

Baldon Wind Farm - Hydrology & Flooding Assessment

Technical Report for Environmental Impact Statement



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1 Introduction

This report presents the flood assessment undertaken on behalf of NGH Pty Ltd (for Baldon Wind Farm Pty Ltd) to support the State Significant Development Application (SSD-40138508) of the proposed Baldon Wind Farm Project (the “Project”). The flood assessment was undertaken to address the Secretary’s Environmental Assessment Requirements (SEARs) for SSD-40138508, including those recommended by the Biodiversity and Conservation Division (BCD) of DPE. The main objectives are to establish the flood risks and flood impacts of the Project infrastructure including the proposed wind turbine generators (WTGs) and waterway crossings.

1.1 Site Description

The site is located at Baldon Road, approximately 48 km east of Balranald in the Murray River and Hay local government areas (LGAs). The site covers an extent in the order of 46,000 ha (refer Figure 1.1), and falls within the following two catchments:

- Abercrombie Creek; and
- Forest Creek.

The Abercrombie Creek catchment covers the majority of the site, flowing in a westward direction, while The Forest Creek catchment encroaches on a small portion of the site (at the south-east extent). Yanco Creek (which becomes “Billabong Creek”, shown in Figure 2.2) is located in the next catchment south of The Forest Creek, therefore was not included within the model extent. Breakout flows from the Murrumbidgee River to the north of the site have been assessed in an extreme event scenario.

The Sturt Highway passes to the north of the site. The Project is located on rural land which is primarily used for sheep grazing, with some limited agriculture uses outside pasturing.

The existing topography around the Project site is shown in Figure 1.2 and is based on the 1 m Digital Elevation Model (DEM) generated from LiDAR (Light Detection and Ranging) data collected in 2021 available from the Elevation and Depth - Foundation Spatial Data (“ELVIS”) webpage¹. Based on the topographic information, the Project site terrain was found to vary between 65 and 80 m AHD, which signifies a flat terrain and typically sloping towards the south and west. A series of lake systems is found to the southwest, all of which eventually discharge into the Murray-Darling River System along with the Abercrombie Creek system.

1.2 Scope of Assessment

The following tasks have been undertaken as part of the assessment:

- Review of available topographic and flood information for the Project site;
- Review of aerial imagery;
- Review of stream gauge data;
- Simulation and assessment of on-site flood risk for design flood events including the 5% Annual Exceedance Probability (AEP), 1% AEP, the Probable Maximum Flood (PMF), the 0.5% and 0.2%

¹ <https://elevation.fsd.org.au/>

AEP events as proxies for climate change, and breakout flows from the Murrumbidgee River in an extreme event scenario;

- Review of the proposed development works and assessment of flood impacts; and
- Summary of how SEARs have been addressed.

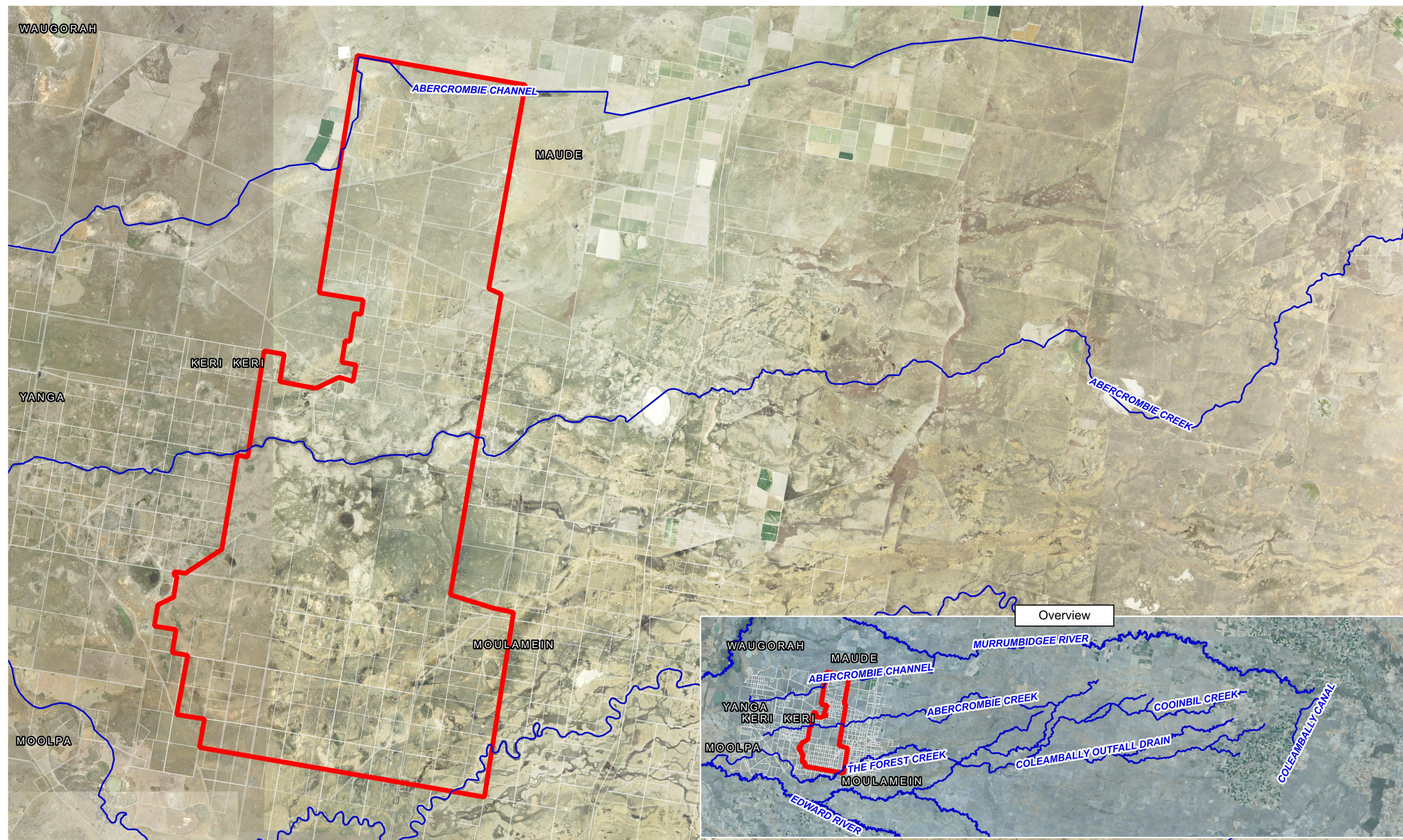
The study focuses on the following two types of flooding which are present in different parts of the study area:

- **Local catchment flooding**, which is experienced in upstream rural and vegetated areas during periods of heavy rain. Local catchment flooding is characterised by relatively shallow and slow-moving floodwater.
- **Murrumbidgee River flooding**, which occurs when floodwater breaks out from the Murrumbidgee River. Murrumbidgee River flooding is typically characterised by relatively deep and faster flowing floodwater in the main channel of the river but can include shallower and slower moving floodwater in overbank areas.

1.3 Relevant Council Studies

Previous key flood studies in the Murrumbidgee catchment include:

- Hay and Maude Flood Study (Lyall & Associates, 2023)
- Murrumbidgee River at Darlington Point and Environs Flood Study (BMT, 2018)



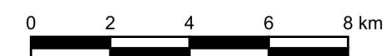
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- Project Extent
- Cadastre
- Hydrolines

Title:

Site Locality

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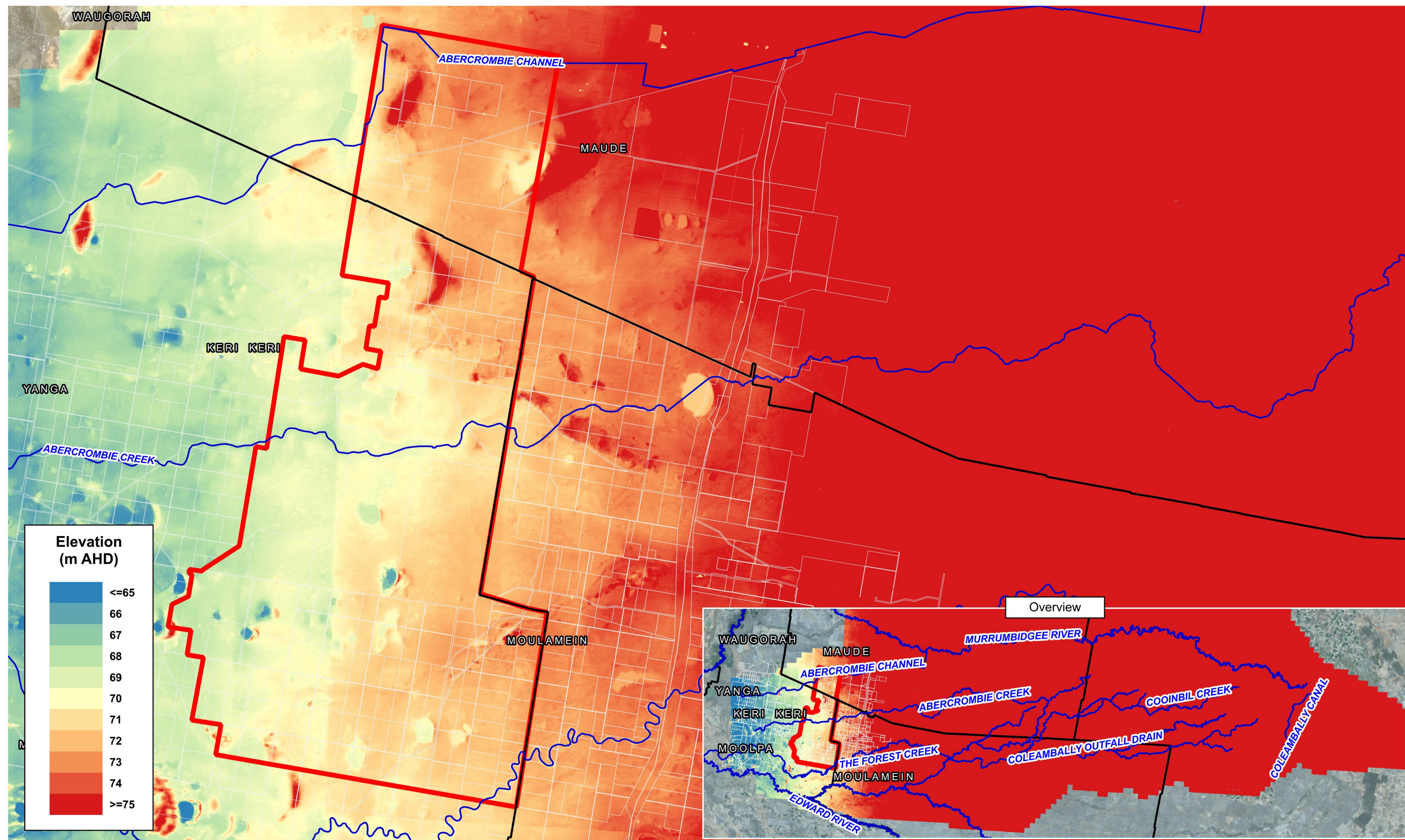
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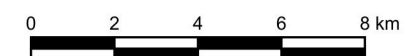
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- Project Extent
- LGA Boundary
- Cadastre
- Hydrolines

Title:

Site Topography

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Fig 1.2

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1.4 Project Description

The Project involves the construction, operation, maintenance and decommissioning of a wind energy facility (WEF) and associated infrastructure, as generally illustrated on Figure 1.3.

As noted in the EIS (Goldwind, 2024) and subsequent Submissions Report (Goldwind, 2025), it is understood that this includes:

- Up to approximately 180 WTGs with a maximum height of 300 m;
- A Battery Energy Storage System (BESS) with a nominal storage of 200 MW / 400 MWh at a centralised location or distributed at turbine hardstands; and
- Ancillary infrastructure including site offices, internal roads, underground and overhead cabling, substations, transmission lines and grid connection to the transmission network.

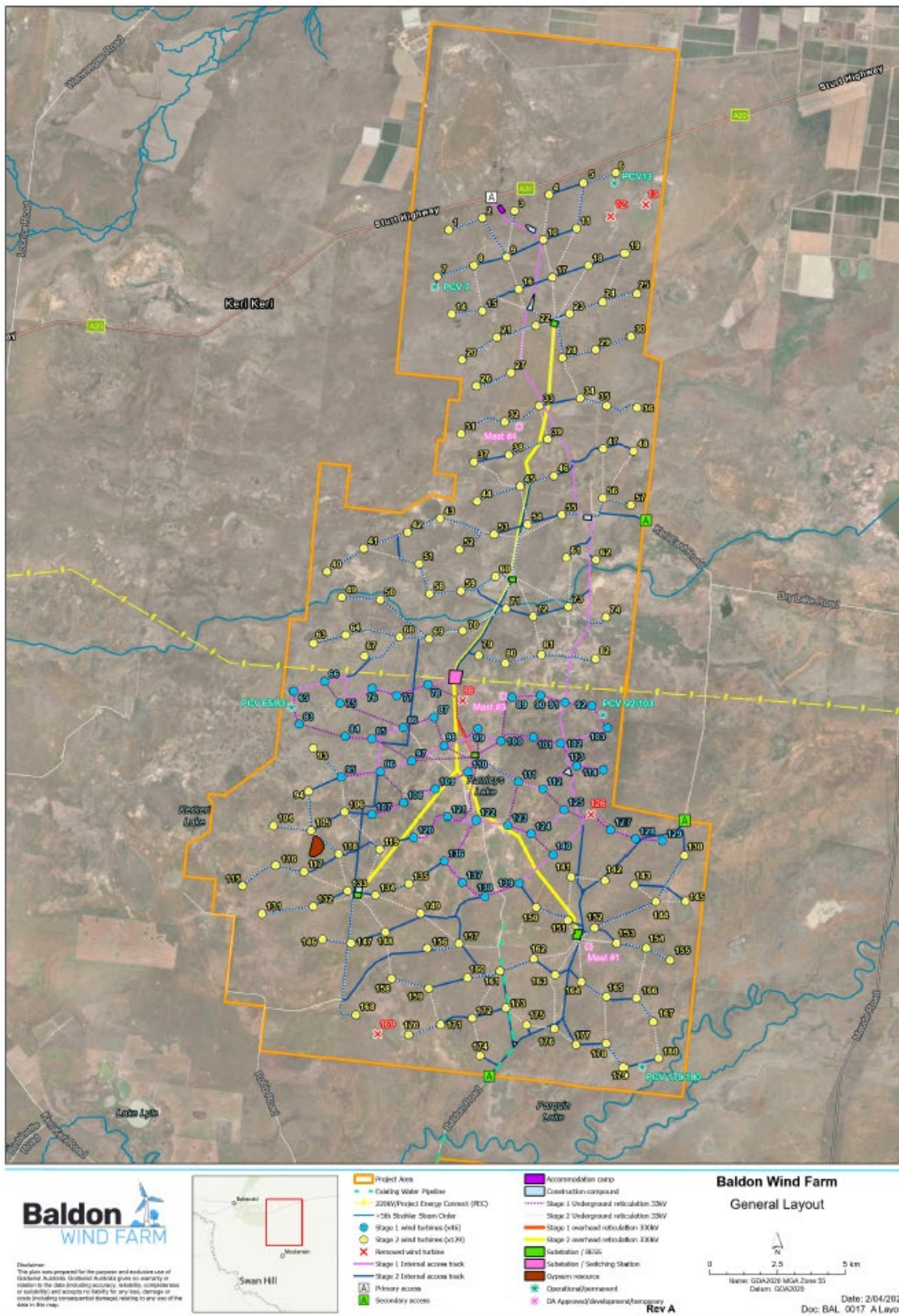


Figure 1.3 General Layout.

2 Methodology

The flood assessment has been undertaken in accordance with Australian Rainfall and Runoff 2019 (ARR 2019) data and methodology to establish existing (baseline) and post-development flood behaviour for the Project site. The assessment approach is discussed further in the following sections.

2.1 Input Data

To facilitate the assessment, the following datasets were reviewed and used to inform the assessment:

- Aerial imagery of the study area;
- Project description (current as of March 2025, for Submissions Report);
- Project layout as GIS files. Digital Elevation Model (DEM) in 1 m resolution tiles based on LiDAR aerial survey obtained from 2021 by the NSW Government²;
- Cadastral information and hydrolines (watercourses) from SIX Maps³;
- Bureau of Meteorology (BoM) 2016 design rainfalls⁴; and
- Storm losses and temporal patterns for design rainfalls from ARR Data Hub⁵.

2.1.1 Elevation Data Limitations

A review of the available DEM, downloaded from ELVIS, identified irregularities in the elevation data covering a large portion of the study area. Figure 2.1 below illustrates the DEM downloaded from ELVIS. The irregularities are visible as vertical lines across the model area. The vertical lines imposed artificial embankments across the floodplain at regular intervals of five kilometres, which is consistent with the width of the LiDAR tiles. While it is difficult to determine the cause of this error, it is likely a result of faults in capturing or processing the original data points. Given this was the only DEM available, the assessment has been completed using this data. Results from the hydraulic model are likely overestimating the flooding extent upstream of each vertical line and underestimating the flooding extent downstream.

The DEM data was downloaded from NSW Spatial Services which is publicly available data commonly used for flood modelling, and has been used for other flood studies in the region. Following review of the DEM data, the impact due to artificial ridge lines is considered minimal, as implications are isolated to the LiDAR tile transitions, and do not appear to affect broader outcomes of the assessment.

² <https://elevation.fsdf.org.au/>

³ <https://maps.six.nsw.gov.au/clipnship.html>

⁴ <http://www.bom.gov.au/water/designRainfalls/revised-ifd/>

⁵ <https://data.arr-software.org/>

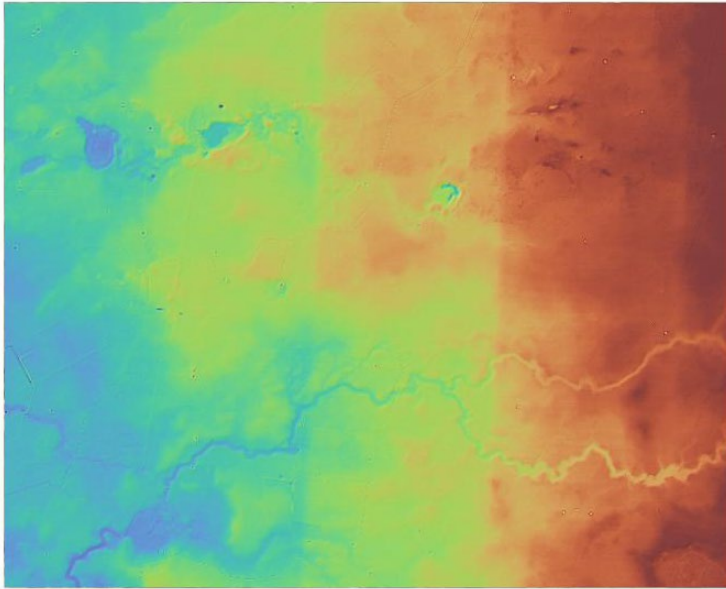


Figure 2.1 DEM vertical lines

2.2 Local Catchment Modelling

2.2.1 Hydrology

As part of the flood assessment, a Rainfall on Grid (RoG) hydraulic model was developed based on ARR 2019 data and methodology to facilitate the design flood simulation of the 5%, 1%, 0.5%, 0.2% AEP and PMF events for the study area.

Spatially distributed design rainfall was obtained from the BoM at 40 locations in the study area, for a range of durations across the design storm events. This provides the spatial distribution of design rainfall across the study area. The use of spatial varying design rainfall has been adopted, with design rainfall depths applied at the centroid of each sub-catchment. For the PMF event, rainfall values were obtained from GSAM methodology described by the BoM.

As per ARR 2019, Areal Reduction Factors (ARFs) were applied in the determination of the design rainfall estimates, for catchments contributing flows to point of interest that is larger than 1 km². The ARF is the ratio between the average rainfall occurring on a specific area and the point rainfall computed for the same duration and AEP. This ratio is applied since design rainfall intensities at a point are not necessarily representative of the average rainfall intensity across the catchment, particularly for larger catchments.

Rainfall losses (i.e. infiltration) were determined at each sub-catchment centroid using ARR19 methodologies. The Initial Loss (IL) and Continuing Loss (CL) were adopted from spatially varying values recommended in the ARR datahub for each sub-catchment. In the PMF event, no initial and continuing losses applied to the sub-catchments.

Design rainfall and losses were then adjusted in accordance with the latest guidance published in Book 1, Chapter 6 of ARR 2019 (version 4.2). This chapter was updated on 27 August 2024, and requires that rainfall intensities and losses be adjusted for climate change. This is to account for the non-stationarity of historic rainfall statistics used to derive design rainfall and losses data – i.e. acknowledging that climate change has already occurred during the period of record.

As per ARR 2019 recommendations, an ensemble of ten temporal patterns for four selected durations have been modelled for the 1%, 2% and 5% AEP design flood events. The ten temporal patterns vary in terms of their distribution and variability (comprising front, middle and back loaded storms) and can result in a wide range of flood behaviour. The procedures for ARR 2019 provide for the selection of the temporal pattern that gives the peak flow closest to the mean across all ten temporal patterns. This method was followed to confirm the critical temporal pattern for each storm duration.

2.2.2 Hydraulics

The RoG hydraulic model requires hydrologic data as inputs, using the 2016 IFD (intensity-frequency-duration) design rainfall estimates developed by BoM. The hydraulic model was developed to simulate the dynamic interactions between watercourses and floodplains as well as overland flow paths within the study area, using the TUFLOW modelling software (version 2023-03-AF-iSP-w64) with HPC⁶ solver and Sub-grid Sampling (SGS)). An overview of the hydraulic model setup is shown in Figure 2.2.

The TUFLOW hydraulic model contains 40 sub-catchments. The model extent is contained within the available LiDAR data and covers all the proposed project infrastructure, with a total model area of approximately 8,852 km². The topography of the model is shown in Figure 2.3.

Due to the size of the model extents, the TUFLOW modelling software with HPC solver and SGS were used to improve simulation run times. To strike a balance between sufficiently representative overland flow distribution across the study area and reasonable simulation run times, a 200 m global model cell size was adopted, with a finer resolution applied to site region (25 m) and roads (12.5 m). SGS was applied at a 2 m sampling distance for the model extent.

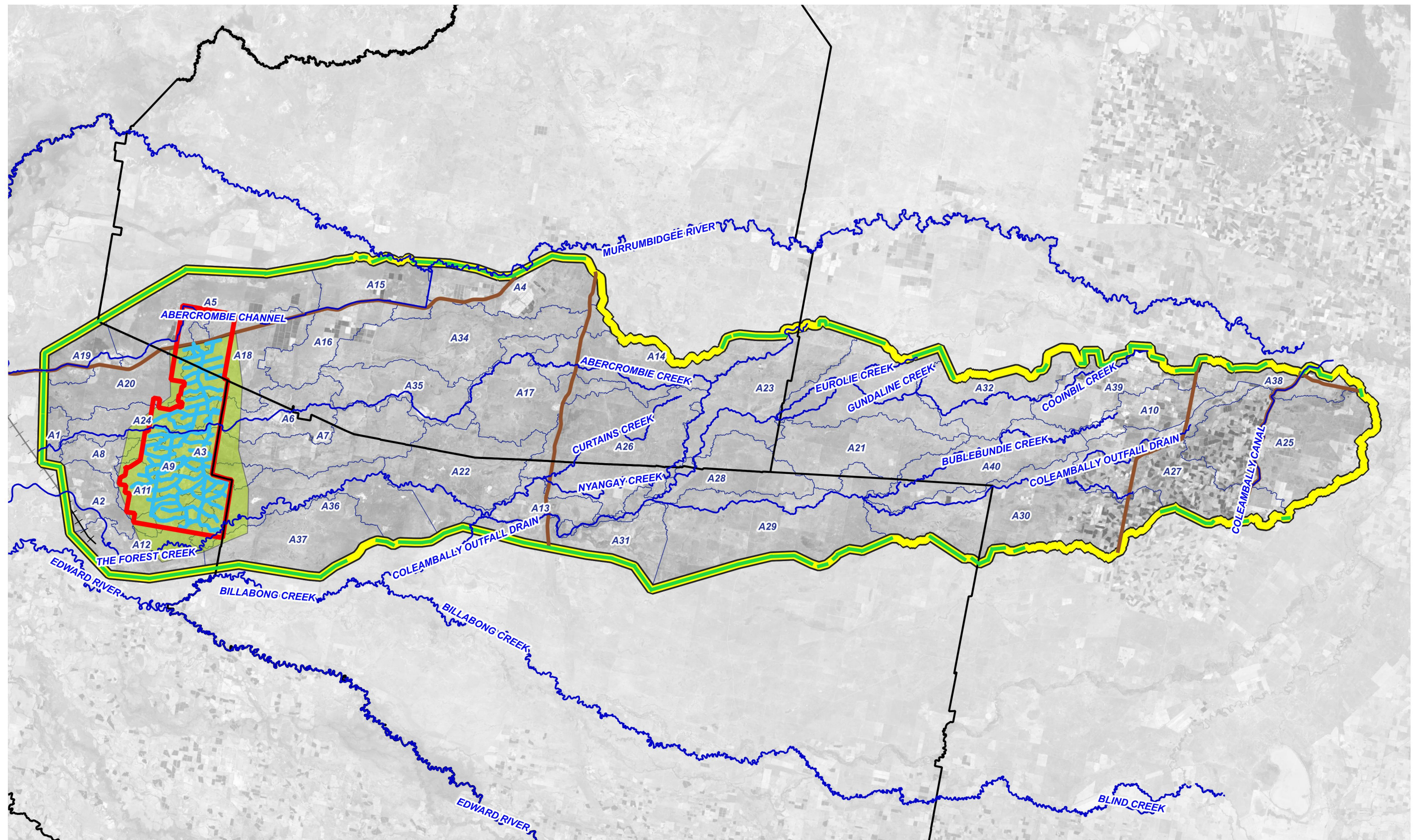
The hydraulic model's Manning's roughness (n), shown in Figure 2.4, was varied for each major land use (Chow, 1959), i.e.

- Medium vegetation ($n=0.085$)
- Roads ($n=0.020$)
- Watercourse ($n=0.045$)
- Lake ($n=0.040$)
- Medium grass floodplain ($n=0.055$)

Model boundaries were determined through a combination of topography (LiDAR) and iterative RoG modelling to ensure all major and minor flow paths relevant to the proposed development were captured. Rainfall inflows were applied at each sub-catchment, with a free discharge at the catchment outlet using a stage-discharge boundary condition.

To assist in informing emergency management considerations, the extreme event break-out flows from the Murrumbidgee River were applied to the local model as discharge time boundary (QT). Detailed information about the regional model is discussed in Section 2.3, and the location of inflows are shown in Figure 2.5.

⁶ TUFLOW HPC (Heavily Parallelised Compute) is a solver which utilises Graphics Processor Unit (GPU) hardware to undertake simulation runs



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	Model Extent		Hydrolines
	Project Extent		Downstream Boundaries
	Main Roads		Quadtrees Region - 25m
	LGA Boundary		Quadtrees Region - 12.5m

Title:
Local Hydraulic Model Boundary Setup

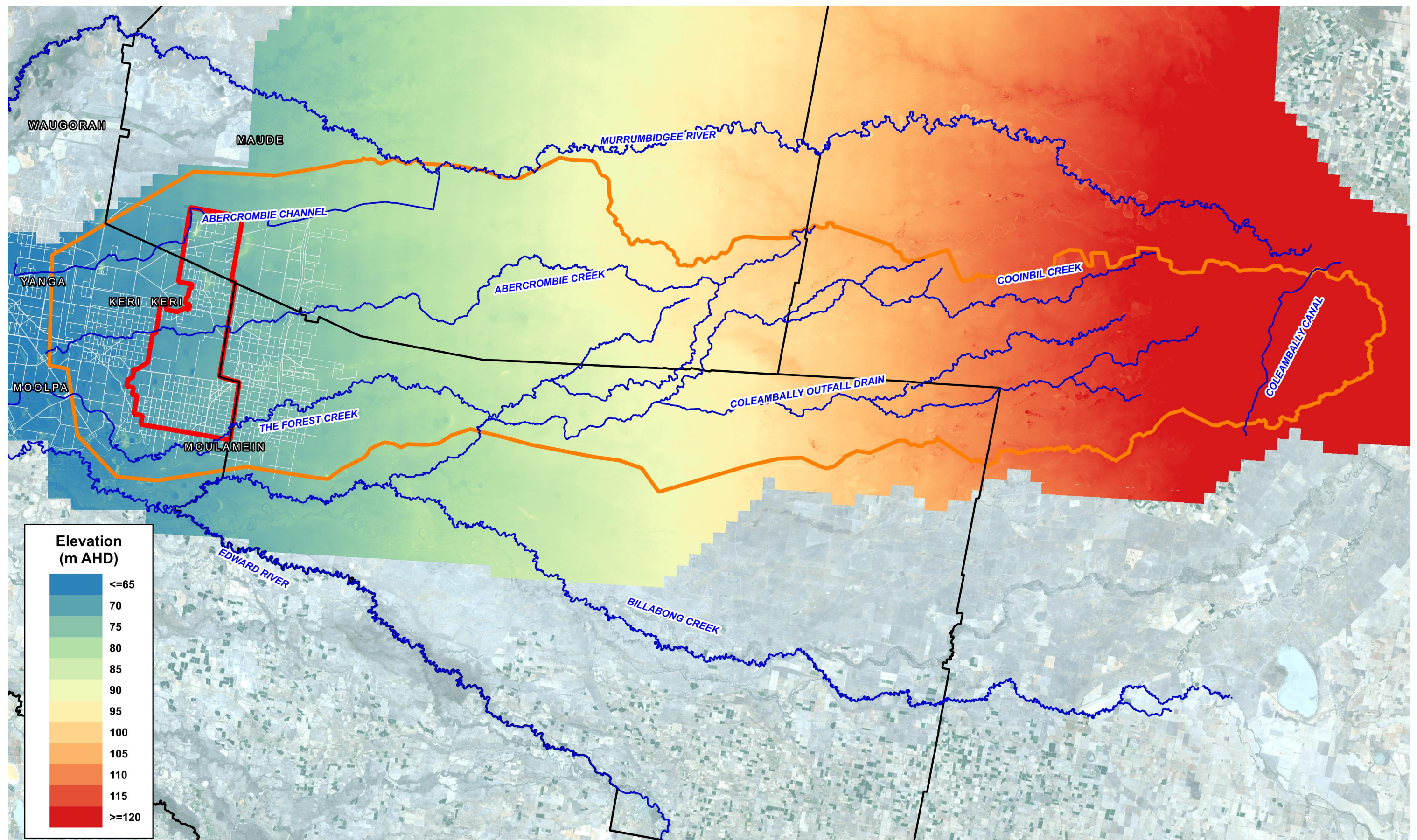
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LEGEND

- Model Extent
- Project Extent
- LGA Boundary
- Cadastre
- Hydrolines

Title:

Model Extent Topography

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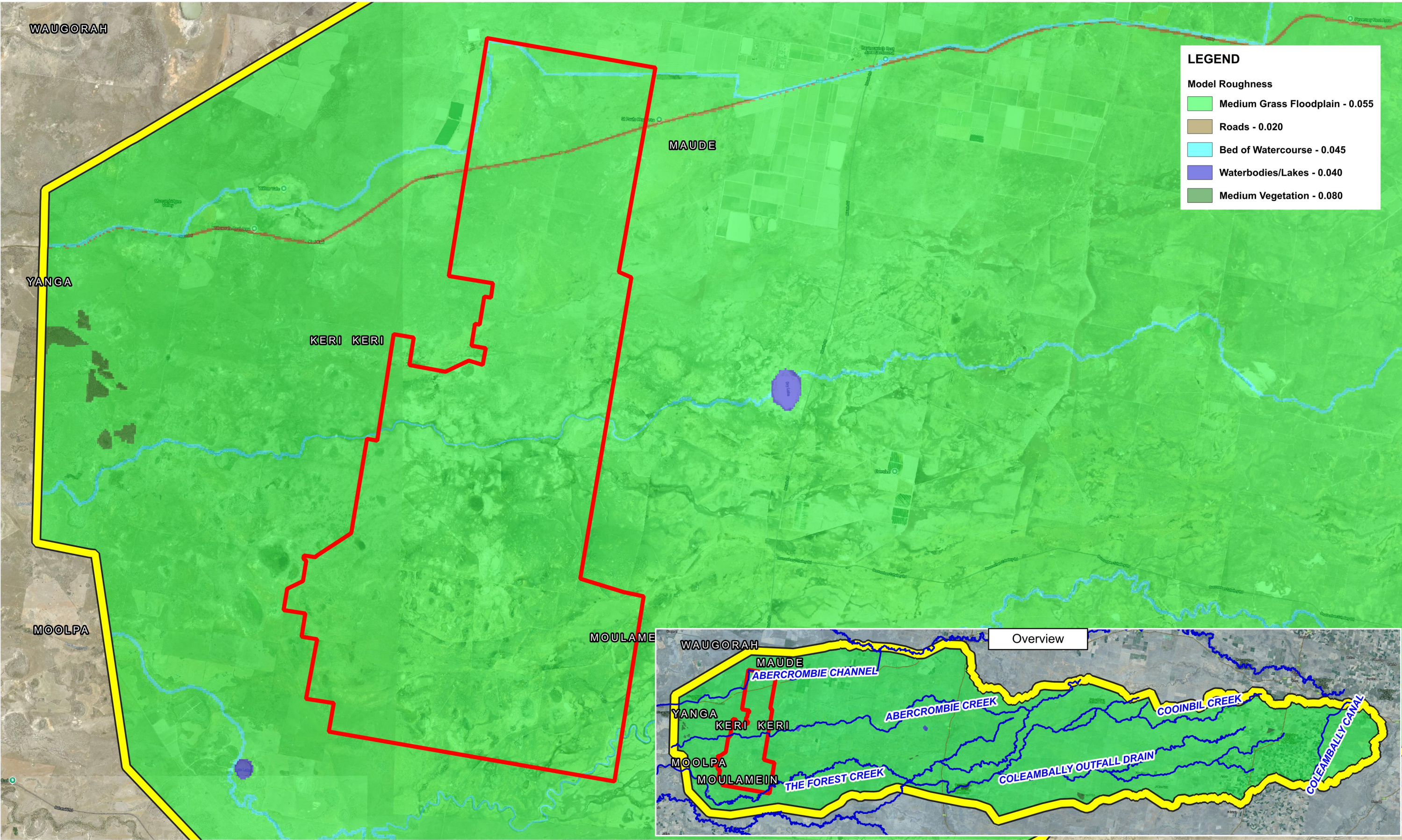
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Model Roughness

- Medium Grass Floodplain - 0.055
- Roads - 0.020
- Bed of Watercourse - 0.045
- Waterbodies/Lakes - 0.040
- Medium Vegetation - 0.080

LEGEND

- Model Extent
- Project Extent

Title:
Local Hydraulic Model Roughness

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Critical Duration Assessment

A critical duration analysis was undertaken for all model events. As per ARR 2019 recommendations, an ensemble of ten temporal patterns for each duration has been modelled for each flood event. The ten temporal patterns vary in terms of their distribution and variability (comprising front, middle and back loaded storms) and can result in a wide range of flooding behaviour within the catchment.

Due to the size of the study area, the generally flat slopes and significant storage capacity, a range of storm durations were tested for critical duration. Durations ranged from 24 hours up to 168 hours for the 10 temporal patterns, using a coarser model (without Quadtree for Site) with SGS for efficiency. Following the ARR 2019 procedures, the statistical median of water levels across 10 temporal patterns of each duration were determined. After this, the maximum duration from the water levels was determined. In this approach, peak water levels at the Site were prioritized over scattered peak water levels throughout the broader model extent. The critical duration and temporal pattern selected for each event are reported in Table 2.1.

Table 2.1 Critical Storm Duration

Design Storm (AEP)	Storm Duration (hr) and Temporal Pattern
5%	168h (TP9)
1%	168h (TP10)
0.5%	168h (TP9)
0.2%	168h (TP2)
PMF ⁷	96h

Grid filtering

The direct rainfall technique features the application of rainfall hyetographs directly onto the model grid and, as such, the model results are characterised by wet terrain throughout the model extent. For this reason, grid filtering of the model results is necessary to discern sheet flows from overland flowpaths and obtain a more realistic representation of the overland flowpaths in the local catchment.

The filtering criteria adopted in the present study featured the application of conditions to flood depths, velocity-depth product and pond sizes in order to obtain well-connected flowpaths and avoid the patchiness often resulting from the application of a simple cutoff depth criteria to the direct rainfall model results.

The final grids of each AEP event were filtered in accordance with the following filtering criteria:

- Step 1: The wet cells were retained for flood depths > 0.01 m AND depth-velocity product > 0.125 m²/s;
- Step 2: The remaining wet cells from step 1 were retained for flood depths > 0.2 m OR depth-velocity product > 0.02 m²/s;
- Step 3: Ponds smaller than 100 m² resulting from step 2 were removed.

⁷ PMF hydrology for the Abercrombie Creek TUFLOW model was determined based on the procedures outlined in 'Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Southeast Australia Method' (BoM, 2006).

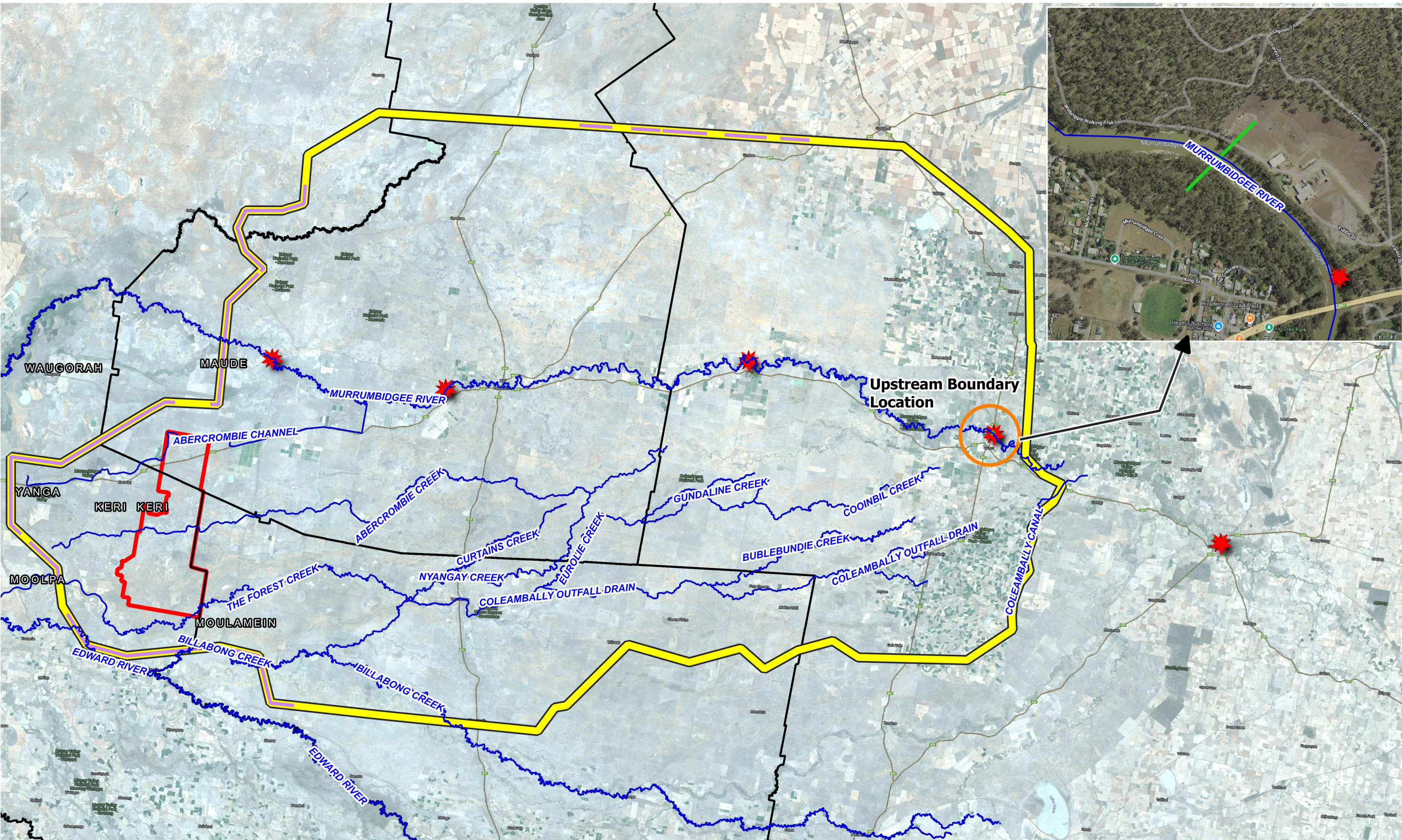
2.3 Regional Catchment Modelling

Breakout flows from the Murrumbidgee River were assessed for the extreme event, to determine the potential for them to affect the developed scenario site. This will assist in informing emergency management considerations, in combination along with the PMF modelled for the local model. A regional model was developed for this purpose, using available LiDAR for topography and a relatively coarse cell size to ensure reasonable model simulation times. Modelling of structures, bathymetry or detailed survey were not included at this regional scale. The regional model setup is shown in Figure 2.5.

The extreme event flow rate was estimated based on flood frequency analysis (FFA) of available flow data from Narrandera, Darlington Point, Carrathool Bridge, Hay Weir and Maude Weir stream gauges (see Section 2.3.2 for FFA). The 0.05% AEP (1 in 2,000 year) event was adopted as the 'Extreme Event' in this work. After conducting the FFA, the highest flow rate estimated observed from the FFAs across the 5 gauges was adopted in the hydraulic model to obtain a conservative modelling outcome.

The 'Extreme Event' flow rate obtained from FFA was applied at the upstream boundary of the model as a discharge vs time (HT) boundary, located at Darlington Point, 160 km east of the site. A coarse grid model (100m cells) was used with SGS. Hydraulic structures such as bridges, and culverts were not represented in this regional model. The Sturt highway was represented using a breakline based on LiDAR data to represent high ridge line. Roughness was applied assuming a global roughness for medium grass floodplain (0.055), watercourses (0.045), and roads (0.02). At the downstream extent of the model, water is allowed to freely drain using a head height vs discharge (HQ) boundary with 0.1% slope due to the flat nature of the terrain.

At the upstream boundary, the peak 0.05% AEP flow rate was applied as a constant flow rate for a duration of 2,000 hours, which ensured that the flow reaches the site area. A long duration was required due to the small velocities observed as a result of flat terrain and presence of a large number of storage areas. At the site area, water levels and flow rates were observed to ensure that the flow reaches the site and steady-state levels were achieved.



LEGEND

Model Extent

Project Extent

LGA Boundary

Hydrolines

Upstream Boundaries

Downstream Boundaries

Gauges Adopted for FFA

Title:
Regional Model Setup

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Drawing:
Fig 2.5

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2.3.2 Flood Frequency Analyses

The FFAs adopted a Log Pearson III fitting model, along with a Grubbs Beck test to censor low flow outliers above the zero threshold (noting that this resulted in no data values). Table 2.2 shows the information of gauges used for the FFAs.

Table 2.2 Data available for Flood Frequency Analyses

Gauge Number	Gauge Name	Period of Record	Years of Record	Comments
410021	Murrumbidgee River at Darlington Point	1970 to 2023	55	No censored data.
410005	Murrumbidgee River at Narrandera	1891 to 1933, 1973 to 2023	43 + 52 = 95	Gap in data from January 1934 to August 1973
41000281	Murrumbidgee River at Carrathool Bridge	1995 to 2023	29	No censored data.
410136	Murrumbidgee River Downstream Hay Weir	1982 to 2023	43	2 data points censored.
410040	Murrumbidgee River Downstream Maude Weir	1974 to 2023	51	25 data points censored

FFA results for the five selected gauges are shown in Table 2.3 to Table 2.7, with results illustrated in the plots presented in Figure 2.6 to Figure 2.10.

Table 2.3 FFA results for Murrumbidgee River at Darlington Point

AEP	Best Fit	5% Quantile	95% Quantile
5% AEP (1 in 20)	895.66	752.29	1112.8
1% AEP (1 in 100)	1433.57	1103.74	2072.2
0.5% AEP (1 in 200)	1689.89	1243.54	2628.8
0.2% AEP (1 in 500)	2051.49	1418.90	3528.4
0.05% AEP (1 in 2,000)	2647.38	1655.24	5326.1

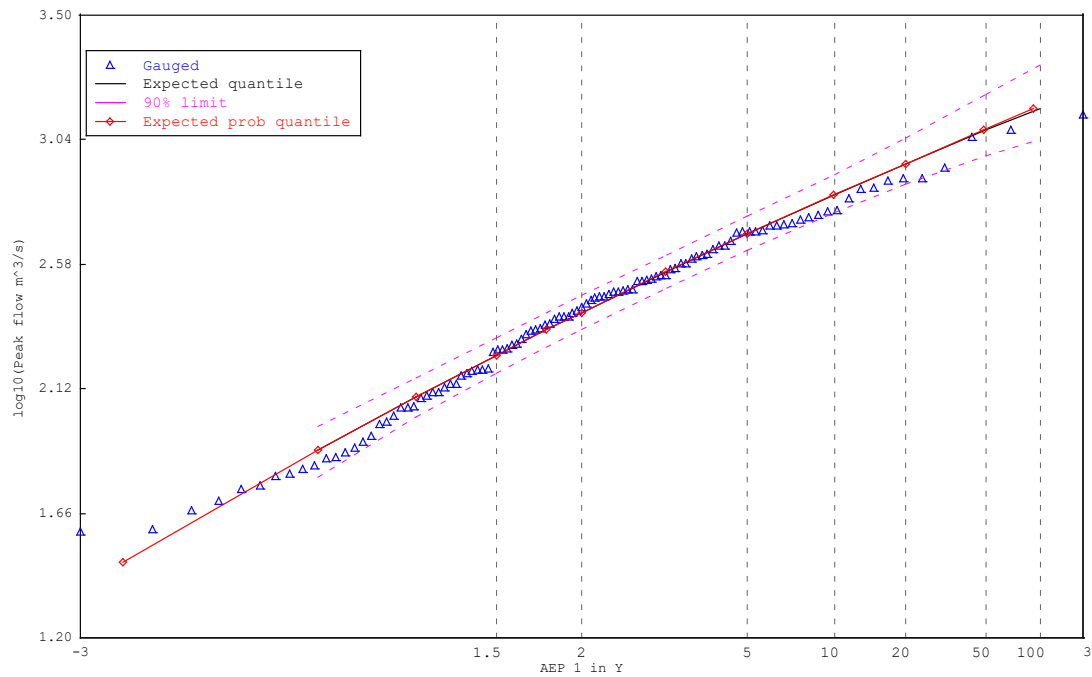


Figure 2.6 FFA at Murrumbidgee River at Darlington Point.

Table 2.4 FFA results for Murrumbidgee River at Narrandera

AEP	Best Fit	5% Quantile	95% Quantile
5% AEP (1 in 20)	2395.61	1775.98	3561.4
1% AEP (1 in 100)	4670.61	2795.39	9500.2
0.5% AEP (1 in 200)	5948.62	3187.74	14065.2
0.2% AEP (1 in 500)	7960.12	3658.14	23249.0
0.05% AEP (1 in 2,000)	11805.17	4331.19	47834.8

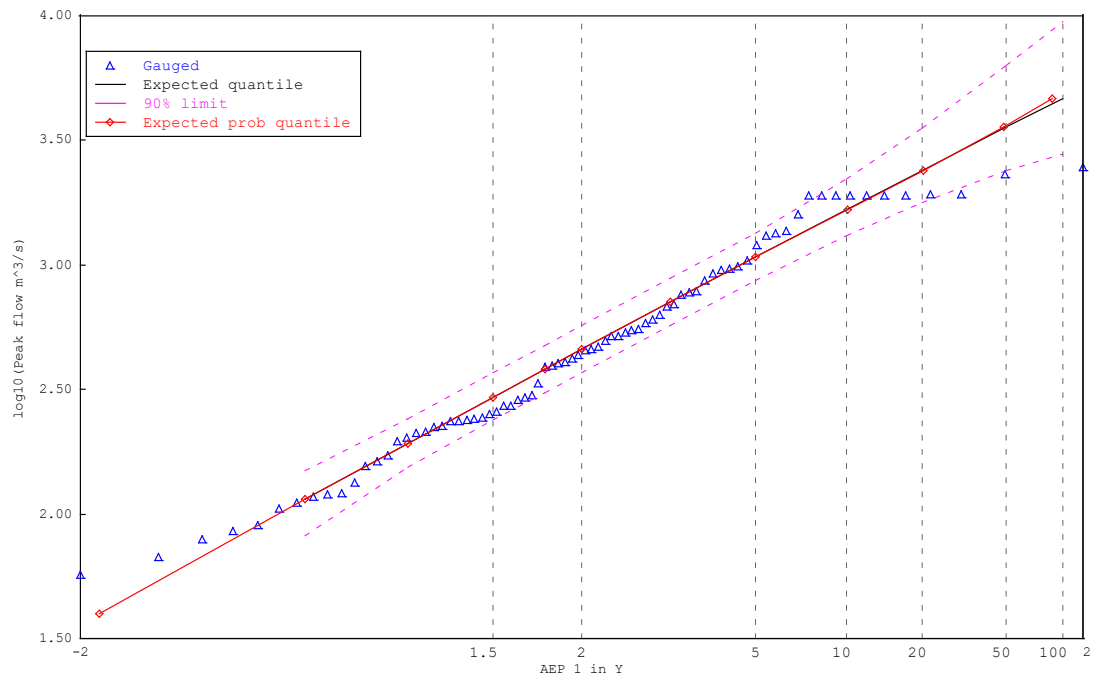


Figure 2.7 FFA at Murrumbidgee River at Narrandera.

Table 2.5 FFA results for Murrumbidgee River at Carrathool Bridge

AEP	Best Fit	5% Quantile	95% Quantile
5% AEP (1 in 20)	807.59	458.90	1833.6
1% AEP (1 in 100)	2142.70	882.76	8602.4
0.5% AEP (1 in 200)	3165.49	1117.37	16529.1
0.2% AEP (1 in 500)	5204.08	1478.54	38448.0
0.05% AEP (1 in 2,000)	10707.29	2155.92	133458.7

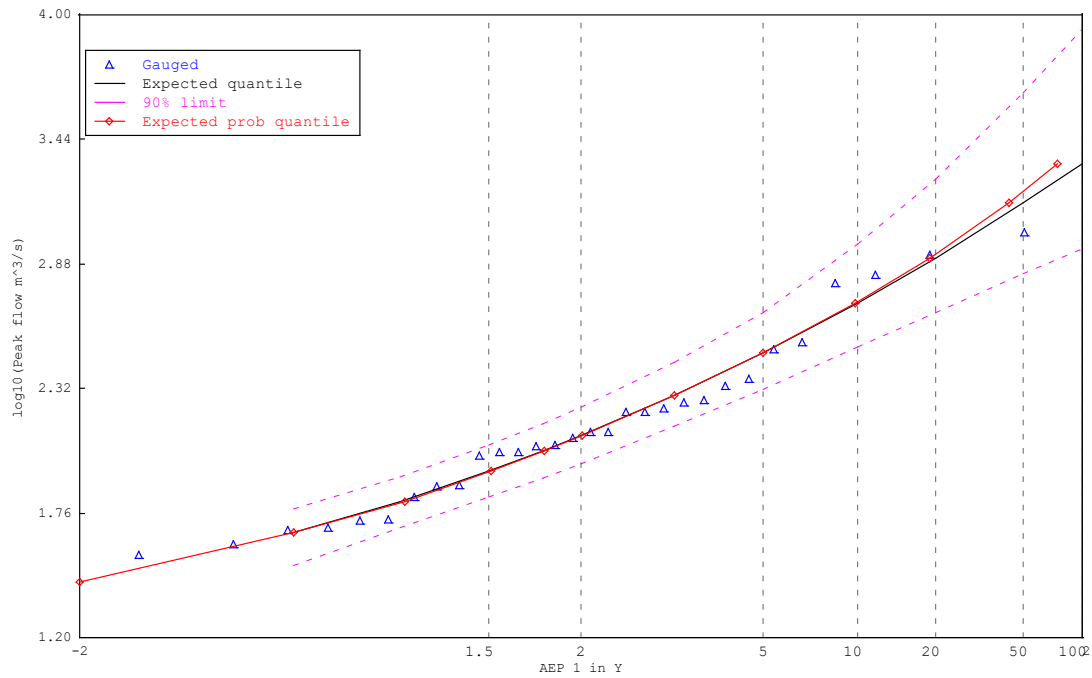


Figure 2.8 FFA at Murrumbidgee River at Carrathool Bridge.

Table 2.6 FFA results for Murrumbidgee River Downstream Hay Weir

AEP	Best Fit	5% Quantile	95% Quantile
5% AEP (1 in 20)	739.03	511.10	1300.1
1% AEP (1 in 100)	1367.02	738.24	3772.2
0.5% AEP (1 in 200)	1706.79	806.68	5916.3
0.2% AEP (1 in 500)	2228.55	878.34	10384.5
0.05% AEP (1 in 2,000)	3193.70	966.18	23721.2

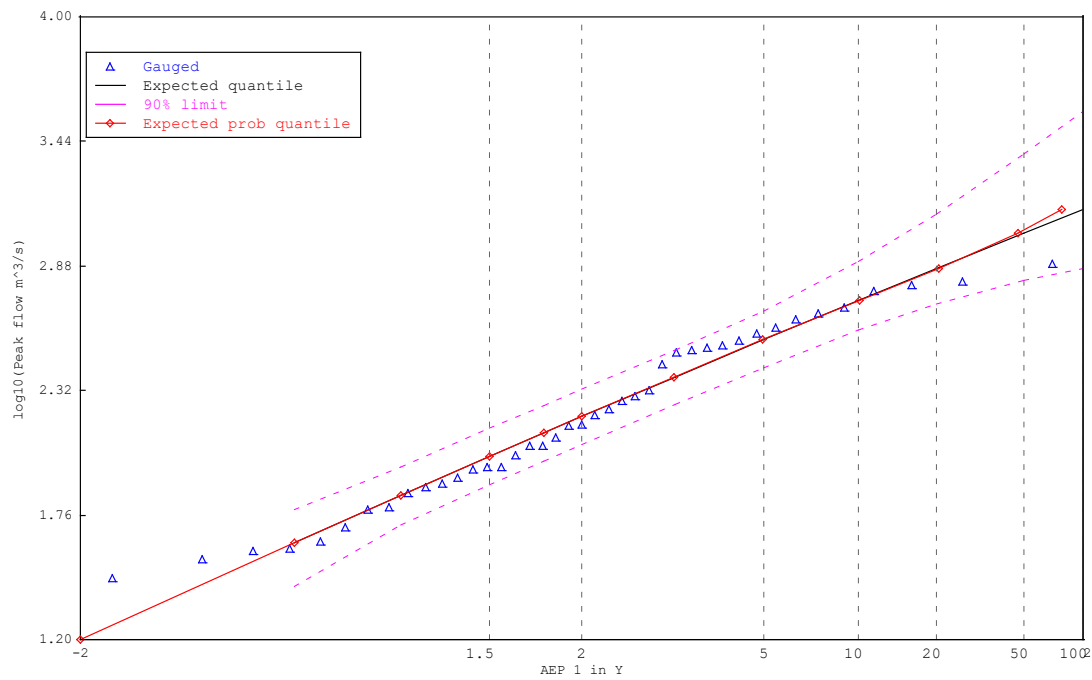


Figure 2.9 FFA at Murrumbidgee River Downstream Hay Weir.

Table 2.7 FFA results for Murrumbidgee River Downstream Hay Weir

AEP	Best Fit	5% Quantile	95% Quantile
5% AEP (1 in 20)	338.17	300.43	395.4
1% AEP (1 in 100)	407.31	361.35	506.9
0.5% AEP (1 in 200)	429.19	380.44	550.9
0.2% AEP (1 in 500)	452.81	393.01	605.8
0.05% AEP (1 in 2,000)	479.72	406.88	682.9

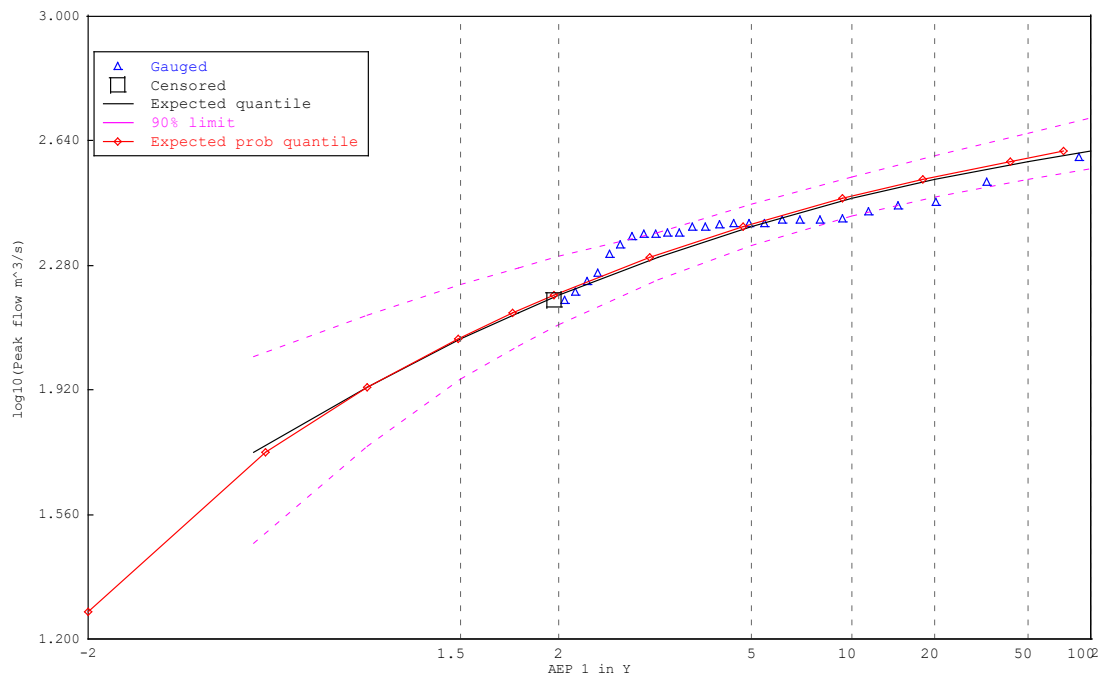


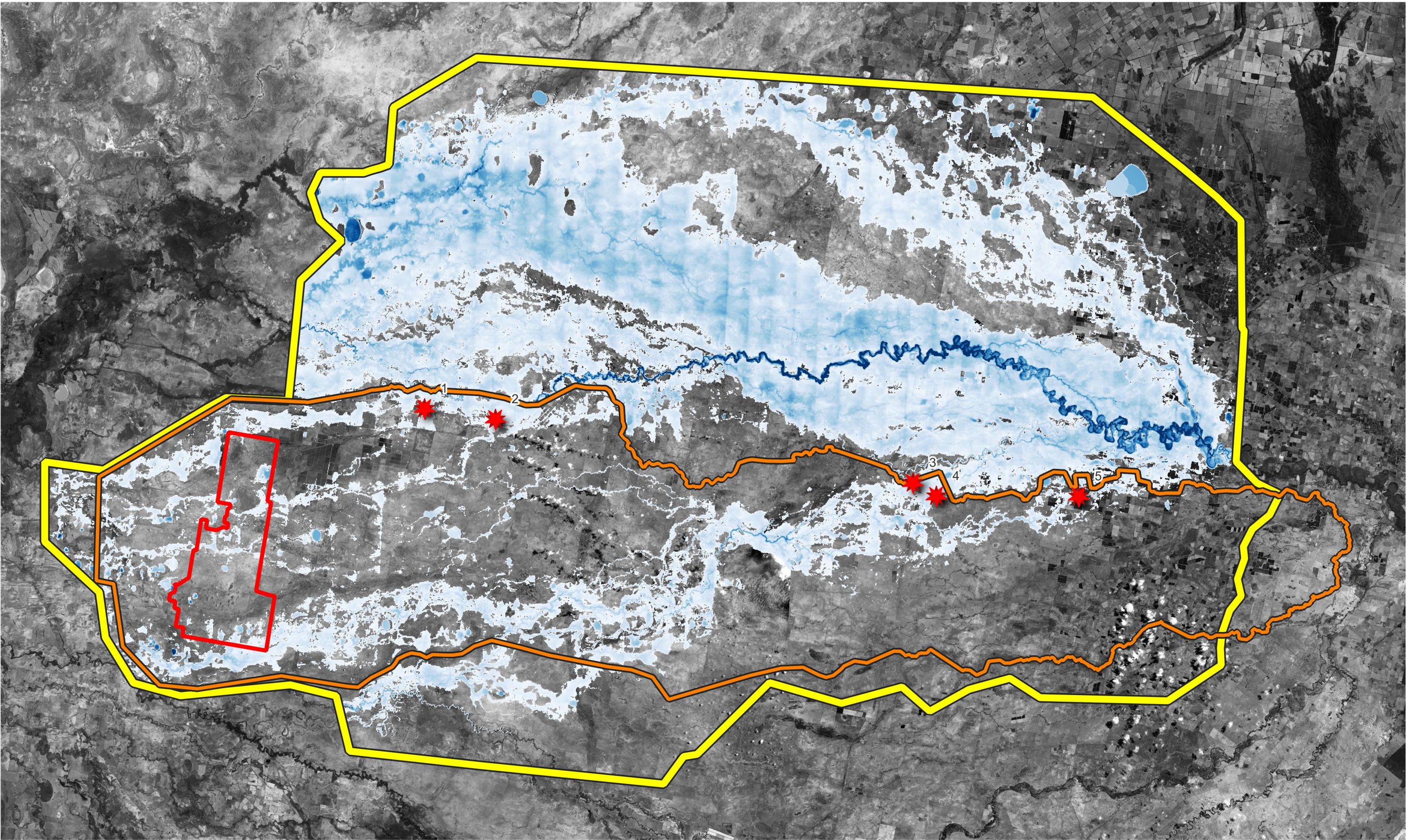
Figure 2.10 FFA at Murrumbidgee River Downstream Hay Weir.

The FFA results show that the estimated peak flow rates for 0.05% AEP event (adopted Extreme Event) at each of the gauges are as follows:

- Murrumbidgee River at Narrandera (11,810 m³/s)
- Murrumbidgee River at Carrathool Bridge (10,710 m³/s)
- Murrumbidgee River Downstream Hay Weir (3,190 m³/s)
- Murrumbidgee River at Darlington Point (2,650 m³/s)
- Murrumbidgee River Downstream Maude Weir (479 m³/s)

For the modelling of Extreme event, the maximum 0.05% AEP flow rate at Narrandera was selected to be conservative. A steady flow rate of 11,810 m³ was applied at the upstream boundary of the regional model and simulated for a period of 2,000 hours, ensuring that this flow reaches the site approximately 220 km downstream.

The regional model flood extent for 0.05% AEP, the gauges used in the FFAs and the location of inflows to local model are illustrated in Figure 2.11.



LEGEND

 Regional Model Extent

 Local Model Extent

 Project Extent

 Regional Model Inflows Location

Peak Flood Depth (m)

 0.1

 4

Title:

Regional Model Flood Extent (0.05% AEP) and the Location of Regional Model Inflows to Local Model

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0 15 30 km



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2.4 Proposed Development

Following the definition of existing scenario flood conditions for the study area, relevant details of the proposed development layout and configuration were included to represent any potential interactions between the proposed works and the floodplain. This includes access roads, hardstand, buildings, structures and WTG foundations. For structures that are expected to be elevated above the floodplain (e.g. WTG towers, buildings), these were raised by nominal amount of 10m in the model, noting that this does not reflect actual structure heights.

BMT were provided with a list of elements for the proposed development on 05 March 2024. Table 2.8 summarises the elements with a description and their respective representation in the hydraulic model.

Table 2.8 Developed Scenario Representation in the hydraulic model

Proposed Design Item	Representation*
Substation	2d_zshp region polygon with elevation* above 1% AEP +0.5m freeboard. Building model roughness.
BESS and Transformer	2d_zshp region polygon with elevation* above 1% AEP +0.5m freeboard. Building model roughness.
Access Roads	Gravel model roughness.
Accommodation Buildings	2d_zshp region polygon with elevation* above 1% AEP +0.5m freeboard. Building model roughness.
Construction Compound	2d_zshp region polygon with elevation* above 1% AEP +0.5m freeboard. Building model roughness.
WTG and associated infrastructure	WTG hardstand footprint, with elevation 0.1m above ground, or 1% AEP(whichever is greater). Gravel model roughness. Top of foundation, 7.2m diameter with elevation 0.65m above ground, or 1% AEP +0.5m freeboard (whichever is greater). Building model roughness. Tower, 6m diameter, with elevation* above floodplain. Building model roughness.

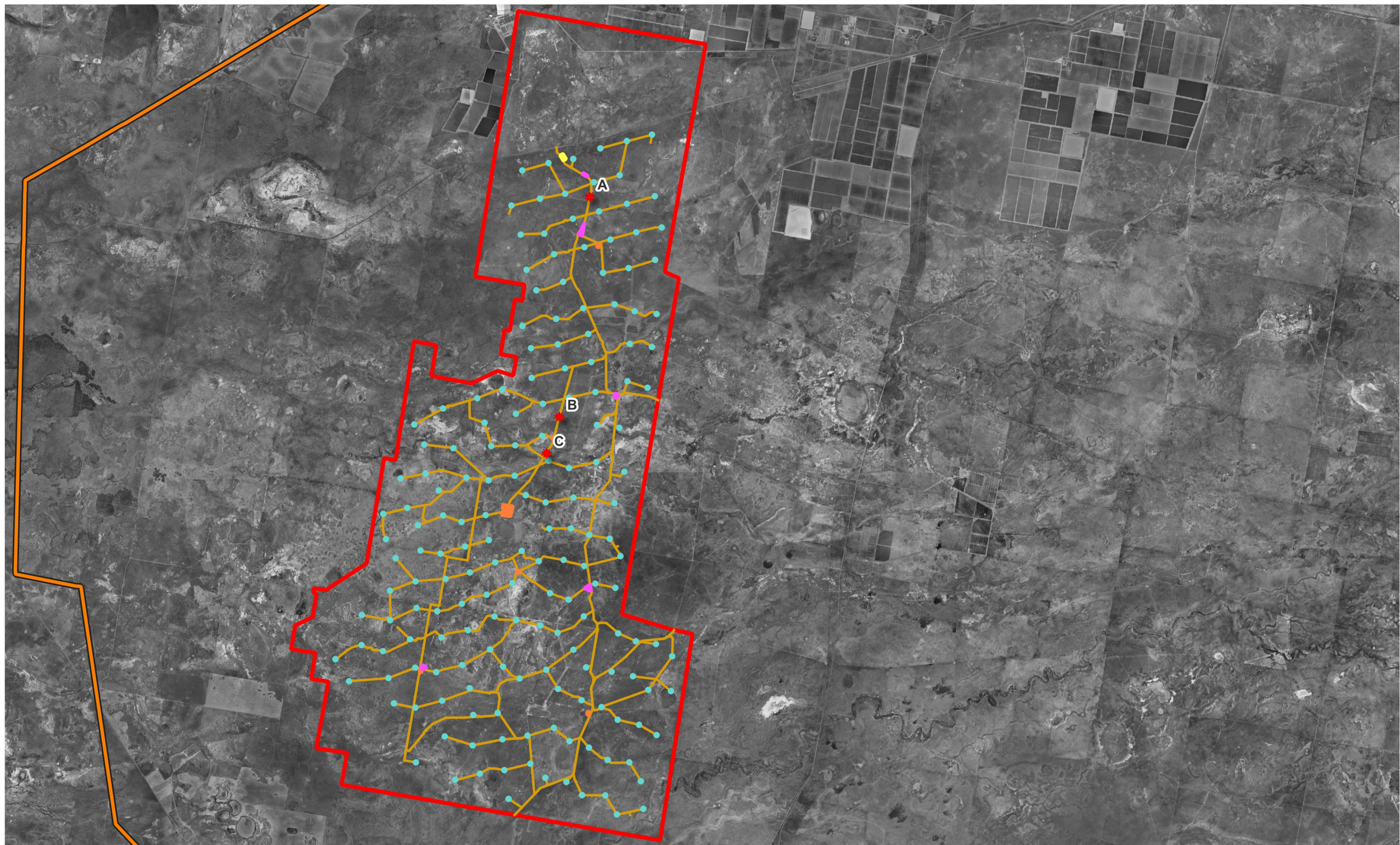
*10m elevations were adopted to ensure structures extend out of the floodplain, and do not reflect actual heights.

In order to protect assets, the design of buildings, equipment foundations, footings for electrical componentry and WTGs were designed to consider the 1% AEP flood level plus 0.5m freeboard. .As shown in Table 2.8, the elevation for proposed substations, accommodation buildings and construction compounds were set to 10m to ensure they are elevated above the floodplain, noting that this does not reflect actual structure heights, but ensures that structures are adequately reflected in the model. In addition, the elevation for those WTGs located in 1% flood extent were raised to 1% AEP flood level plus 0.5m freeboard. Required elevations were determined through an iterative approach, with adopted levels for WTGs located within 1% AEP flood extent shown in Table 2.9. Also, the elevation for those WTG hardstand footprints located within 1% AEP Flood extent were raised to 1% AEP flood level and those located outside 1% AEP flood extent were raised by 0.1m.

Table 2.9 Levels adopted for WTGs located in 1% AEP flood extent

WTG ID	1% AEP flood level at WTG	Adopted level (flood level + 0.5m freeboard)
30	72.63	73.13

WTG ID	1% AEP flood level at WTG	Adopted level (flood level + 0.5m freeboard)
24	72.61	73.11
29	72.61	73.11
36	72.58	73.08
35	72.54	73.04
19	72.49	72.99
34	72.47	72.97
128	72.15	72.65
154	71.98	72.48
165	71.82	72.32
9	71.68	72.18
27	71.37	71.87
38	71.32	71.82
74	71.27	71.77
62	71.09	71.59
175	71.05	71.55
90	70.81	71.31
73	70.78	71.28
26	70.63	71.13
20	70.59	71.09
158	70.39	70.89
170	70.39	70.89
60	70.30	70.80
71	70.26	70.76
70	70.12	70.62
79	70.08	70.58
52	69.94	70.44
42	69.67	70.17
68	69.55	70.05
119	69.54	70.04
50	69.51	70.01
65	68.87	69.37



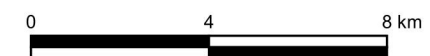
LEGEND

-  Local Model Extent
-  Project Extent
-  Construction Compound
-  Accommodation Buildings
-  WTG
-  Access Roads
-  Reporting Locations For Inundation

Title:

Proposed Development Setup in Local TUFLOW Model

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3 Results and Discussion

3.1 Comparison to Council Studies

Although there is no Council model which covers the extent of the modelling undertaken as part of this assessment, a summary of how the parameters and approach adopted in this assessment are generally consistent with the closest relevant council flood study (Hay and Maude Flood Study, 2023) is provided as follows:

- Hydrology & FFA
 - Covers a full range of flood events from 5% AEP to PMF, consistent with Council study.
 - Follows ARR 2019 guidelines for hydrologic assessments (including losses).
 - FFA based on gauge data from the Murrumbidgee River at Darlington Point, Narrandera, Carrathool Bridge, Hay Weir, and Maude Weir.
- Hydraulic Modelling
 - Uses TUFLOW modelling with RoG simulation and Quadtree & SGS for accuracy.
 - Applies critical storm duration analysis, following ARR 2019 recommendations.
 - Includes 0.5% AEP and 0.2% AEP events as climate change proxies.

Although this assessment and the Council study cover differing extents, it is confirmed that this study is consistent with council study in terms of modelling approach and input data.

3.2 Flood Depths and Levels

Baseline Scenario

Results for baseline scenario indicate that surface flow hydrodynamics are significantly storage driven due to the shallow slopes and presence of many small storages within the catchment. This is demonstrated by relatively low velocities observed in the events from 5% AEP up to the PMF (Annex A). Significant ponded water depths are also observed in these regions for the same events.

Baseline scenario peak water levels and depths for the PMF (local) and PMF (local + regional inflow) are also presented in Annex A. Baseline scenario results from the regional model show that breakout flows from the Murrumbidgee River during the extreme event (0.05% AEP) join the flows of Abercrombie Creek and Forest Creek. However, baseline scenario results from local model demonstrate that including regional inflows in an extreme event does not affect water depths across Abercrombie Creek within the site area, while water depths across The Forest Creek increase marginally in the extreme event (up to 20 mm near the site). As such, smaller events (such as the 1% AEP) are also not expected to impact water levels within the site.

Developed Scenario

Developed scenario results are shown in Annex B. Most WTGs are outside of modelled flood extents in the 5% and 1% AEP events, while most are located within the modelled extents of the PMF. Those WTGs located in 1% AEP flood extent have been modelled to ensure 1% AEP plus 0.5m flood immunity. Most proposed developments on the site (except for some development located at the centre

of the site), are outside of the 1% AEP flood extent, with floodplain encroachment occurring in the 0.5% AEP and greater. All proposed developments (e.g., substations) have 1% AEP plus 0.5m flood immunity.

Although the project allows for up to 180 WTGs (as discussed in Section 1.4), it is noted that 3 WTGs were removed due to flooding constraints, while a further 2 WTGs were removed due to biodiversity constraints. As such impacts are presented on this basis of a total of 175 WTGs.

Flood impacts for all events are provided in Annex C. Within the site boundary, the most significant impacts are observed in the natural storage area within the southern extent of the site (1% and 5% AEPs), proposed infrastructure such as the accommodation building within the northern extent of the site, and the BESS substation in the centre of the site. These increases in water level are primarily due to obstructions to flow caused by the proposed infrastructure within the floodplain, and are fully contained within the site.

Flood level increases within the site are summarised as follows (refer Annex C for detailed mapping).

- 5% AEP event: up to +3.7m increase near proposed Substation.
- 1% AEP event: up to +3.6m increase near proposed Substation.
- 0.5% AEP event: up to +3.6m increase near proposed Substation.
- 0.2% AEP event: up to +3.6m increase near proposed Substation.
- PMF event: (local): up to +3.5m increase near proposed Substation.
- PMF event (with regional inflows): up to +3.5m increase near proposed Substation.

As summarised above, the most notable impacts are observed to be localised around the proposed infrastructure. In all events, no offsite impacts are observed due to inclusion of proposed development. It is noted that Austroads (2023) considers impacts of up to 400mm acceptable for open space / forest areas.

Some WTGs are located in areas where flood levels have increased, especially in the north of the site, during events from the 1% AEP to the PMF. Similarly, some proposed developments in the central and northern parts of the site are also within impacted areas. However, these impacts are considered non-detrimental to the proposed WTGs, while proposed developments will be elevated above 1% AEP flood level plus 0.5m freeboard.

Flood level decreases within the site are summarised as follows (refer Annex C for detailed mapping):

- 5% AEP event: up to -26 mm reduction south of proposed Substation.
- 1% AEP event: up to -25 mm reduction west of proposed Development.
- 0.5% AEP event: up to -76 mm reduction west of proposed Development.
- 0.2% AEP event: up to -76 mm reduction west of proposed Development.
- PMF event: (local): up to -100 mm reduction west of proposed Development.
- PMF event (with regional inflows): up to -100 mm reduction west of proposed Development.

3.3 Flood Velocities

Flood velocities in both baseline and developed scenarios for the events from the 5% AEP up to the PMF event show that there is slow moving water in Abercrombie Creek and Forest Creek (<0.4 m/s). The reason for slow velocities is understood to be the shallow slope in the catchment and presence of significant storage areas. As such, it is expected that there will be limited erosion in the river banks, destruction of riparian vegetation or reduction in the stability of river banks or watercourses. No significant changes to velocity are expected outside the site as a result of the proposed development, as indicated by pre and post velocity maps presented in this report.

3.4 Flood Hazards

Flood hazard for the Project site and surrounding floodplain has been defined based on the composite six-tiered hazard classification in the 'Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia' (AIDR, 2017) and reproduced in Figure 3.1. These hazard classifications are based on adopted thresholds of flood depth, velocity and velocity-depth product that identify when flood conditions are likely to present a risk to people, vehicles and buildings. A description of each hazard threshold is provided in Table 3.1.

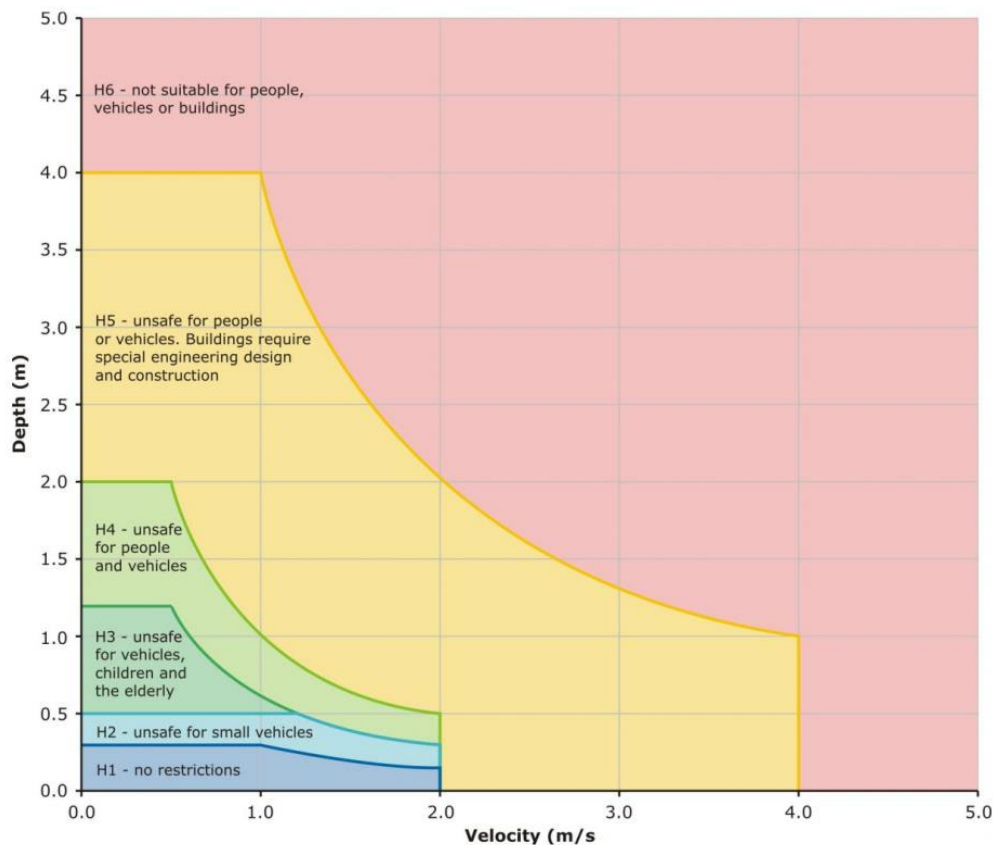


Figure 3.1 Flood Hazard Curves (AIDR, 2017)

Table 3.1 Flood Hazard Classification Thresholds (AIDR, 2017)

Hazard Classification	Description
H1	Relatively benign flow conditions. No vulnerability constraints.
H2	Unsafe for small vehicles.
H3	Unsafe for all vehicles, children and the elderly.
H4	Unsafe for all people and vehicles.
H5	Unsafe for all people and vehicles. Buildings require special engineering design and construction.
H6	Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure.

Baseline and developed scenario results (shown in Annex A and Annex B) for events from 5% AEP to 0.2% AEP show that there are relatively low hazards in most areas along Abercrombie Creek and The Forest Creek (up to Hazard Category H3) within the site. However, higher hazard levels (up to H5) are observed in storage areas within the site where water is shown to accumulate.

In the PMF event, small areas of high hazard (up to H5) are observed within the site in Abercrombie Creek and The Forest Creek, while storage areas reach hazard levels up to H6.

The proposed WTGs are in low hazard areas (up to H3) for events from the 5% to 0.2% AEP, with the exception of WTG 165 which is located in a higher hazard area (H4) for 1% AEP and rarer events. In the PMF event, most WTGs remain in low hazard areas (up to H3), while a few are in high hazard areas (up to H4) along Abercrombie Creek in the centre of the site and south of the Site (WTG 165). No significant changes to hazard are expected within or outside of the site as a result of the proposal, as indicated by pre and post hazard maps presented in this report. Some minimal changes to hazard conditions occur due to storage areas filling up over a long simulation period (i.e. due to increased depth rather than velocities), which are shown to cause non-detrimental changes to hazard conditions. Flood hazards and their extents are considered generally compatible with the proposal.

3.5 Flood Planning Area

Flood Planning Levels (FPLs) are typically derived by adding a freeboard to a specific design flood level, with this specific design flood frequently referred to as the “planning” flood. The FPL can be applied directly to topographic data to determine the extent of the Flood Planning Area (FPA), which was determined in this assessment as requested by the SEARs.

The FPA has been derived based on the 1% AEP flood level plus 0.5 m freeboard. The freeboard was applied to the peak 1% AEP flood level results from the TUFLOW modelling and the resultant flood surface was laterally extended until it intersected with the ground surface to develop the FPA for the study area (Annex D).

3.6 Hydraulic Categories

Flood function categories (also referred to as hydraulic categories) defined in ‘Flood Function: Flood Risk Management Guide FB02’ (DPE, 2023) are as follows:

- **Floodway:** Areas that convey a significant portion of the flow. These are areas that, even if partially blocked, would cause a significant increase in flood levels or a significant redistribution of flood flows, which may adversely affect other areas.

- **Flood Storage:** Areas that are important in the temporary storage of the floodwater during the passage of the flood. If the area is substantially removed by levees or fill it will result in elevated water levels and/or elevated discharges. Flood Storage areas, if completely blocked would cause peak flood levels to increase by 0.1 m and/or would cause the peak discharge to increase by more than 10%.
- **Flood Fringe:** Remaining area of flood prone land, after floodway and flood storage areas have been defined. Blockage or filling of this area will not have any significant effect on the flood pattern or flood levels.

For this assessment, hydraulic categorisation was determined according to the combination of flood depths, velocities and velocity-depth product ($V \times D$), as shown in Table 3.2.

Table 3.2 Flood Categorisation Criteria

Classification	Criteria	Description
Floodway	[$V \times D > 0.25 \text{ m}^2/\text{s}$ AND Velocity $> 0.25 \text{ m/s}$] OR [Velocity $> 1.0 \text{ m/s}$]	Areas and flow paths where a significant proportion of floodwaters are conveyed (including all bank-to-bank creek sections).
Flood Storage	Area outside floodway where depth $> 0.5 \text{ m}$	Areas where floodwaters accumulate before being conveyed downstream. These areas are important for detention and attenuation of flood peaks.
Flood Fringe	Remaining flood extent	Areas that are low-velocity backwaters within the floodplain. Filling of these areas generally has little consequence to overall flood behaviour.

As requested by the SEARs (and following the above criteria), pre and post flood function maps for the site are shown in Annex D based on the 1% AEP event. Due to the very slow moving water in the catchment, it is observed that the site is comprised of Flood Storage and Flood Fringe categories only. No significant changes to flood function are expected as a result of the proposal, as indicated by pre and post flood function maps presented in Annex D. Flood functions and their extents are considered generally compatible with the proposal.

3.7 Climate Change

As requested by the SEARs, the 0.5% and 0.2% AEP flood events have been modelled as proxies for increased rainfall intensity in a 1% AEP due to climate change. As would be expected, results indicate an increase in flood depths and extents for the proxies modelled. A corresponding increase in flood hazard is also observed, although no significant increase in flood velocity is expected in the climate change scenarios modelled.

3.8 Emergency Management

Based on results outlined, the proposal is not expected to impact the existing emergency management arrangements for flooding, as outlined in the Hay Shire Local Flood Plan. As indicated in the hazard maps derived for this assessment, the site is generally subjected to hazards of up to H3 along the Abercrombie and Forest Creek from 5% AEP to 0.2% AEP, while there are isolated storage areas exhibit higher hazards. Access throughout the site would be considered limited for events greater than 5% AEP due to these hazards, with most of the site becoming inundated in a PMF. The risk of isolation

during significant flood events requires mitigation through appropriate emergency management, including the preparation and implementation of a site Emergency Response Plan.

It is proposed that the NSW Hazards Near Me app is monitored for warnings of extreme weather. This includes severe weather warnings and severe thunderstorm warnings issued by the BoM and which may include warnings for possible flooding. These warnings are also disseminated via various media outlets and are available on the BoM website. In the event of a local warning advising of the potential for flooding it is recommended that the site is closed and evacuated.

Given the large catchment area upstream of the site, the time of concentration (i.e. time taken for rainfall to generate runoff at the site) is relatively long. This is reflected in the critical durations determined in this assessment (Table 2.1) which range from 4 to 7 days. Therefore, it is expected that in the event of a major event occurring, there will be ample opportunity for any staff on site to evacuate prior to the onset of flooding. It is recommended that the site remain closed until floodwaters have sufficiently receded and safe access restored. All site staff should be made aware of the potential flood risk during site induction. In the event of site closure, a safety bulletin should be sent to all workers via SMS. A staff member should be nominated to the role of chief flood warden, and ensure that the Site is fully evacuated in the event of a site closure.

In order to provide some indication of how long the site may be inundated during a major flood event, an analysis was conducted for selected sections along the internal access road connecting the Sturt Highway to the substation buildings. Figure 3.2, Figure 3.3, and Figure 3.4 illustrate flood levels during the TUFLOW simulation time (0 to 600 hrs) at three locations along the access road. Specifically:

- Location “A”
- Location “B”
- Location “C”

These results from selected locations (refer Figure 2.12) are considered broadly indicative of the inundation durations across the site. For each location and modelled event, the inundation start time, end time and duration are summarised in Table 3.3, Table 3.4 and Table 3.5 (respectively).

As shown in Figure 3.2 and Figure 3.3, roads remain flooded for greater than the model duration of 600 hours (25 days) in events greater than 5% AEP. Based on approximate extrapolation of these outputs, it is estimated that roads may remain flooded for up to 1,200 hours (50 days) in the 1%, 0.5% and 0.2% AEP events. This is primarily due to the slow movement of water in the region and the extended time it takes for water to travel from the upstream areas (large upstream catchment) to the site. It is also noted that estimates are indicative only, given limitations associated with model run times and uncertainty associated with extrapolation. Estimates are also subject to assumptions surrounding infiltration rates, while evaporation is not accounted for within the flood model.

A general summary of outcomes with respect to depth and duration of inundation on internal access roads is provided as follows:

- In all sections, overtopping may occur for over 600 hours (25 days), and up to approximately 1,200 hours (50 days) in the 1%, 0.5% and 0.2% AEP events, with water depths up to 0.1m in the 5% AEP event and up to 0.2m in events greater than 5% AEP in location A, and with water depth up to 0.5m in events greater than 5% AEP in location B and C.
- Access roads with flood depths of up to 0.3 m and velocities below 2 m/s are assumed safe and trafficable. These conditions correspond to hazard category H1, as per Figure 3.1.

A general summary of outcomes with respect to the trafficability of internal access roads is provided as follows:

- The maximum velocity observed across access roads is less than 0.4 m/s.
- As shown in Figure 3.3 and Figure 3.4, flood depths along the access road in locations B and C exceed the 0.3 m threshold in all events, while Location A is trafficable in events smaller than 0.5% AEP.
- Therefore, only a few access roads can be trafficable in the 5%, 1% AEP and 0.2%AEP events. However, access roads specifically located across Abercrombie Creek in the centre of the site are not trafficable during all events.
- In the 0.5% AEP event, it is estimated that access roads will not be trafficable from approximately 180 to 260 hours (8 to 11 days) after the start of the event.
- In the 0.2% AEP event, it is estimated that access roads will not be trafficable from approximately 140 to 320 hours (4 to 13 days) after the start of the event.
- In a PMF event, it is estimated that access roads will not be trafficable from approximately 50 to 320 hours (2 to 13 days) after the start of the event.

Table 3.3 Inundation start time (hours) at three selected locations along access roads

Location	5% AEP	1% AEP	0.5% AEP	0.2% AEP	PMF
"A"	20	72	10	10	10
"B"	90	50	10	10	10
"C"	70	60	10	10	10

Table 3.4 Inundation end time (hours) at three selected locations along access roads

Location	5% AEP	1% AEP	0.5% AEP	0.2% AEP	PMF
"A"	> 600	> 600	> 600	> 600	> 600
"B"	> 600	> 600	> 600	> 600	> 600
"C"	> 600	> 600	> 600	> 600	> 600

Table 3.5 Duration of inundation (hours) at three selected locations along access roads

Location	5% AEP	1% AEP	0.5% AEP	0.2% AEP	PMF
"A"	<1200	<1200	<1200	<1200	<1200
"B"	<1200	<1200	<1200	<1200	<1200
"C"	<1200	<1200	<1200	<1200	<1200

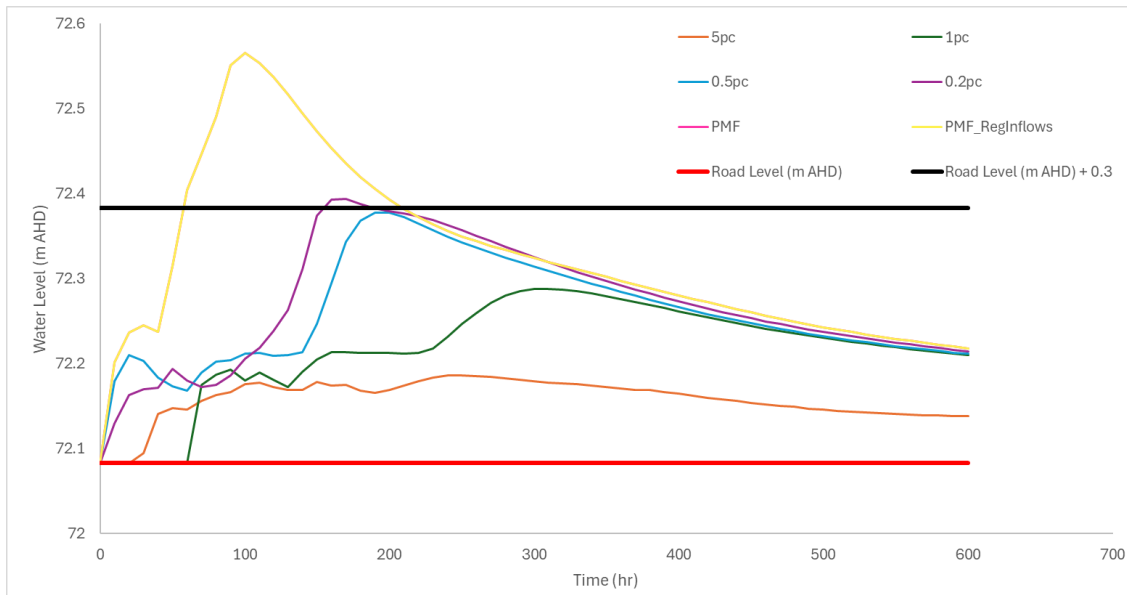


Figure 3.2 Inundation time along the access road in the north of the site (Location "A").

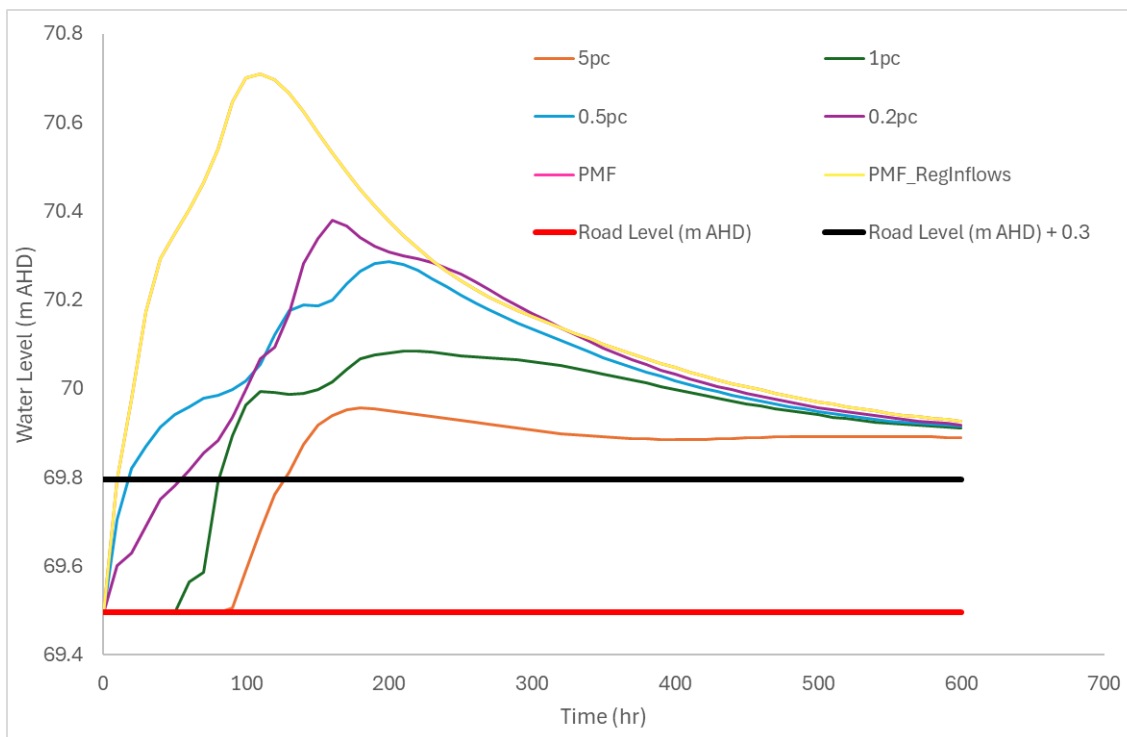


Figure 3.3 Inundation time along the access road in the centre of the site (Location "B").

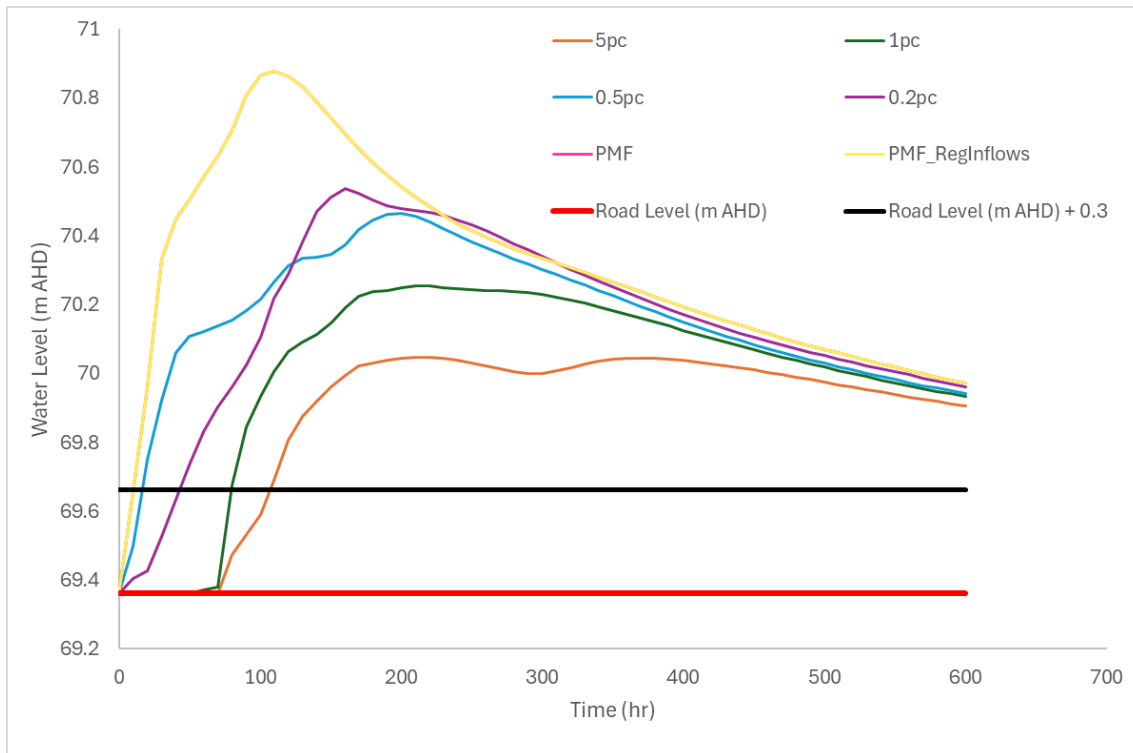


Figure 3.4 Inundation time along the access road in the centre of the site (Location “C”).

3.9 SEARs Responses

Project specific requirements were received in a letter from BCS dated 04 October 2024, with those relevant to flood risk management and how they have been addressed summarised in Table 3.6.

Table 3.6 Response to BCS requirements

SEAR	Response
1.1. The EIS needs to map the following features relevant to flooding as described in the Flood Risk Management Manual 2023 (DPE 2023) including: a) Flood Prone Land. b) Flood Planning area, the area below the flood planning level. c) Hydraulic categorisation (floodways and flood storages). d) Flood hazard.	Relevant flood maps are provided in Annexes of this report.
1.2. The EIS needs to describe flood assessment and modelling completed to determine the design flood levels for events. This needs to include a minimum of the 5% Annual Exceedance Probability (AEP), 1% AEP flood levels and the probable maximum flood, or an equivalent extreme event.	Flood assessment approach is described in Section 2 of this report. In summary, the flood assessment has been undertaken in accordance with Australian Rainfall and Runoff 2019 (ARR 2019) data and methodology to establish existing (baseline) and post-development flood behaviour for the Project site. Events assessed include the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and PMF for the local

SEAR	Response
	catchment, along breakout of the 0.05% AEP for the regional (Murrumbidgee) catchment.
1.3. The EIS needs to model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios: a) Current flood behaviour for a range of design events. This includes the 0.5% and 0.2% AEP year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.	Flood impacts have been estimated for the 5% AEP, 1% AEP and PMF events, in addition to the 0.5% AEP and 0.2% AEP events as proxies for climate change (refer Section 2).
1.4. Modelling in the EIS needs to consider and document: a) Existing council flood studies in the area and examine consistency to the flood behaviour documented in these studies. b) The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood. c) Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazards and hydraulic categories. d) Related provisions of the NSW Flood Risk Management Manual (DPE 2023).	a) This study is consistent with council study (Hay and Maude Flood Study - 2023) in their use of data and modelling approaches. b) Flood impacts have been estimated for all requested design storm events, refer to Section 3. Any changes to flood extents, velocities, levels, hazards and hydraulic categories are highlighted in baseline and developed scenario maps, and discussed in Section 3. In summary, no offsite impacts are observed due to inclusion of the proposed developments in all events. c) In all events, no offsite impacts are observed due to inclusion of the proposed developments. Additionally, the impacts within the site are considered non-detrimental to the proposed WTGs and developments. d) All related provisions in the NSW Flood Risk Management Manual (DPE 2023) have been considered in this assessment.
1.5. The EIS needs to assess the impacts on the proposed development on flood behaviour, including: a) Whether there will be detrimental increases in the potential flood affection of other properties, assets and infrastructure. b) Consistency with Council Flood/Floodplain Risk Management Plans. c) Consistency with any Rural Floodplain Management Plans. d) Compatibility with the flood hazard of the land. e) Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land. f) Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site. g) Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation	a) The proposal does not result in detrimental increases to flood affection of other properties as discussed in Section 3. b) There are no Council Floodplain Risk Management Plans in the study area. c) There are no Rural Floodplain Management Plans in the study area. d) Flood hazards and their extents are considered generally compatible with the proposal as indicated in mapping provided. In summary, the proposed developments and WTGs are located in low hazard areas (up to H3) for events from the 5% to 0.2% AEP, with a few WTGs in high hazard areas (up to H4) along Abercrombie Creek during the PMF event, refer to Section 3.4. No significant changes to hazard are expected within or outside the site, as shown by the pre- and post-hazard maps. e) Hydraulic functions and their extents are considered generally compatible with the proposal as indicated in mapping provided. In summary, the

SEAR	Response
or a reduction in the stability of riverbanks or watercourses. h) Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the State Emergency Services (SES) and Council. i) Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and Council. j) Emergency management, evacuation and access, and contingency measures for the development considering the full range of flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the SES. k) Any impacts the development may have on the social and economic costs to the community as consequence of flooding.	site consists of Flood Storage and Flood Fringe categories due to slow-moving water in the catchment. No significant changes to flood function are expected as a result of the proposal, as shown by the pre- and post-flood function maps. f) The proposal does not result in detrimental increases to flood affection outside the site as discussed in Section 3.2. g) Given the relatively low flood velocities across the site (and that these are not expected to change), no increases to erosion, siltation, or bank instability are expected. h) Existing community emergency management arrangements are not impacted by the proposal as discussed in Section 3.8. i) Recommended emergency management measures are discussed in Section 3.8. Council / SES are to be contacted during the preparation of the site Emergency Response Plan. j) As above. k) Based on the non-detrimental nature of estimated impacts, no social or economic impacts are expected as a consequence of flooding.

4 Conclusions & Recommendations

A hydrology and flooding assessment has been undertaken for the proposed Baldon Wind Farm Project located approximately 48 km east of Balranald. The following key observations are noted in terms of flood risk to the site:

- This assessment is generally consistent with the closest relevant council flood study (Hay and Maude Flood Study, 2023) in terms of modelling approach and input data.
- Baseline scenario results indicate that surface flows are of relatively low velocity, due to shallow grades in the catchment and presence of significant storage areas. No significant changes to velocity are expected outside the site as a result of the proposed development.
- With consideration of relatively low velocities in existing and developed scenarios, it is expected that there will be limited erosion in the riverbanks, destruction of riparian vegetation or reduction in the stability of riverbanks or watercourses.
- All proposed developments and WTGs achieve 1% AEP plus 0.5m flood immunity.
- Most WTGs are outside the modelled flood extents for the 5%, and 1% AEP events but are largely within the modelled extents of the PMF.
- In events from 5% to 0.2% AEP, low hazards (Hazard Category H1 to H3) are observed in areas within the site affected by Abercrombie Creek and The Forest Creek flow paths, except for storage areas within the site which exhibit high hazards (up to H5).
- In the PMF, small areas of high hazard (up to H5) are observed within the site along Abercrombie Creek and The Forest Creek, while storage areas reach hazard levels up to H6.
- The site consists of flood storage and flood fringe categories due to slow-moving water, and the proposal is not expected to cause significant changes to flood function. Flood functions and their extents are considered generally compatible with the proposal.
- Modelling of the 0.5% and 0.2% AEP events as proxies for increased rainfall intensity in a 1% AEP due to climate change shows increased flood depths, extents, and hazard, but no significant change in flood velocities.
- For all modelled events, no flood impacts are observed outside the site.
- The impacts within the site are considered non-detrimental to the proposed WTGs and developments.
- Emergency management measures may be required to mitigate risks associated with access or isolation during flood events.
- In general, most access roads within the site, specifically centre of the site across Abercrombie Creek, are not trafficable during major flood events. It is estimated that access roads in the centre of the site across Abercrombie Creek will not be trafficable from approximately 12 to over 600 hours after the start of the event.

- Breakout flows from Murrumbidgee River in the extreme event do not affect water levels or increase flood risk within the Site. As such, smaller events such as the 1% AEP are not expected to impact water levels within the site.
- Based on this assessment, the following recommendations are suggested:
 - Consider the outcomes of this hydrology and flooding assessment during subsequent design phases, including the incorporation of any design refinements into updated modelling as necessary, to ensure hydrology and flooding outcomes remain suitable.
 - Prepare and implement a site Emergency Response Plan in consultation with Council and the NSW SES.

5 References

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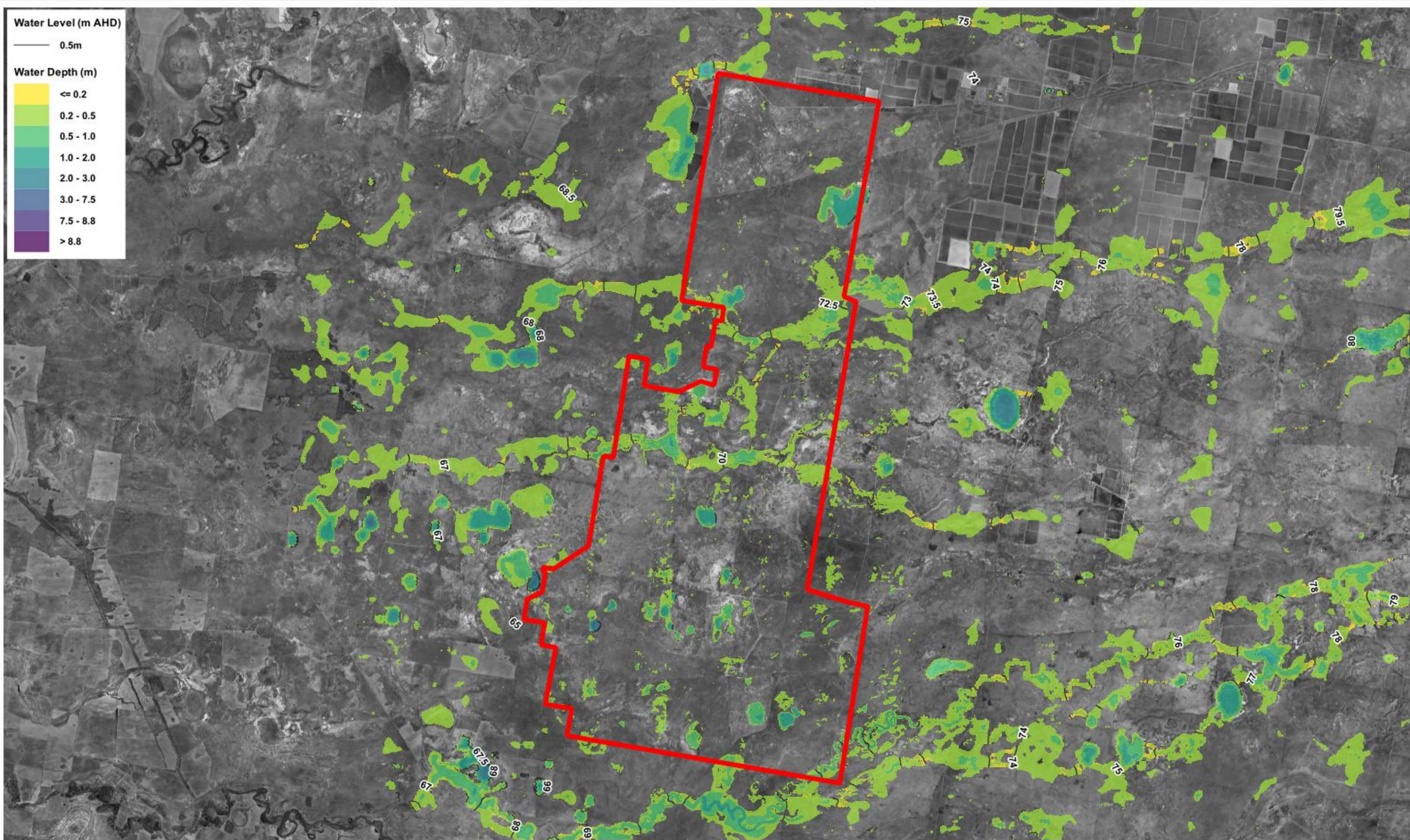
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Annex A Baseline Scenario Flood Maps



LEGEND

 Project Extent

Title:

Baseline Scenario - 5% AEP Peak Flood Levels and Depths

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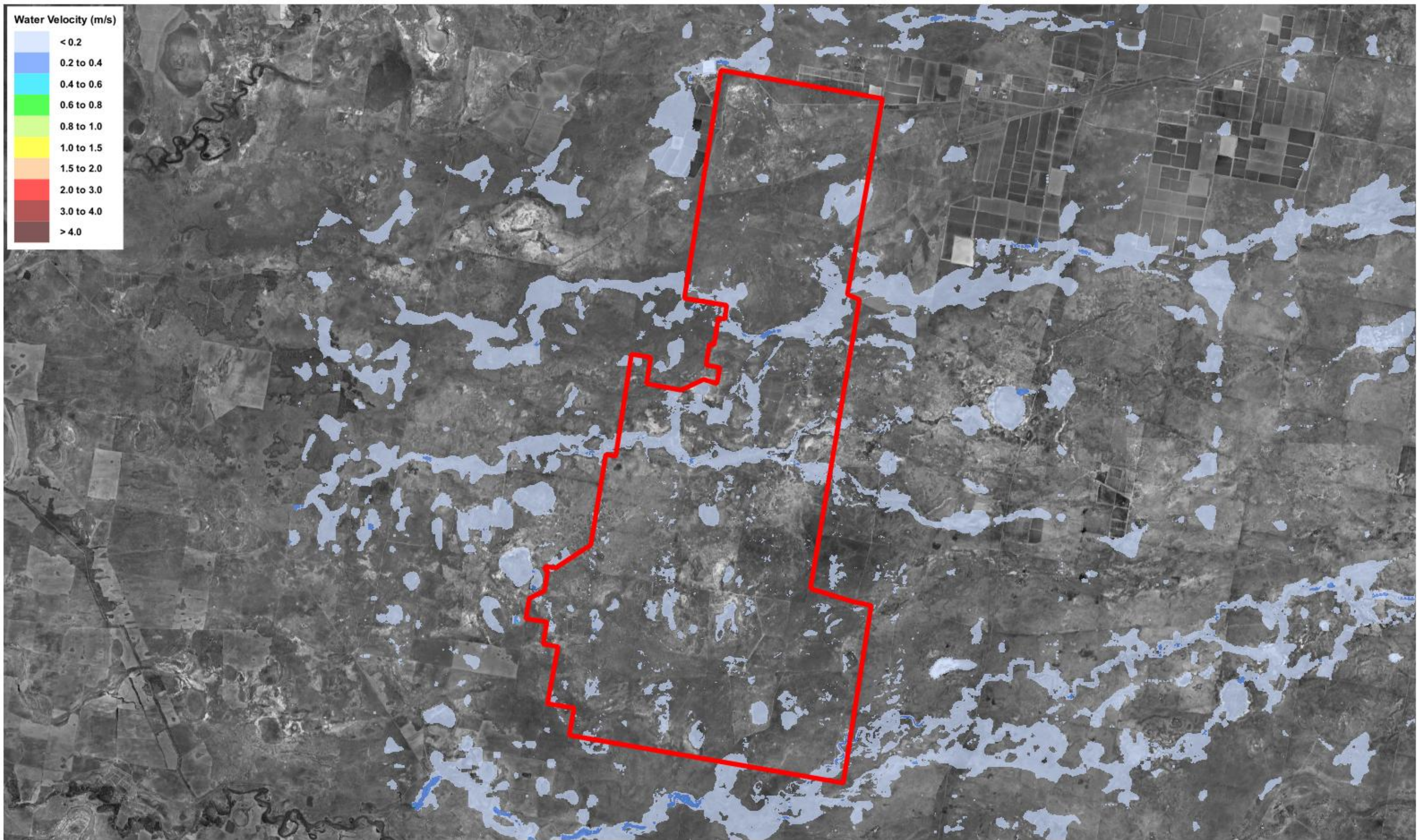
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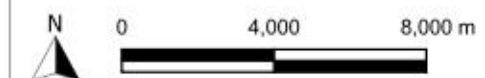
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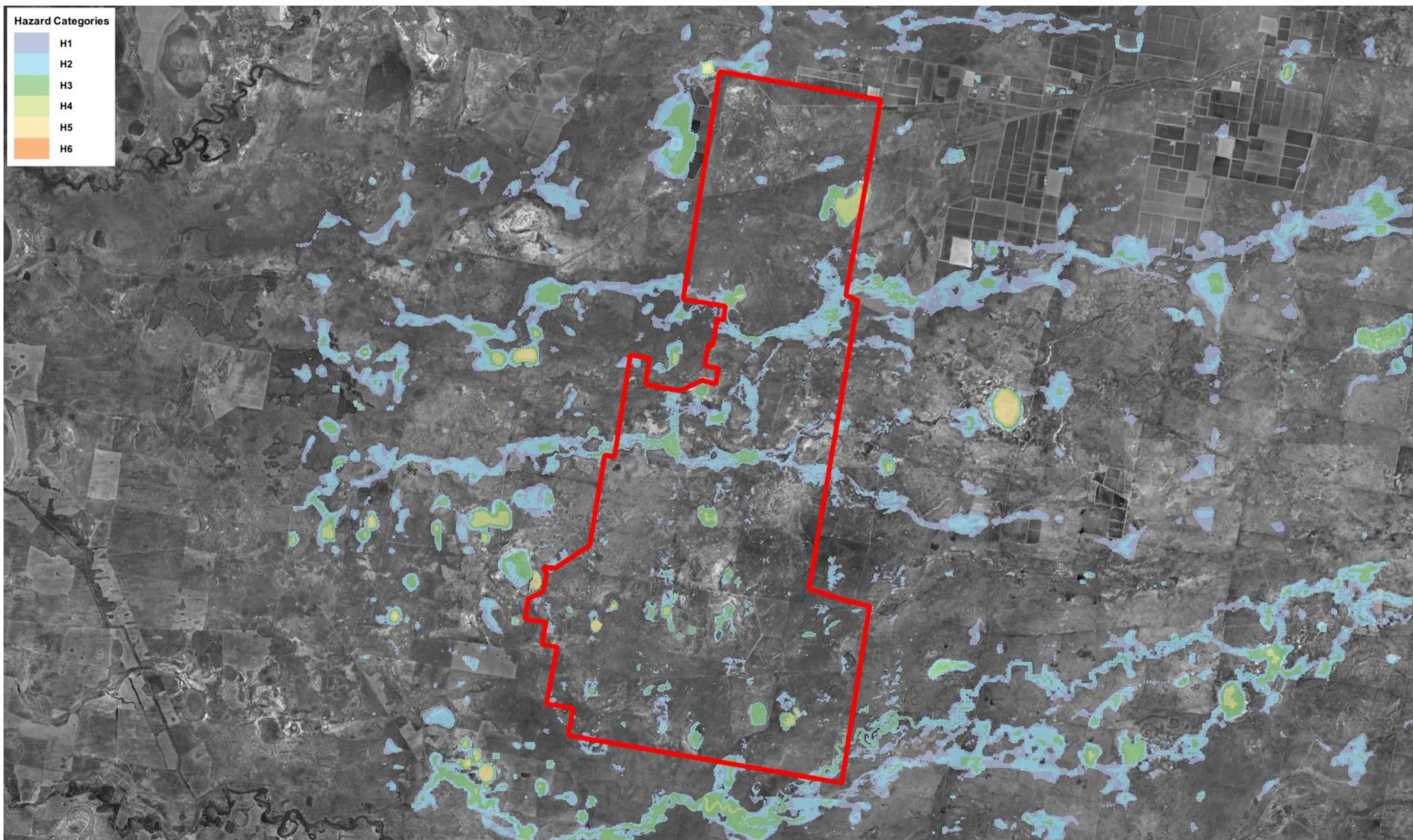
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 Project Extent

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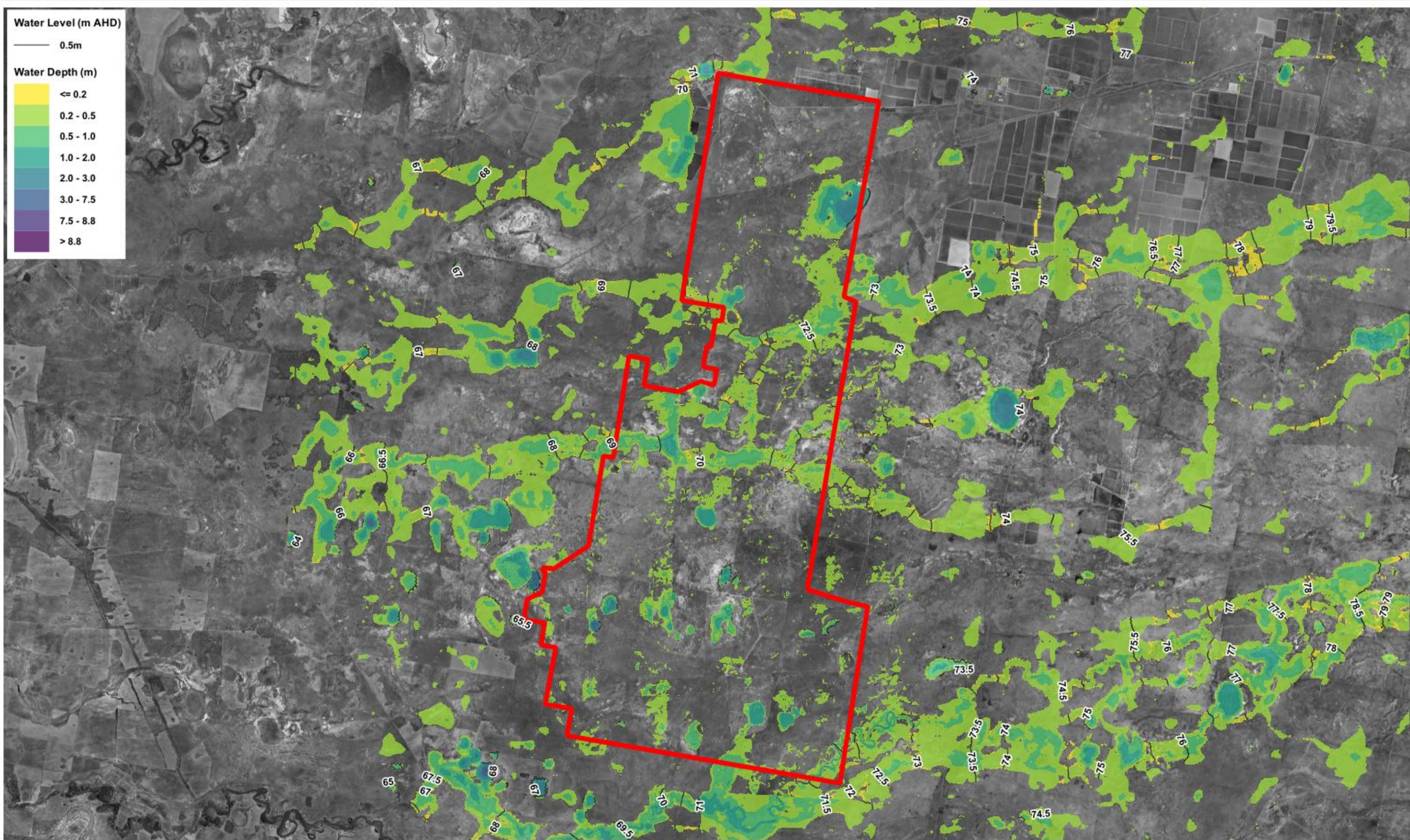
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LEGEND

 Project Extent

Title:

Baseline Scenario - 1% AEP Peak Flood Levels and Depths

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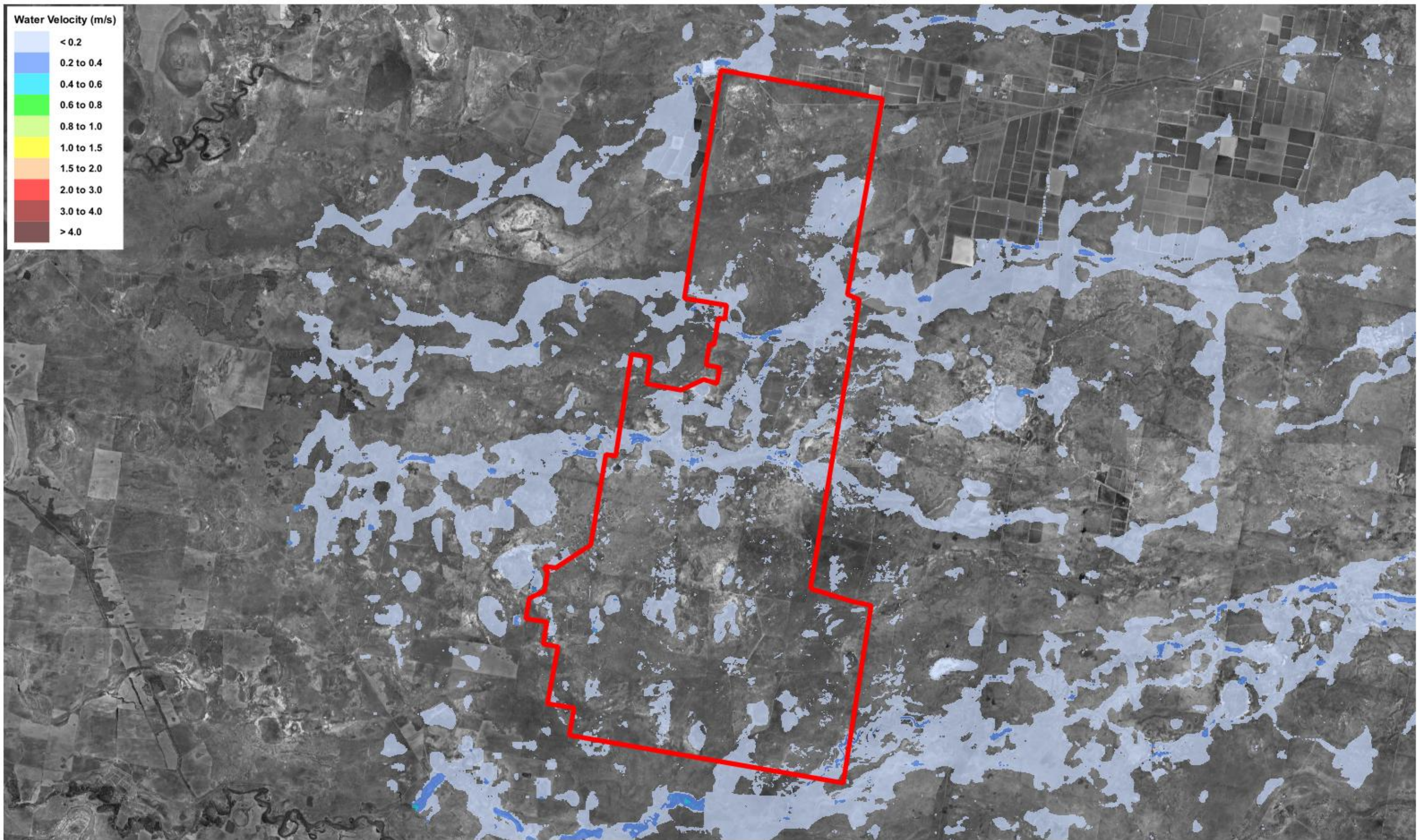
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LEGEND

 Project Extent

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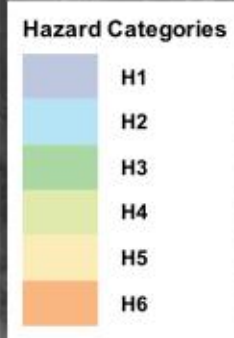
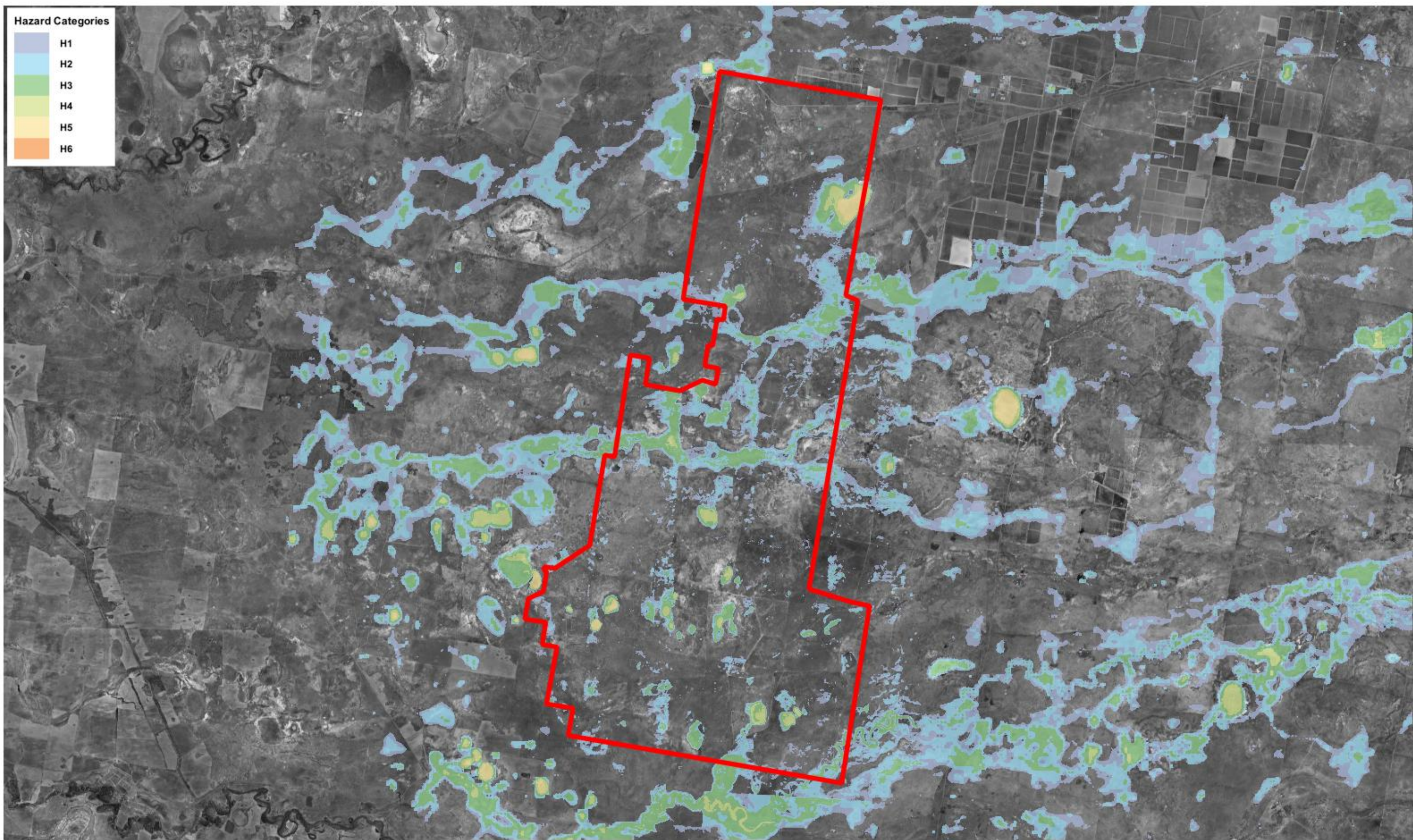
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 Project Extent

Title:

Baseline Scenario - 1% AEP Peak Hazard Conditions

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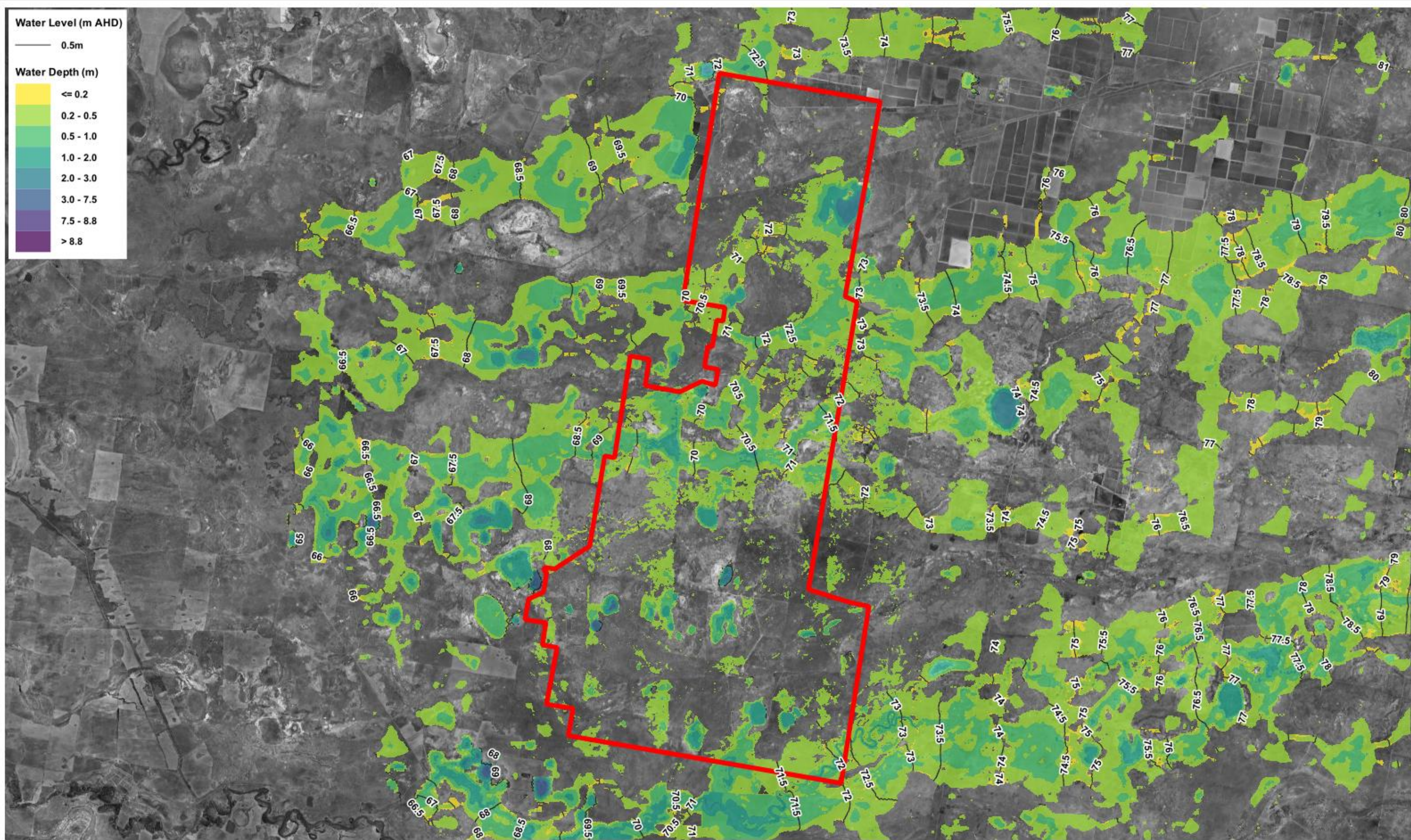
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LEGEND

 Project Extent

Title:

Baseline Scenario - 0.5% AEP Peak Flood Levels and Depths

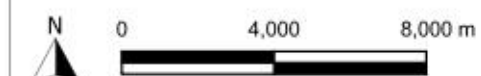
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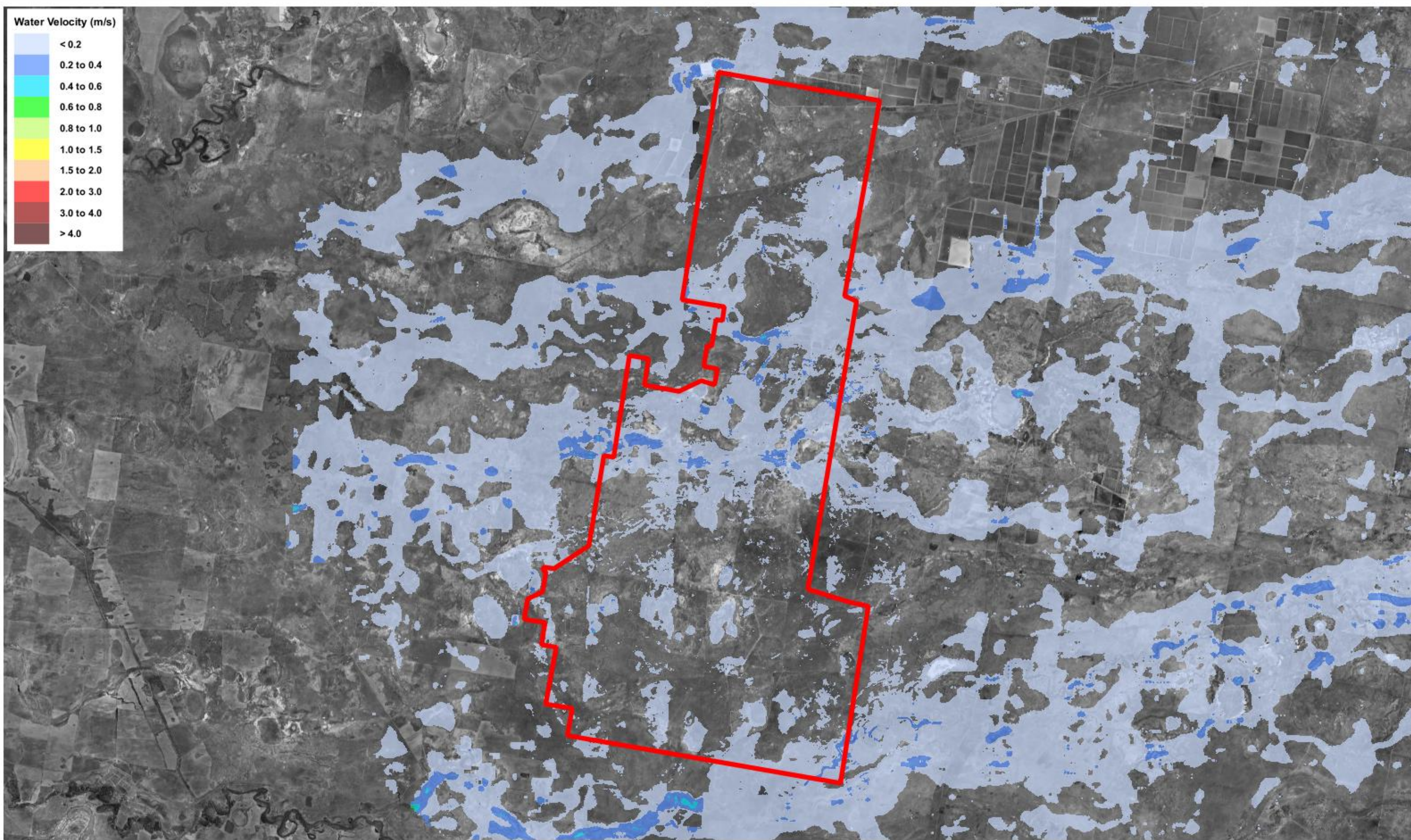
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LEGEND

 Project Extent

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Baseline Scenario - 0.5% AEP Peak Velocity

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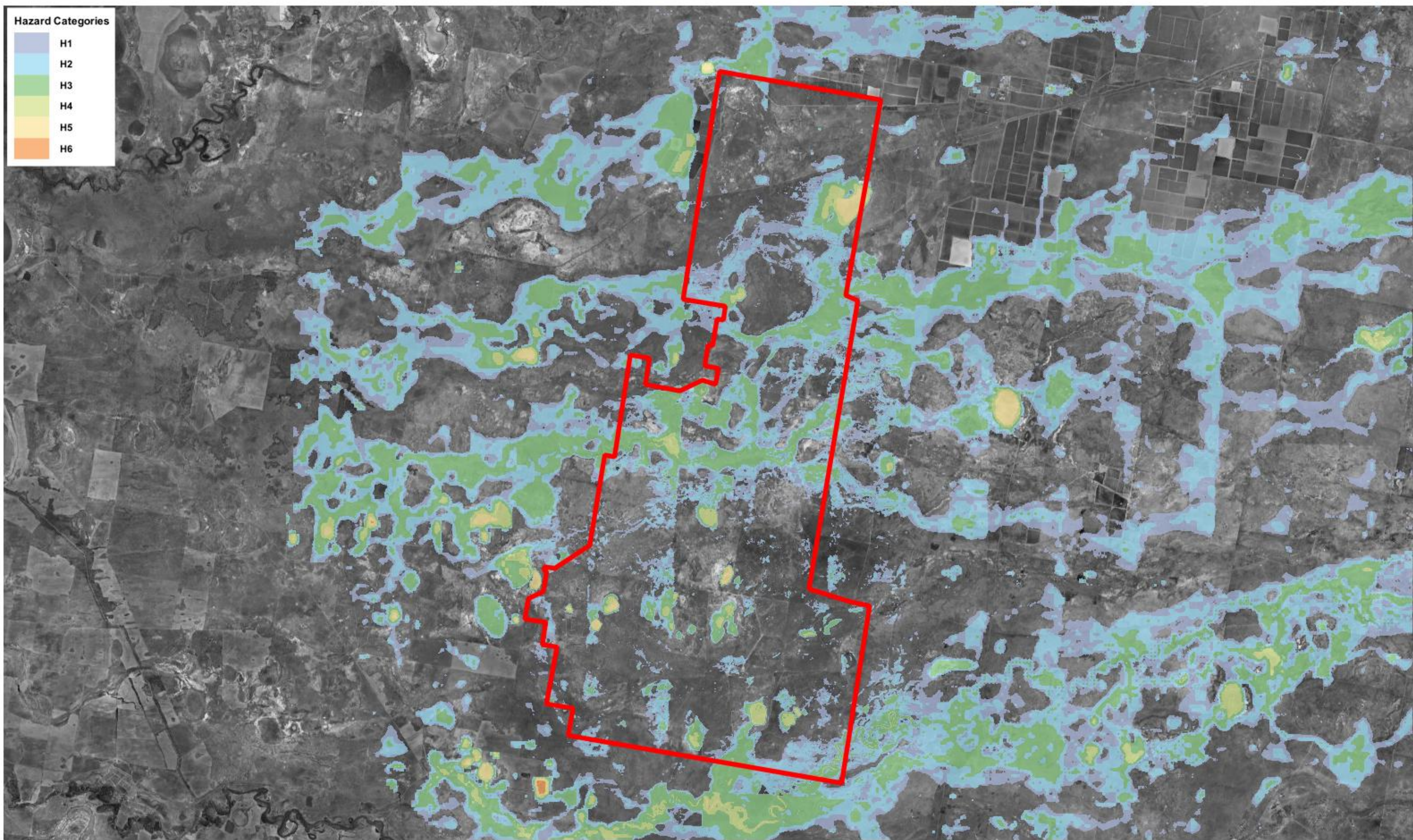
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LEGEND

 Project Extent

Title:

Baseline Scenario - 0.5% AEP Peak Hazard Conditions

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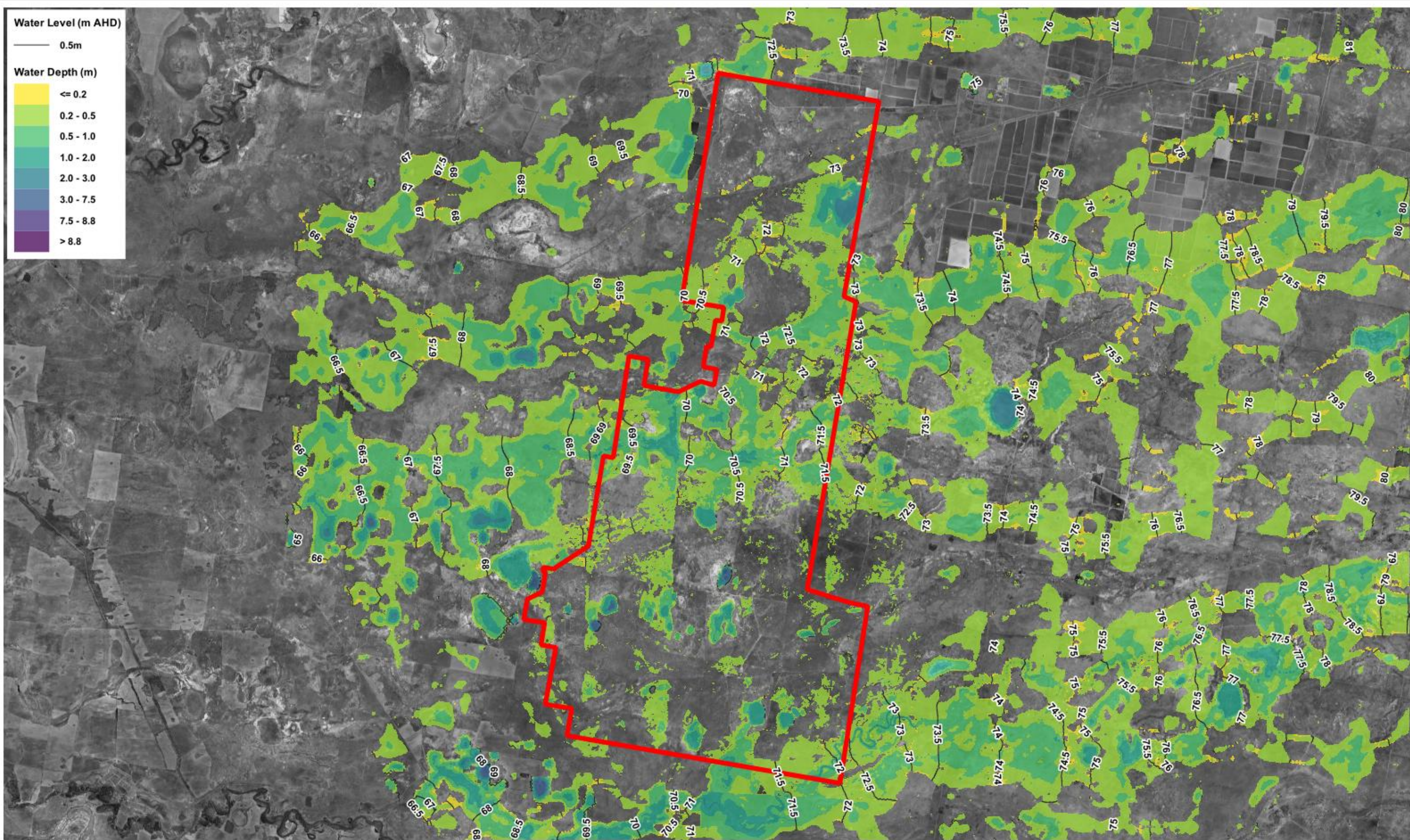
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LEGEND

 Project Extent

Title:

Baseline Scenario - 0.2% AEP Peak Flood Levels and Depths

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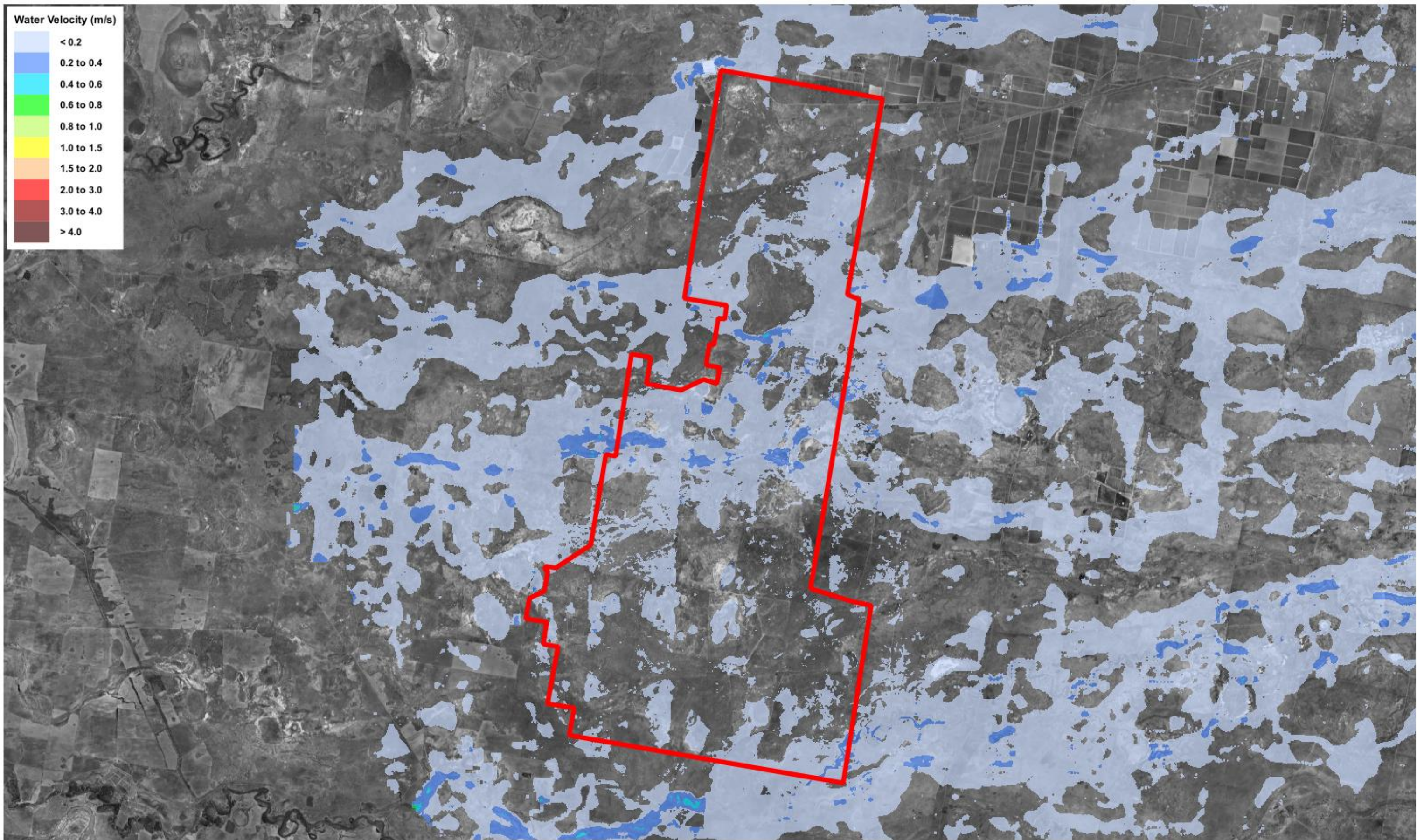
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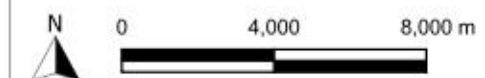
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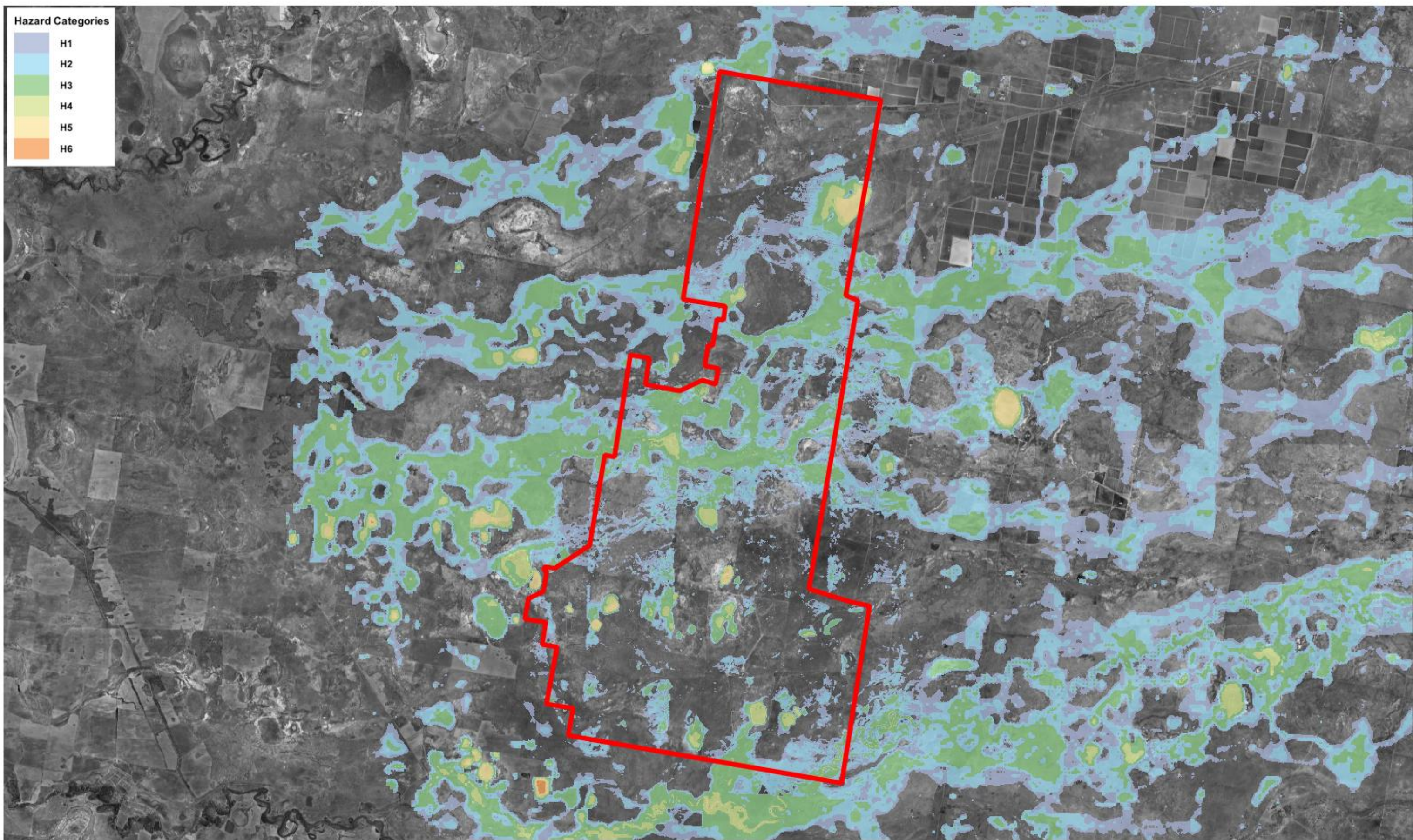
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LEGEND

 Project Extent

Title:

Baseline Scenario - 0.2% AEP Peak Hazard Conditions

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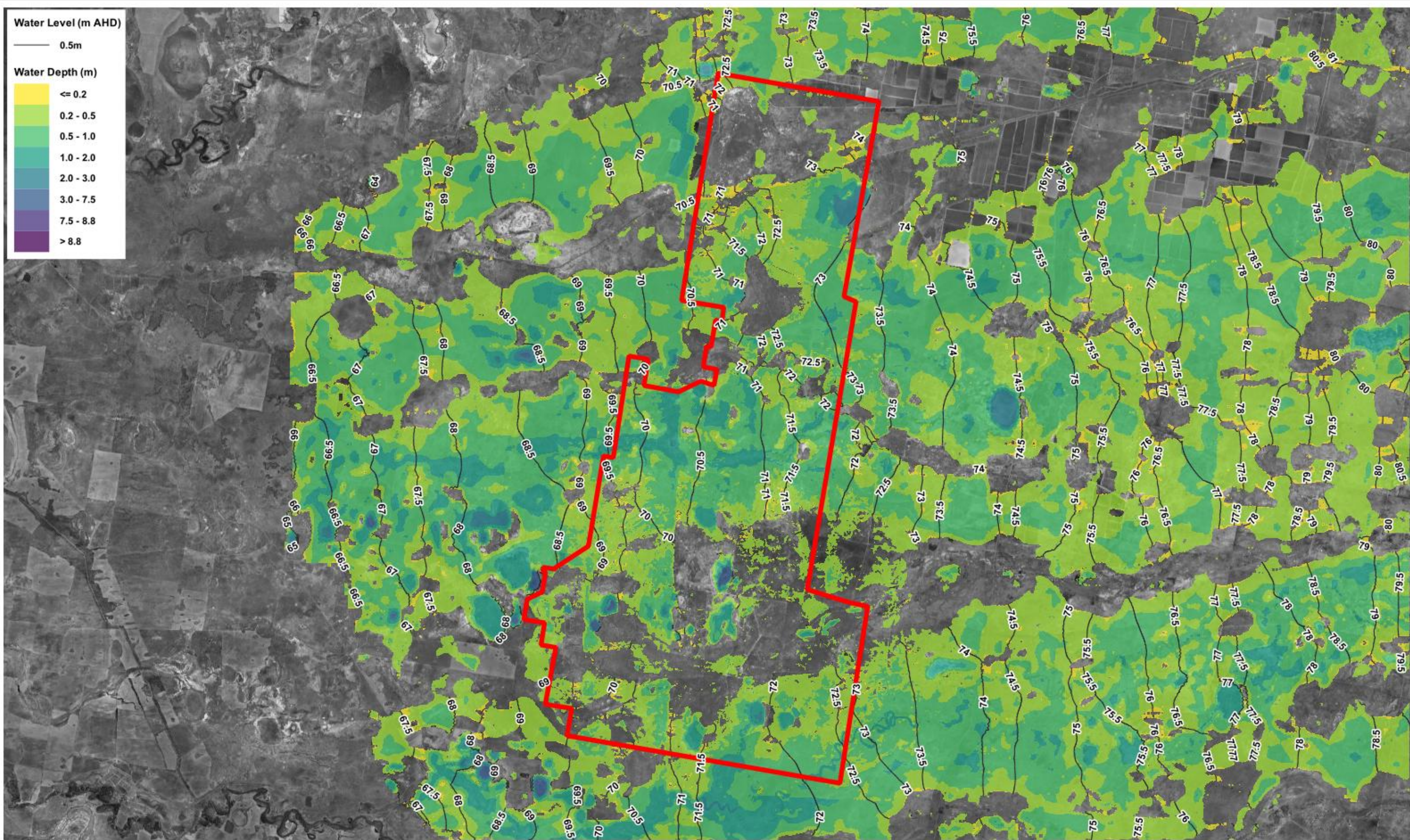
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LEGEND

 Project Extent

Title:

Baseline Scenario - PMF Peak Flood Levels and Depths

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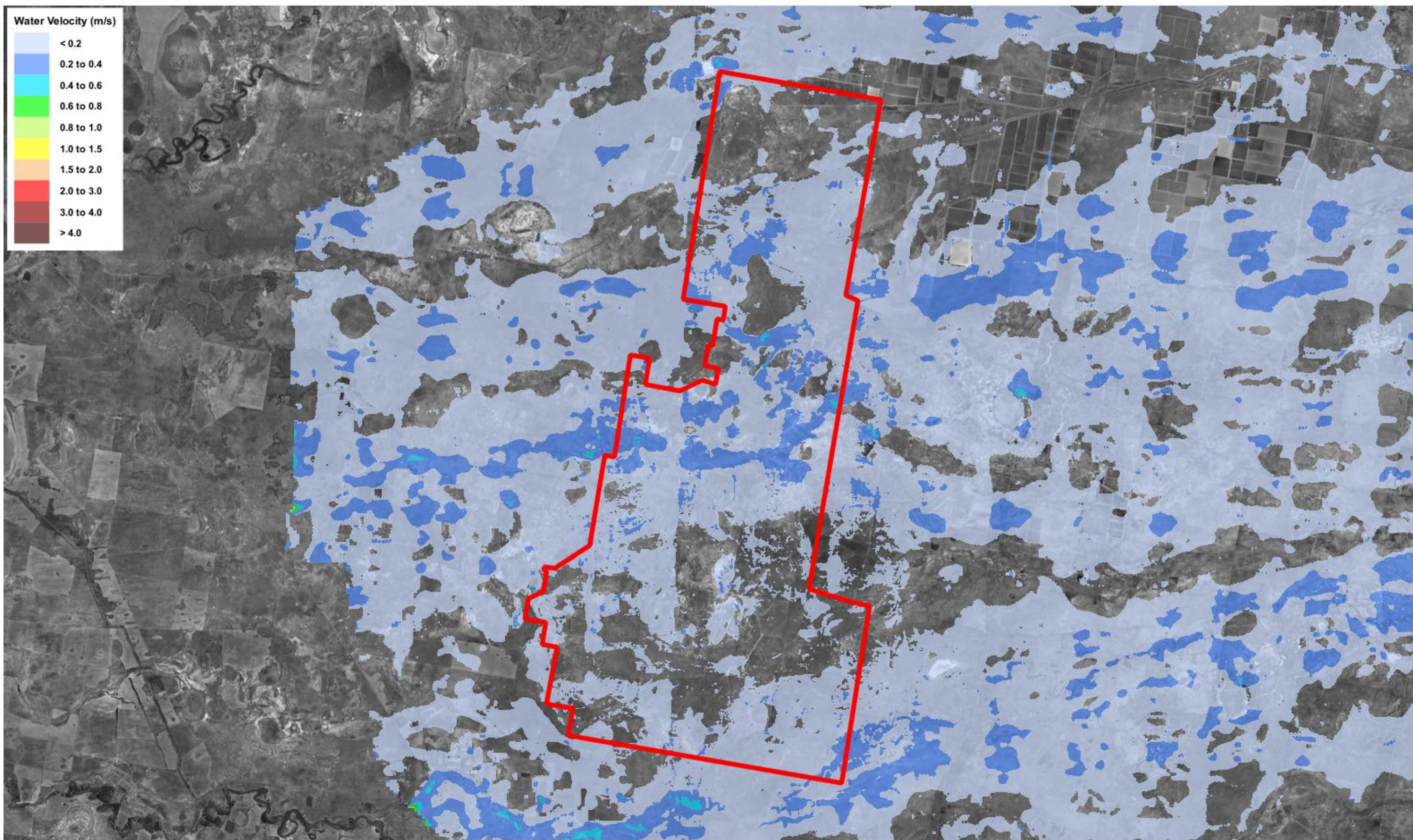
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LEGEND

 Project Extent

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Baseline Scenario - PMF Peak Velocity

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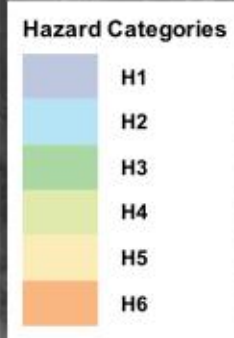
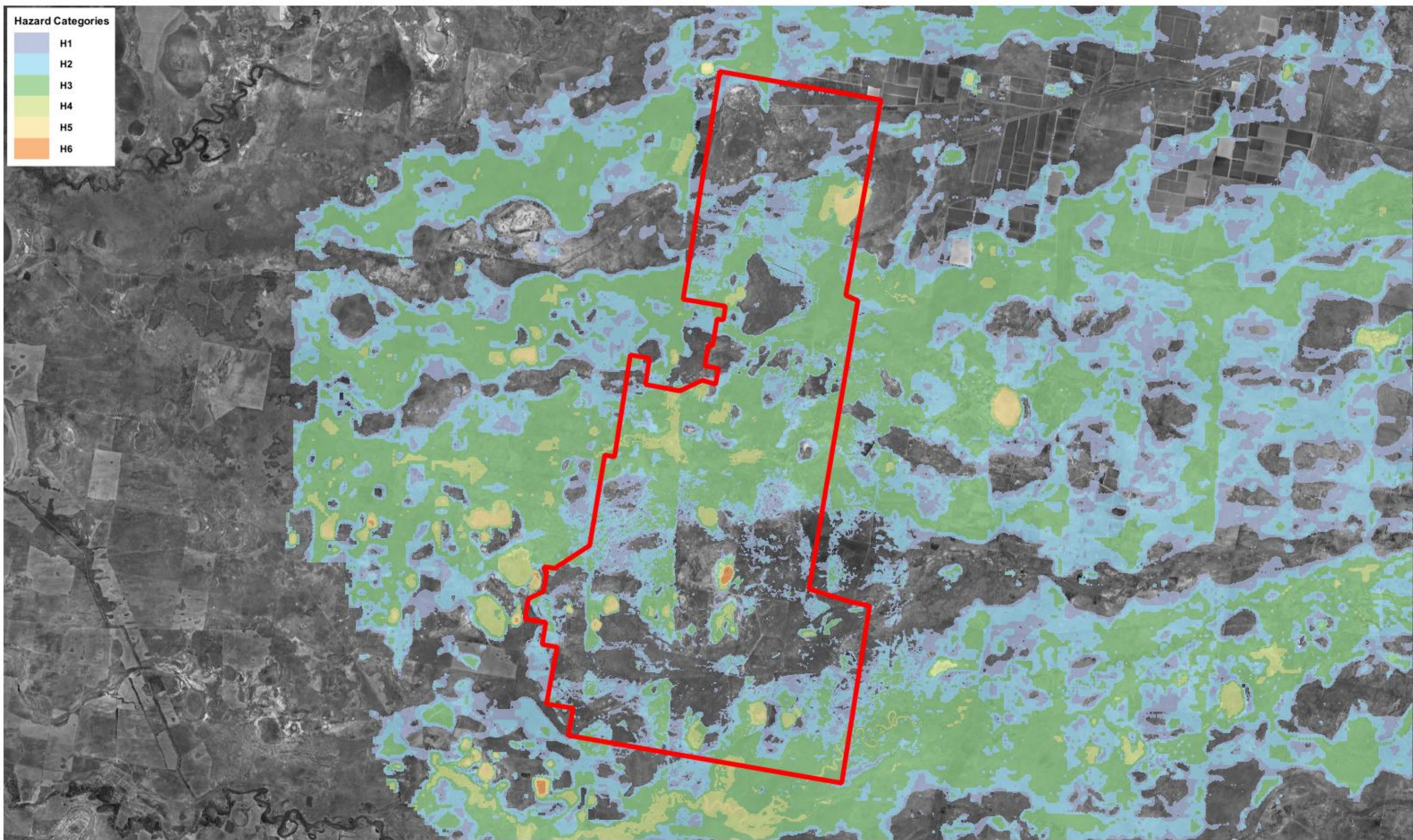
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LEGEND

 Project Extent

Title:

Baseline Scenario - PMF Peak Hazard Conditions

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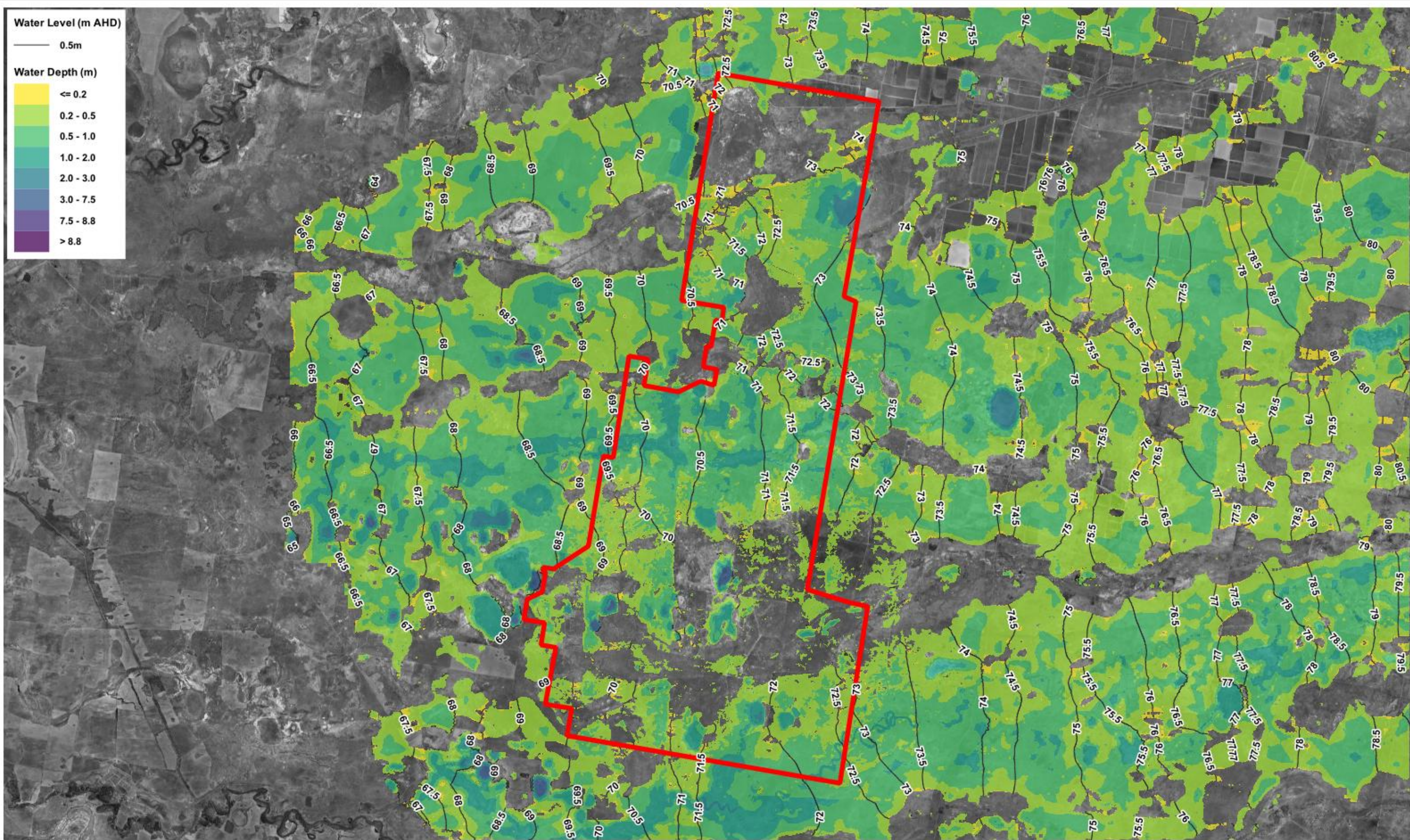
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LEGEND

 Project Extent

Title:

Baseline Scenario - PMF with Regional Inflows Peak Flood Levels and Depths

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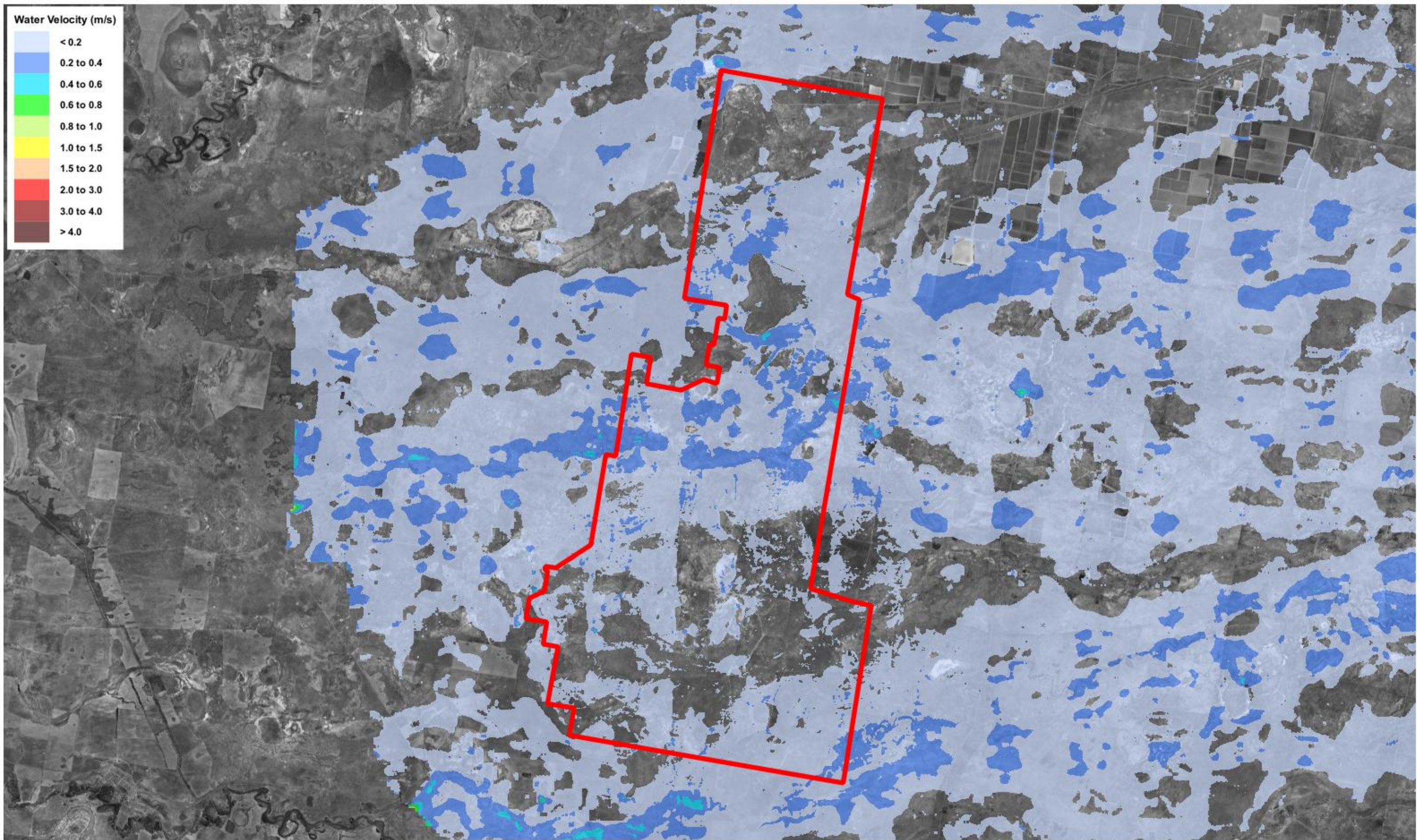
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LEGEND

 Project Extent

Title:

Baseline Scenario - PMF with Regional Inflows Peak Velocity

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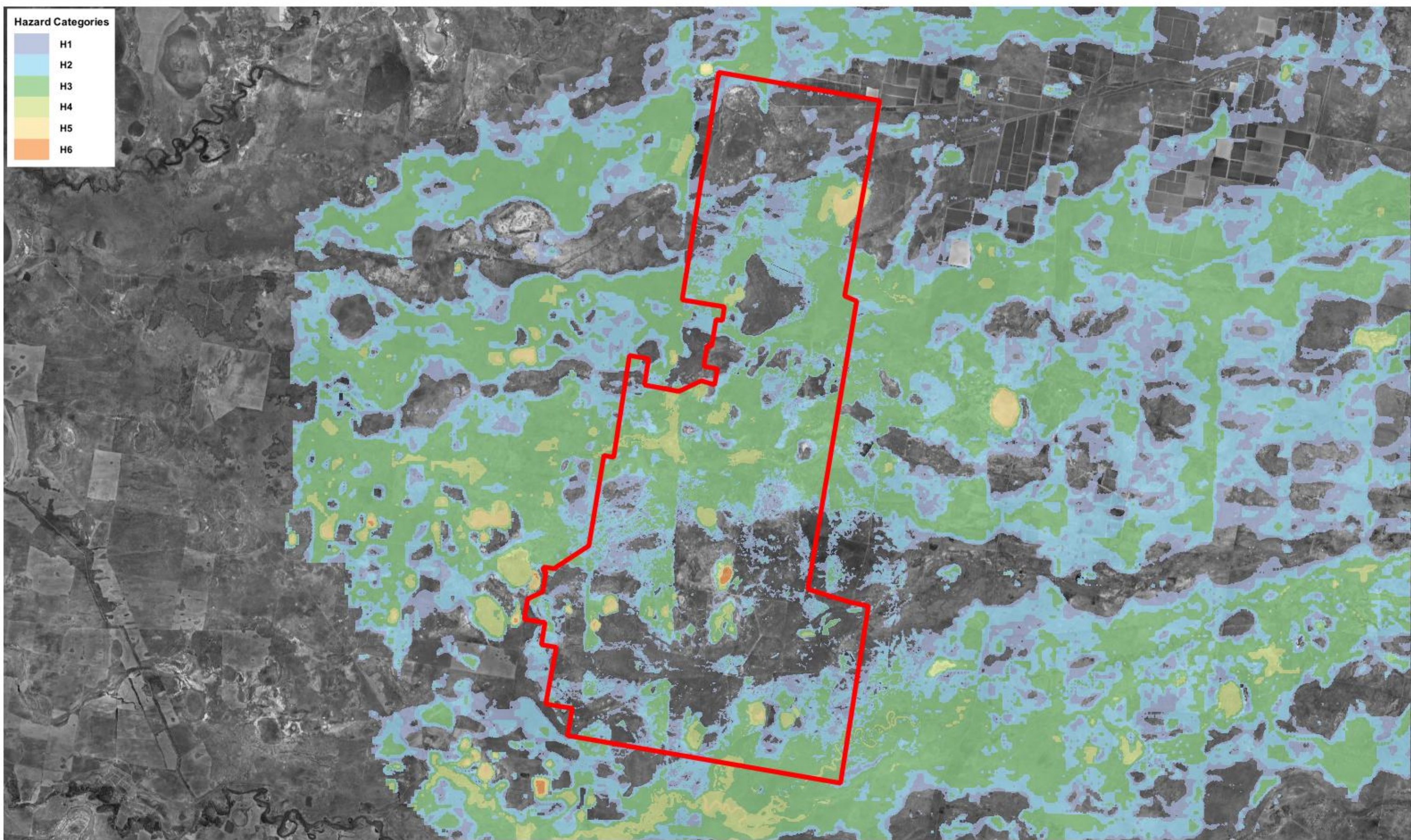
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LEGEND

 Project Extent

Title:

Baseline Scenario - PMF with Regional Inflows Peak Hazard Conditions

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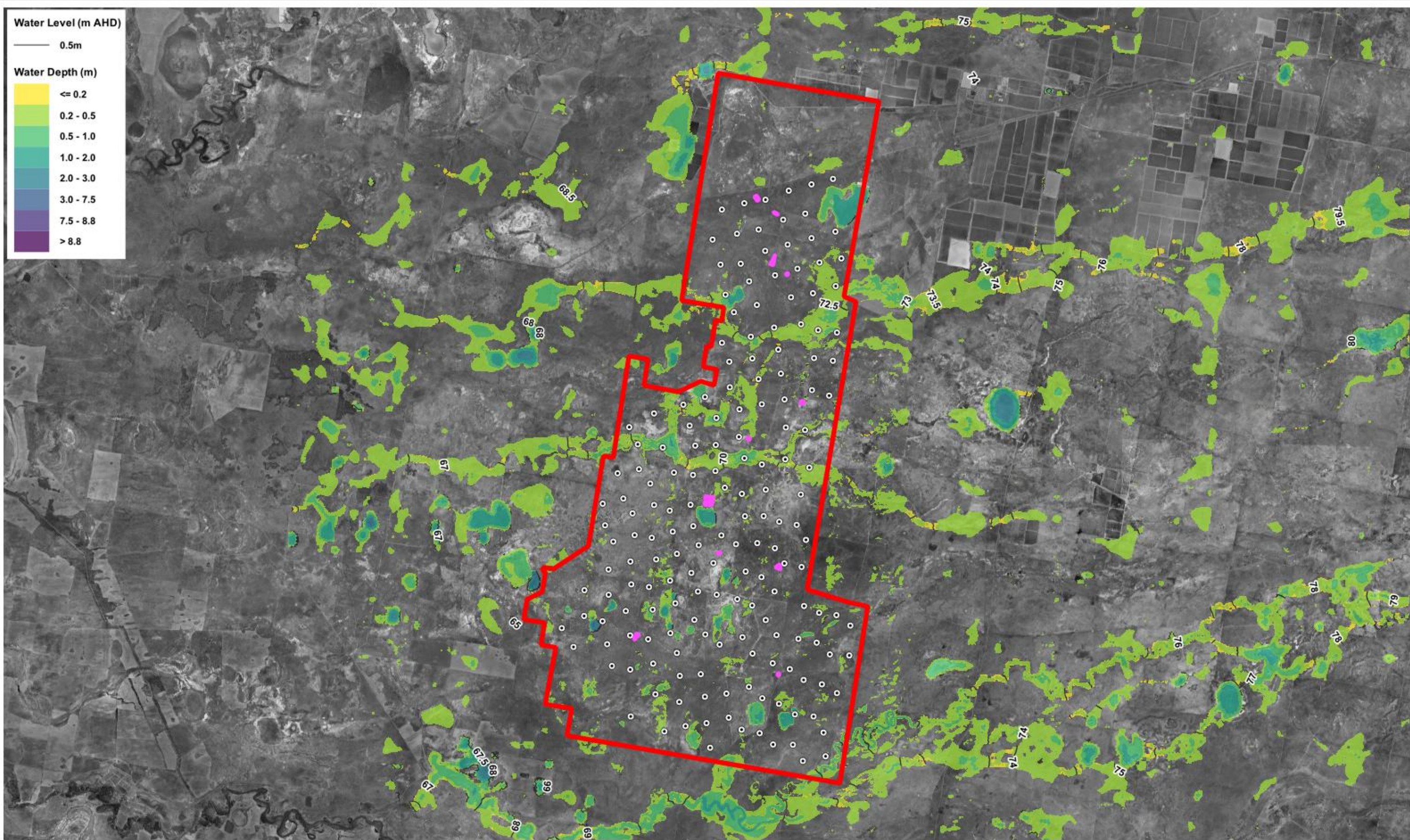
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Annex B Developed Scenario Flood Maps



LEGEND

- ▭ Project Extent
- ▭ Proposed Developments
- Turbine Locations

Title:

Developed Scenario - 5% AEP Peak Flood Levels and Depths

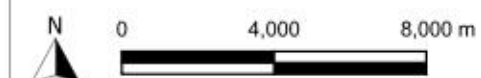
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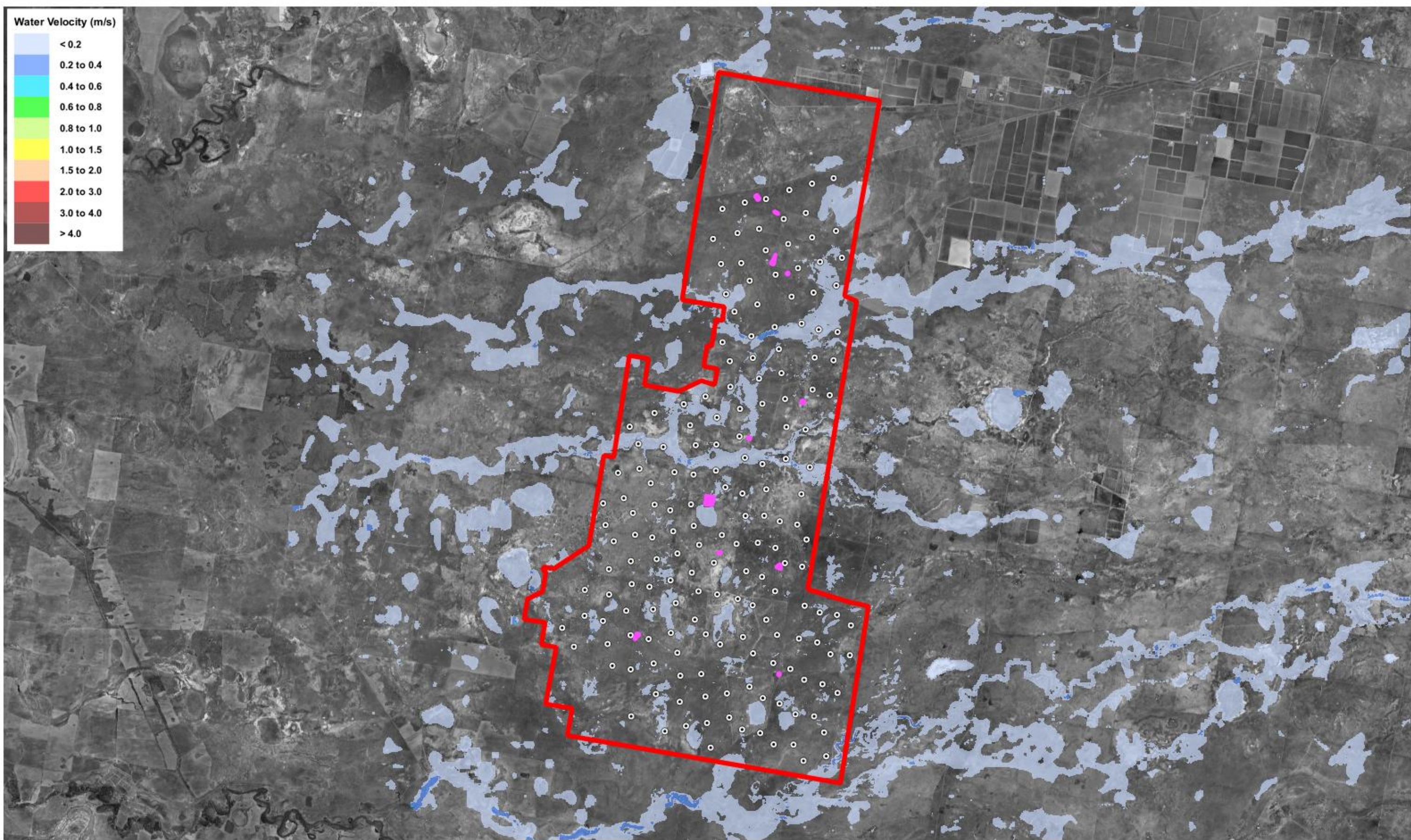
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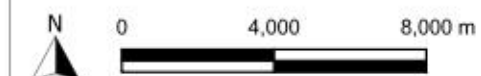
- LEGEND**
- Project Extent
 - Proposed Developments
 - ⊙ Turbine Locations

Title:
Developed Scenario - 5% AEP Peak Velocity

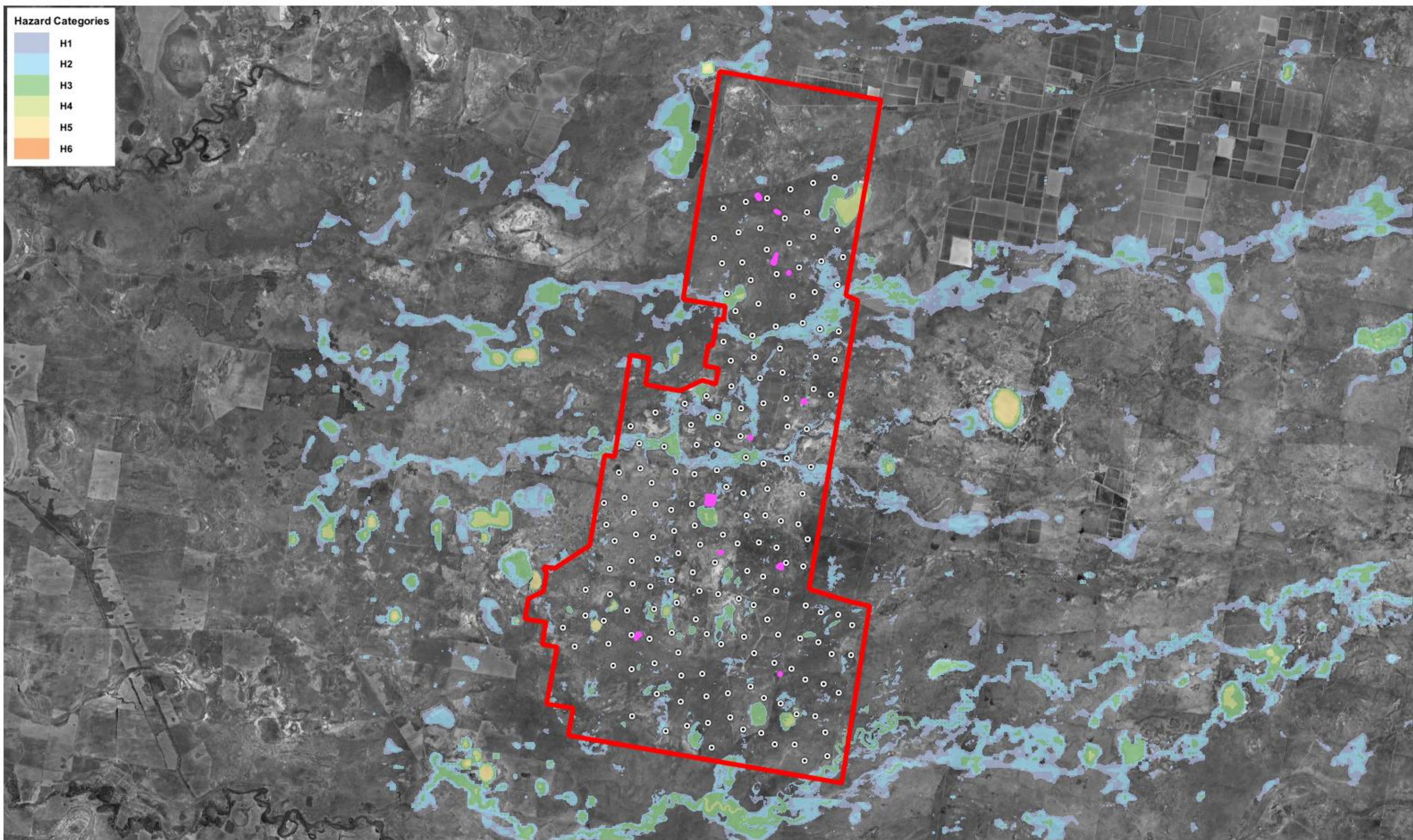
Drawing:
B.2

Rev:
A

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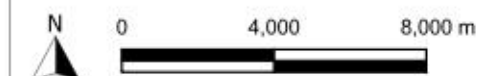
- LEGEND**
- Project Extent
 - Proposed Developments
 - Turbine Locations

Title:
Developed Scenario - 5% AEP Peak Hazard Conditions

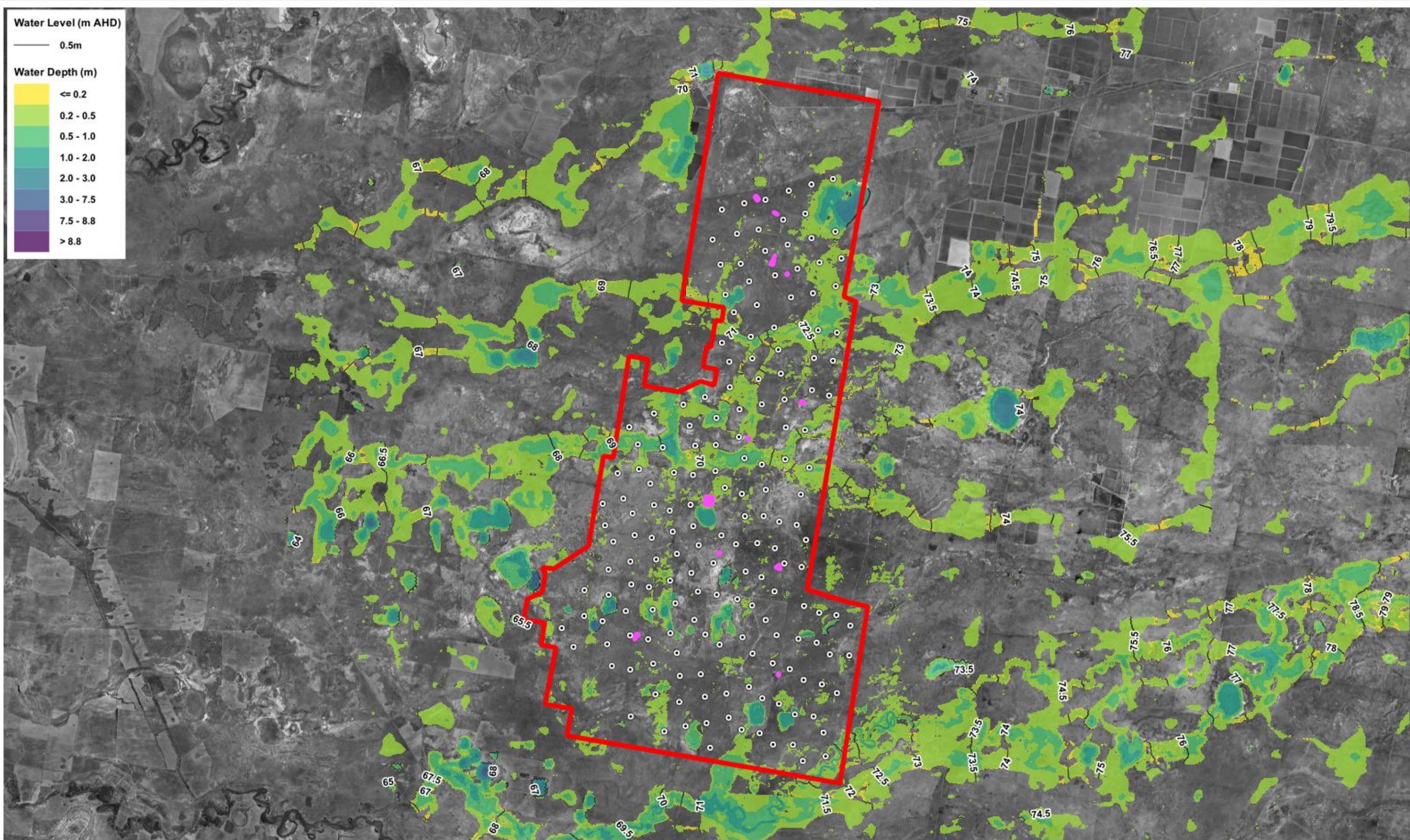
Drawing:
B.3

Rev:
A

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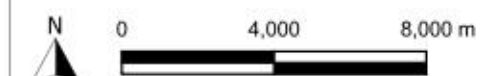


LEGEND

- ▭ Project Extent
- ▭ Proposed Developments
- Turbine Locations

Title: Developed Scenario - 1% AEP Peak Flood Levels and Depths

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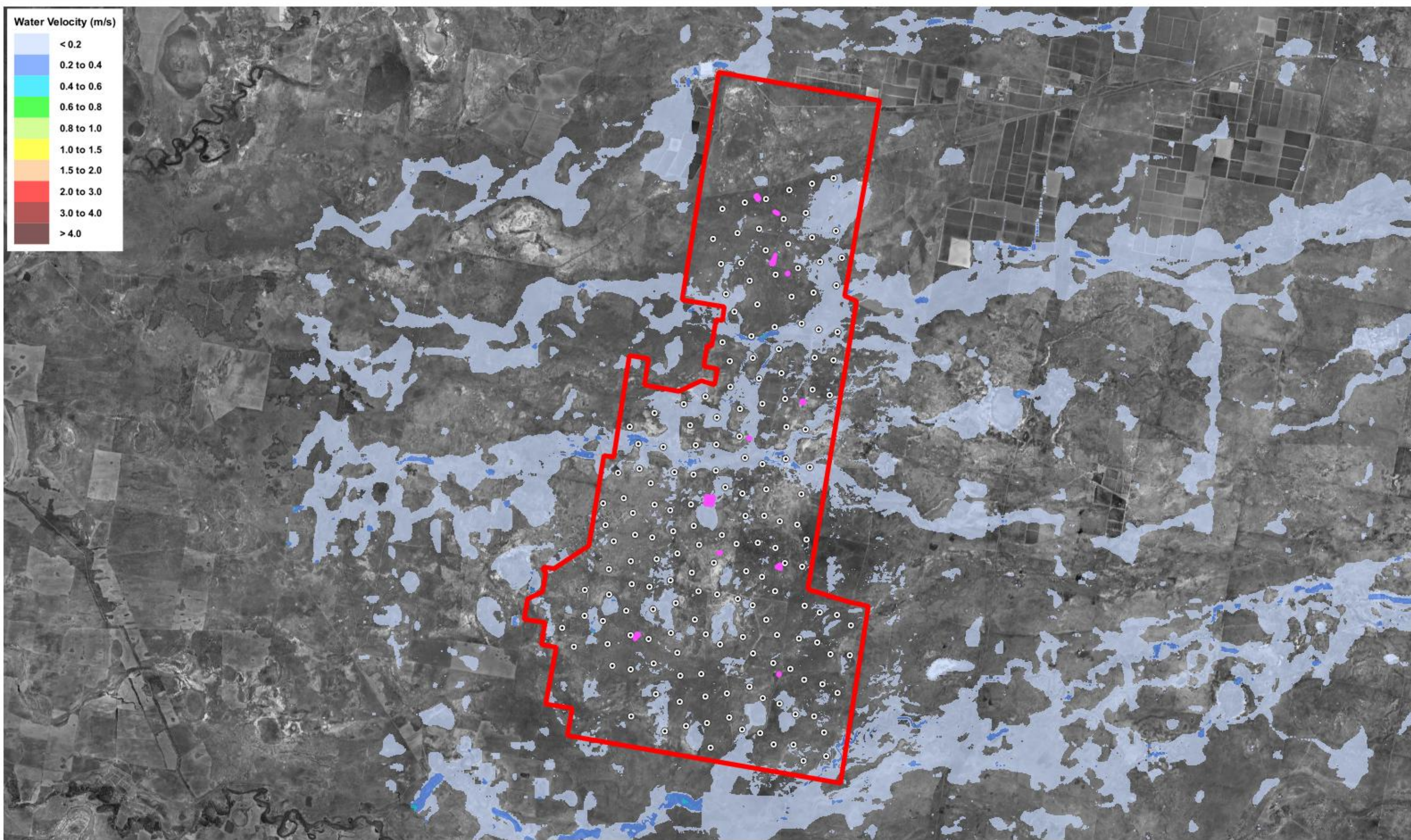


Drawing:
B.4

Rev:
A



Filepath: K:\003609.k.odj\BaldonWF_FIA\02_Workspace\Figure_Generator\Project_Mar25_AnnexB\BaldonWF_AnnexB_Flood_Maps_DevCase.qgz



LEGEND

- ▭ Project Extent
- ▭ Proposed Developments
- ⊙ Turbine Locations

Title:

Developed Scenario - 1% AEP Peak Velocity

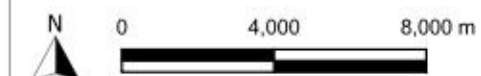
Drawing:

B.5

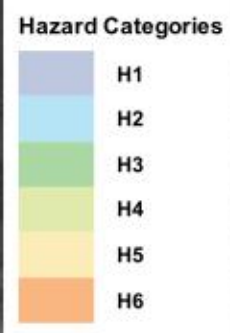
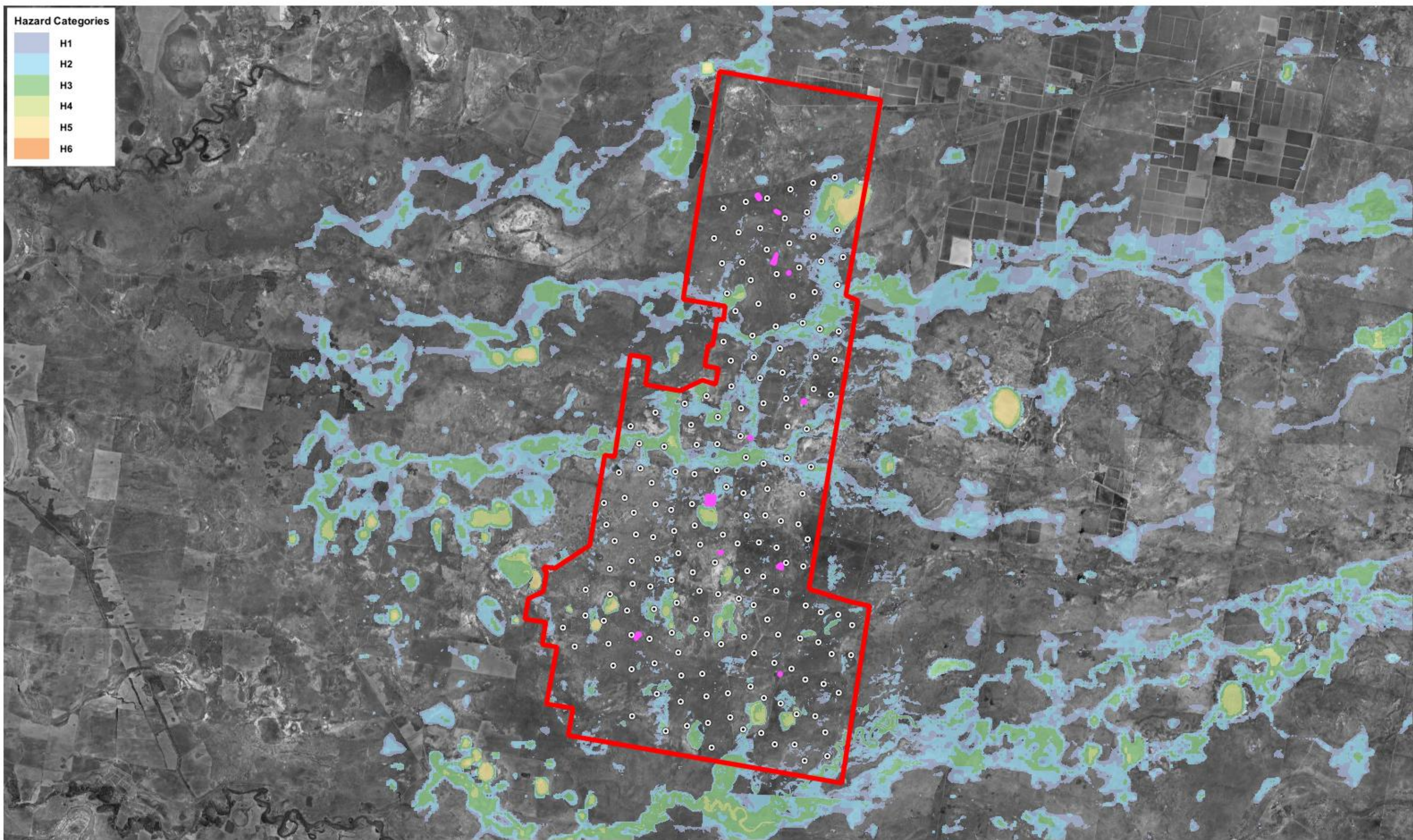
Rev:

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LEGEND

- Project Extent
- Proposed Developments
- ⊙ Turbine Locations

Title:

Developed Scenario - 1% AEP Peak Hazard Conditions

Drawing:

B.6

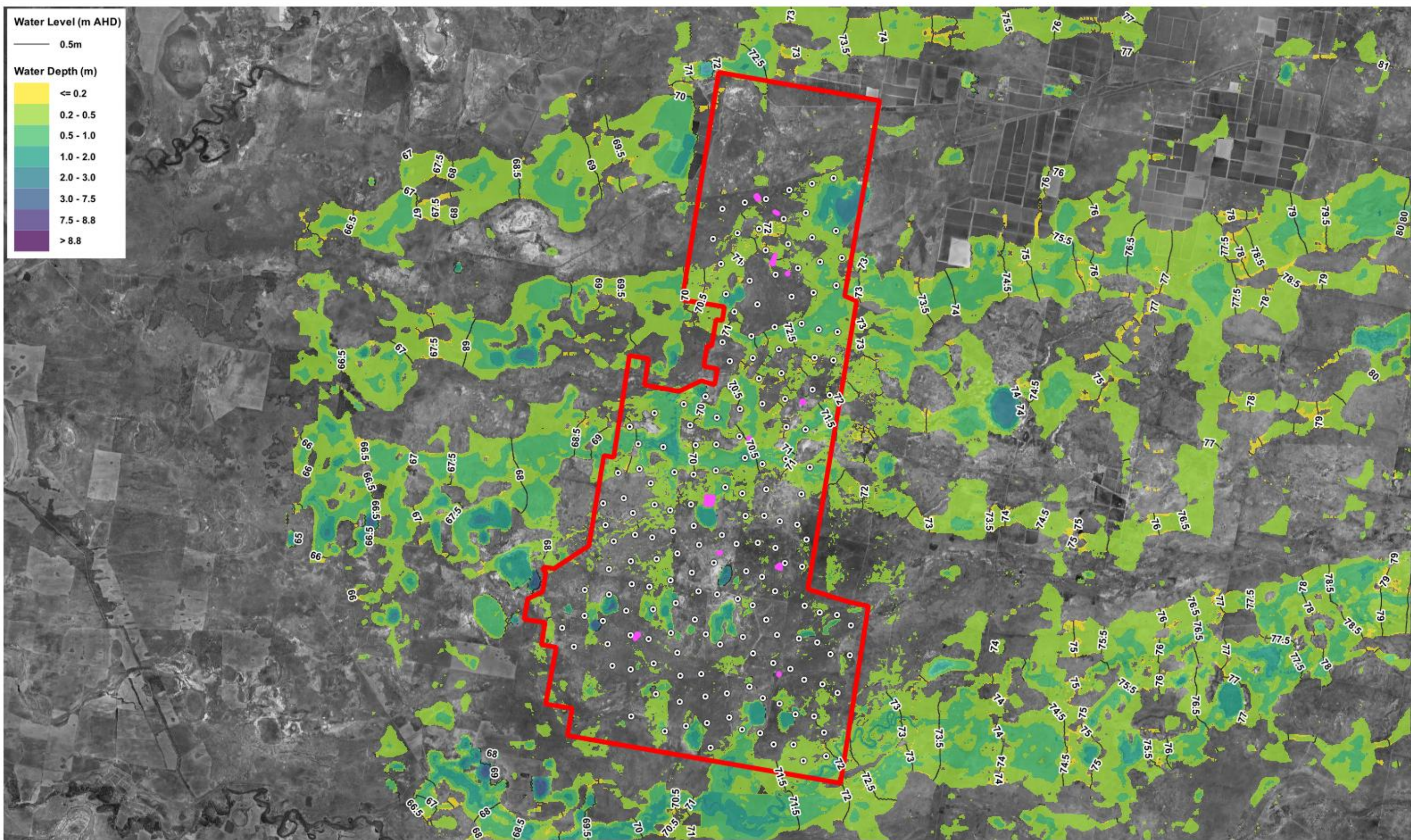
Rev:

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LEGEND

- ▭ Project Extent
- ▭ Proposed Developments
- Turbine Locations

Title:

Developed Scenario - 0.5% AEP Peak Flood Levels and Depths

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Drawing:

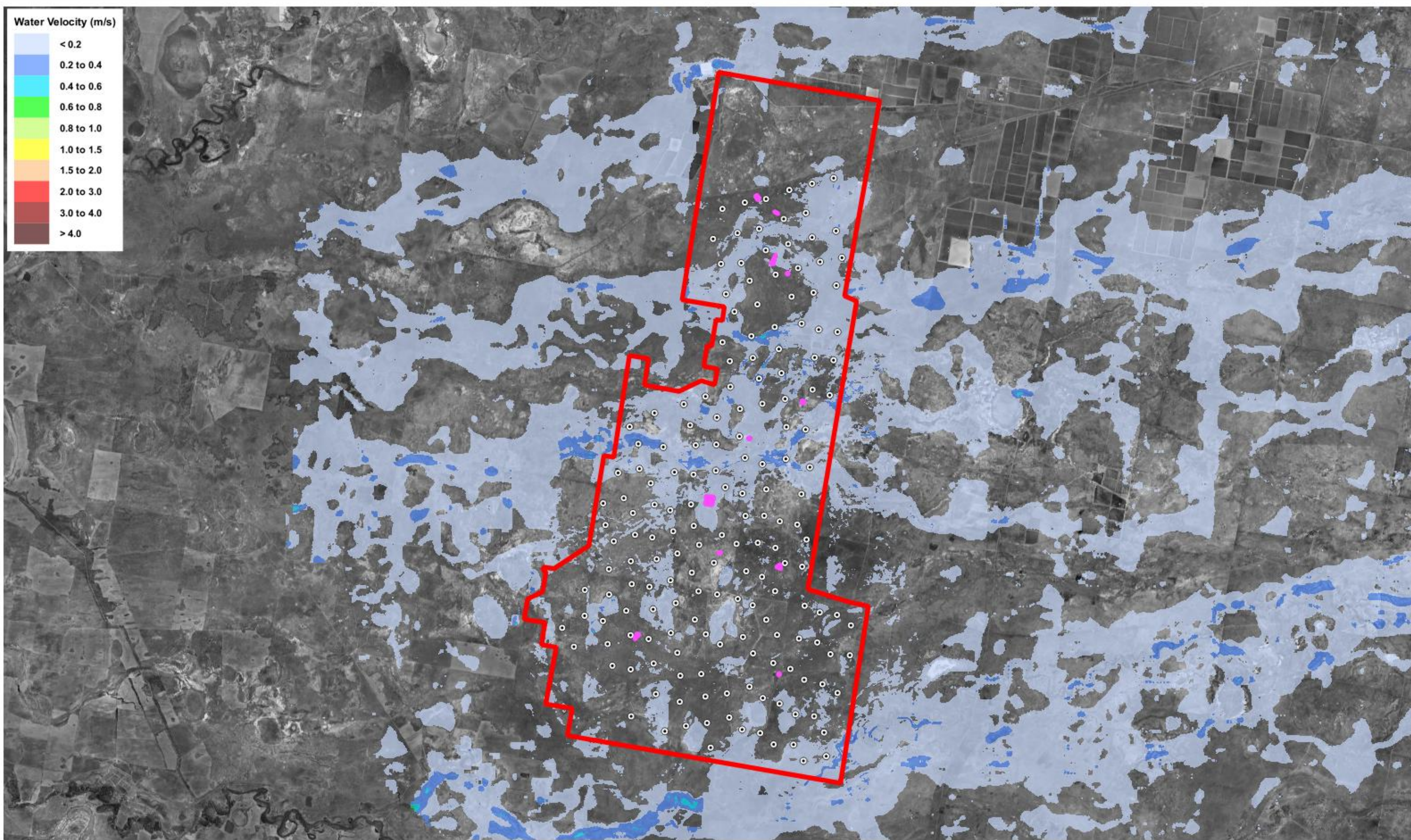
B.7

Rev:

A



Filepath: K:\003609.k.odj\BaldonWF_FIA\02_Workspace\Figure_Generator\Project_Mar25_AnnexB\BaldonWF_AnnexB_Flood_Maps_DevCase.qgz



LEGEND

- Project Extent
- Proposed Developments
- ⊙ Turbine Locations

Title:

Developed Scenario - 0.5% AEP Peak Velocity

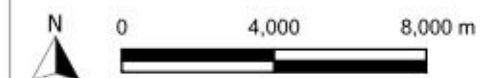
Drawing:

B.8

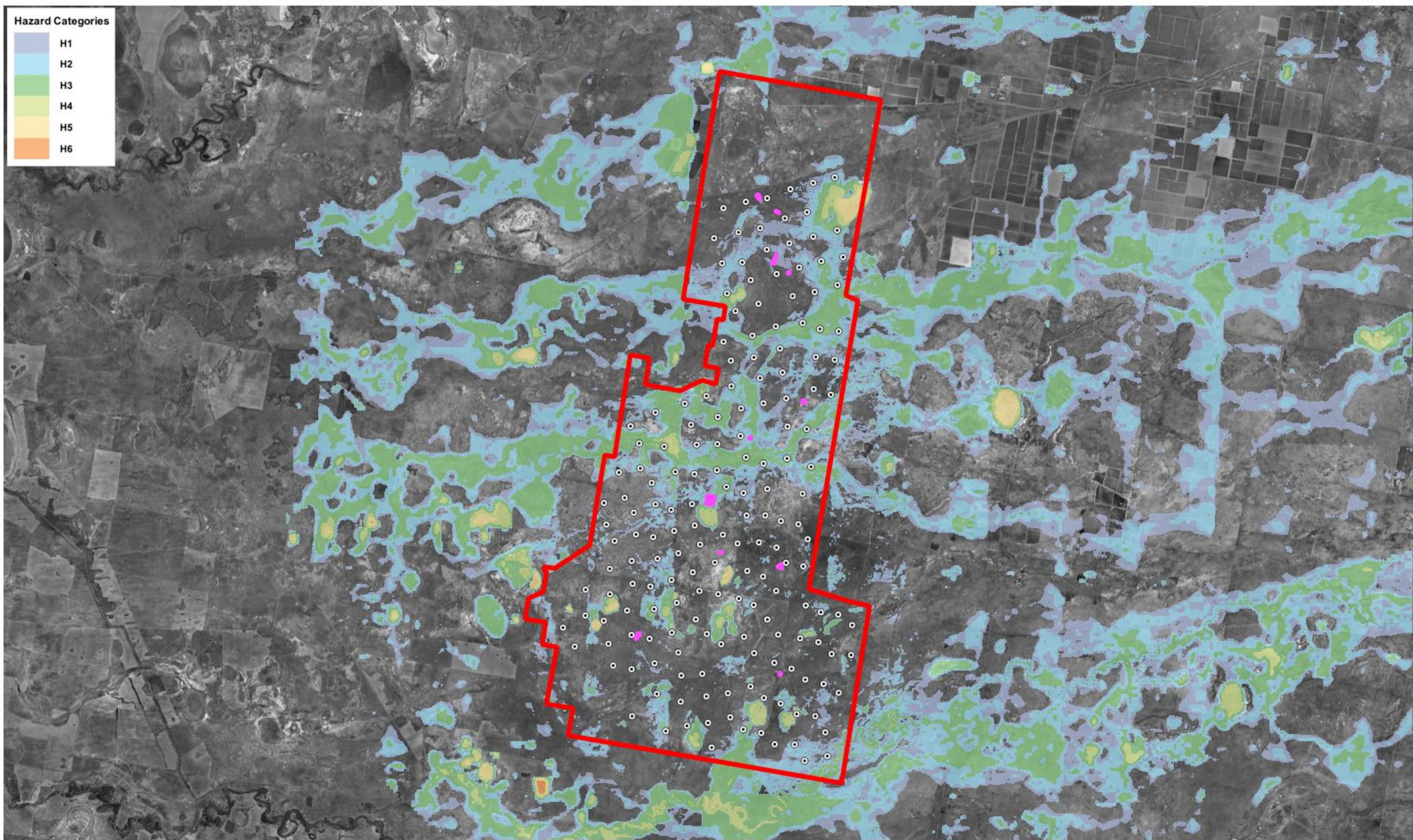
Rev:

A

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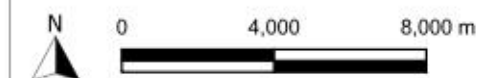
- LEGEND**
- Project Extent
 - Proposed Developments
 - Turbine Locations

Title:
Developed Scenario - 0.5% AEP Peak Hazard Conditions

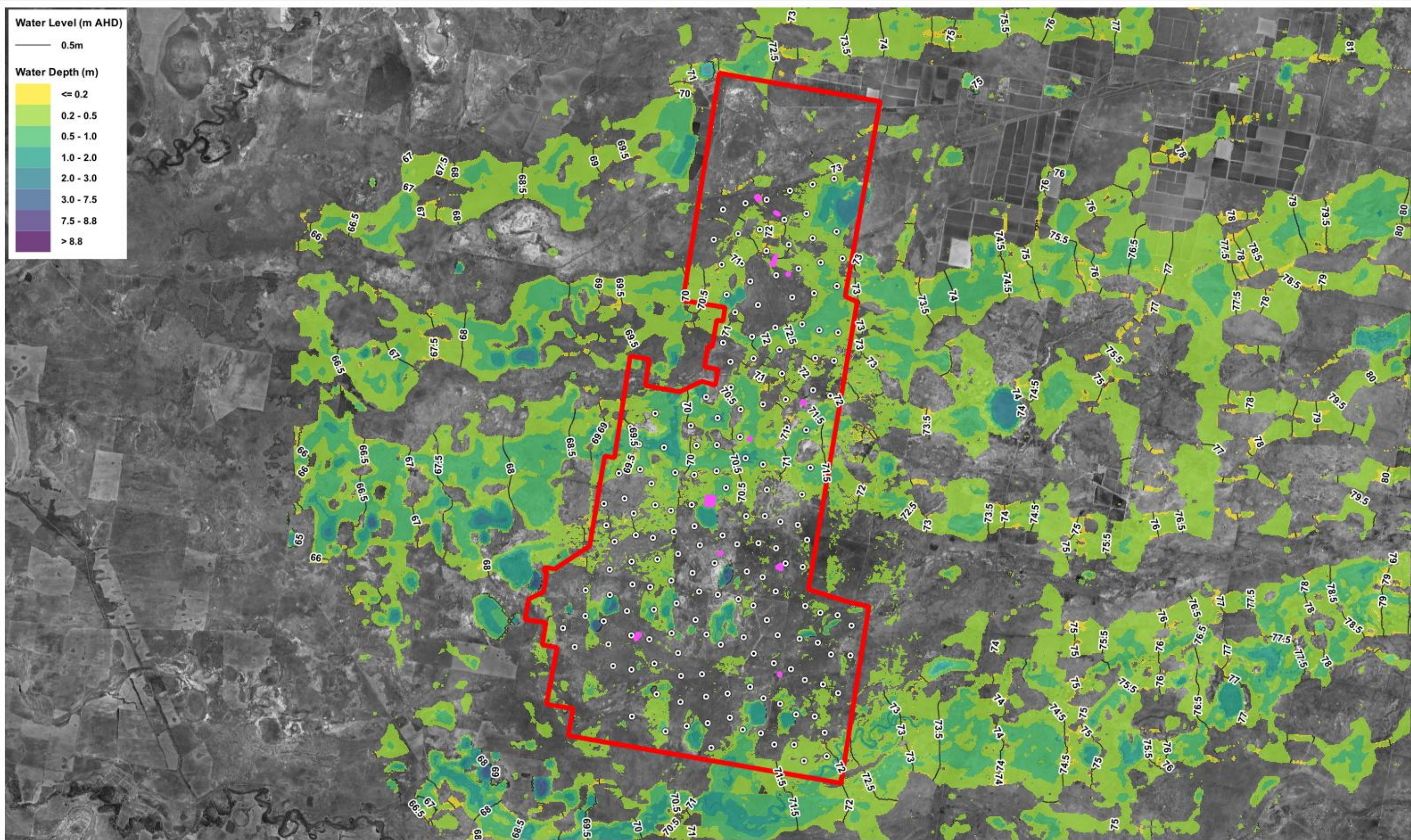
Drawing:
B.9

Rev:
A

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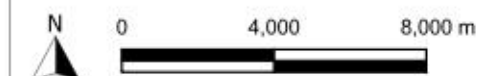
LEGEND

- ▭ Project Extent
- ▭ Proposed Developments
- Turbine Locations

Title:

Developed Scenario - 0.2% AEP Peak Flood Levels and Depths

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Drawing:

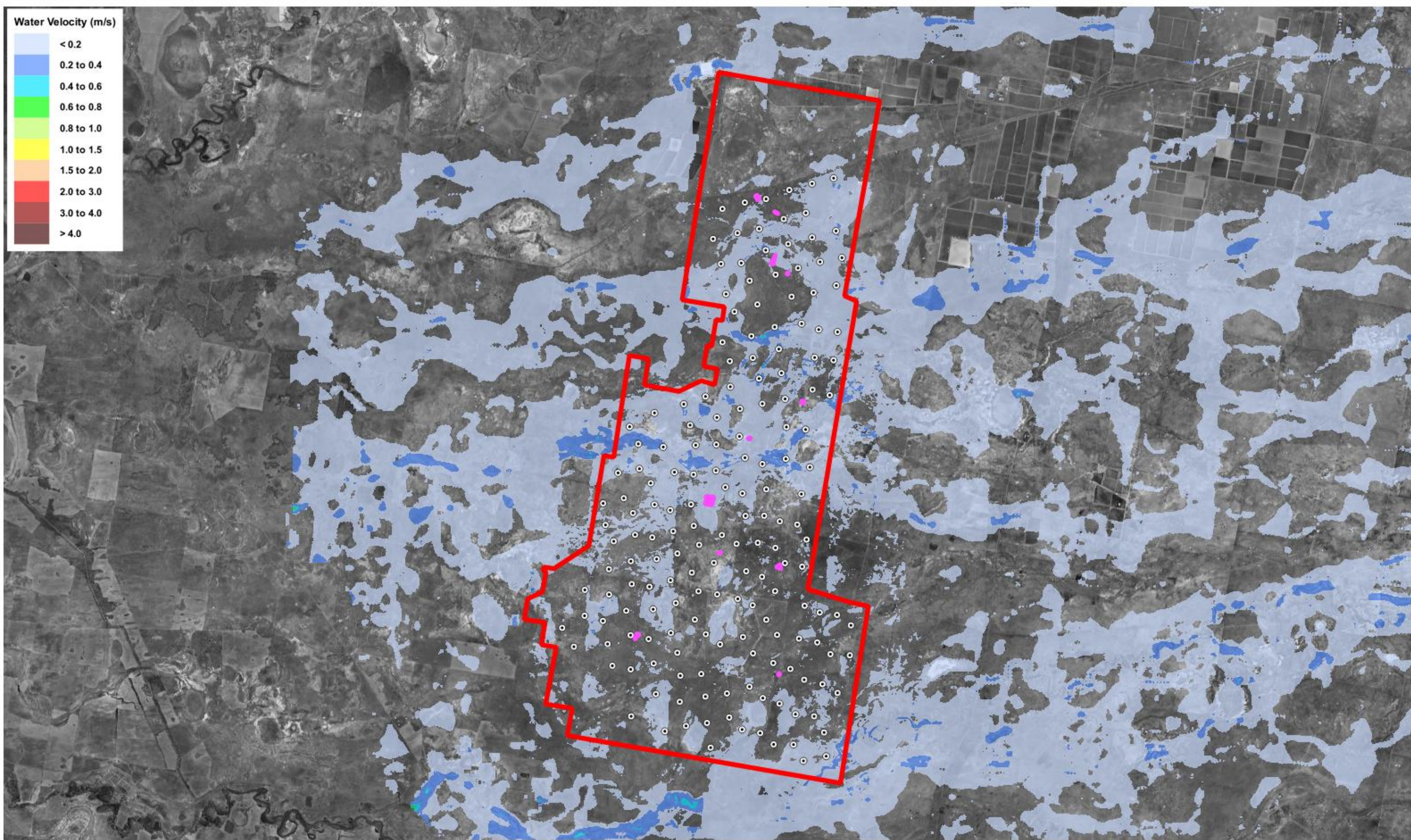
B.10

Rev:

A



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LEGEND

- Project Extent
- Proposed Developments
- ⊙ Turbine Locations

Title:

Developed Scenario - 0.2% AEP Peak Velocity

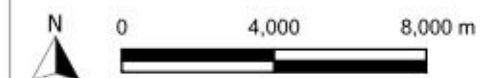
Drawing:

B.11

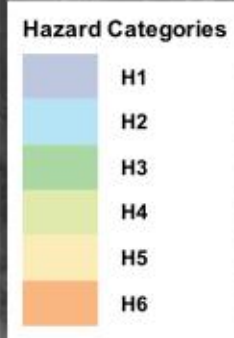
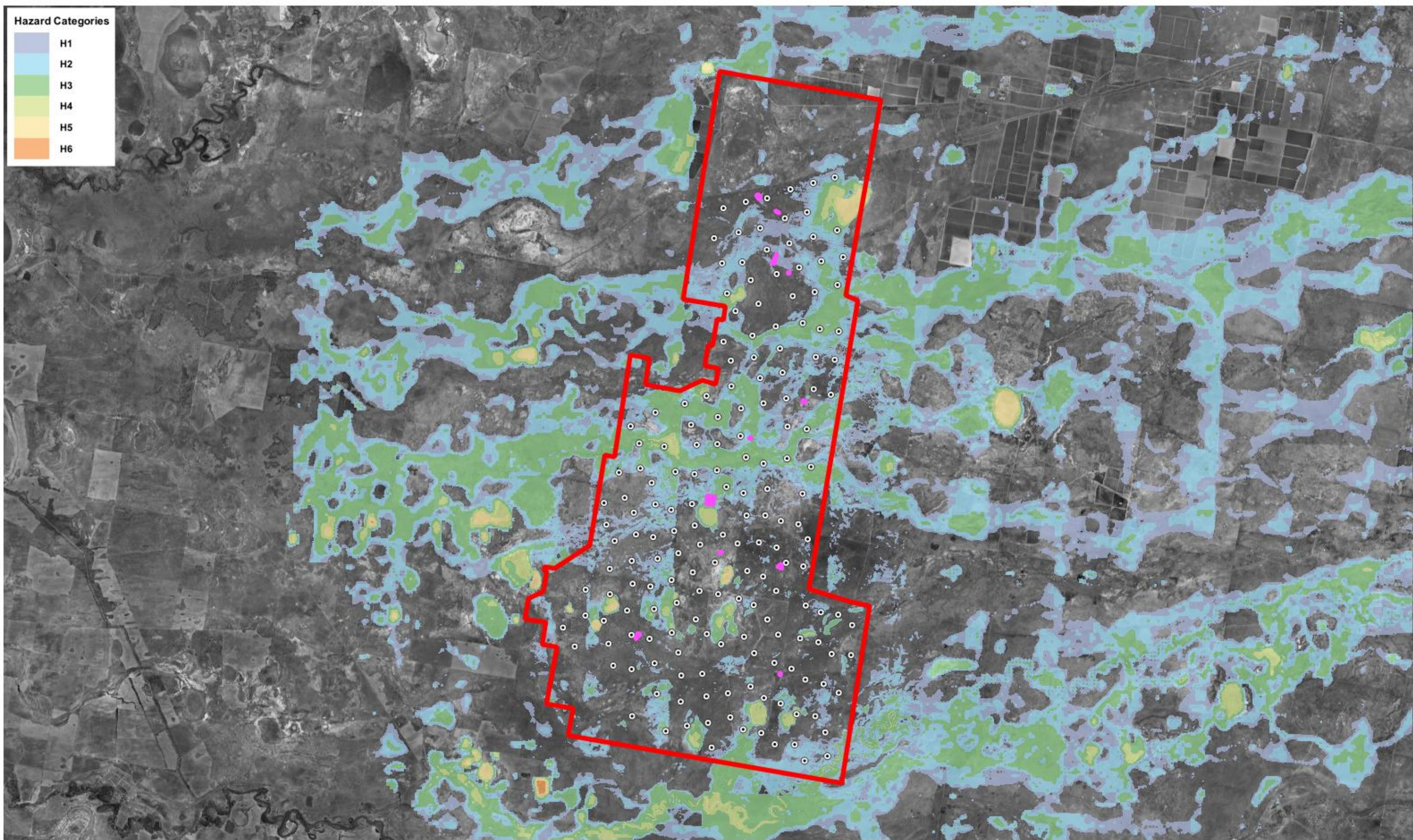
Rev:

A

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LEGEND

- Project Extent
- Proposed Developments
- ⊙ Turbine Locations

Title:

Developed Scenario - 0.2% AEP Peak Hazard Conditions

Drawing:

B.12

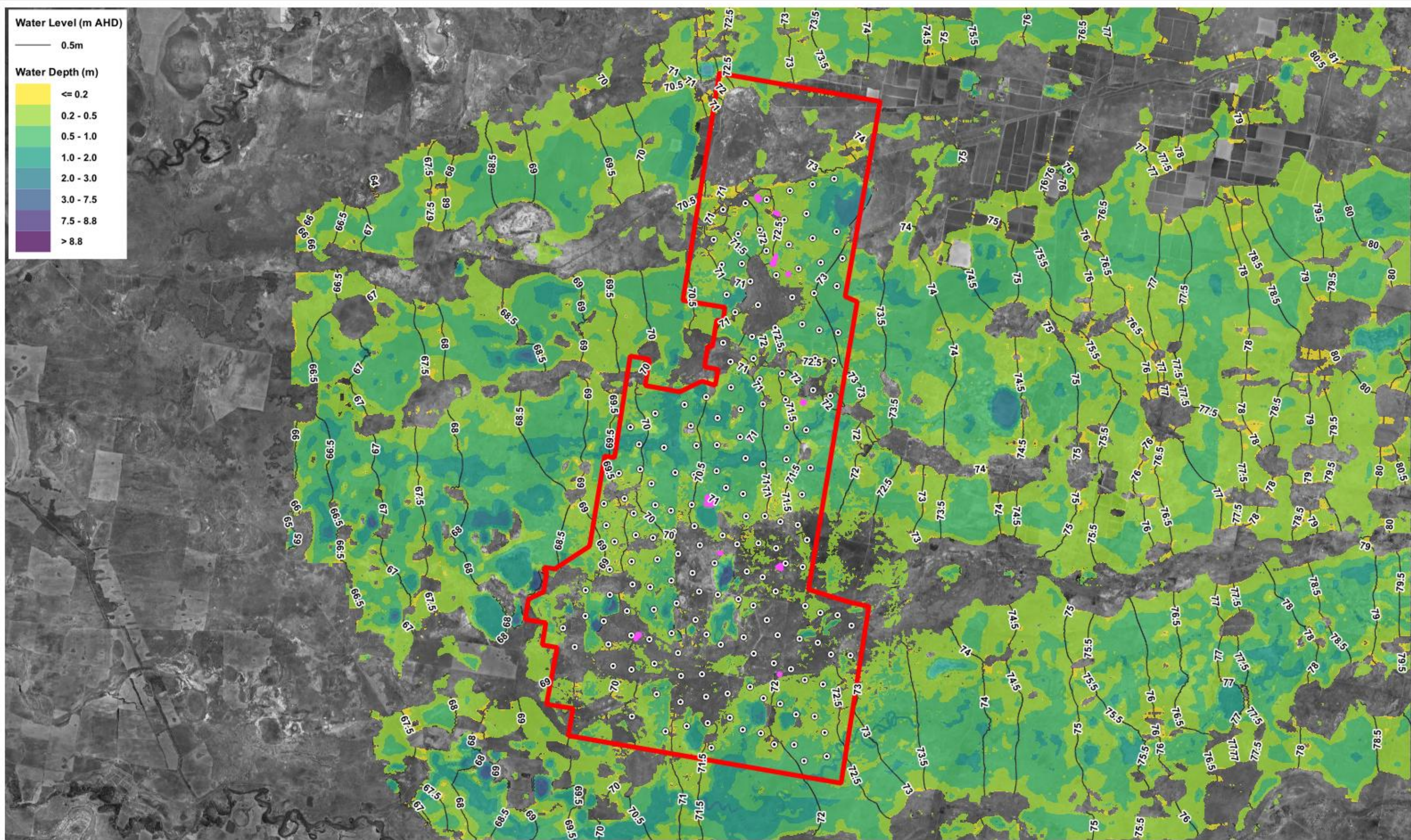
Rev:

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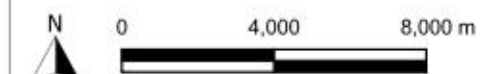
LEGEND

- ▭ Project Extent
- ▭ Proposed Developments
- Turbine Locations

Title:

Developed Scenario - PMF Peak Flood Levels and Depths

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Drawing:

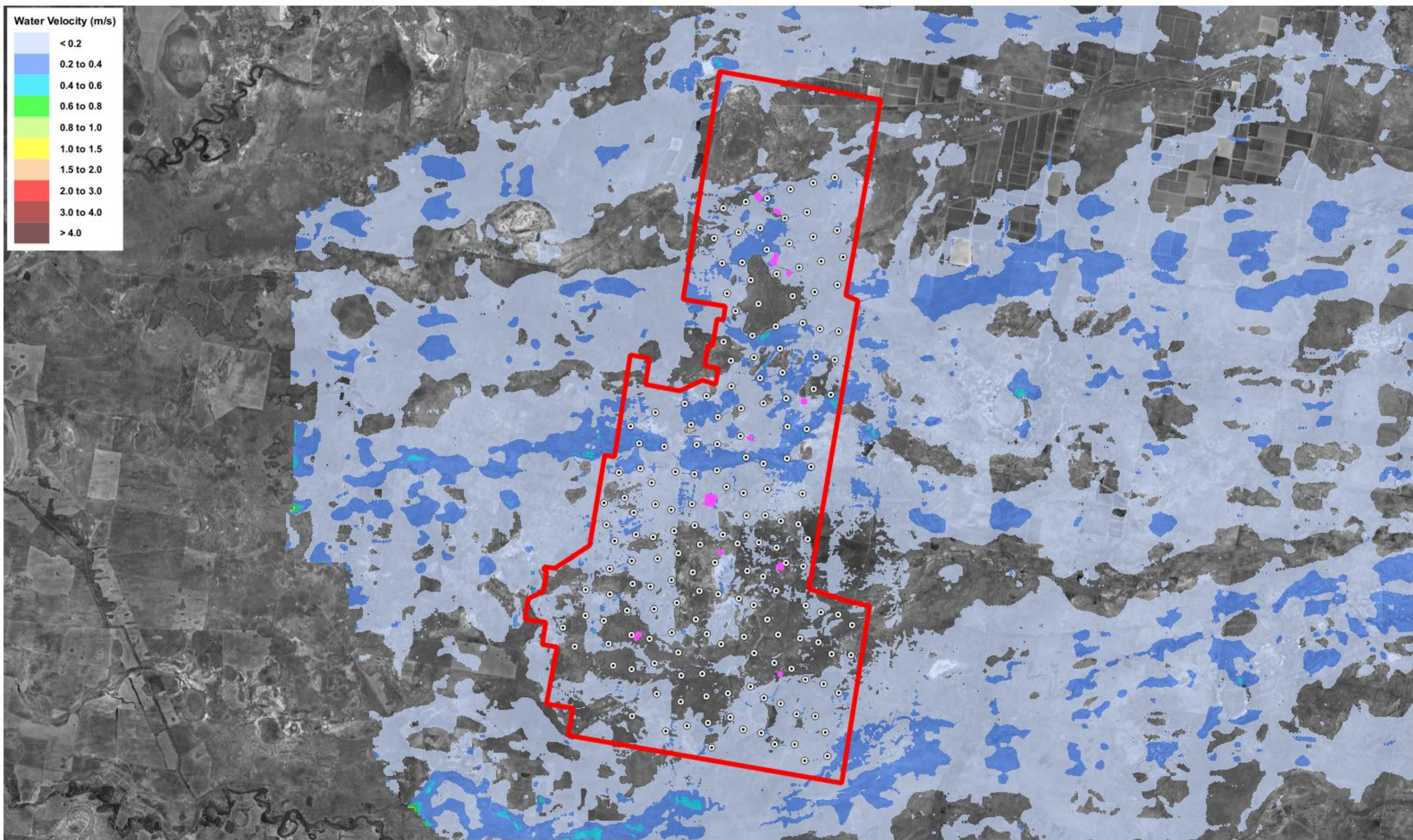
B.13

Rev:

A



Filepath: K:\003609.k.odj\BaldonWF_FIA\02_Workspace\Figure_Generator\Project_Mar25_AnnexB\BaldonWF_AnnexB_Flood_Maps_DevCase.gqz



LEGEND

- ▭ Project Extent
- ▭ Proposed Developments
- Turbine Locations

Title:

Developed Scenario - PMF Peak Velocity

Drawing:

B.14

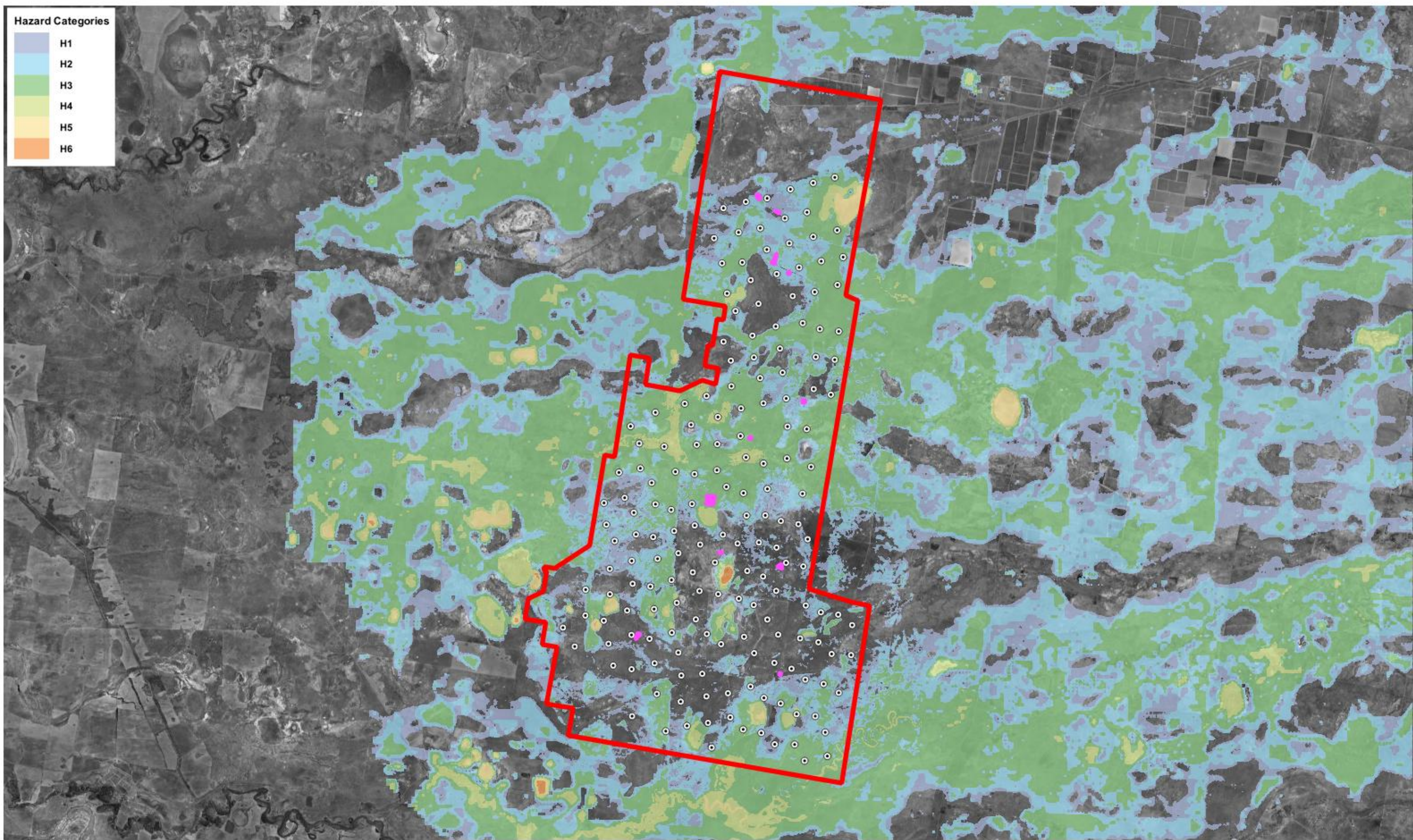
Rev:

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LEGEND

- ▬ Project Extent
- ▬ Proposed Developments
- Turbine Locations

Title:

Developed Scenario - PMF Peak Hazard Conditions

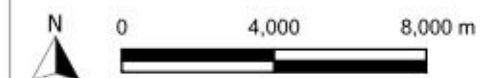
Drawing:

B.15

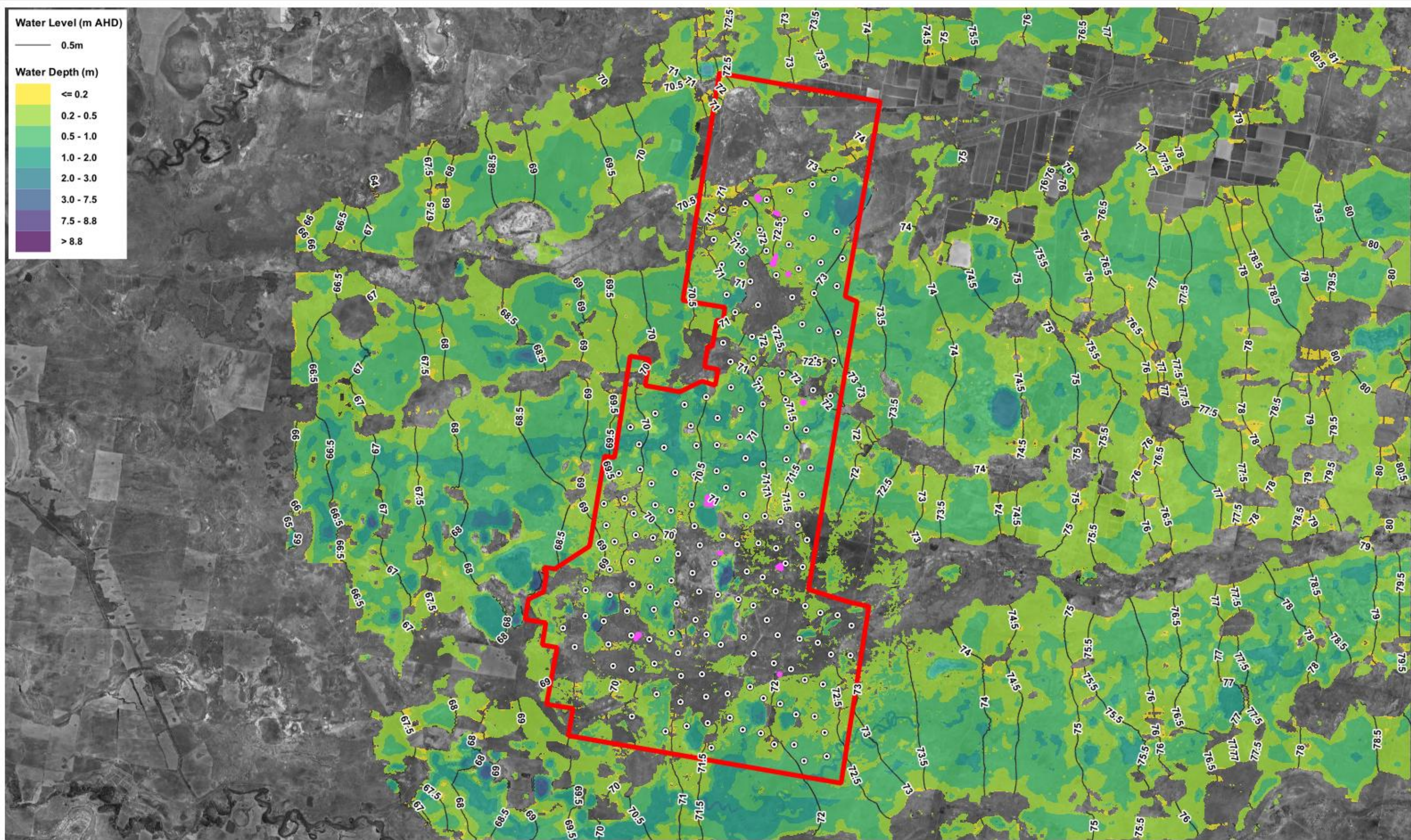
Rev:

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LEGEND

- ▭ Project Extent
- ▭ Proposed Developments
- Turbine Locations

Title:

Developed Scenario - PMF with Regional Inflows Peak Flood Levels and Depths

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Drawing:

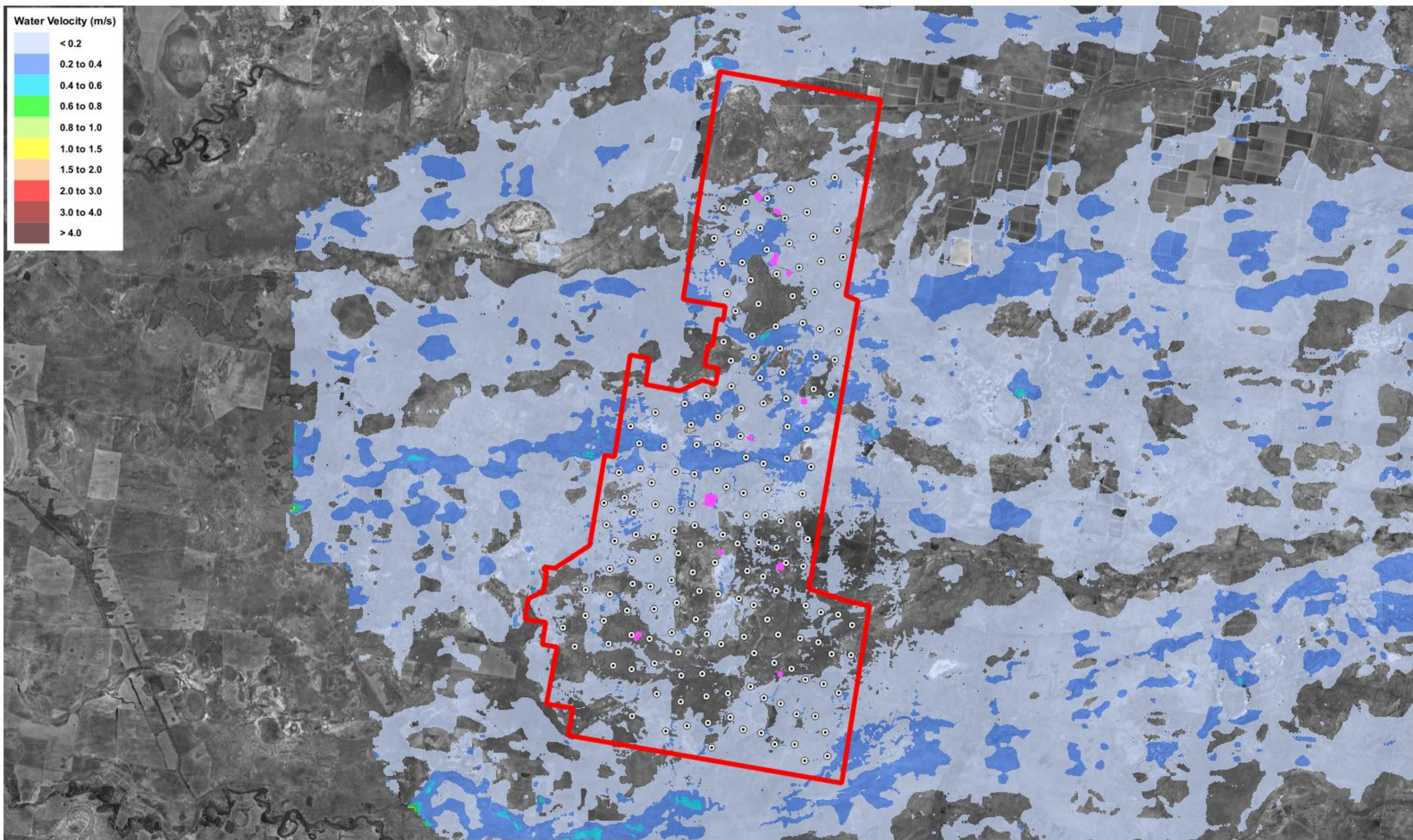
B.16

Rev:

A



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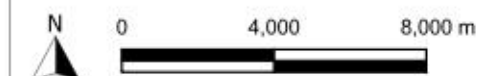
LEGEND

- Project Extent
- Proposed Developments
- Turbine Locations

Title:

Developed Scenario - PMF with Regional Inflows Peak Velocity

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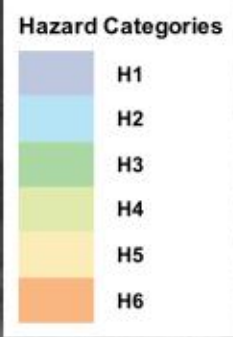
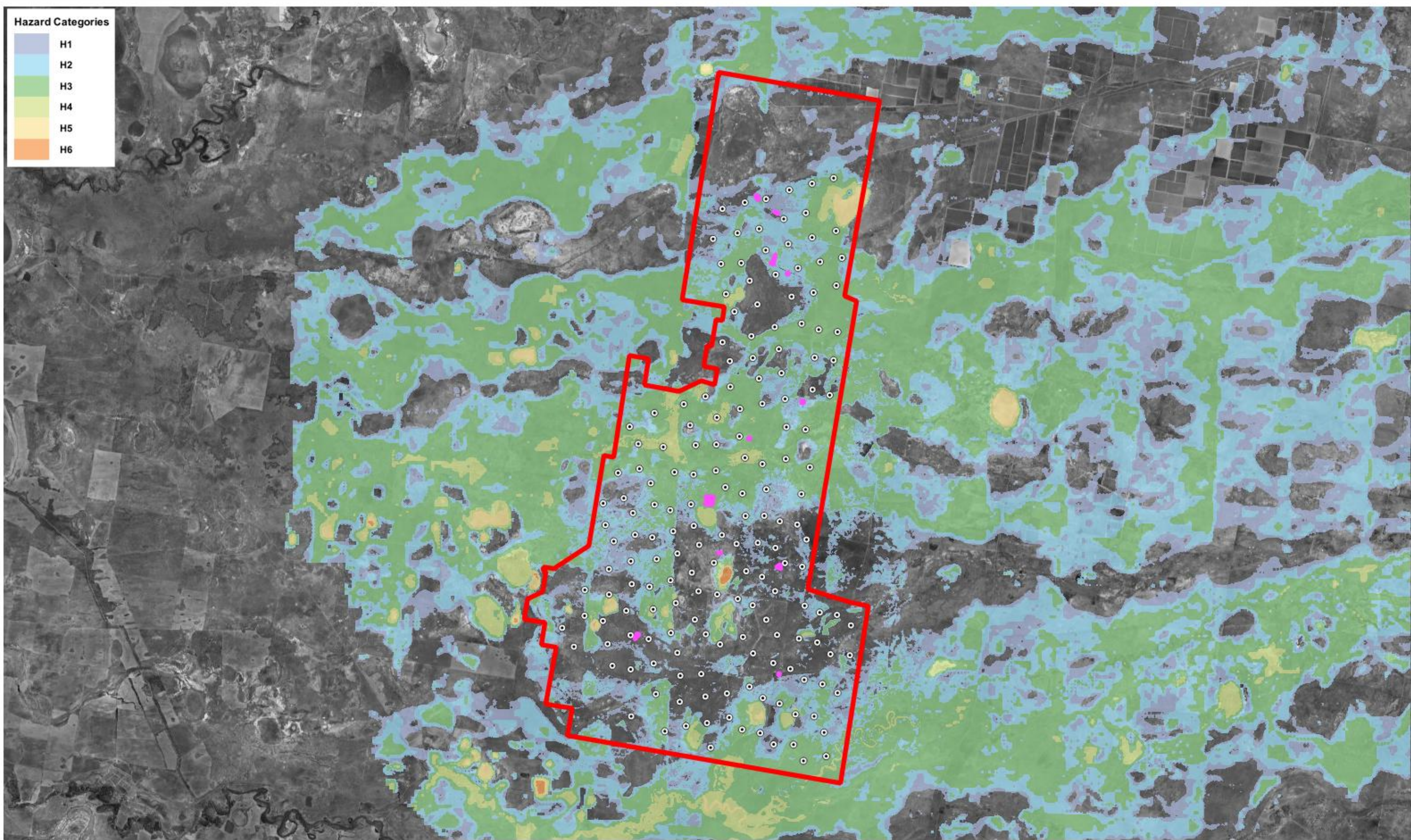
B.17

Rev:

A



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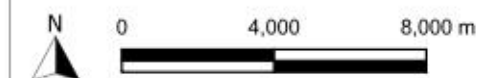


- LEGEND**
- Project Extent
 - Proposed Developments
 - Turbine Locations

Title:

Developed Scenario - PMF with Regional Inflows Peak Hazard Conditions

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Drawing: **B.18** Rev: **A**



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Annex C Flood Impact Maps



LEGEND

- Project Extent
- Proposed Developments
- Turbine Locations

Title:

5% AEP Flood Level Impacts - Developed Scenario

Drawing:

C.1

Rev:

A

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LEGEND

- Project Extent
- Proposed Developments
- Turbine Locations

Title:

1% AEP Flood Level Impacts - Developed Scenario

Drawing:

C.2

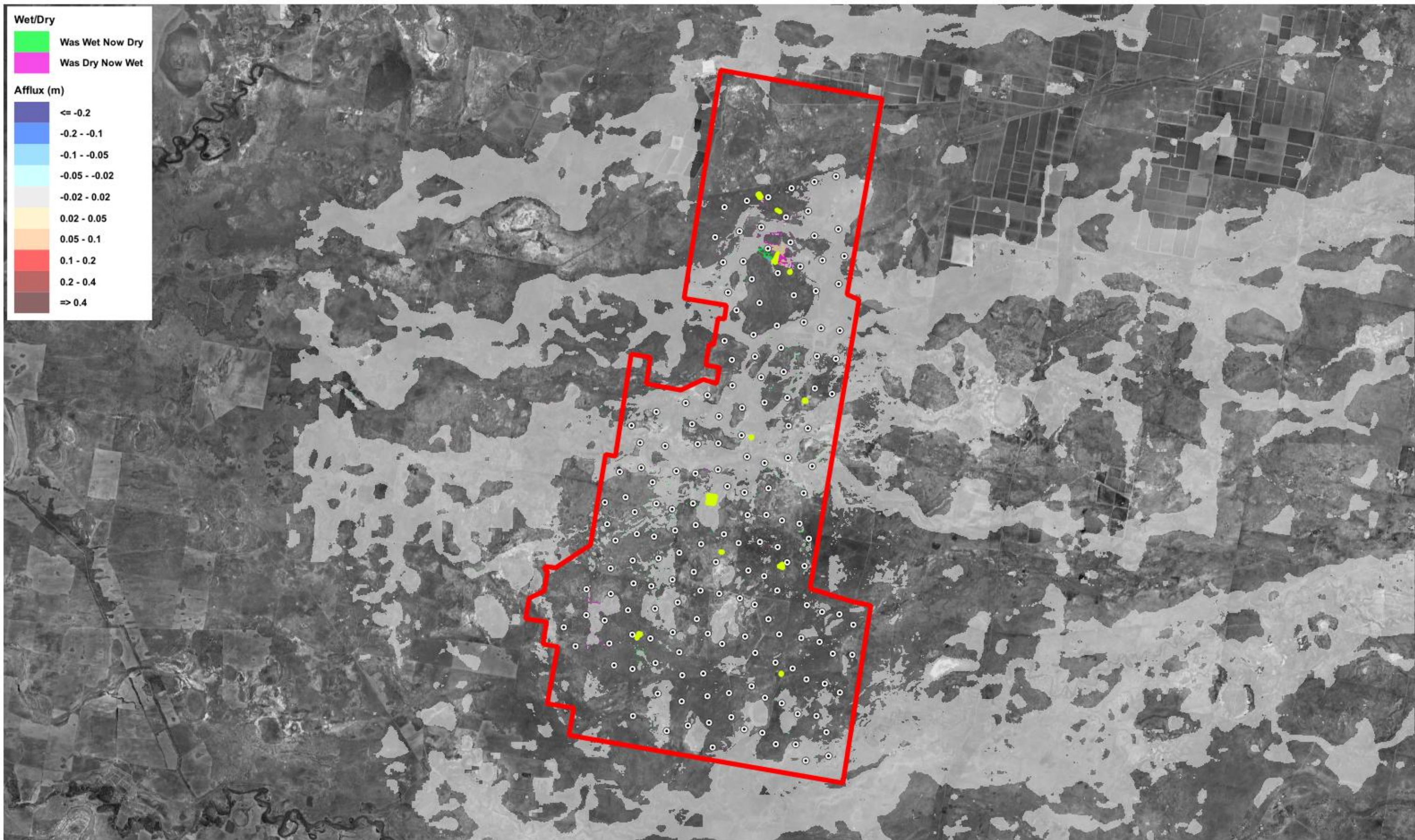
Rev:

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LEGEND

- Project Extent
- Proposed Developments
- Turbine Locations

Title:

0.5% AEP Flood Level Impacts - Developed Scenario

Drawing:

C.3

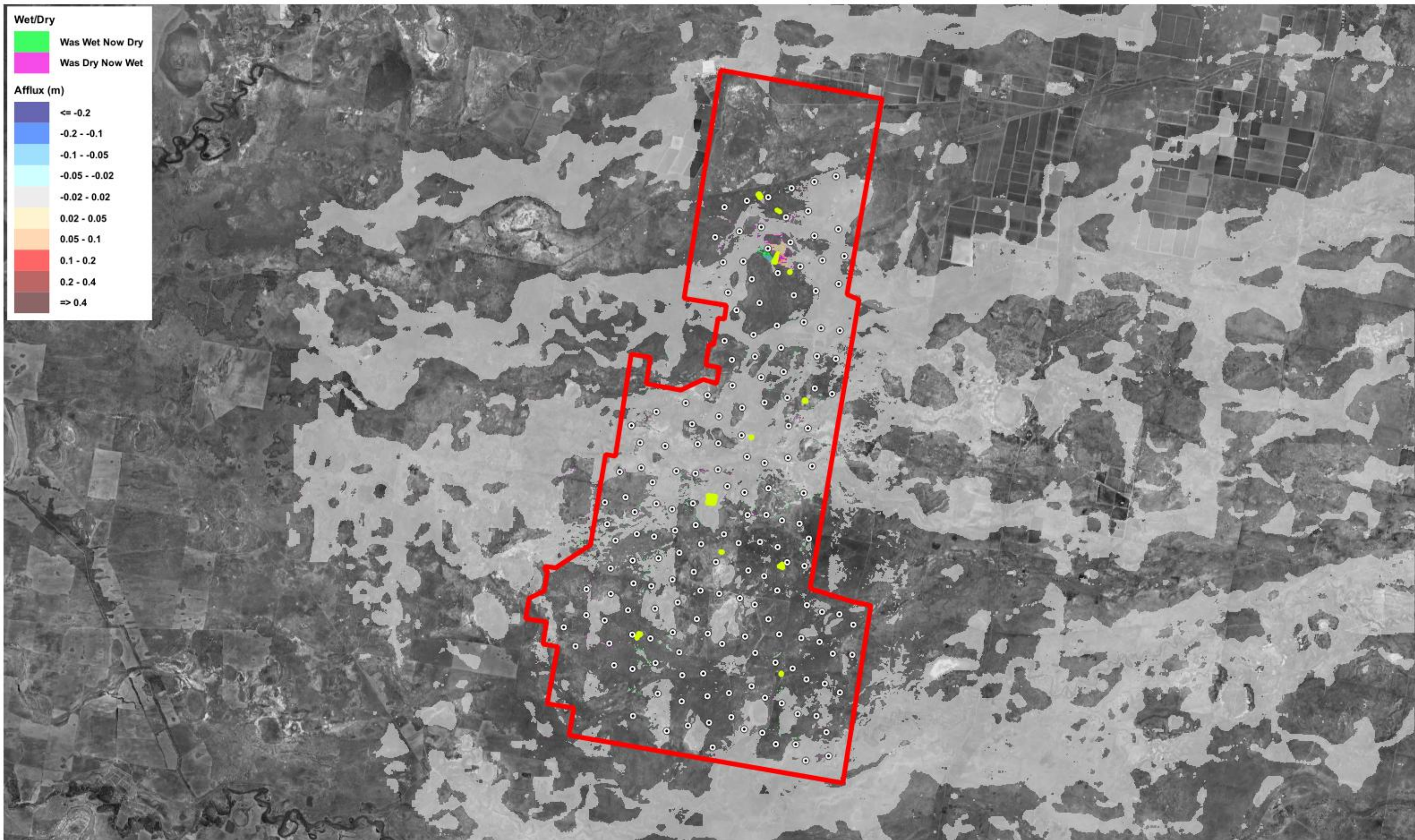
Rev:

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LEGEND

- Project Extent
- Proposed Developments
- Turbine Locations

Title:

0.2% AEP Flood Level Impacts - Developed Scenario

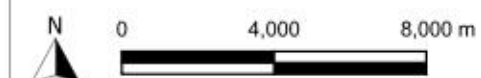
Drawing:

C.4

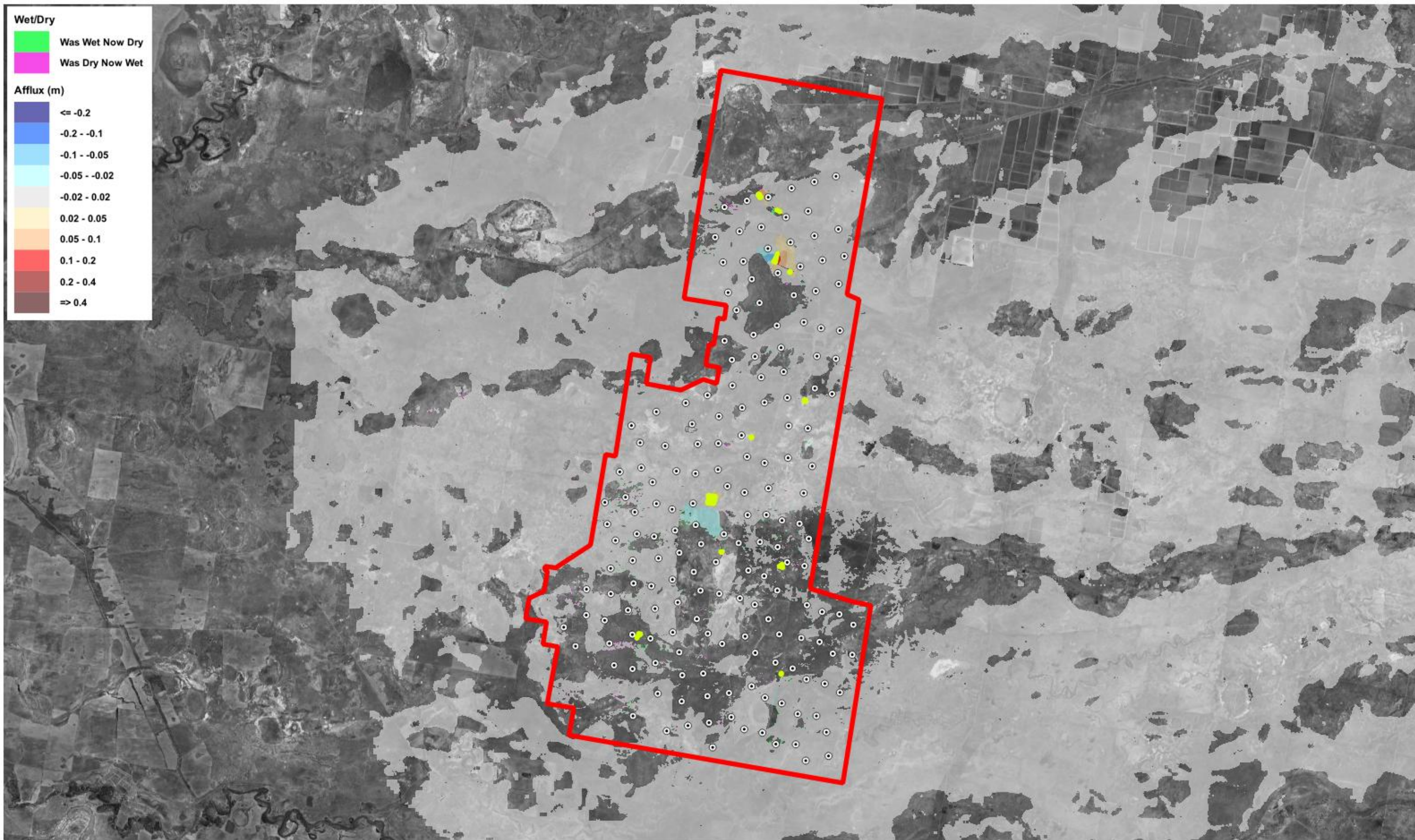
Rev:

A

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LEGEND

- ▭ Project Extent
- ▭ Proposed Developments
- ⊙ Turbine Locations

Title:

PMF Flood Level Impacts - Developed Scenario

Drawing:

C.5

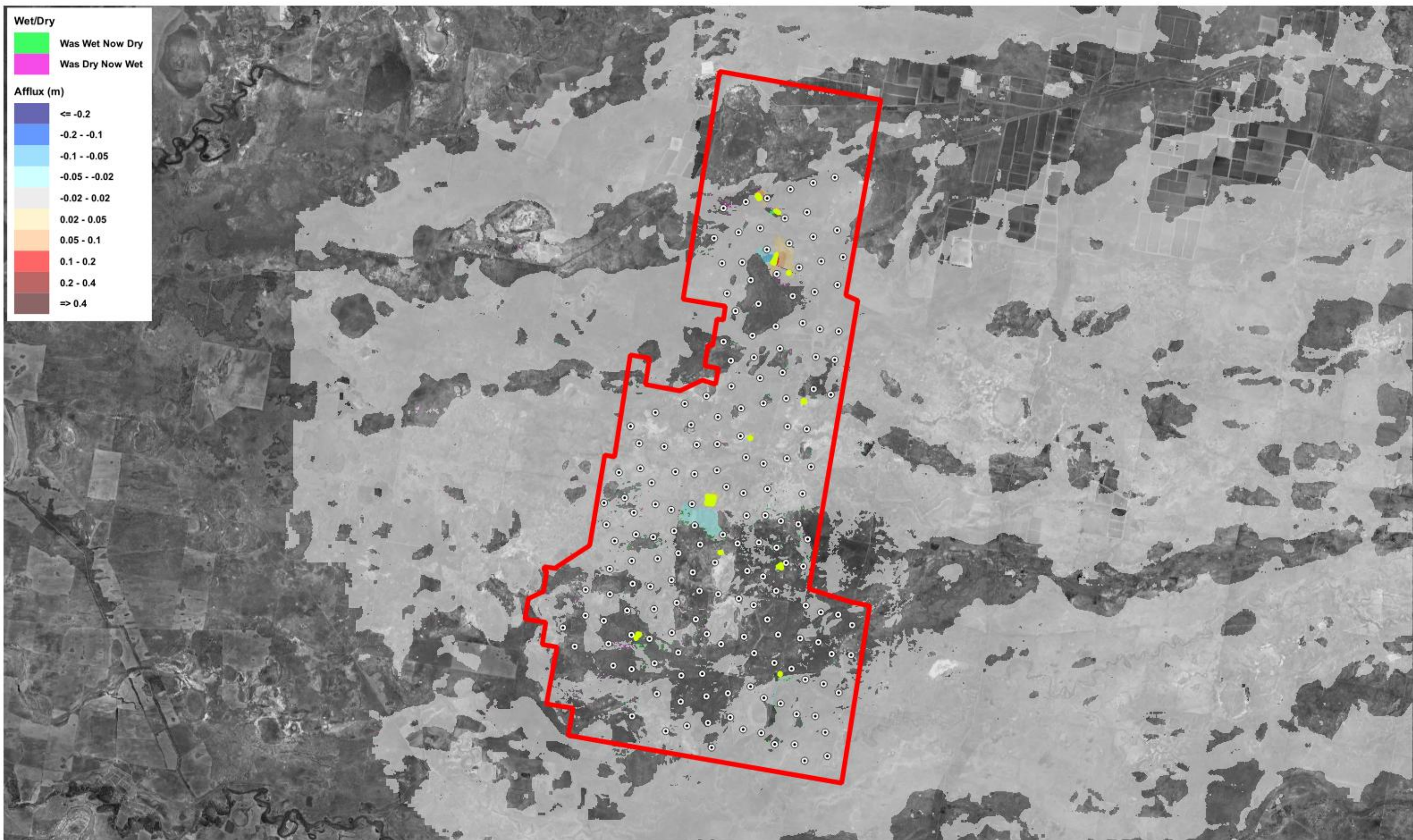
Rev:

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LEGEND

- ▭ Project Extent
- ▭ Proposed Developments
- ⊙ Turbine Locations

Title:

PMF with Regional Inflows Flood Level Impacts - Developed Scenario

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Drawing:

C.6

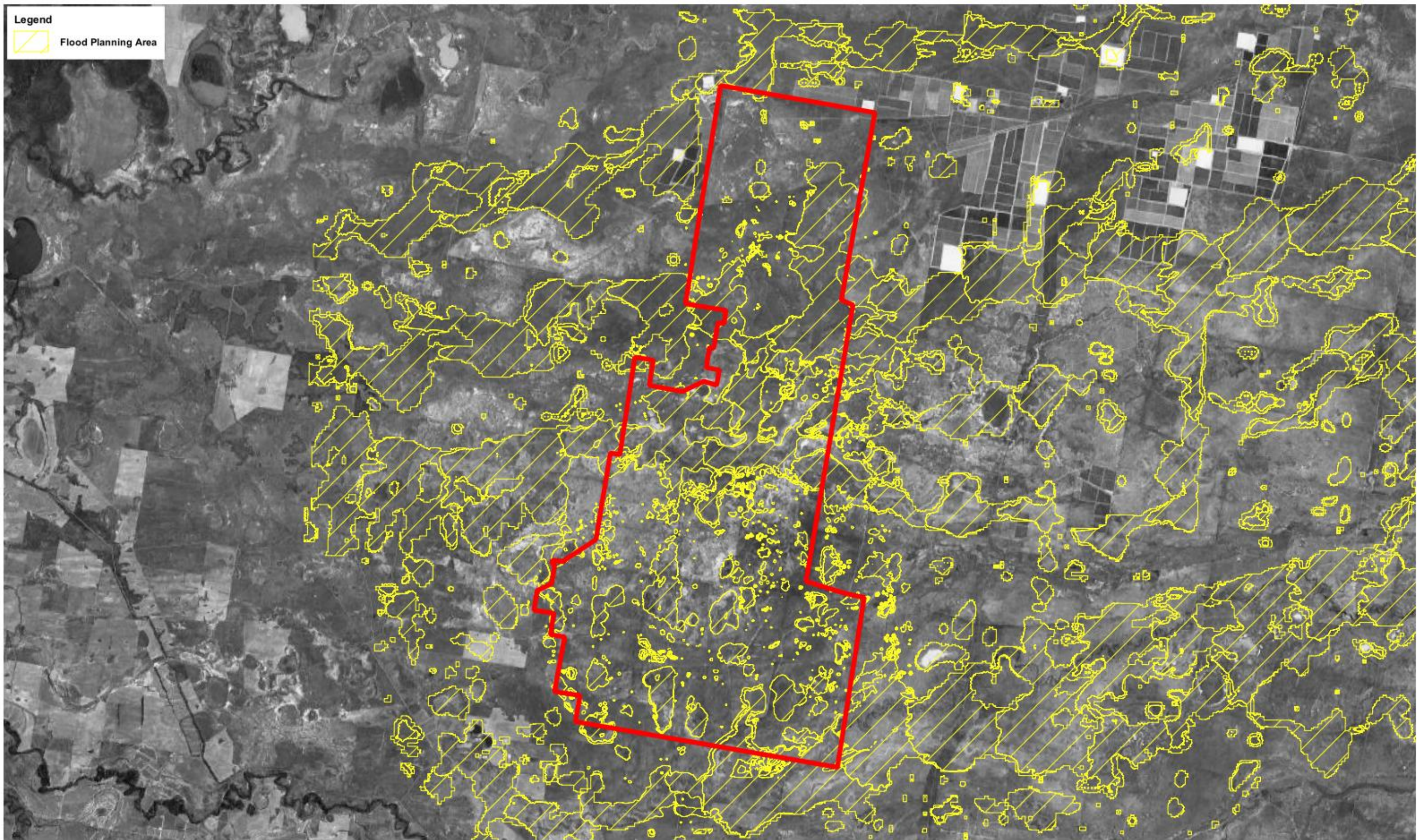
Rev:

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Annex D Flood Function and Flood Planning Area Maps



LEGEND

 Project Extent

Title:

Flood Planning Area

Drawing:

D.1

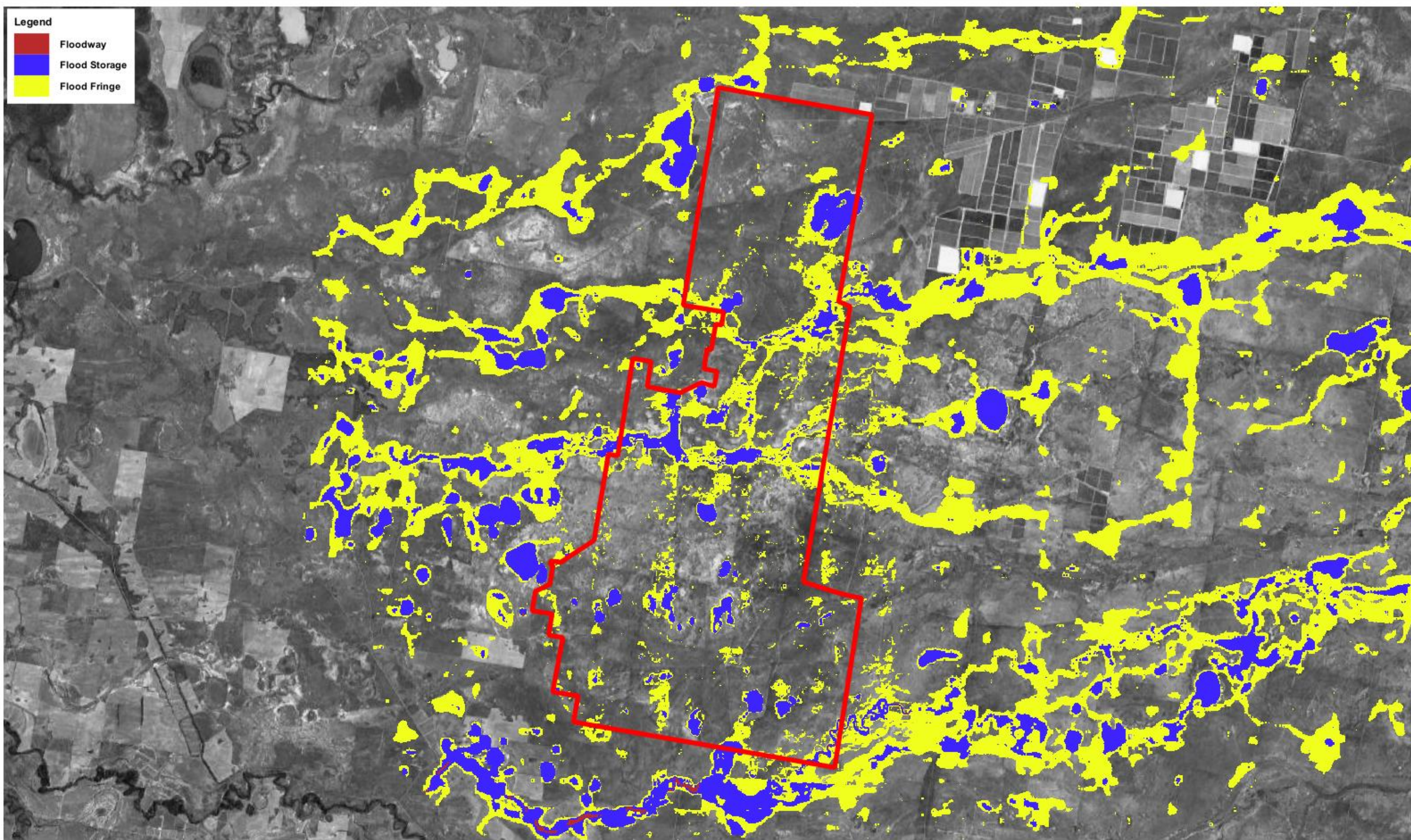
Rev:

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Legend

- Floodway
- Flood Storage
- Flood Fringe

LEGEND

- Project Extent

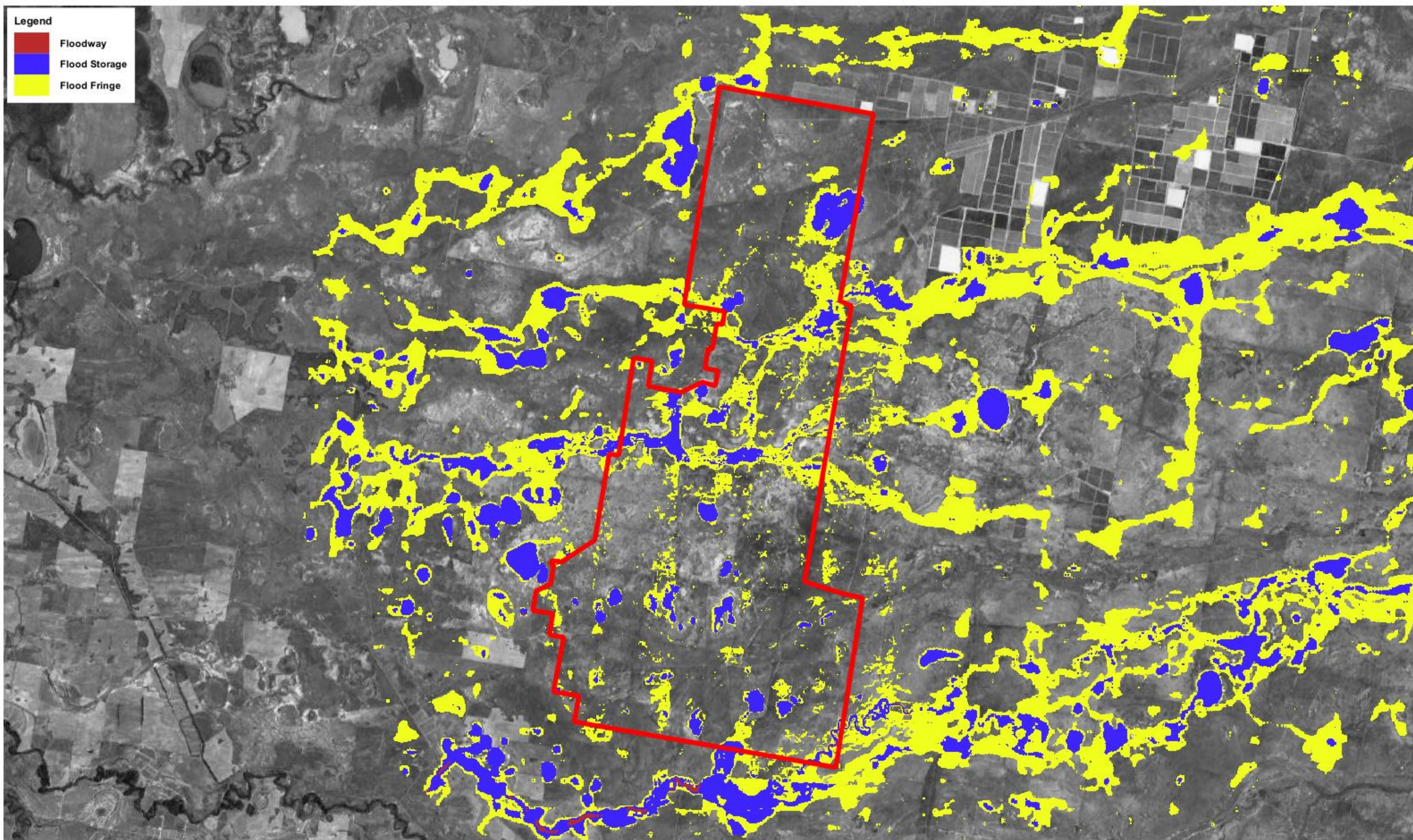
Title:
Flood Function - Base Scenario

Drawing: **D.2** Rev: **A**

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LEGEND

 Project Extent

Title:

Flood Function - Developed Scenario

Drawing:

D.3

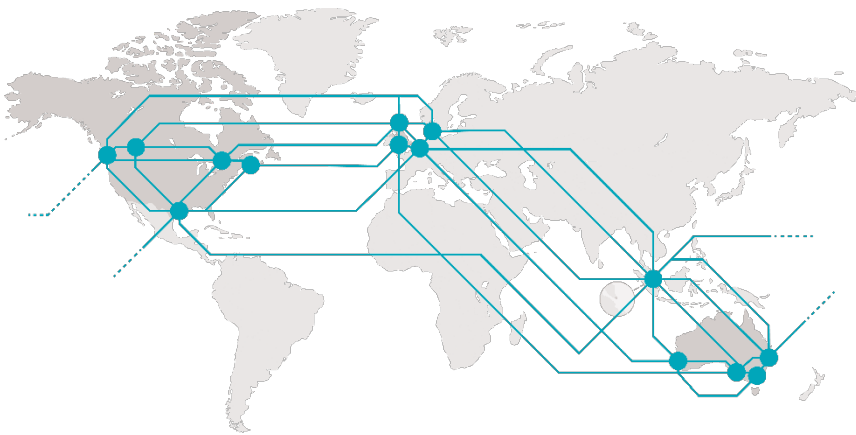
Rev:

A

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