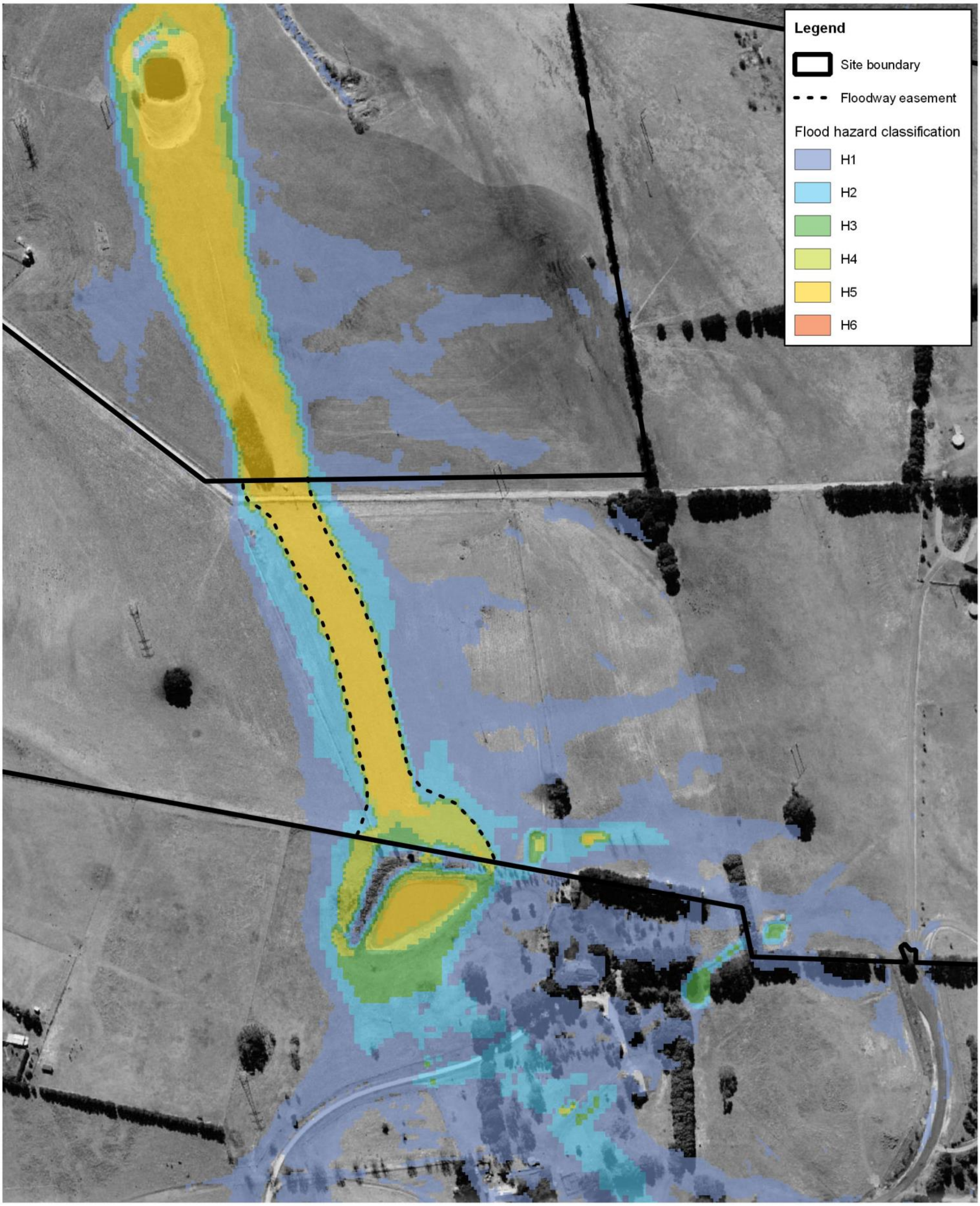
Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or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

N

Torrent CONSULTING

www.torrentconsulting.com.au

Filepath: \Projects\T2257_Cussack_Pl_FRA\GIS\T2257_011_220728_Management.qgz



Title:

PMF Flood Hazard Classification with Construction of a 30 m wide Floodway Easement

0 90 180 m

approx. scale

Figure: **12**

Revision: **A**

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.

N

Torrent CONSULTING

www.torrentconsulting.com.au

Filepath: \Projects\T2257_Cussack_Pl_FRA\GIS\T2257_012_220728_Easement.qgz