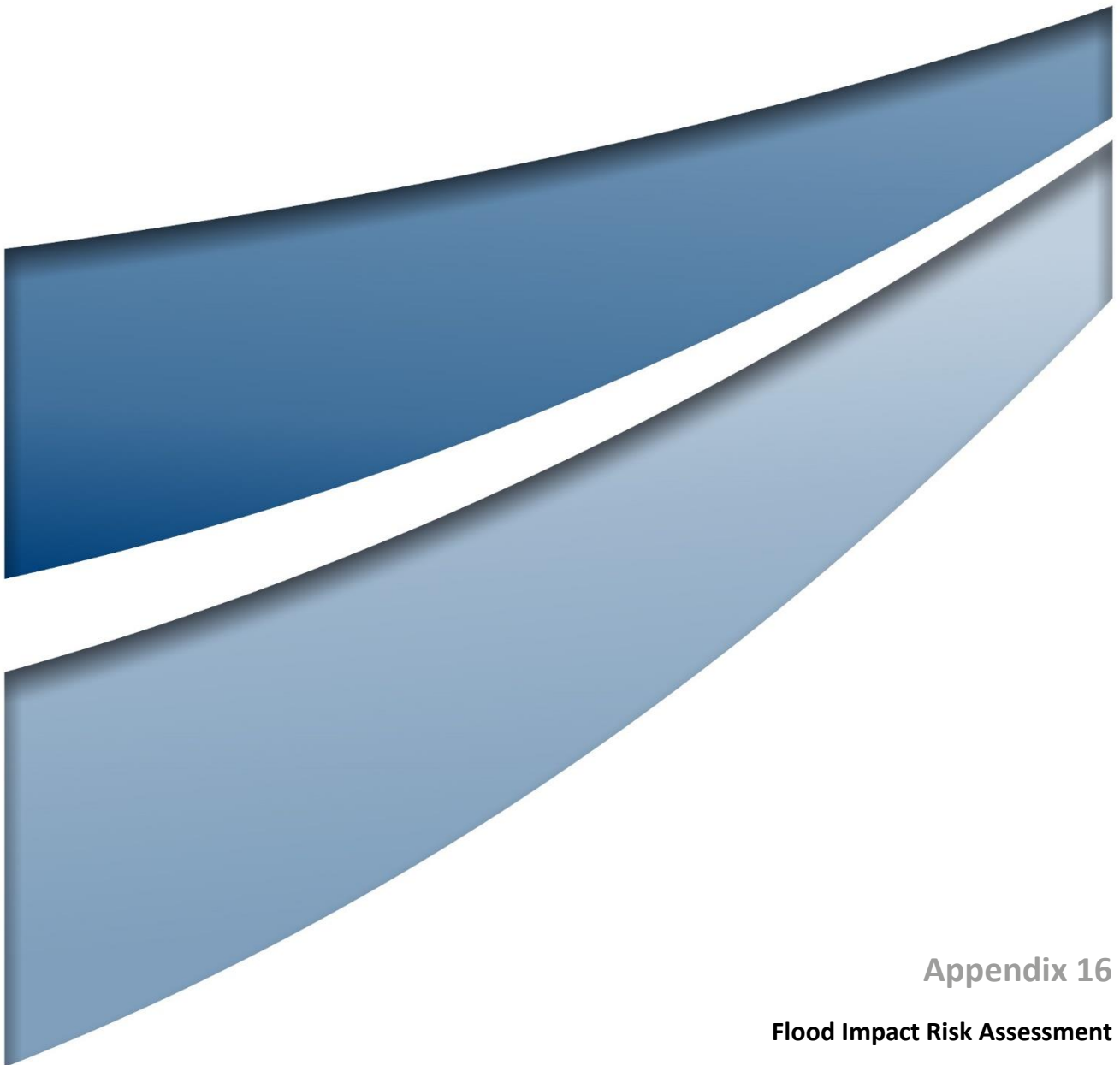




Appendix 16

Flood Impact Risk Assessment



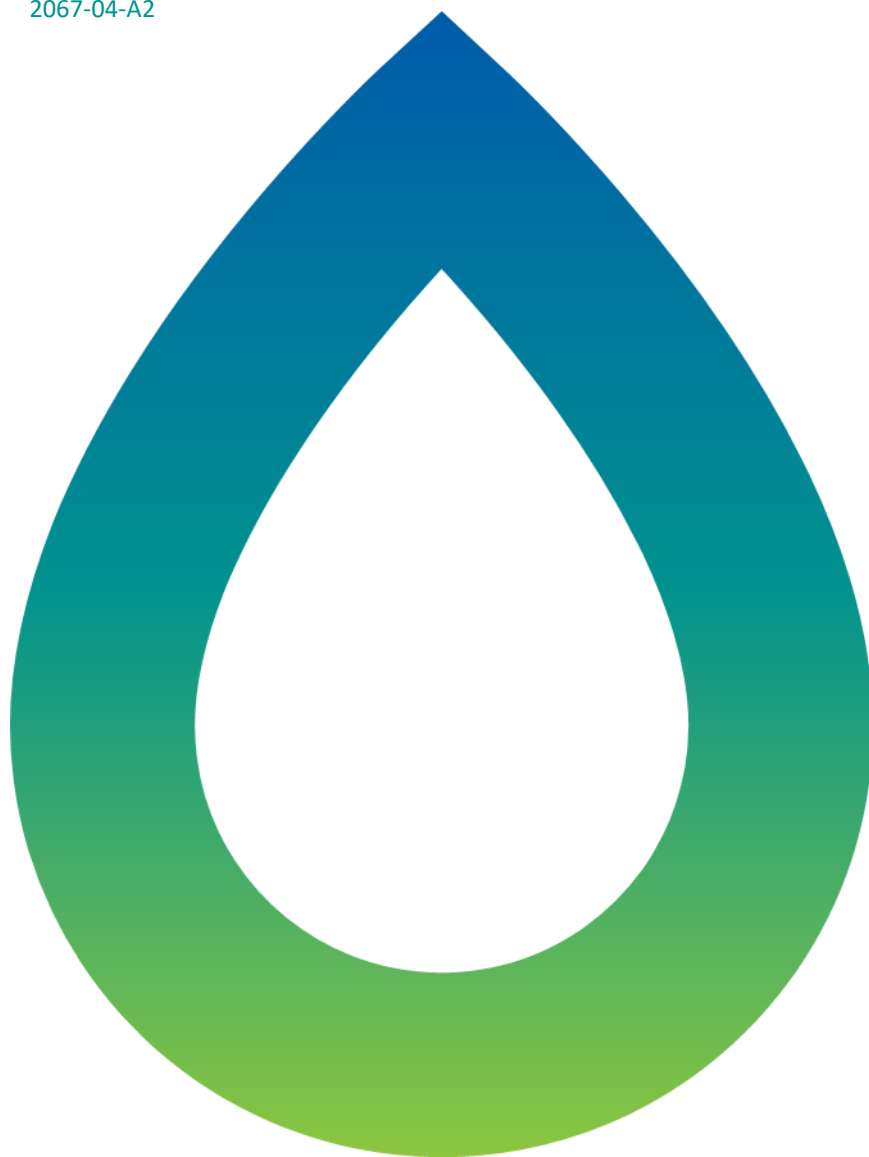
JUNCTION RIVERS WIND PROJECT

Flood Impact Risk Assessment

Umwelt (Australia) Pty Ltd

15 May 2024

2067-04-A2



DETAILS

Report Title	Junction Rivers wind project, Flood Impact Risk Assessment
Client	Umwelt (Australia) Pty Ltd

THIS REVISION

Report Number	2067-04-A2
Date	15 May 2024
Author	Lindsay Millard
Reviewer	DN

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1 INTRODUCTION

1.1 BACKGROUND

Umwelt are preparing an Environmental Impact Statement (EIS) on behalf of Windlab Developments Pty Ltd (Windlab) for development of the Junction Rivers Wind Project (the Project). The Project involves the construction and operation of renewable energy generation and electricity transmission infrastructure. Figure 1.1 shows the Project locality.

The Project Area (164 km²) is located approximately 15 km south of Balranald, 10 km north of Kyalite, 24 km north of Tooleybuc, and 20 km northeast of the NSW and Victorian border within the southern section of the Murray-Darling Basin. The Project is within the Murray River Local Government Area (LGA), immediately east of Balranald LGA, and within the South-West Renewable Energy Zone (SW REZ). Topography in the Project Area is characterised by complex and broad floodplain flow paths, with poorly defined waterways and numerous lakes.

1.2 PROJECT CONTEXT

The Project will have a generating capacity of approximately 750 megawatts (MW) and would connect to the existing 220 kilovolt TransGrid transmission line and/or Project EnergyConnect transmission line which both traverse the site. The key components of the Project include:

- Up to 96 (3 blade) Wind Turbine Generators (WTG)s with a maximum blade tip height of up to 300 metres above ground;
- Electrical connections between the proposed WTGs and substations/switching stations (underground or a combination of underground and overhead powerlines);
- Substations/switching stations and transmission connections to connect to the existing 220 kV transmission line and/or Project EnergyConnect transmission line;
- up to four BESS facilities (to a total of 200 MW with a four-hour delivery capacity), or up to four STATcom facilities
- other ancillary infrastructure including access roads and tracks, operation and maintenance buildings and construction facilities
- temporary calibration meteorological masts and permanent power performance masts
- temporary on-site concrete batching plant and rock crushing facilities during the construction phases
- targeted road network upgrades to facilitate delivery of WTG components to the Project Area as required.

The Project may be constructed in two stages. Stage 1 may see the construction of up to 30 WTGs and required ancillary infrastructure and Stage 2 may see the construction of the balance of WTGs and required ancillary infrastructure. The construction period would be approximately four years across the two stages.

The Project 'Development Footprint' is the maximum extent of ground disturbance associated with the construction and operation of the Project. For environmental assessment purposes, a Project 'Development Corridor' has been established generally consisting of a buffer around the Development Footprint for the Project. The Development Corridor represents a worst-case assessment scenario and allows for refinement of Project infrastructure, such as micro-siting of WTGs, during the detailed design phase.

1.3 PURPOSE AND SCOPE

This Flood Impact Risk Assessment (FIRA) was prepared by WRM Water & Environment Pty Ltd (WRM) in accordance with the Secretary's Environmental Assessment Requirements (SEARs) (Application Number SSD-30448824, dated 19 December 2023) issued by the then Department of Planning and Environment (DPE) (now the Department of Planning, Housing and Infrastructure (DPHI)) and as presented in Table 1.1.

The FIRA provides an assessment of the potential impacts of the Project on surface water in the vicinity of the Project Area. The assessment considers water demand and hydrologic impacts associated with the construction and operation of the Project and includes the following scope:

- Assessment of the potential impacts on:
 - flooding for the 10%, 1%, 0.5%, 0.2% Annual Exceedance Probability (AEP) events and the Probable Maximum Flood (PMF) for the current climate; and,
 - water users and supply.

The SEARs for the Project identify key issues and referenced guidelines that must be addressed in the EIS. Table 1.1 references the specific requirements for water resources and where these are addressed in this report.

Table 1.1 Planning Secretary's Environmental Assessment Requirements (SEARs)

SEARs Key Issues - Water and Soils:	Where addressed in this report
a site water balance for the development, quantify water demand, identify water sources (surface and groundwater), including any licensing requirements, and determine whether an adequate and secure water supply is available for the development;	Section 3
an assessment of the likely impacts of the development (including flooding and flood modelling) on surface water traversing the site and surrounding watercourses (including their Strahler Stream Order), drainage channels, measures proposed to monitor, reduce and mitigate these impacts;	Section 4

1.4 REPORT STRUCTURE

This report is structured as follows:

- Section 2 provides details of the existing surface water environment;
- Section 3 describes detailed site water balance for the Project;
- Section 4 describes the methodology of the flood assessment;
- Section 5 presents the results of the flood assessment;
- Section 6 presents the potential surface water impacts and mitigation measures;
- Section 7 presents the conclusions of the assessment;
- Section 8 is a list of references;
- Section 9 is a list of abbreviations and definitions;
- Appendix A contains A3 flood maps for the Project Area.



Figure 1.1 Locality of Project Area

2 EXISTING SURFACE WATER ENVIRONMENT

2.1 CATCHMENT CHARACTERISTICS

The Project Area is located within an area of flat topography and poorly defined waterways, with numerous lakes. Directly to the north of the Project Area is Yanga National Park (667 km²) and Yanga State Conversation Area (346 km²). Within the National Park is Lake Yanga and it is considered a location of high biodiversity value due to the fish, amphibian and waterbird habitat and breeding site. Within and adjacent to the Project Area are Condoulpe Lake, Dusty Lake and Condoulpe Creek which are connected to Lake Yanga. These watercourses are interconnected and link to the Murrumbidgee River and support the high biodiversity values.

The Murrumbidgee River is located to the north and west of the Project Area and flows in a south-westerly direction, joining the Murray River about 10 km west of the Project Area. The Murrumbidgee River is the major drainage feature in the vicinity of the Project and has a catchment of about 166,600 km² at Balranald.

2.1.1 Topography and drainage

LiDAR topographic data at a 1 m resolution (acquired in 2020 and 2021) covering the area of Junction Rivers Wind Project catchment was obtained from the ELVIS (Elevation Information System) portal (<https://elevation.fsdf.org.au/>). This data was used for the hydraulic modelling presented later in this report.

The Project Area is 30 km to the west of the confluence of the Murray and Murrumbidgee Rivers. Five kilometres to the south are the Edward and Wakool Rivers which are tributaries of the Murray River. The local topography of the Project Area based on LiDAR survey is shown in Figure 2.1. The Project Area is generally flat with ground levels varying between about 50 to 80 metres Australian Height Datum (mAHD). The topography of the Project Area is undulating, sloping gently away from the western area.

2.1.2 Watercourses

The waterway network traversing the Project Area is shown in Figure 2.2, including numerous minor waterways of 1st and 2nd Strahler order based on the NSW hydroline spatial data. Further ephemeral depressions are located throughout the Project Area and numerous small farm dams are present. The majority of the Project Area drains in a northerly direction through the Project Area. There are several other unnamed perennial creeks and drainage lines that traverse the Project Area. The regional watercourses that drain to the Project Area are shown in Figure 2.8. Open and gravity-controlled channel irrigation schemes service surrounding areas. The water supply is from the regulated Murrumbidgee River Water Sharing Plan.

2.1.3 Groundwater

There is one registered groundwater bore located within the Project Area (BoM, 2022) and four others located immediately adjacent to the Project Area extent, as shown in Figure 2.2. Of these, two are identified as water supply bores, and the remainder are for monitoring purposes.

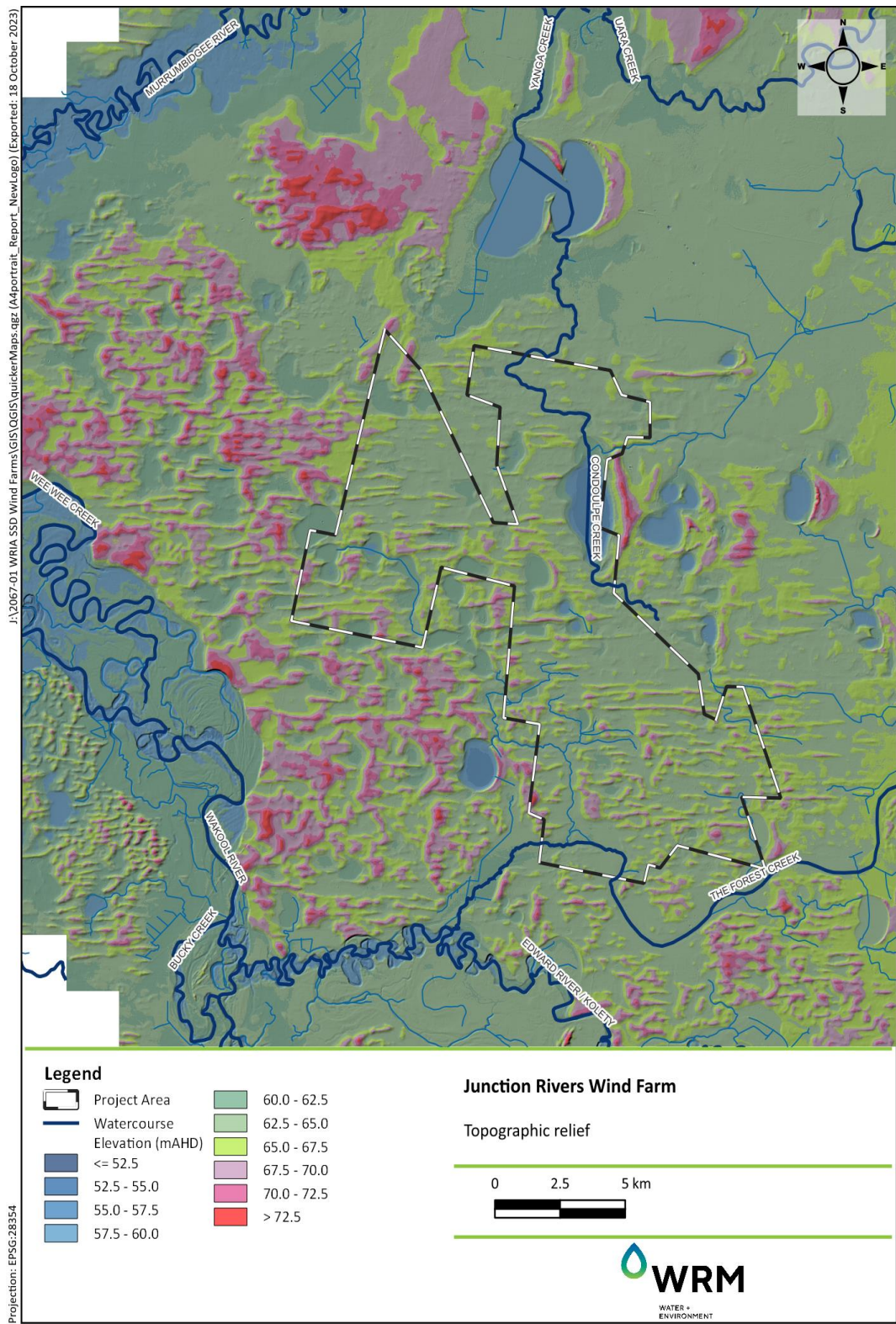
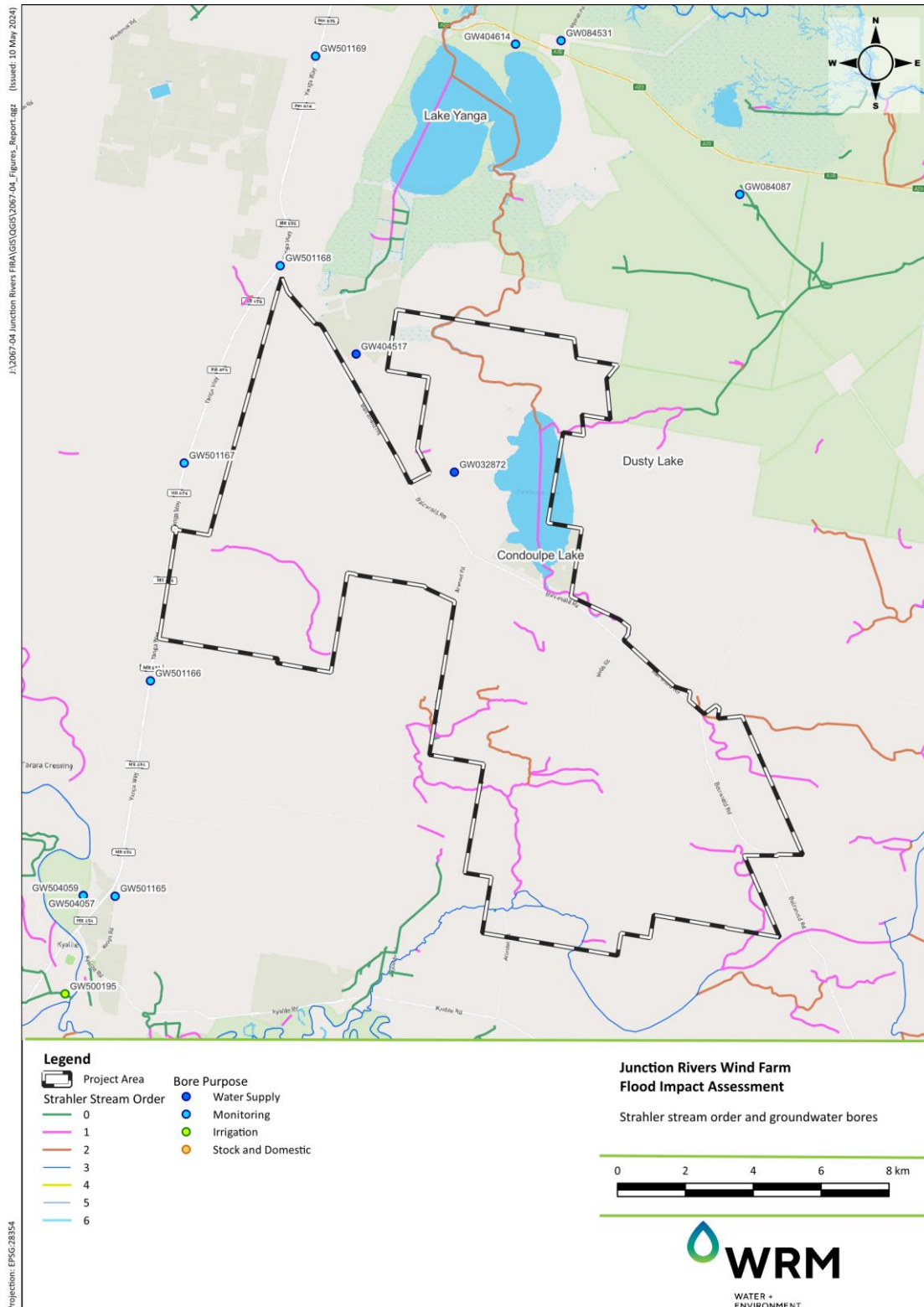


Figure 2.1 Topographic and drainage features



2.2 CLIMATE

Daily rainfalls have been recorded at Balranald (RSL) (BOM Station No. 049002), about 15 km north of the Project Area, since 1879. Table 2.1 shows summary details of the rainfall station. Given the proximity of the gauge to the Project Area, the recorded data is considered representative of the local region rainfall patterns.

Climate data was obtained from the SILO database of historical climate records for Australia hosted by the Queensland Government's Department of Environment and Science (DES). This service interpolates raw rainfall and evaporation records obtained from the Bureau of Meteorology (BOM) to provide a spatially and temporally complete climate dataset. Climate data was obtained for a SILO grid point within the Project Area for the period 01/01/1889 to 31/01/2024.

Table 2.1 Balranald (RSL) rainfall station details

Station No.	Station Name	Elevation (mAHD)	Latitude	Longitude	Distance from Project Area (km)	Opened	Closed
049002	Balranald (RSL)	61	34.64° S	143.56° E	15	1879	-

Figure 2.3 presents annual rainfall totals based on the Project Area SILO grid point. The highest annual rainfall at this station (692.3 mm) was recorded in 1973.

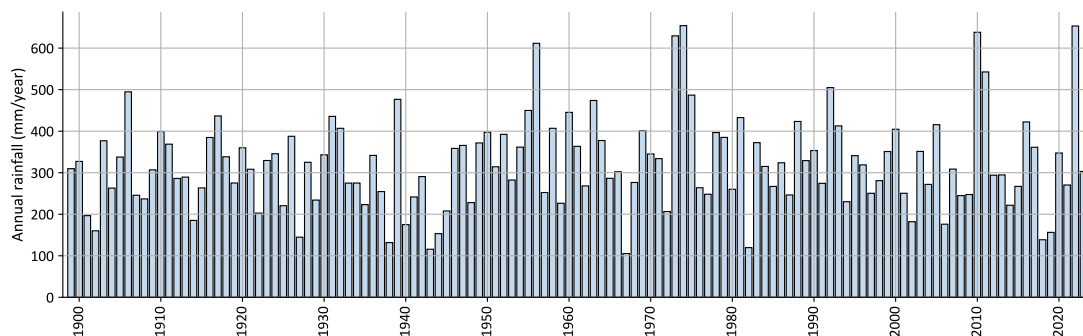


Figure 2.3 Annual rainfall totals at Project Area (source: SILO, 2024)

Table 2.2 shows summary rainfall statistics for the Balranald (RSL) station. Mean annual rainfall is 321.1 mm with the highest monthly rainfalls occurring between May and October.

Table 2.2 Monthly and annual rainfall statistics, Balranald (RSL) (Station No. 049002), 1879-2024

Statistic	Rainfall (mm)												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean	22.4	23.0	22.6	22.5	31.6	29.1	27.3	30.2	29.1	32.5	26.8	24.0	321.1
Lowest	0	0	0	0	0	0.5	0	0.4	0.5	0	0	0	121.7
5th %ile	0	0	0	0	1.4	4.8	4.1	3.7	5.3	1.9	0	0	154.5
10th %ile	0	0	0.5	1.3	3.8	7.6	7.1	7.9	6.9	3.7	2	1.2	202.7
Median	10.9	13.4	15.1	15.2	25.1	24.4	23	25.9	23.5	22.4	19.6	17.3	314.3
90th %ile	60.8	69.6	60	58	67.7	56.5	50.2	53.3	58.9	71.9	67.8	57.7	465.8
95th %ile	82.6	84.9	76.1	74.9	84.3	66.3	57.9	60.3	67.3	89.3	87.4	71.4	518.5
Highest	137.6	141.5	133.3	125.7	117.4	137.5	82.3	85.2	99	130	125	145.3	692.3

Table 2.3 shows mean monthly evaporation (based on Class A pan evaporation) for Balranald, estimated from the SILO mean monthly and mean annual evaporation gridded datasets. Mean annual evaporation is 1,826 mm, which is nearly 6 times the mean annual rainfall of 321 mm.

Table 2.3 Balranald mean monthly and annual pan evaporation

Statistic	Mean Pan Evaporation (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	284.8	233.6	190.3	115	67.2	43.9	50.1	76.2	112.4	166.5	217.2	268.4	1825.6

Utilising the climate database, the average total rainfall for each calendar month from 1889 to 2024 was calculated and is summarised in Figure 2.4 and Figure 2.5. Figure 2.4 shows the distribution of average monthly rainfall and evaporation. Evaporation is greater than rainfall in all months, but is much greater than rainfall in the warmer months.

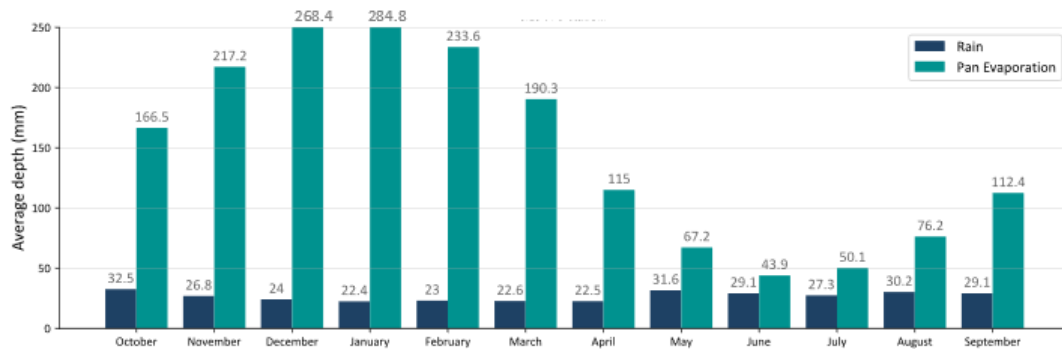


Figure 2.4 Mean monthly rainfall and evaporation for Project Area, 1890 to 2024 (source: SILO, 2024)

Figure 2.5 shows that there is only a moderate level of seasonality to rainfall within the Project Area, and that rainfall is typically low in summer months. Lowest average (mean) rainfall is recorded in January through April. Highest monthly rainfall is recorded in May, June and October.

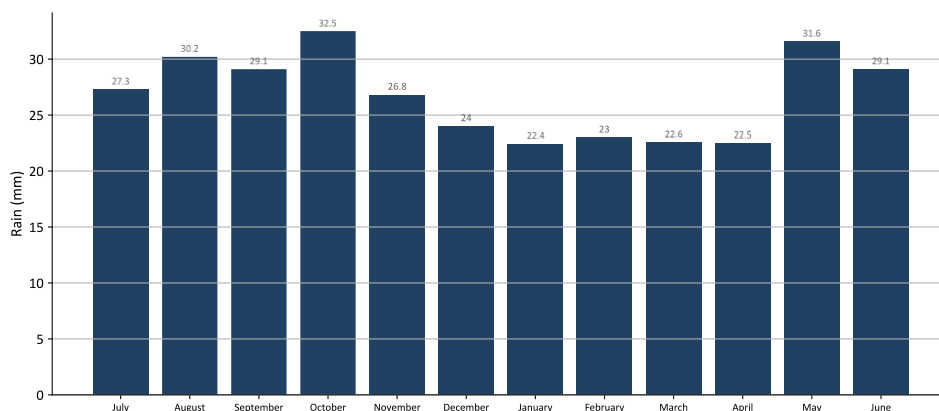


Figure 2.5 Mean monthly rainfall (mm), 1890 to 2024 (source: SILO, 2024)

Figure 2.6 presents a timeseries of daily rainfall accumulation starting on 1 October each year to represent the water year. There is minimal variance between the 25th to 75th percentile annual

rainfall total. It is possible for annual rainfall sequences to generate four times the median rainfall as occurred in the 1974/75 water year.

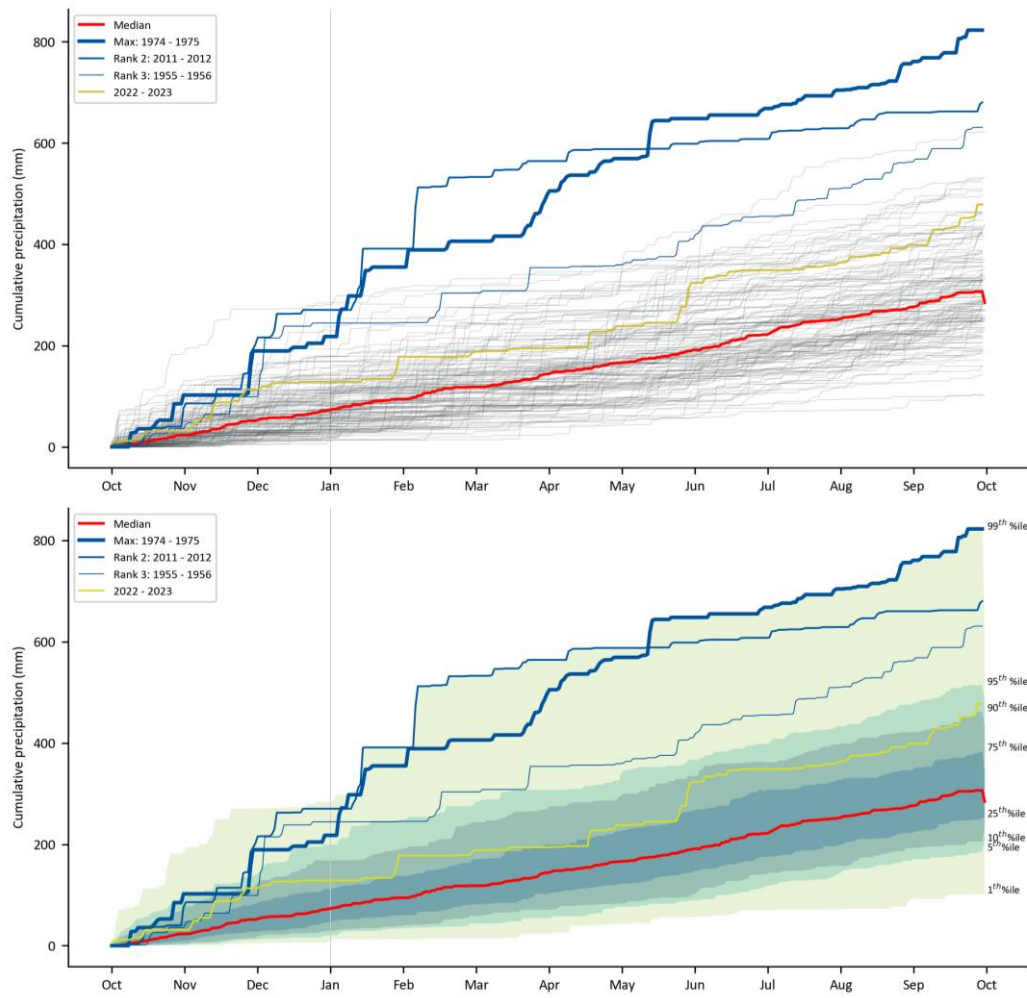


Figure 2.6 Rainfall variability at Project Area (source: SILO, 2024)

2.3 REGIONAL FLOOD HISTORY

Flooding in the Murrumbidgee River in the Balranald area was documented shortly after European settlement of the area. A pastoral station was established at Yanga in the 1830s. In the 1890s dams, levee and irrigation scheme commenced in upstream catchments of the Murrumbidgee River. The flood of record for the area occurred in 1956. Historic newspaper articles indicate that notable flood events occurred in the Balranald area in the following years: 1824, 1832, 1852, 1870, 1878, 1890, 1897, 1922, 1931, 1950, 1956, 1959, 1974, 1990, 2010 and 2022.

Figure 2.8 shows the LandSat satellite flood imagery captured on 4 December 2022 for the Murrumbidgee and Murray River flood event. Breakout flows from these rivers may potentially contribute to floodplain flows near the Project Area. While the Project Area is located in an area of low flood risk, the Project Area may be impacted by complex and broad floodplain flow paths.

Anecdotal flood history is brief and is shown compiled from landholders near to the Project Area. The anecdotal evidence corresponds to the detail captured and shown by LandSat in Figure 2.8 and as

one landholder noted that “heights varied from about waist height close to Yanga Lake to below knees as the water travelled South from Yanga Lake. Lasted from early November to Jan 23”

2.4 CONDOULPE LAKE WATER LEVELS

Condoulpe Lake is an ephemeral waterbody within the northeastern portion of the Project Area. The lake collects local runoff from a catchment of approximately 2,400 ha and overflows north towards the larger Yanga Lake. Historical aerial images show that Condoulpe Lake can completely dry out during extended dry periods.

An assessment of the frequency of inundation in Condoulpe Lake was undertaken by reviewing historical satellite and aerial images. A water balance model was also developed to assess the likely variation in lake water levels over time.

2.4.1 Review of aerial and satellite images

Additional data was obtained from LandSat and Sentinel-2 satellite monitoring of water reflectance at the lake’s location. Publicly available aerial photographs were examined spanning 1986 until 2024. Many aerial photographs were only recorded by year. Almost all aerial photographs were similar to the photograph, shown on the right in Figure 2.7, where no standing water is perceptible.



Figure 2.7 Condoulpe Lake aerial imagery (left 11 Feb 2023, right: 2022) Source: earth.google.com and Airbus

Geoscience Australia’s Water Observations from Space (WOfS) service provides information regarding the frequency of inundation at the Condoulpe Lake. The data is derived from Landsat-5 and Landsat-7 satellite imagery acquired over Australia between 1987 and 2024. The detection process is based on spectral analysis of each pixel in each Landsat scene. The water detection for a pixel through time is combined to produce a total number of water observations for each pixel. This is compared to a total number of clear observations for the same pixel. There were a total 416 observations collected since 1986 until present. From those observations, only 20 detected water in Condoulpe Lake. The wet pixel observation count is shown in Figure 2.9.

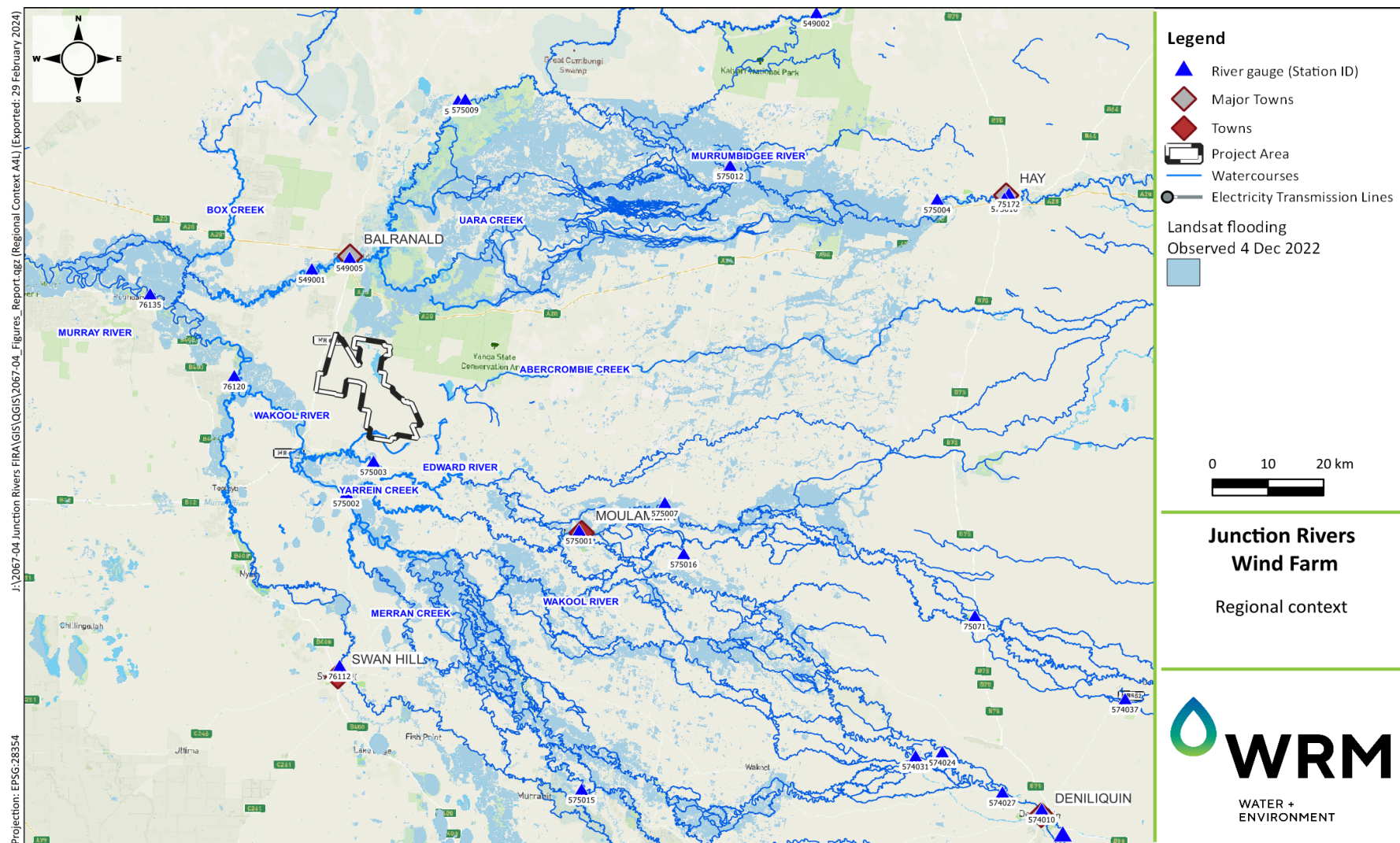


Figure 2.8 Regional drainage network and December 2022 flood extent

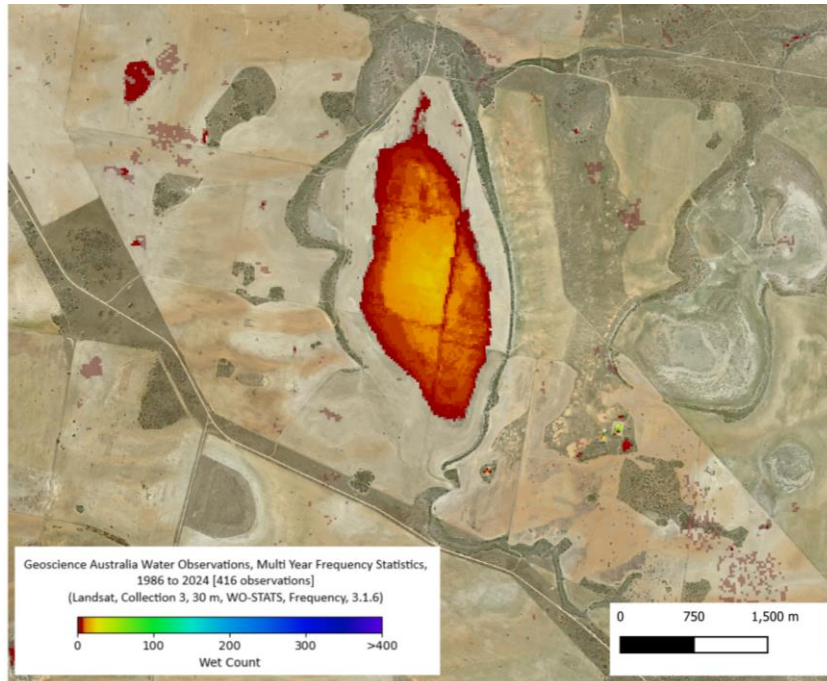


Figure 2.9 Condoulpe Lake frequency of wet cells 1986 – 2024 Source: Geoscience Australia

2.4.2 Simulated lake water levels

A surface water balance model was prepared for the wetland and its catchment using the GoldSim software. The model comprises a single water storage, with the following processes simulated on a daily timestep using climate data presented in Section 2.2:

- Surface runoff from the upstream catchment using the AWBM rainfall-runoff model;
- The AWBM model parameters were adopted;
- Evaporation from and direct rainfall to the water surface;
- Overflows from the lake when its capacity is exceeded;
- Losses due to seepage and or rural water use;
- Groundwater inflows were assumed to be nil.

The storage curve of the Condoulpe Lake (elevation vs area and stored volume) was derived from LiDAR data when the lake was empty. The lake is relatively shallow. The full volume was assumed to be a water level at 61 mAHD and has a surface area of 540 ha. This lowest elevation is 56.1 mAHD. The total storage capacity is approximately 17,000 ML. The catchment area draining to the lake was estimated to be 2,400 ha.

Due to the semi-arid nature of the area, evaporation would typically empty the lake from full over a period of approximately four months (see Figure 2.10). The modelling suggests that the lake would be frequently near empty. The lake could not be expected to provide a useful volume of water for the four-year construction phase. Aerial imagery has only captured a few instances of standing water within the lake, the water balance modelling of the last 50 years has indicated that it does impound water but only for short periods typically throughout winter and spring.

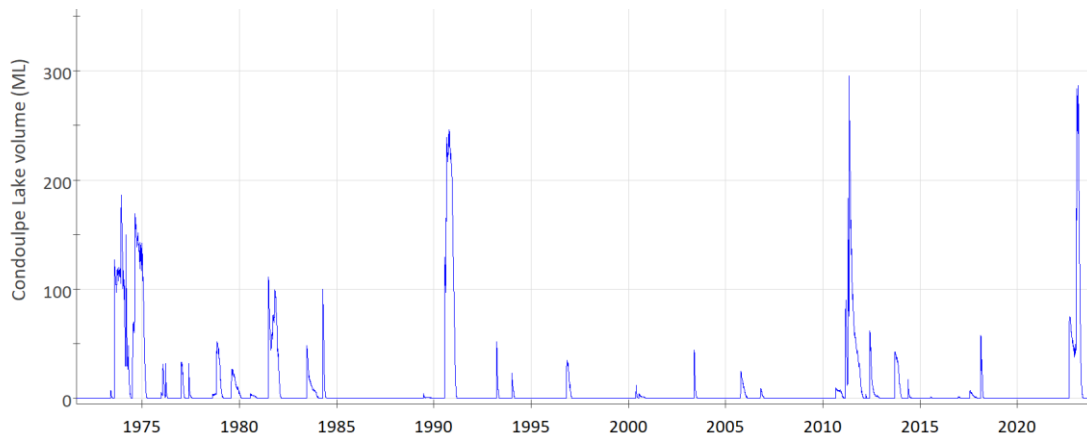
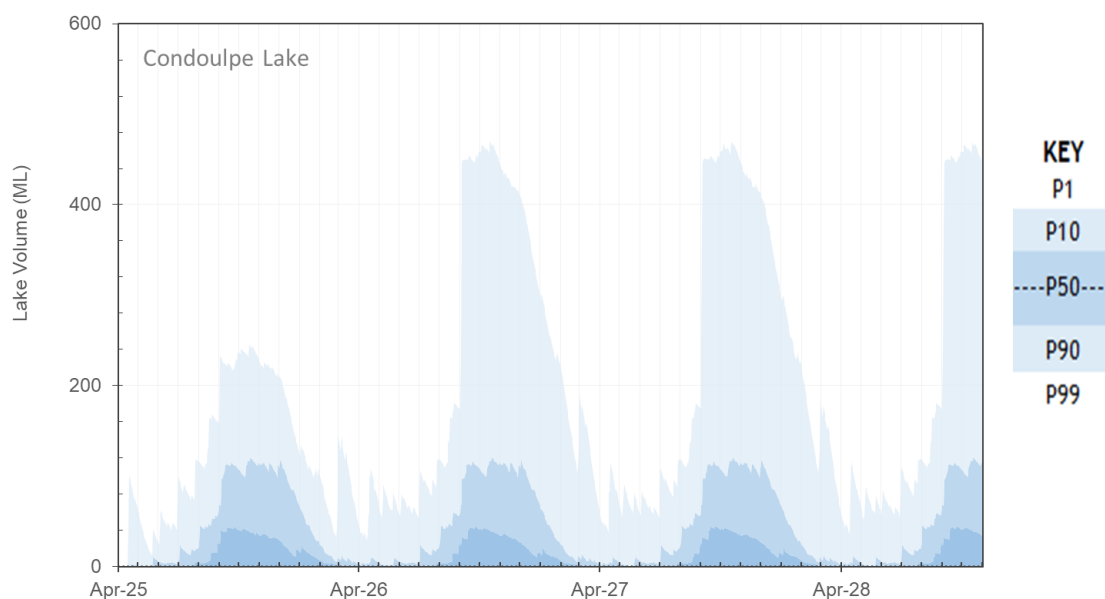


Figure 2.10 Indicative historical volumes within Condoulpe Lake

The water balance model simulated the lake's behaviour on a daily time step over the proposed construction phase. The model was run for 135 climate sequences, each referred to as a "realisation". Each realisation is based on a sequence extracted from the historical rainfall data. The first realisation is based on rainfall data from 1 April 1889 to 31 March 1892. The second uses data from 1 April 1890 to 31 March 1893 and so on. This approach provides the widest possible range of climate scenarios covering the full range of climatic conditions represented in the historical rainfall record. Statistical analysis of the results from all realisations provides a probability distribution of the lake's volume for each day of the year.

The modelled behaviour of the lake is illustrated in the following probabilistic time series produced by the model, refer to Figure 2.11. The results show occasional filling of the lake, followed by a gradual reduction in water levels over the course of subsequent months, due to evaporation in the seasonally dry periods. The key indicates the exceedance of modelled volumes against probabilities.



Notes:
 1. Probabilistic model results presented using blue shading.
 2. Model run to forecast lake volume for a three year construction period

Figure 2.11 Probabilistic model results of monthly lake levels

The probabilistic model results demonstrate that the lake, even during very wet sequences will evaporate over the course of the year. In the absence of water monitoring data for the lake, the results were consistent with the observations of inundation based on satellite monitoring and aerial photographs, which show that the wetland is ephemeral, and generally contains only small volumes of water.

3 SITE WATER BALANCE

3.1 OVERVIEW

The Project will require water supply during the construction, operational and decommissioning phases. During construction, water will primarily be used for concrete production, revegetation and dust suppression. The associated water demand during the construction phase is estimated to be approximately 400 ML for the anticipated four-year duration of construction. The water demand during operations and decommissioning is expected to be significantly lower in the range of 0.2 ML per annum.

3.2 WATER DEMAND

3.2.1 Construction Water Demand

The greatest water demand would be during the construction phase of the Project. Key Project water demands include:

- Soil and fill conditioning;
- Dust suppression;
- Concrete production;
- Concrete washout;
- Vehicle and equipment wash down; and
- Amenities.

A preliminary assessment of water demands has been made based on the current design and a number of assumptions outlined in Table 3.1. Demands include bulk earthworks, concrete, dust suppression, potable water, and other site activities. Water demand during construction phase will increase gradually, peak, and then decline gradually as the Project reaches practical completion. Maximum water demand is expected towards the end of the first year of construction. This coincides with the main period of construction of access tracks, foundations, and hardstand areas. Over the first half of the construction phase, the average monthly demand is approximately four to five times higher than the consumption expected in the final half. Water demand during the initial operational phase will be lower again. The assumed average and maximum daily breakdown of water requirements for the construction period:

- Peak daily demand of 600-700 kL/day raw with 40 kL/day potable water; and
- Average daily demand of 300-350 kL/day raw with 20 kL/day of potable water.

These values are indicative only for the purposes of impact assessment. Detailed assessment of water demands will be undertaken during detailed design of the Project.

Table 3.1 Construction water balance assumptions

Water Demand	Water Usage Assumptions
Key assumption is that demand is evenly distributed over excavation and foundation construction period	
Dust suppression (nett. Evap)	Active work areas only - assume at 10% of total tracks at any one time Assume balanced with pan evaporation, refer Section 2.2
Construction – road	6.5m wide by 90 km. Rip to 500mm and re-compact – assume on site soils are 12% dry of optimum moisture content (OMC) add 10% mass of Bulk Earthworks and Pavement Material water content to achieve compaction and consolidation Pro-rata over period of road construction
Washdown - concrete	Approx. 250 L per 10 m ³ of concrete poured
Washdown - vehicle	Allowance 5 kL/day typical, 10 kL/day (wet days), refer Section 2.2
Construction – Concrete	3000 m ³ to cover balance transmission footings/ BESS/ main / Collector substations
Construction - Turbine Foundations	96 units excavation and foundation construction period 1,000 m ³ / WTG footing approx. 100 L water per tonne 1 week curing - 5 L/m ² (mixing curing compound)
Potable	Construction workforce: Median 150 personnel, Peaking at 400 personnel Allowance 40 L/pers/day - 6 days week
Total demand	400 – 500 ML (indicative only)

3.2.2 Operational Water Demand

During operations, up to 0.2 ML per year would be required for ongoing maintenance activities such as amenities and potable purposes by operational staff, and equipment washing down, if required. Washing would not require any detergent or cleaning agents. A static water supply, with the capacity to be determined during the detailed design phase, will also be established and maintained for fire protection.

3.3 WATER SUPPLY SOURCES

Water requirements will be met in accordance with the provisions of the *Water Management Act 2000* (WM Act) by sourcing water from within the locality where practicable and from a licensed supplier.

Windlab has investigated various potential water sources including on site bores, surface water, river sources and potential mains water supply through discussions with Balranald Shire Council and Murray River Council. Based on the estimated average water demand and initial discussions with Balranald Shire Council, it is likely that the majority of water could be sourced from the Balranald Shire Council mains water supply utilising an existing standpipe with an available draw of 30-40 litres/second. The Project will have multiple water tanks within the Project Area, to distribute and store water as required and to act as a buffer to temporary variations in water availability.

Windlab is investigating additional options to supplement water supplies if required. This includes discussions with Murray River Council regarding potential supplementary Project water from standpipes in Tooleybuc and Moulamein. Windlab is also in discussions with Project landowners and

neighbours regarding the potential to source water from the Edward River to provide an alternative source.

There are numerous small farm dams/depressions within the Project Area. These storages will be subject to water evaporation and of low reliability for water supply. Water from dams with a capacity of up to 10% of the average annual runoff for the landholding in coastal draining catchments may be used for any purpose under harvestable rights. Based on the total Project Area of 16,367 ha, the Maximum Harvestable Right Dam Capacity (MHRDC), from which water can be used for any purpose, is 656 ML based on a Project Area of 164 km² at 34.826S, 143.607E. This value was calculated using WaterNSW's MHR calculator available at this link¹.

Water for construction and operational phase non-potable water demands could be supplied from one or a combination of the following sources:

- Mains water supply, Balranald Shire Council and potentially Murray River Shire Council (via water truck);
- Harvested runoff from farm dams under agreement with host or local landholders;
- Groundwater from licenced bores under agreement with host or local landholders;
- Extraction from Edward River to south of Project Area under agreement with host or local landholders;
- Harvested runoff from disturbed areas captured in excavations or sediment basins/traps constructed to prevent sediment transport off-site; and,
- Recycling and reusing water.

The largest water demands, such as for dust suppression, soil conditioning, and concrete batching, are all nonrecoverable water uses. Where possible, water uses, such as vehicle washdown, would be recycled and reused as far as practical.

During construction there may also be opportunities to utilise water collected in sediment retention ponds, or locally sourced from farm dams or private bores. Local water supply from private dams and bores would be taken under harvestable rights or water access licence (WAL) conditions.

Where further licenses are needed to access water from these sources or licence amendments are required, these would be sourced prior to the water being used.

Any water supplied to the Project from existing groundwater bore or farm dams will be sourced under agreement with relevant landholders while ensuring any WALs, works approvals and water use approvals required under the *WM Act* (2000) are obtained.

Water sources would be determined prior to the commencement of construction in consultation with suppliers and landholders.

3.3.1 Potable Water Supply

Potable water demands for the Project would be supplied via water tanker and stored in on-site water tanks. Potable water storages would be routinely tested to ensure water quality meets the requirements of the Australian Drinking Water Guidelines (ADWG) (National Health and Medical Research Council, 2011) and an appropriate maintenance regime would be implemented to ensure ADWG water quality standards are maintained.

¹ <https://www.watarnsw.com.au/customer-services/water-licensing/maximum-harvestable-rights-calculator>

3.3.2 Amenities Wastewater

Wastewater from amenities during all phases of the Project will be captured in a tank and transferred periodically by a suitably licensed contractor to an appropriate wastewater treatment facility.

3.4 PROJECT WATER BALANCE

The Project will require water to be supplied from a variety of sources and qualities. The water demands were quantified in Section 3.2 and the possible supply sources were outlined in Section 3.3. An indicative summary site water balance is shown in Table 3.2.

Table 3.2 Detailed site water balance (indicative)

		Construction Phase (4 years)	Operation (annual)
Water Demands			
	Dust suppression (climate dependent)	100 ML (median) 200 ML (dry)	2 ML /a
	Construction activities	300 ML	-
	Potable	~1 ML	~0.1 ML /a
	Total water demand	401 ML – 500 ML	2.1 ML/a
Water Supply			
	External raw water (Balranald Shire Council) [#]	350 - 400 ML ^b acquired from licensed sources or via agreements	0
	Collected runoff within Project Area * (where possible)	0 - 50 ML ^a	2 ML /a
	Dry weather contingency	100 ML (dry)	
	External potable water	1 ML purchased	~0.1 ML purchased

[#] Negotiated supply from Balranald Shire Council standpipe

* maximum harvestable right for Project Area is 656 ML/a

^a indicative estimate

^b balance of demand after allowing for captured site runoff

4 EXISTING FLOOD BEHAVIOUR

4.1 MODELLING APPROACH

The purpose of the flood modelling was to assess the current climate flood behaviour within the Project Area to inform siting of flood vulnerable infrastructure and assessment of Project impacts. The 2023-03-AC version of the two-dimensional TUFLOW hydrodynamic model (BMT, 2018a) was used to simulate the flow behaviour in the vicinity of the Project Area for the 10%, 1%, 0.5% (1 in 200) and 0.2% (1 in 500) AEPs and the Probable Maximum Flood (PMF) for current climate. The SEARs requested that 0.5% (1 in 200) and 0.2% (1 in 500) AEPs be considered as a proxy for future climate sensitivity for increases in the 1% AEP current climate.

There is no recorded water level data but some anecdotal information available within the Project Area. However none of these anecdotes provided sufficient detail of water levels or timing frame that would be required for undertaking model calibration.

Inundation within the Project Area could occur, exclusively or as a combination of three mechanisms:

- Site runoff: Short duration (< 60 minutes) intense rain falling directly on the Project Area;
- Local catchment flooding: Medium duration (1 hour – 6 hours) rain falling on land draining to the Project Area;
- Regional flooding: Long duration (6 - 72 hours) arriving from rainfall falling on the catchments of the Murrumbidgee or Murray Rivers upstream of the Project Area.

A test model was developed to investigate the potential contribution of regional flooding caused by Murray or Murrumbidgee River breakouts draining to the Project Area. The test model indicated that the Project Area was at a sufficient elevation that it was not at risk of regional flooding.

Site runoff and local catchment flooding were modelled using a direct rainfall model to determine the extent of the surrounding floodplain that drains to the Project Area. The flat nature of the area precluded the use of a semi-distributed hydrologic model (URBS or RORB) from defining upstream catchments. The hydraulic model domain was defined by the extent of rainfall that was assessed as likely to reach the Project Area. This ensured that model run times and file sizes provided optimal coverage of the local catchment flood behaviour.

Preliminary TUFLOW hydraulic model runs for a range of durations and temporal patterns were used to identify the critical storm duration for the study area, and relevant design storm temporal patterns. Design storm modelling results were post-processed to derive design flood parameters (e.g., peak flood depths and extents) for each AEP and PMF.

4.2 HYDROLOGICAL INPUTS

Design rainfall depth data, as well as design losses, and storm pre-burst details were obtained from the Australian Rainfall and Runoff (ARR) datahub, in accordance with the current ARR guidelines. Design flows were estimated by applying design rainfall directly to the TUFLOW model grid. Details of the process and inputs are provided in the following sections.

4.2.1 Design Rainfall and Losses

Design rainfall depths were obtained from Design Rainfall Data System based on a single point location at the centroid of the Project Area. The Probable Maximum Precipitation (PMP) was derived from the GSAM and GSDM estimation methods (BOM, 2003)(BOM, 2006). These depths are summarised in Table 4.1.

For the purpose of the local catchment investigation, no areal reduction factors were applied to the design rainfalls. This approach is considered conservative for the purpose of this study.

Table 4.1 Design Rainfall Depths (mm) for Various Event Durations and AEPs

Duration (min)	10% AEP	1% AEP	0.5% AEP	0.2% AEP	PMP
60	21	37	40.6	45	190
90	25.1	43.4	47.6	52.6	220
120	28.2	47.8	52.3	57.6	250
180	32.7	54.1	59.1	65	300
270	38	62.4	68.8	76.4	320
360	42.5	70.1	78.1	88.1	335
540	48.5	79	88.5	100.4	380
720	52.4	83.6	94.1	106.9	410
1080	58.1	91.2	102.3	115.6	450
1440	62.6	96.4	108.9	123.8	480

4.2.2 ARR data hub

Recommended design rainfall parameters were based on current ARR guidelines (referred to as ARR 2019) (Ball et al, 2019), available from the ARR Data Hub portal². Key design rainfall parameters include:

- Initial and continuous loss rates;
- Design storm pre-burst depths; and,
- Design storm temporal patterns.

4.2.3 Design rainfall losses and pre-burst rainfall

The storm initial loss (IL) and continuing loss (CL) method of accounting for rainfall losses was adopted based on ARR Data Hub recommendations. An IL and a CL were adopted with median pre-burst depths obtained from the Data Hub used to adjust the IL with 1% AEP.

IL and CL losses were derived by interpolating between rainfall losses adopted for infrequent events (up to 1% AEP) noting that:

- Initial losses (ILs) for infrequent events were derived based on the Probability Neutral Burst ILs provided by ARR datahub. This approach results in a unique Initial Loss for each duration;
- Continuing losses (CLs) for infrequent events were derived based on the suggested data hub and regional flood study CLs.

Estimation of initial and continuing loss rates is provided in ARR 2019 as accessed through the online Datahub. The suggested probability neutral losses for initial losses were adopted. The adopted initial and continuing losses are provided in Table 4.2 and Table 4.3. These losses are relevant to the pervious catchment areas noting that there is no significant proportion of impervious area within the modelled catchments.

² <https://data.arr-software.org/>

Table 4.2 Losses Used in the Developed Hydraulic Model

Losses	Frequent and infrequent ($\leq 1\%$ AEP)	Rare ($> 1\%$ AEP)	PMF
Initial loss (mm)	Probability Neutral Initial Loss	Probability Neutral Initial Loss	0
Continuing Loss (mm/h)	2.5	1.5	1

Table 4.3 Probability Neutral Burst Initial Loss

Storm duration (min)	Probability Neutral Initial Loss (mm)			
	0.2% AEP	0.5% AEP	1% AEP	10% AEP
60	0	0	21.7	23.9
90	0	0	22.9	23.5
120	0	0	22.3	24.7
180	0	0	22.4	24.9
270	0	0	23.6	27.2
360	0	0	24.9	29.5
540	0	0	26.1	31.6
720	0	0	27.3	33.7
1080	0	0	32.6	37.1
1440	0	0	35.2	38.5
1800	0	0	36.8	39.6
2160	0	0	38.3	40.7
2880	0	0	40.4	42.8
4320	0	0	40.2	43.8

4.2.4 Temporal Patterns

Temporal patterns are the distribution of the total rainfall in different periods within a given duration. The suite of 10 temporal patterns appropriate to the Project Area were downloaded from ARR 2019 Datahub and used to simulate the temporal distribution of rainfall depths during each storm duration modelled. The suite of temporal patterns has been applied to estimate the critical design event for flood estimation in accordance with ARR 2019 procedures.

4.2.5 Critical Storm Durations

A range of storm durations and temporal patterns were simulated using the TUFLOW model (using ARR 2019 inputs) to identify the critical storm duration and temporal pattern results providing the design peak discharges at the Project Area. The usage of a direct rainfall model resulted in numerous critical duration events at various locations within the Project Area. However, while different durations were identified, the modelled flood results were of similar depths. The overall critical duration event was selected based on the main flow path through the Project Area. This simplification may have the impact that shorter duration (intense) storms may result in slightly higher (approximately 10 mm) water levels in localised areas. This approach was considered appropriate given the broadscale nature of this assessment.

4.3 HYDRAULIC MODELLING

4.3.1 Topography and grid cell size

The 1 m LiDAR topographic data obtained from the Elvis database was adopted as the base model topography. A 10 m grid size resolution was adopted for hydraulic modelling. In combination with TUFLOW's sub-grid sampling functionality, the 10 m cell size provided adequate resolution to capture key drainage features and overland flow paths, while maintaining reasonable simulation times.

4.3.2 Initial water level

An initial water level (IWL) of 63 mAHD derived from the topographic data was adopted at numerous lakes across the hydraulic model domain. Figure 4.1 shows the IWL locations.

4.3.3 Boundary conditions

Figure 4.1 shows the locations of inflow and outflow boundaries in the TUFLOW model. The model includes:

- Direct rainfall boundary covering the entire hydraulic model extent;
- Two 'Stage-time' (HT) type tailwater boundaries;
- Four 'Stage-discharge' (HQ) type outflow boundaries, with a fixed slope of 0.1% selected based on available topographic data.

4.3.4 Adopted tailwater boundaries

Two tailwater boundaries were provided to represent the Murrumbidgee River and Edward River. Water levels within these river systems are highly regulated by weirs and irrigation schemes. For all modelled design flood events, it was considered appropriate to assume a constant water level. This constant water level reflects the presence of downstream controls and were placed sufficiently far downstream to not influence calculated levels within the Project Area. The selected levels were derived from examination of the river level gauge nearest the boundary.

- The northern tailwater adopted a level of 63.5 mAHD (Yanga Creek gauge GS41000278)
- the southern tailwater adopted a level of 63.0 mAHD (Edward River at Liewah GS409035).

4.3.5 Hydraulic resistance

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance. Analysis of available aerial imagery showed that there are six (6) general land use classifications of relevance in the vicinity of the Project Area. Adopted Manning's 'n' values for each land use classification are listed in Table 4.4. The values adopted correspond to the values adopted in nearby flood studies.

Depth varying Manning's 'n' values were adopted as recommend by the TUFLOW manual for the direct rainfall (rain on grid) approach. Between flood depths of 50 mm and 100 mm, hydraulic roughness values are linearly interpolated by the TUFLOW software.

Table 4.4 Adopted hydraulic roughness coefficients

Land Use	Manning's 'n'	
	Depth < 50 mm	Depth > 100 mm
Active channel with light vegetation	0.080	0.035
Paved surface / hardstand	0.045	0.020
Water body/dam	0.020	0.020
Medium vegetation / rural res	0.060	0.060
Dense vegetation / residential	0.080	0.080
Exposed dirt/unsealed road	0.080	0.025

4.3.6 Hydraulic structures

No hydraulic structures were included in the model.

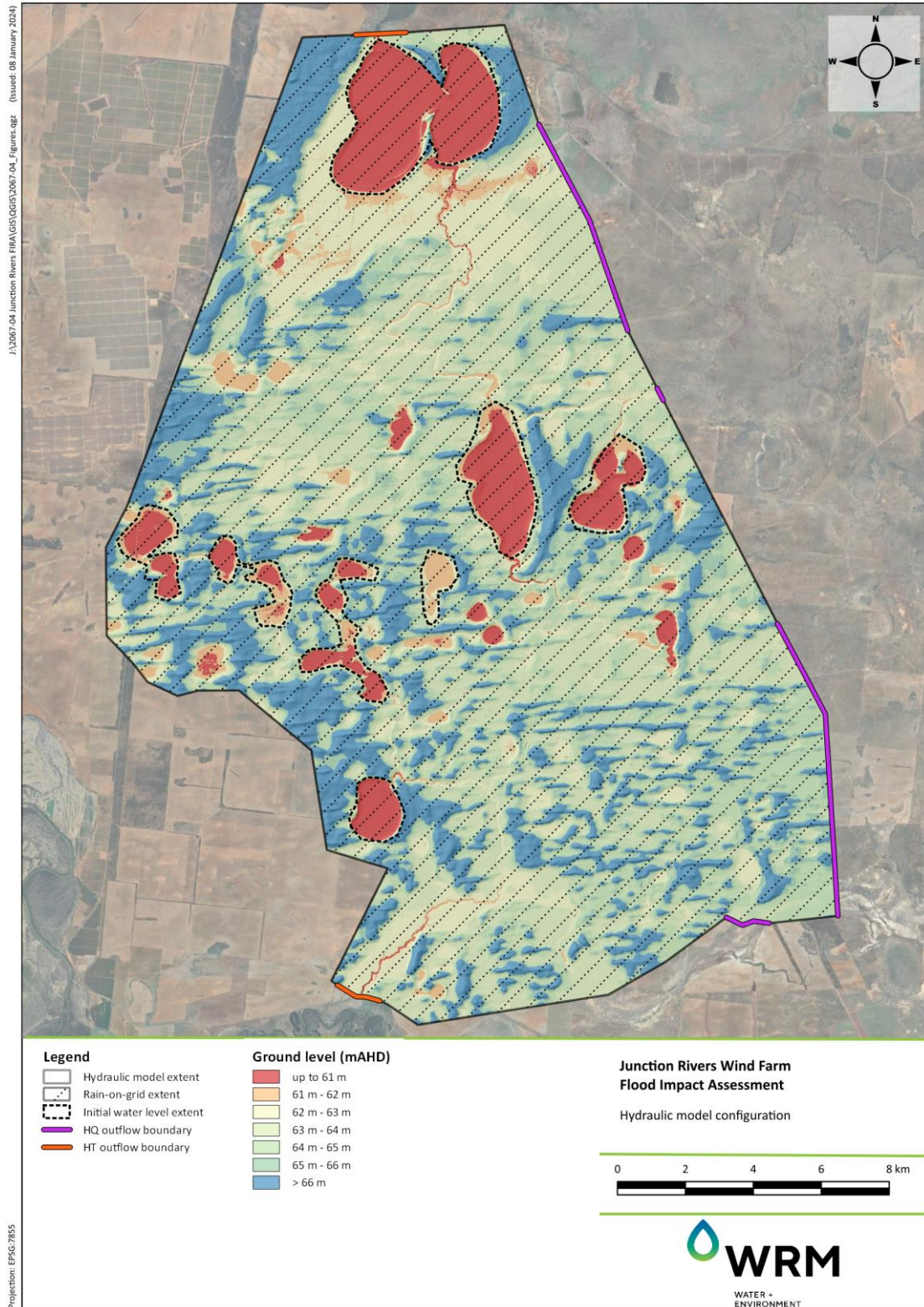


Figure 4.1 Hydraulic model configuration

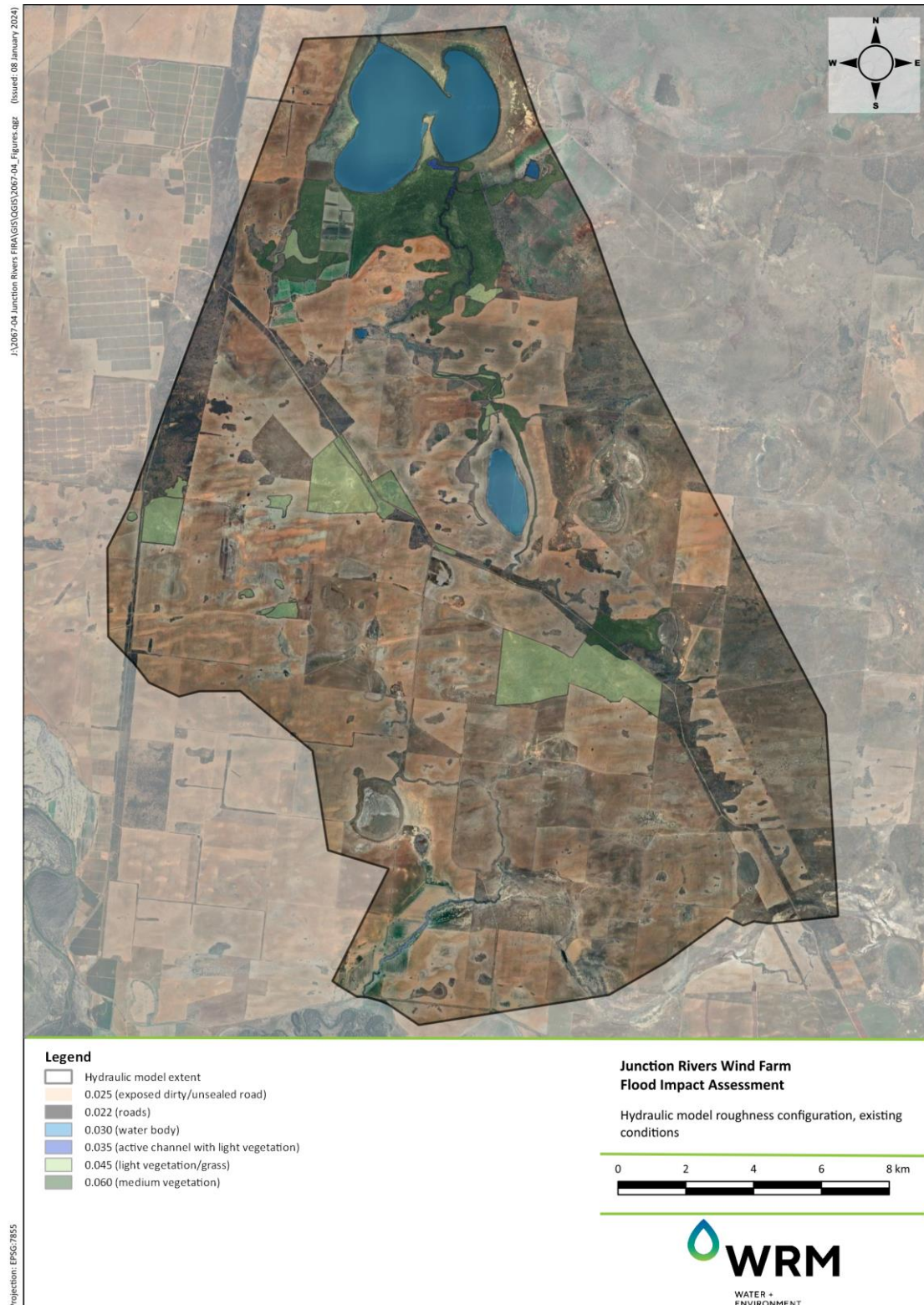


Figure 4.2 Hydraulic model roughness configuration

5 FLOOD MODEL RESULTS AND ANALYSIS

5.1 OVERVIEW

The flood model results provide the distribution of peak flood levels, depths, velocities, and hazards across the Project Area for each modelled design magnitude flood event. Areas where the modelled flood depths are less than 50 mm have been filtered from the results. Note that this does not affect the hydraulic computations.

The suite of detailed flood mapping of the simulated depth, velocity and flood hazard distributions for all modelled events is provided in Appendix A. The figures show that the peak flood extent is largely confined to the watercourse alignments, with some moderate inundation beyond the channel corridors. The modelled flood events are indicative of conditions as outlined below:

- 10% AEP event – representative of a frequent-rare flood event;
- 1% AEP event – representative of the principal flood planning event;
- 0.5% and 0.2% AEP events – representative of indicative climate change impacts; and
- PMF – representative of a rare-extreme flood event.

The model results indicate a critical rainfall duration of 6 hours for local catchment flooding.

5.2 FLOOD HAZARD

The flood hazard at the Project Area was assessed in accordance with ARR 2019. Flood hazard occurs due to the vulnerability of the public and assets interacting with floodwaters. ARR 2019 adopted the combined flood hazard classification based on research presented in the *Australian Disaster Resilience Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR, 2017). The flood hazard categories according to the AIDR definition are summarised in the Table 5.1 and flood hazard colour coded curves are shown in Figure 5.1. The flood hazard mapping is provided in Appendix A.

Table 5.1 Hazard Classification (AIDR, 2017)

Hazard Vulnerability Classification	Classification Limit (D and V in combination)	Limiting Still Water Depth (D)	Limiting Velocity (V)	Description
H1	$D \cdot V \leq 0.3$	0.3	2.0	Generally safe for vehicles, people and buildings.
H2	$D \cdot V \leq 0.6$	0.5	2.0	Unsafe for small vehicles.
H3	$D \cdot V \leq 0.6$	1.2	2.0	Unsafe for vehicles, children, and the elderly.
H4	$D \cdot V \leq 1.0$	2.0	2.0	Unsafe for vehicles and people.
H5	$D \cdot V \leq 4.0$	4.0	4.0	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	$D \cdot V \geq 4.0$	-	-	Unsafe for vehicles and people. All building types considered vulnerable to failure.

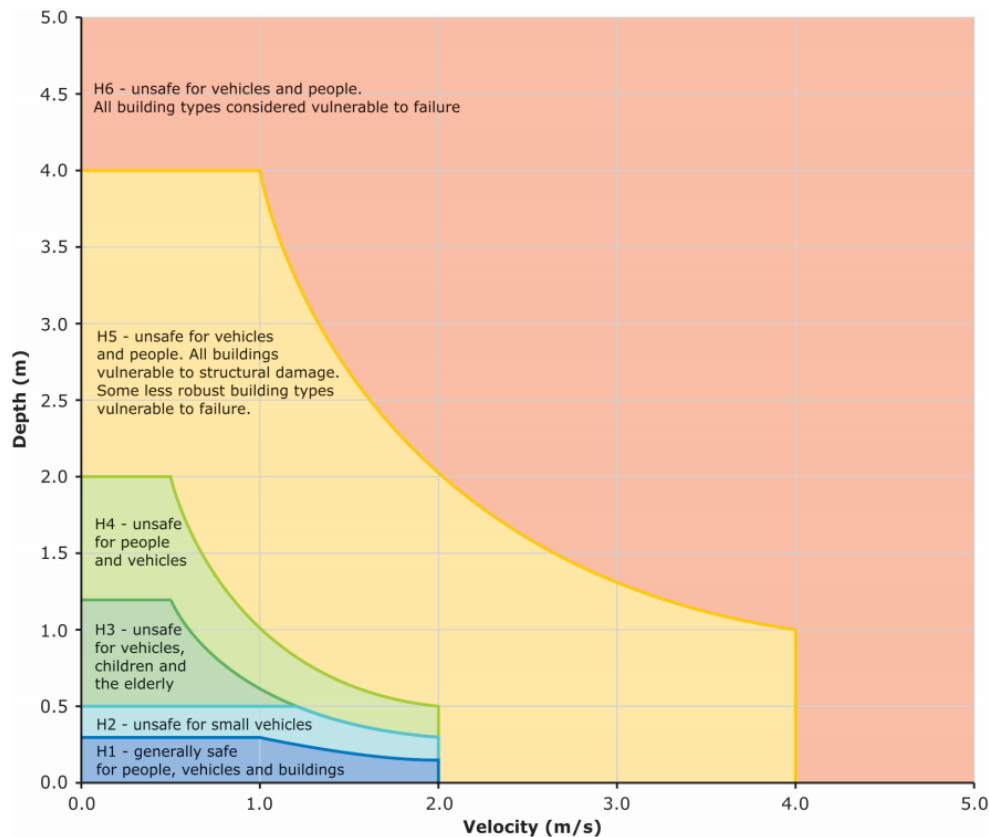


Figure 5.1 Combined Flood Hazard Curves (Smith et al. 2014)

5.3 DESIGN FLOOD EVENTS

The flood modelling results are discussed below. Mapped results are provided in Appendix A. The modelled flood behaviour within the hydraulic model's domain is shown in Figure 4.1. Summary observations about flood behaviour are as follows:

- **10% AEP:** Results show there is generally no widespread flooding within the Project Area, with active flow paths confined within the watercourses and local depressions. General overland flood flow depths outside of the main waterway alignments are typically shallow at less than 0.1 m. The greatest depths within the watercourses within the Project Area are up to 0.8 m.
- **1% AEP:** The general flood inundation extents are increased from the 10% AEP event, with increasing depths and velocities associated with the higher flows.
- **0.5% AEP and 0.2% AEP:** The flood depths are only marginally larger than those of more frequent events, with a median depth of 0.13 m and a peak depth of 1.7 m. Higher AEP events show similar results, indicating the inundation impact of climate change is not anticipated to be a significant issue for the Project.
- **PMF:** The northeastern and southern extent of the Project Area is inundated and flood free access (via highways crossing Murrumbidgee River or Murray River) to the Project area is not possible. The general flood inundation extents have significantly increased from the 0.2% AEP event, with increasing depths predicted throughout the Project Area.

6 POTENTIAL SURFACE WATER IMPACTS AND MITIGATION MEASURES

6.1 FLOOD IMPACTS

The 10 %, 1 %, 0.5 %, 0.2 % AEP and PMF events were assessed to quantify flood depth, velocity, and hazard levels. Modelling has shown the Project Area to be of generally low flood risk.

The access into the Project Area from the east is predicted to be low flood risk. Design of waterway crossings for access points and crossings within the Project Area will be undertaken at the detailed design phase. Waterway crossings are to be designed in consideration of requirements of *Guidelines for Controlled Activities on Waterfront Land*, to reduce construction impacts to the riparian corridors of watercourses within the Project Area.

The results of the 1% AEP flood hazard assessment have identified that the Project Area is classified as generally safe (H1). Isolated pockets of H2 and H3 hazard exist where water accumulates. The peak modelled velocities were notably low due to the flat topography. Peak stormwater discharges from the Project Area for impervious areas may increase slightly through the creation of compacted gravel roads and some small operational buildings. However, potential impacts to drainage features and downstream watercourses will be negligible due to the relative size of the Project Area in relation to the size of the receiving catchments, and the distributed nature of minor impacts. The total new impervious area for the Project is estimated to be of the order of 1 ha within the entire extent of the Project Area, comprising:

- 96 wind turbine foundations,
- Footings for overhead transmission lines, substations and switchyards,
- Roof areas relating to BESS, substations, operation and maintenance buildings, and,
- Access and hardstand area.

This total impervious area represents less than 0.1% of the total Project Area. Drainage from these impervious areas will not be directly connected, providing opportunity for distribution and infiltration of stormwater between the impervious area and receiving waterway. Consequently, the hydrologic impacts of the Project at the catchment scale are likely to be undetectable.

Minimal changes to the land topography, impervious fraction and therefore runoff and groundwater infiltration are expected due to the nature and extent of proposed infrastructure. Implementation of the proposed management and mitigation measures outlined in Section 6.3 will ensure negligible residual impacts on surface water.

Access tracks and cable reticulation are the only works proposed within the watercourses and no other artificial structures are planned to be installed in the creeks within the Project Area. Where waterway crossings (i.e., culvert crossings or causeways) are required, these would be designed and constructed in compliance with the *Guidelines for Controlled Activities on Waterfront Land*.

6.2 IMPACTS ON WATER SUPPLY

Water required for the Project will likely be sourced from:

- Existing Balranald Shire Council standpipe(s) (preferred)
- Farm dams and existing groundwater bore within the Project Area.
- Extraction from Edward River

The maximum water demand will be during construction phase. The bulk of water will be supplied from commercial suppliers in the nearby region (via water trucks) and potentially farm dams located

within the Project Area. A similar volume of water is likely to be required during the decommissioning phase.

As surface water or groundwater used by the Project will be obtained from licensed sources under agreement with landholders and in accordance with the relevant water source water sharing plan, no impacts to surface water or groundwater availability in the vicinity of the Project are anticipated.

Loss of catchment yield associated with containment of runoff from disturbed areas is expected to be negligible and will be temporary during the construction and decommissioning phases. As such, impacts on surface water availability to downstream water users are expected to be negligible.

6.3 MITIGATION MEASURES

Table 6.1 lists the principal management measures required to manage the potential surface water impacts that are considered likely for the Project. For the operational phase of the Project, the measures outlined are to be documented in the Emergency Response Plan (ERP) and in the Operational Environmental Management Plan (OEMP). These documents will be developed for the Project's operational phase. The OEMP will address potentially adverse impacts resulting from flooding during the operational phase. The ERP will include and outline the flood hazards, evacuation and warning procedures to ensure the safety of all onsite.

Table 6.1 Mitigation Measures

Potential Risk	Proposed Management and Mitigation Measure
Flood risk to project personnel	- Develop an ERP in accordance with https://www.environment.nsw.gov.au/topics/water/floodplains/floodplain-guidelines - The ERP is to include consideration of emergency site access/egress specifically under flood conditions, noting the western site access may not be trafficable in certain flood conditions. - Flood emergency management procedures and training should be provided for staff and management working at the facility. A formalised induction will also be required for new members. Annual testing (e.g., drills) of ERP procedures, including annual review and update. - Operations staff will have access to the following facilities for early severe weather warnings: The Bureau of Meteorology's "MetEye" and The Bureau of Meteorology's "RSS feeds". Radio and Bureau of Meteorology information will be reviewed frequently for potential major weather events. Facility members and visitors can be notified of potential flooding, road and facility closure. - If sheltering in place is the selected response action stocking of food and medications is undertaken by occupants according to the maximum possible duration of isolation - Evacuation routes will be designed during the detailed design phase and will take into account zones of flood hazard. The Project Area is free from regional riverine flooding from the Murrumbidgee and Murray Rivers, and flood risks are from flash flooding of the local creeks.
Flood risk impacting project infrastructure	- In the event of flooding, infrastructure located anywhere within the Project Area, such as inverters and battery storage, will be located with a minimum 300 mm freeboard above the maximum 1% AEP flood level. Given the shallow depths across the Project Area, the minor raising of a sensitive location within the Project with a small fill pads is unlikely to result in any adverse impacts offsite. - Foundations for the wind turbines and transmission lines will be located away from areas that exceed both flood depths of 0.3 m and flow velocities greater than 1.5 m/s. For the concept design considered in the EIS, no wind turbine foundations or overhead

Potential Risk	Proposed Management and Mitigation Measure
	transmission line routes fall within this category. Detailed design of the Project will consider the results of the flood models, in particular the 1% AEP scenario. • Subject to engineering constraints, no sensitive infrastructure (e.g., substation, BESS) will be placed within 20 m of any Strahler 3 or above order streams. Sensitive infrastructure will be placed outside the 0.2% AEP flood extent with a minimum 300mm freeboard to the 1% AEP flood level.
Flood risk adversely impacted by project infrastructure	• Maintaining the natural state of the drainage flow paths whenever possible. Internal access roads, where crossing watercourses, should be designed for 10% AEP design flow and could include compacted rock causeways to provide low maintenance access with limited impact on the waterway or culvert structures. • Controls for receiving waterways which may include designation of ‘no go’ zones for construction plant and equipment.
Water supply	• A water sourcing and monitoring strategy to manage potential availability impacts on downstream water users and ensure compliance with legislation relating to water extraction.

7 CONCLUSIONS

This study has assessed the flood behaviour within the Project Area. The existing conditions flood modelling was undertaken to provide an estimate of flood risk due to the current climate to guide the planning of infrastructure placement.

This document provides an assessment of existing flood behaviour and impacts relating to the Project in accordance with the SEARs and agency advice. Existing conditions flood modelling was undertaken for a range of events; 10%, 1%, 0.5%, and 0.2% AEP flood events and PMF for the Project Area to guide the planning of infrastructure and assess any external impacts.

The flood impact assessment has been conducted in accordance with the Australian Rainfall and Runoff 2019 guidelines. Refer to mapping provided within Appendix A. The modelling indicates that the Project is not likely to cause any significant external impacts in terms of water surface levels and peak discharges and accordingly no substantial mitigation measures such as detention basins are required.

Flood risk to proposed infrastructure should be assessed in the design phase, with infrastructure located with due consideration of flood risk and consequences. This would ideally occur once surface water drainage configuration is defined by the civil design work. This would also allow for consideration of erosion and sediment control devices. Conveyance of flow is hindered due to the flat nature of the site and so making adequate allowance site drainage away from critical infrastructure such as battery energy storage systems, switch gear and substation is necessary. Further, the flat nature of the Project Area is likely to see higher than usual infiltration of standing water. Buried electrical infrastructure should allow for wet conditions that maybe sustained while water infiltrates into deeper stores.

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9 ABBREVIATIONS AND DEFINITIONS

Term/Abbreviation	Definition																																																																																																								
AEP (Annual Exceedance Probability)	Annual Exceedance Probability. The change of a flood of a given or large size occurring in any one year, usually expressed as a percentage. In this study AEP has been used consistently to define the probability of occurrence of flooding. The following relationships between AEP and ARI applies to this study (ARR, 2019).																																																																																																								
	<table><tr><th>Frequency Descriptor</th><th>EY</th><th>AEP (%)</th><th>AEP (1 in x)</th><th>ARI</th></tr><tr><td rowspan="6">Very frequent</td><td>12</td><td></td><td></td><td></td></tr><tr><td>6</td><td>99.75</td><td>1.002</td><td>0.17</td></tr><tr><td>4</td><td>98.17</td><td>1.02</td><td>0.25</td></tr><tr><td>3</td><td>95.02</td><td>1.05</td><td>0.33</td></tr><tr><td>2</td><td>86.47</td><td>1.16</td><td>0.50</td></tr><tr><td>1</td><td>63.2</td><td>1.58</td><td>1.00</td></tr><tr><td rowspan="5">Frequent</td><td>0.69</td><td>50.00</td><td>2</td><td>1.44</td></tr><tr><td>0.5</td><td>39.35</td><td>2.54</td><td>2.00</td></tr><tr><td>0.22</td><td>20.00</td><td>5</td><td>4.48</td></tr><tr><td>0.2</td><td>18.13</td><td>5.52</td><td>5.00</td></tr><tr><td>0.11</td><td>10.00</td><td>10.00</td><td>9.49</td></tr><tr><td rowspan="4">Infrequent</td><td>0.05</td><td>5.00</td><td>20</td><td>20.0</td></tr><tr><td>0.02</td><td>2.00</td><td>50</td><td>50.0</td></tr><tr><td>0.01</td><td>1.00</td><td>100</td><td>100</td></tr><tr><td rowspan="5">Rare</td><td>0.005</td><td>0.50</td><td>200</td><td>200</td></tr><tr><td>0.002</td><td>0.20</td><td>500</td><td>500</td></tr><tr><td>0.001</td><td>0.10</td><td>1000</td><td>1000</td></tr><tr><td>0.0005</td><td>0.05</td><td>2000</td><td>2000</td></tr><tr><td rowspan="5">Extremely Rare</td><td>0.0002</td><td>0.02</td><td>5000</td><td>5000</td></tr><tr><td></td><td></td><td rowspan="4"></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td>Extreme</td><td></td><td></td><td>PMP</td><td></td></tr></table>	Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI	Very frequent	12				6	99.75	1.002	0.17	4	98.17	1.02	0.25	3	95.02	1.05	0.33	2	86.47	1.16	0.50	1	63.2	1.58	1.00	Frequent	0.69	50.00	2	1.44	0.5	39.35	2.54	2.00	0.22	20.00	5	4.48	0.2	18.13	5.52	5.00	0.11	10.00	10.00	9.49	Infrequent	0.05	5.00	20	20.0	0.02	2.00	50	50.0	0.01	1.00	100	100	Rare	0.005	0.50	200	200	0.002	0.20	500	500	0.001	0.10	1000	1000	0.0005	0.05	2000	2000	Extremely Rare	0.0002	0.02	5000	5000														Extreme			PMP	
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AHD	Australian Height Datum. A common national surface level datum approximately corresponding to mean sea level.																																																																																																								
ARR	Australian Rainfall and Runoff. Guidelines prepared by the Institute of Engineers Australia for the estimation of design floods.																																																																																																								
BESS	Battery Energy Storage System.																																																																																																								
Development footprint	The maximum extent of ground disturbance associated with the construction and operation of the Project.																																																																																																								
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m³/s). Discharge is different from speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).																																																																																																								
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.																																																																																																								

Term/Abbreviation	Definition
Flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below: - Existing flood risk: the risk a community is exposed to as a result of its location on the floodplain. - Future flood risk: the risk a community may be exposed to as a result of new development on the floodplain. - Continuing flood risk: the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
Flood storage areas	Those parts of the floodplain that are important for the temporary storage of floodwaters during passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is flood prone land.
GW	Gigawatt.
Hazard	A source of potential harm or situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community.
Hydrology	The study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
kL	Kilolitre, one thousand litres.
km	Kilometres.
kV	Kilovolt.
m AHD	Metres Australian Height Datum (AHD).
m/s	Metres per second. Unit used to describe the velocity of floodwaters.
m ³ /s	Cubic metres per second or “cumeecs”. A unit of measurement of creek or river flows or discharges. It is the rate of flow of water measured in terms of volume per unit time.
ML	Megalitre, one million litres.
MW	Megawatt.
PMF (Probable maximum flood)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide

Term/Abbreviation	Definition
	complete protection against this event. The probable maximum flood defines the extent of flood prone land, that is, the floodplain.
Project Area	The total area in which the Project would be developed. The Project Area covers approximately 708 ha.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual, it is the likelihood of consequences arising from the interaction of floods, communities, and the environment.
Runoff	The amount of rainfall which ends up as a streamflow, also known as rainfall excess.
Scour	Erosion by mechanical action of water, typically of soil.
Sensitive receiver	Non-involved dwellings in proximity to the Project Area that may be sensitive to noise, visual, traffic and other impacts. Potential impacts to sensitive receivers are investigated in the EIS.
TUFLOW	TUFLOW is a computer program which is used to simulate free-surface flow for flood and tidal wave propagation. It provides coupled 1D and 2D hydraulic solutions using a powerful and robust computation. The engine has seamless interfacing with GIS and is widely used across Australia.

APPENDIX A A3 FLOOD MAPS

A.1 MODELLED PEAK DEPTHS

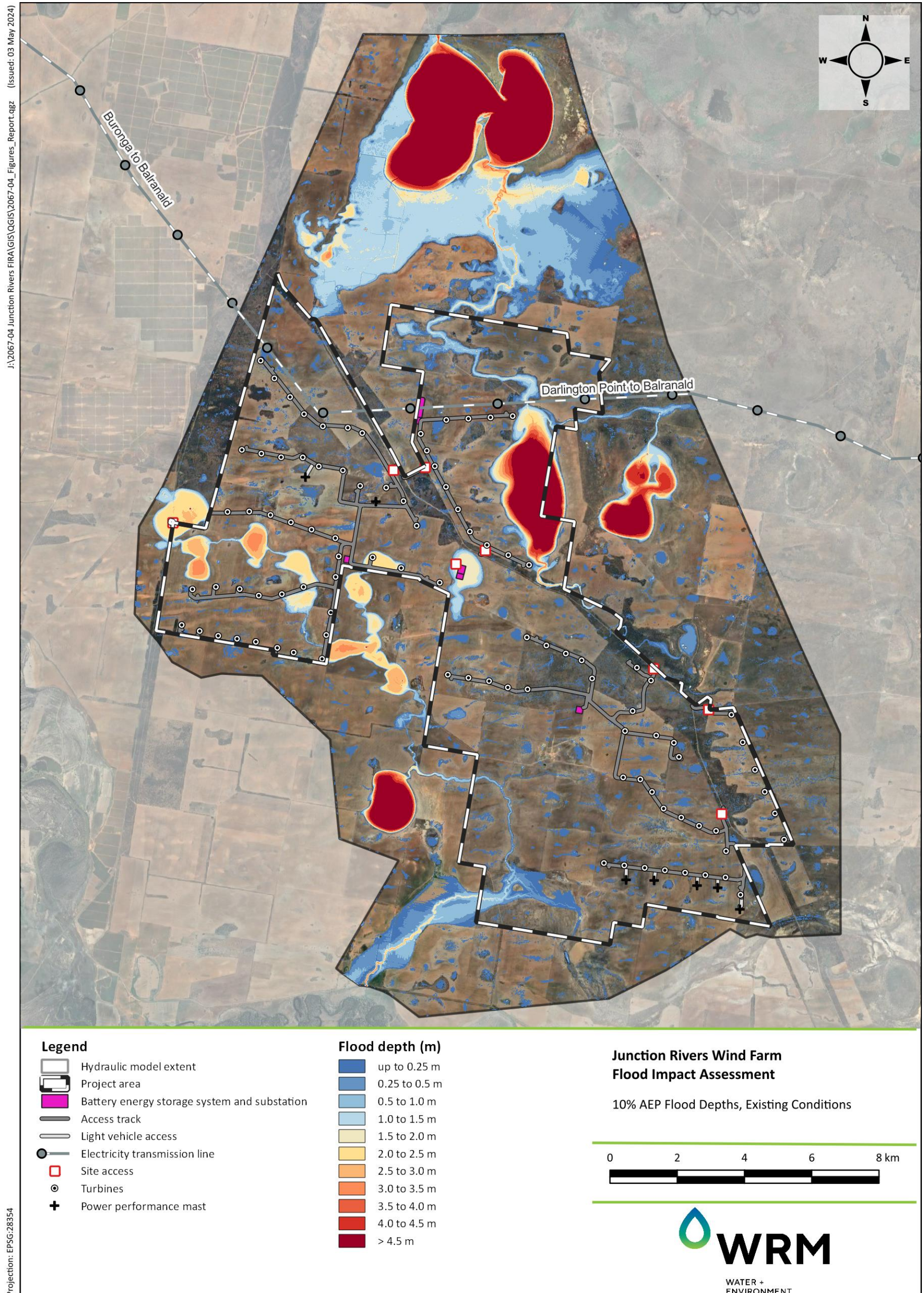


Figure A.1 10% AEP peak flood depths, existing conditions

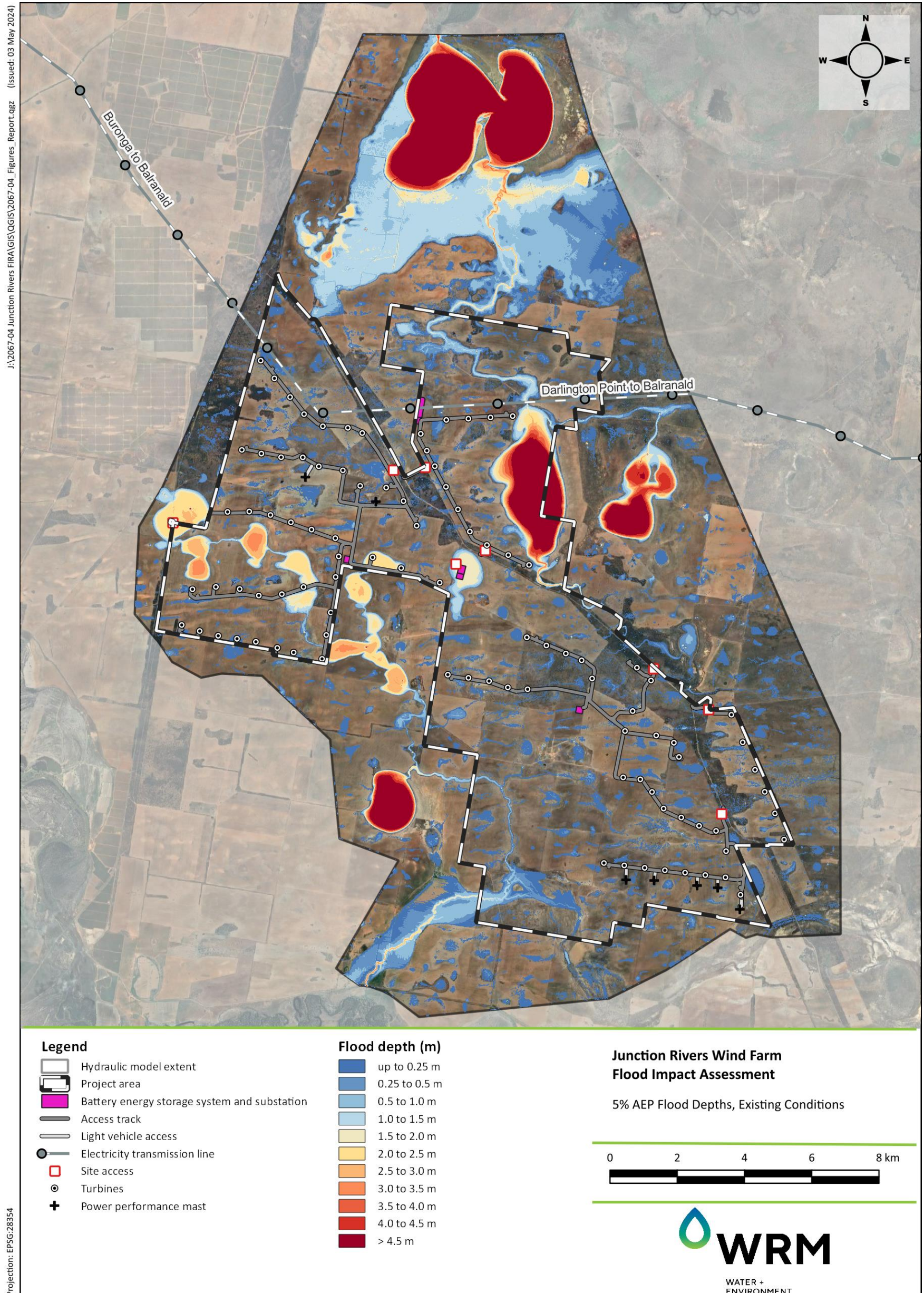


Figure A.2 5% AEP peak flood depths, existing conditions

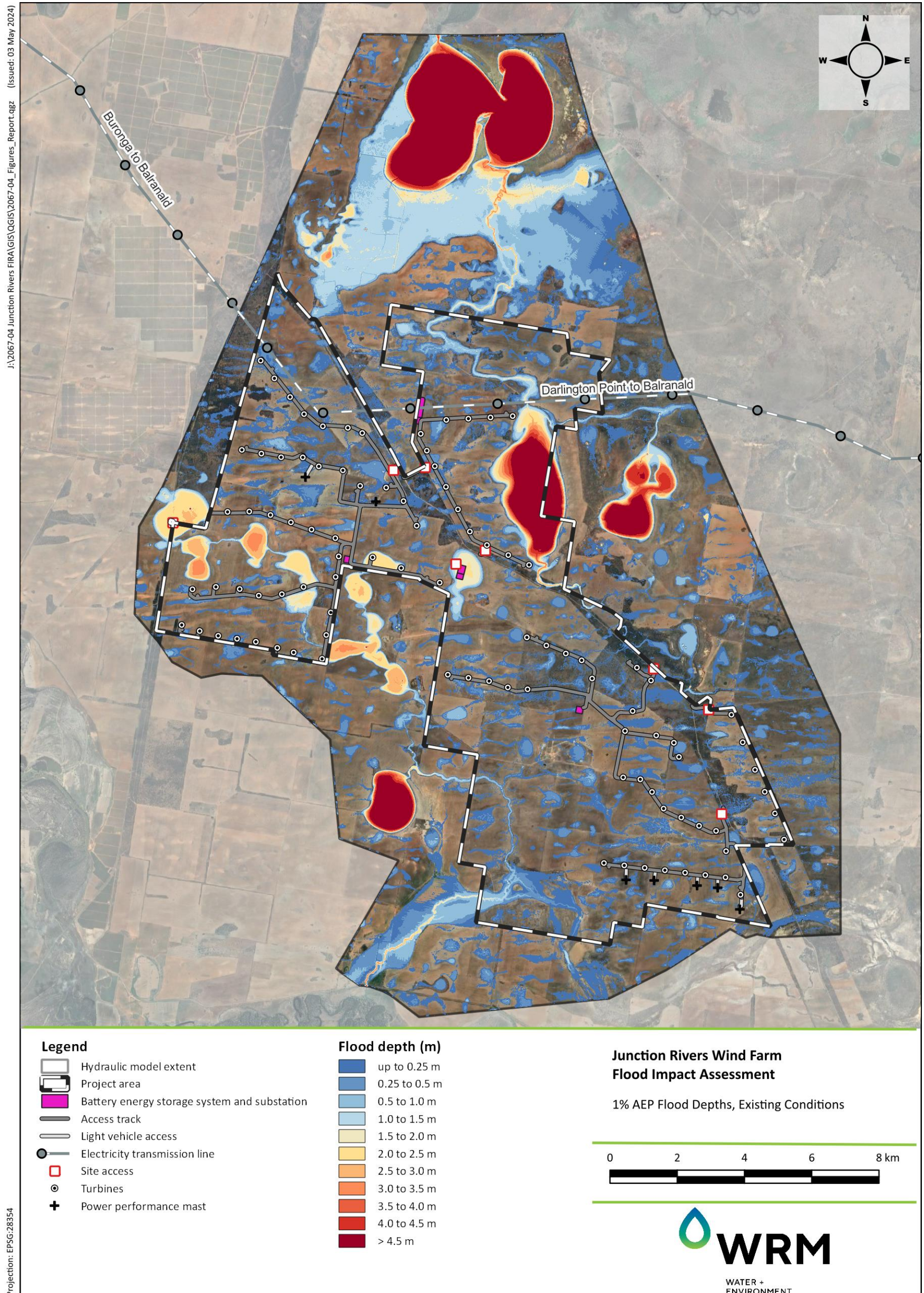


Figure A.3 1% AEP peak flood depths, existing conditions

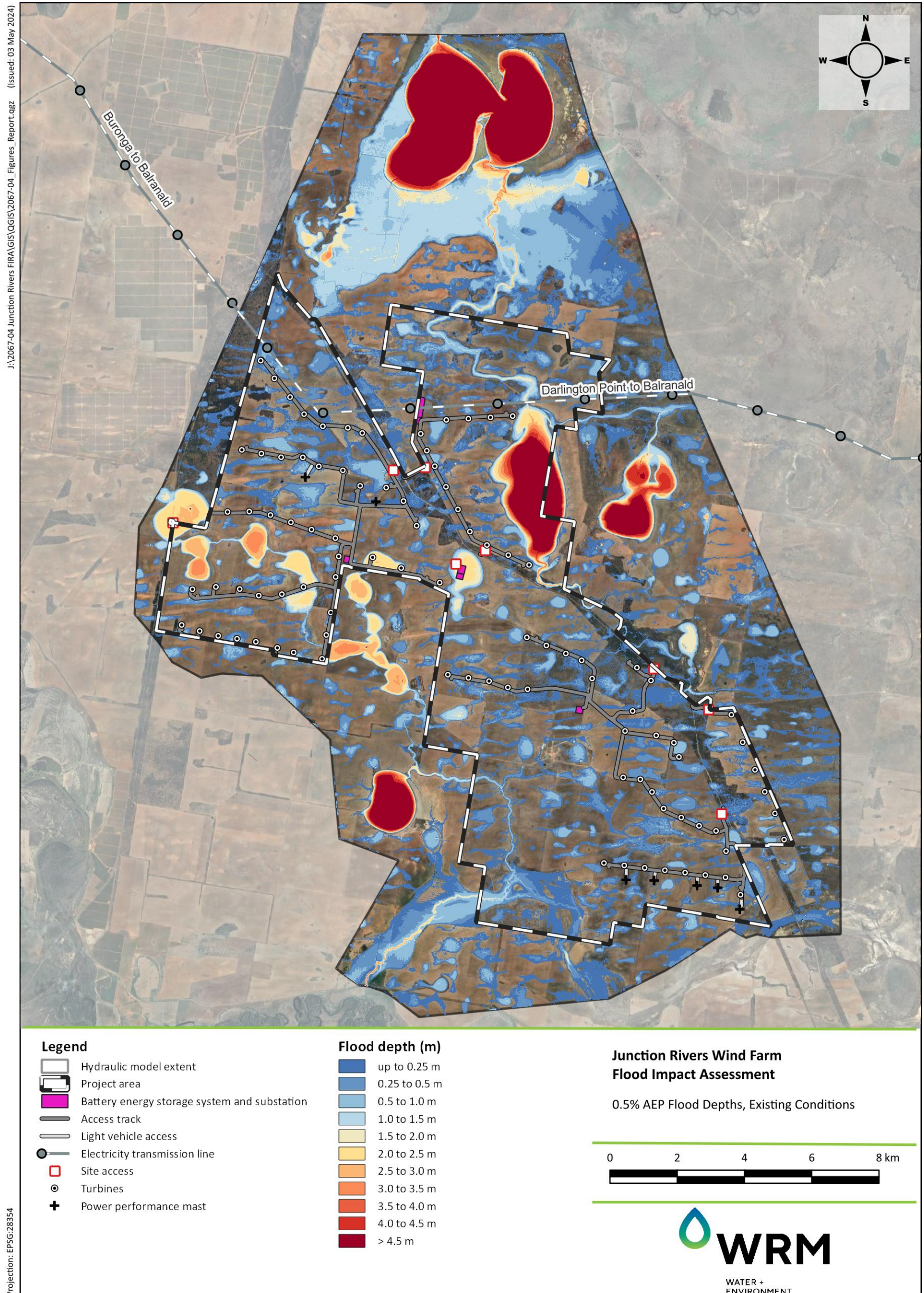


Figure A.4 0.5% AEP peak flood depths, existing conditions

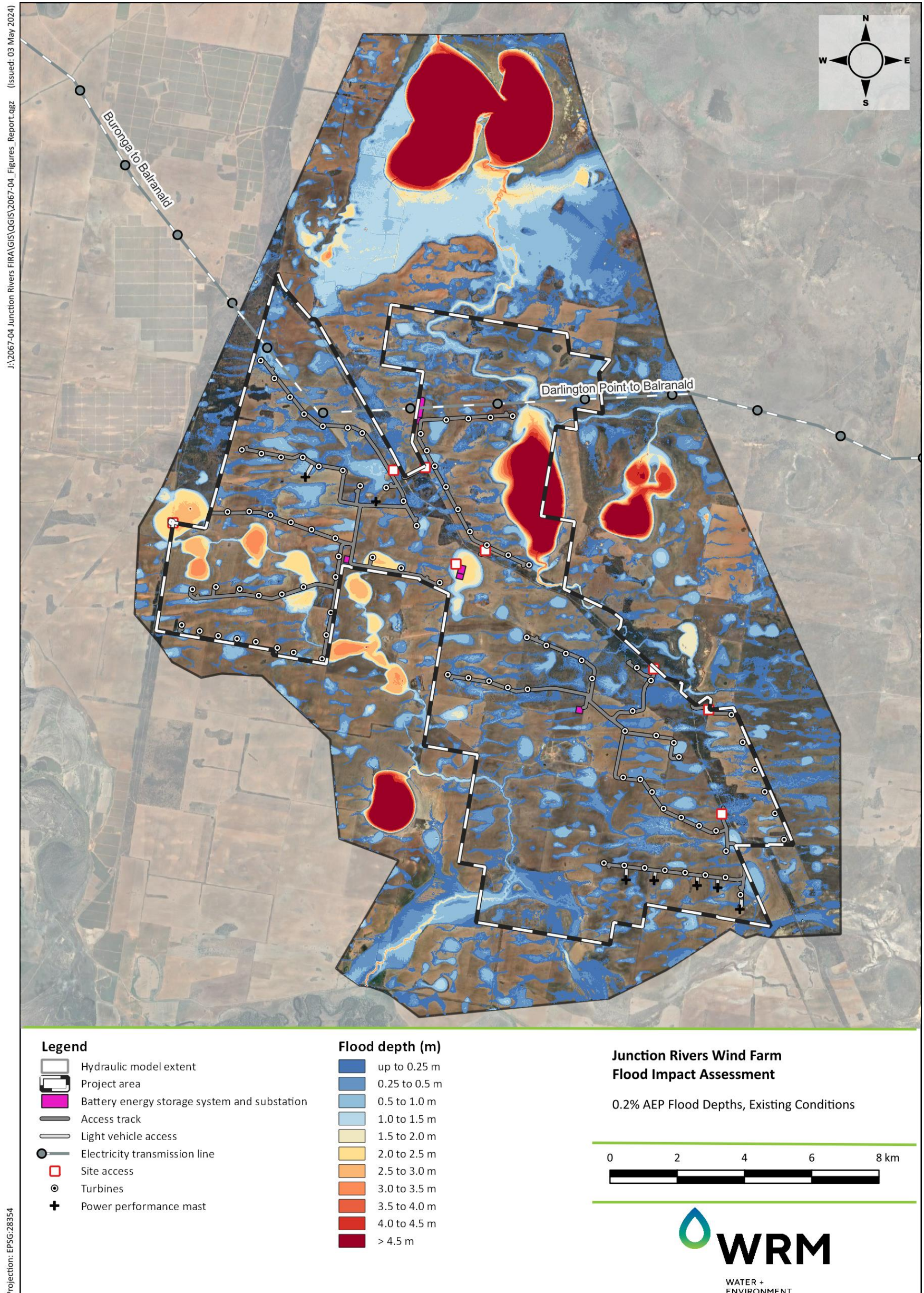


Figure A.5 0.2% AEP peak flood depths, existing conditions

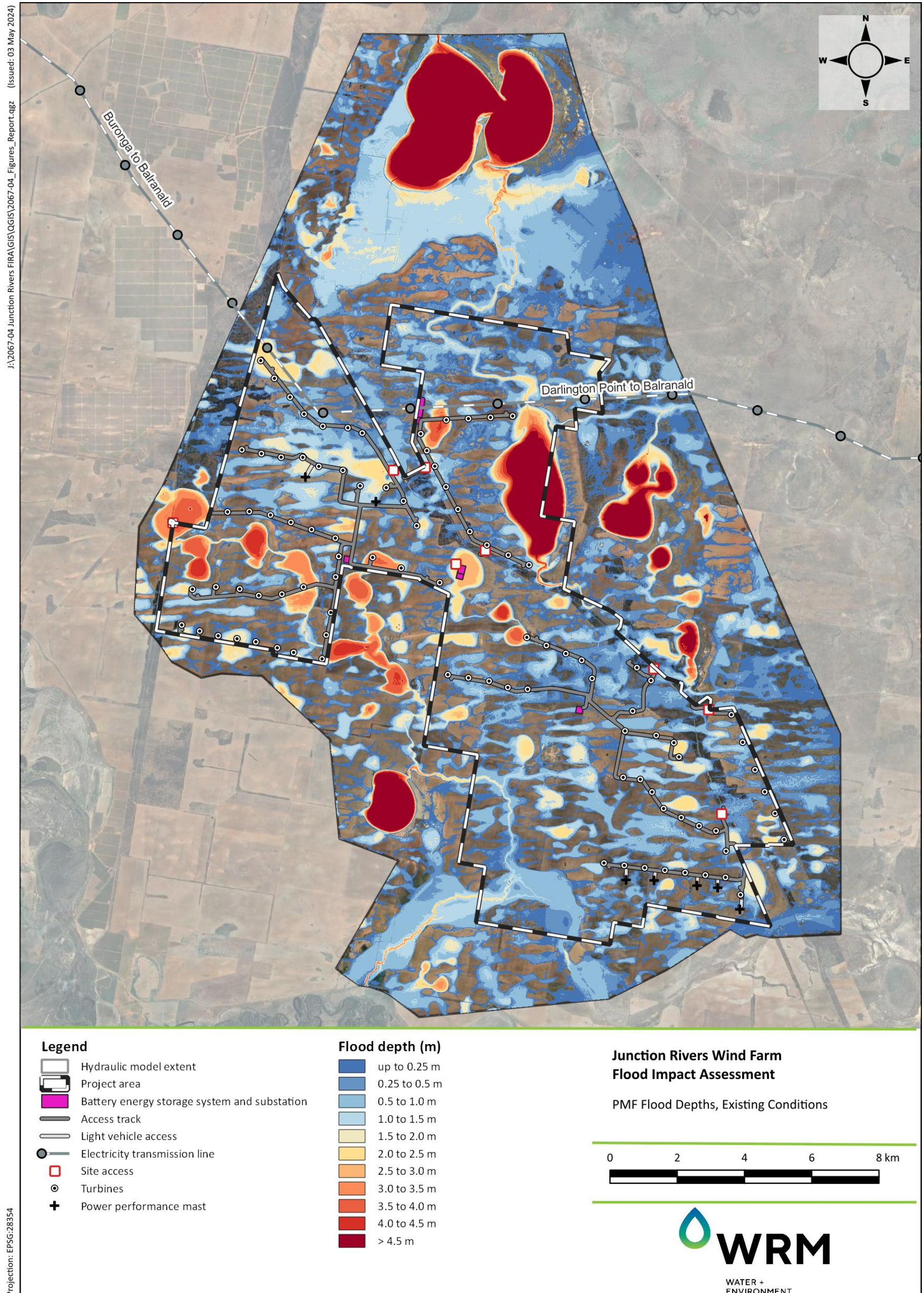


Figure A.6 PMF peak flood depths, existing conditions

A.2 MODELLED PEAK VELOCITIES

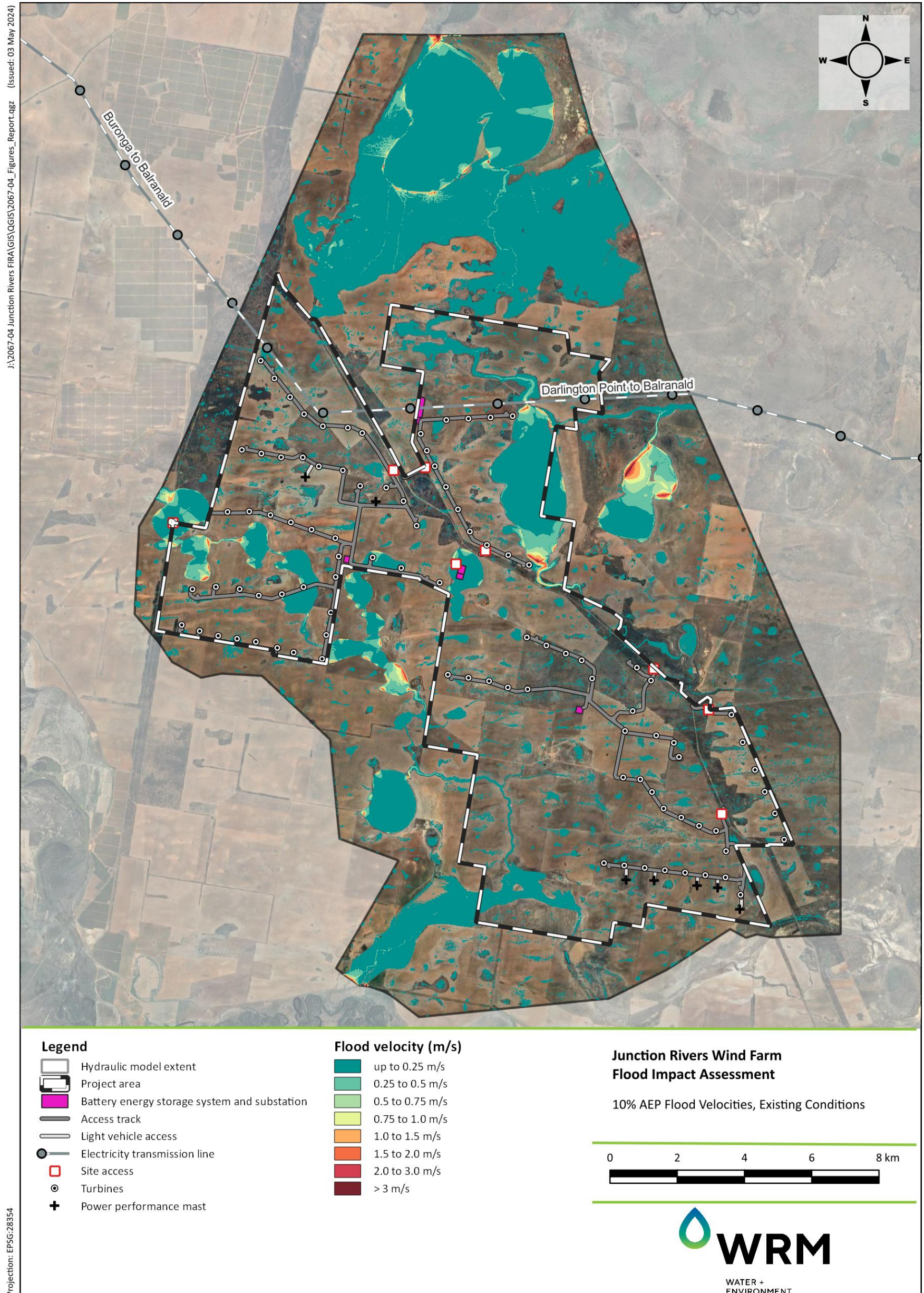


Figure A.7 10% AEP peak flood velocities, existing conditions

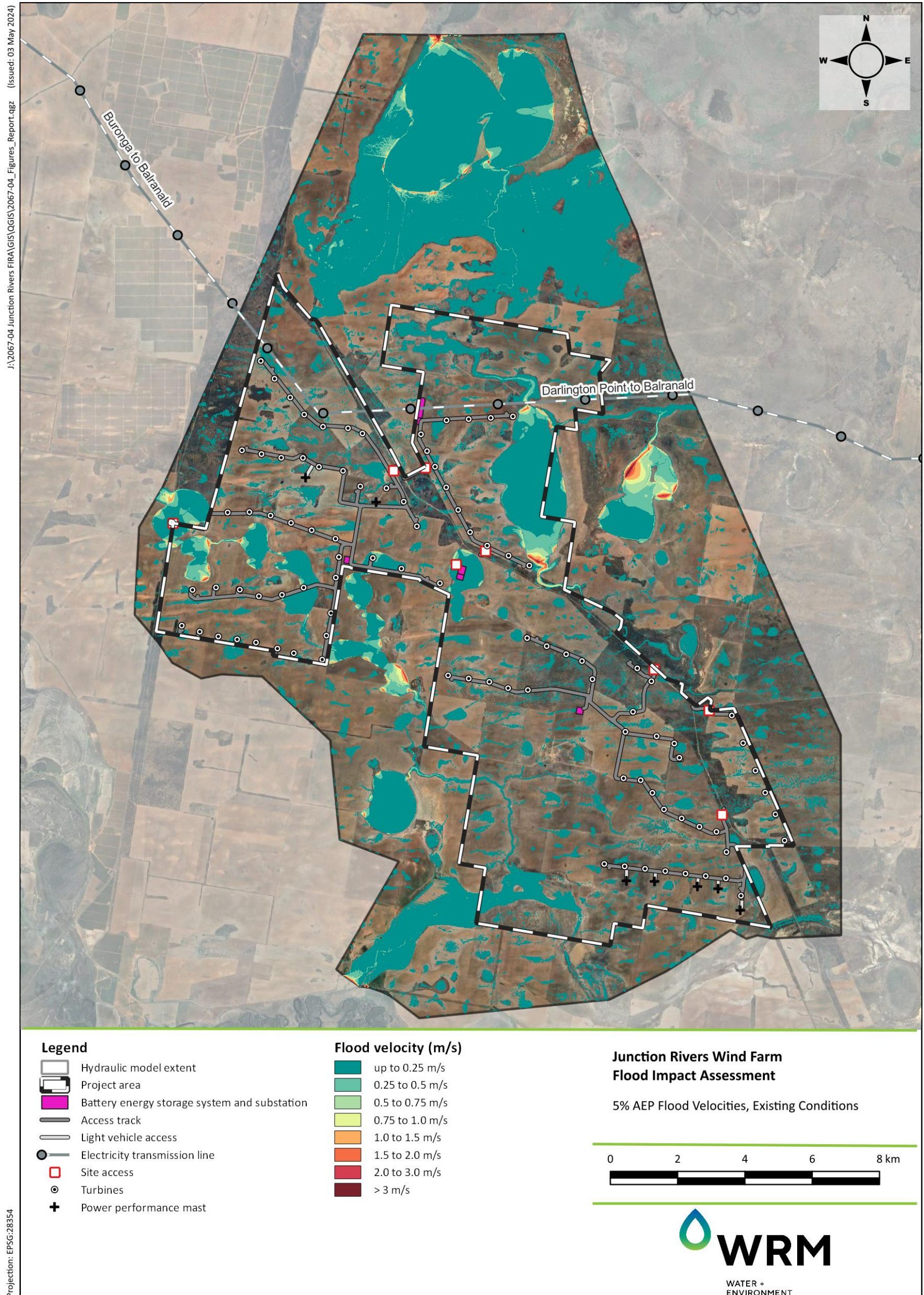


Figure A.8 5% AEP peak flood velocities, existing conditions

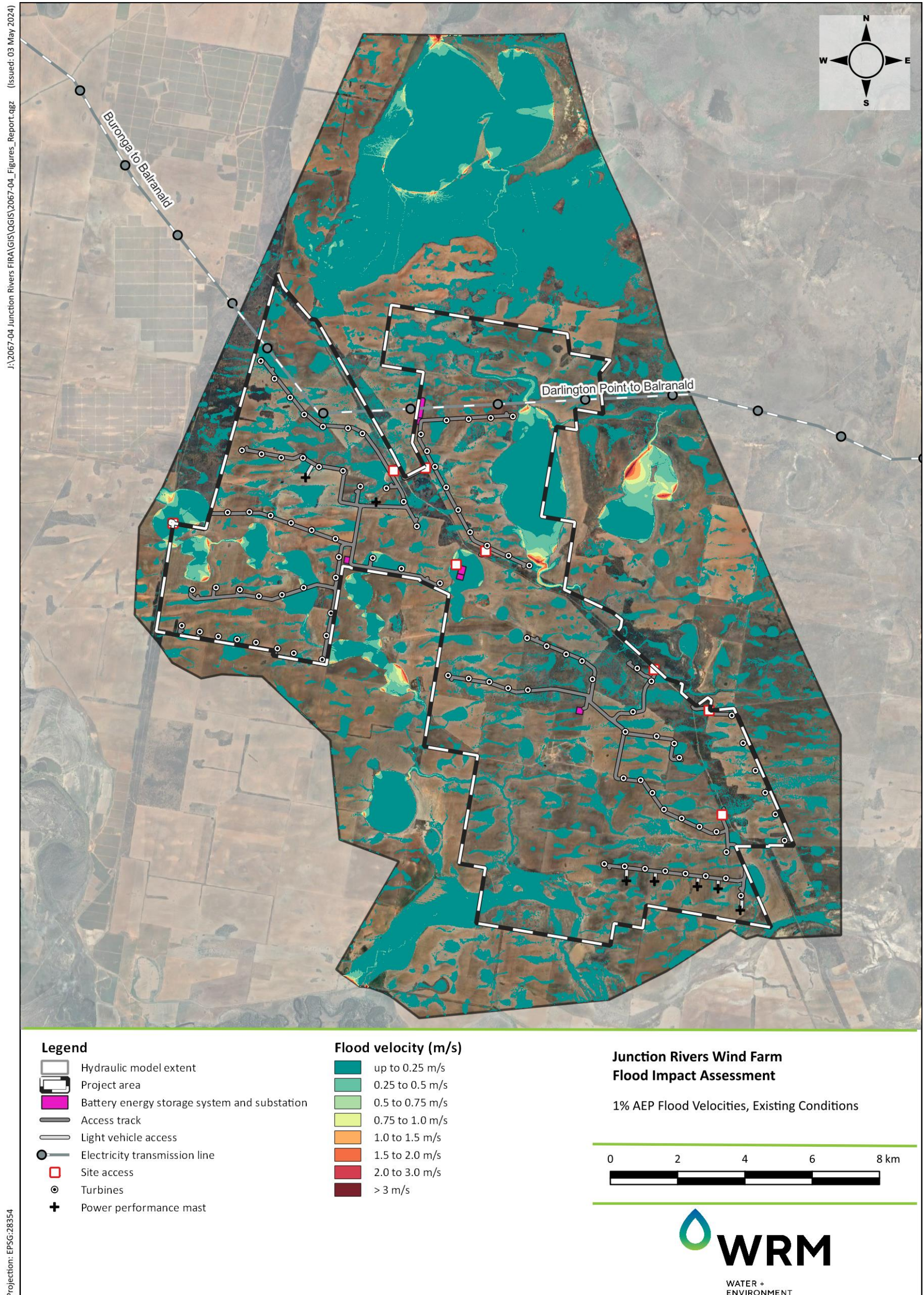


Figure A.9 1% AEP peak flood velocities, existing conditions

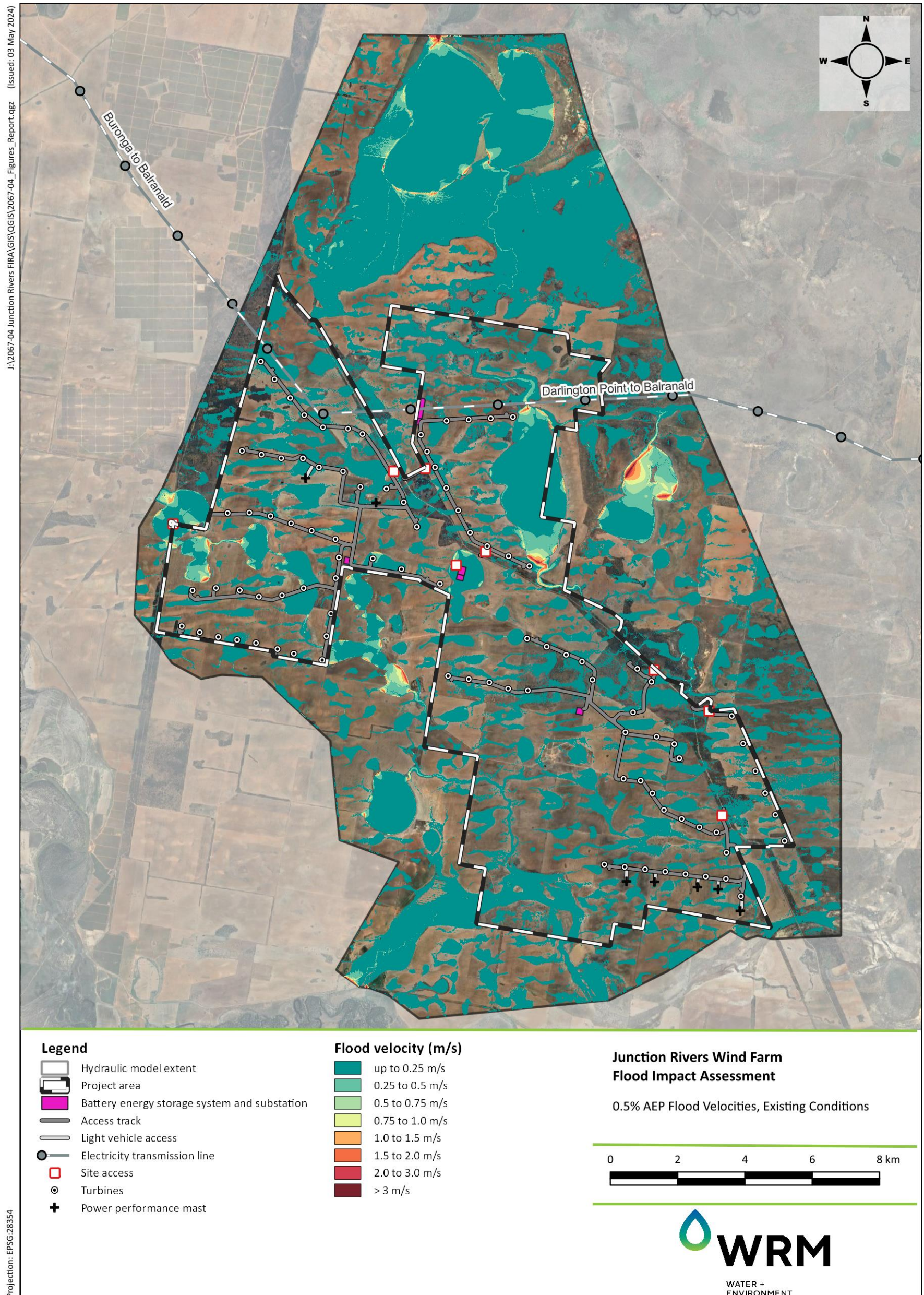


Figure A.10 0.5% AEP peak flood velocities, existing conditions

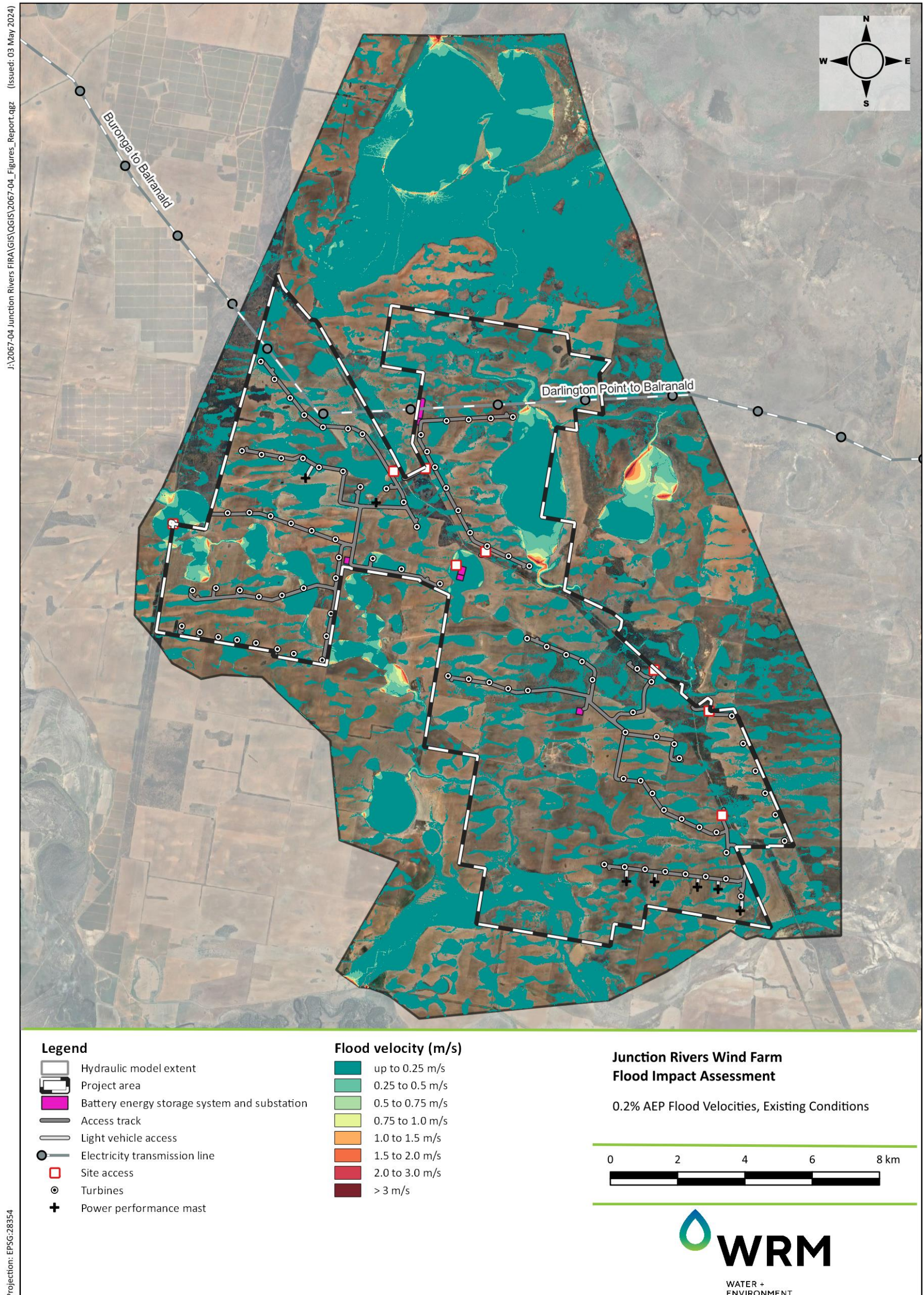


Figure A.11 0.2% AEP peak flood velocities, existing conditions

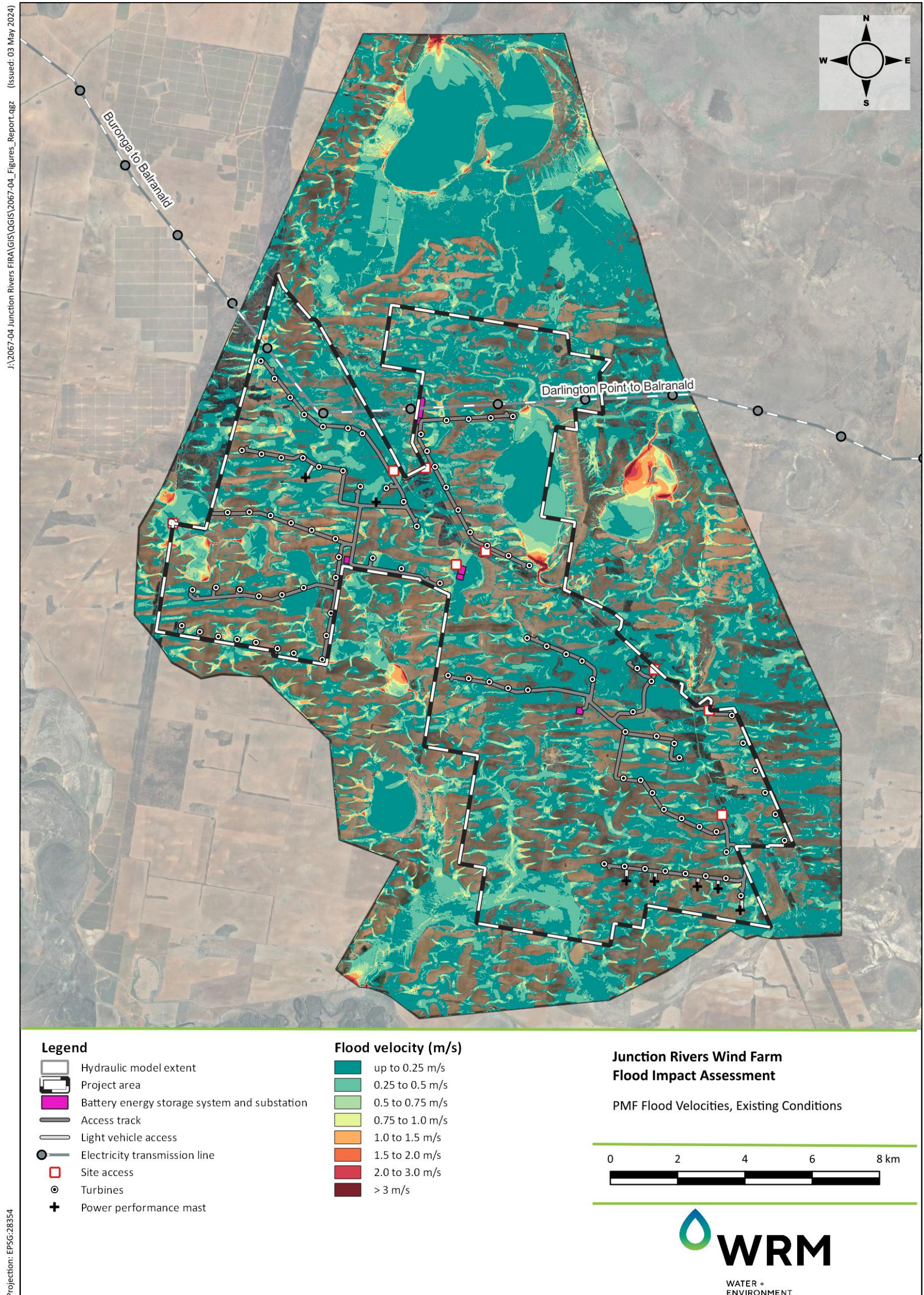


Figure A.12 PMF peak flood velocities, existing conditions

A.3 MODELLED FLOOD HAZARD

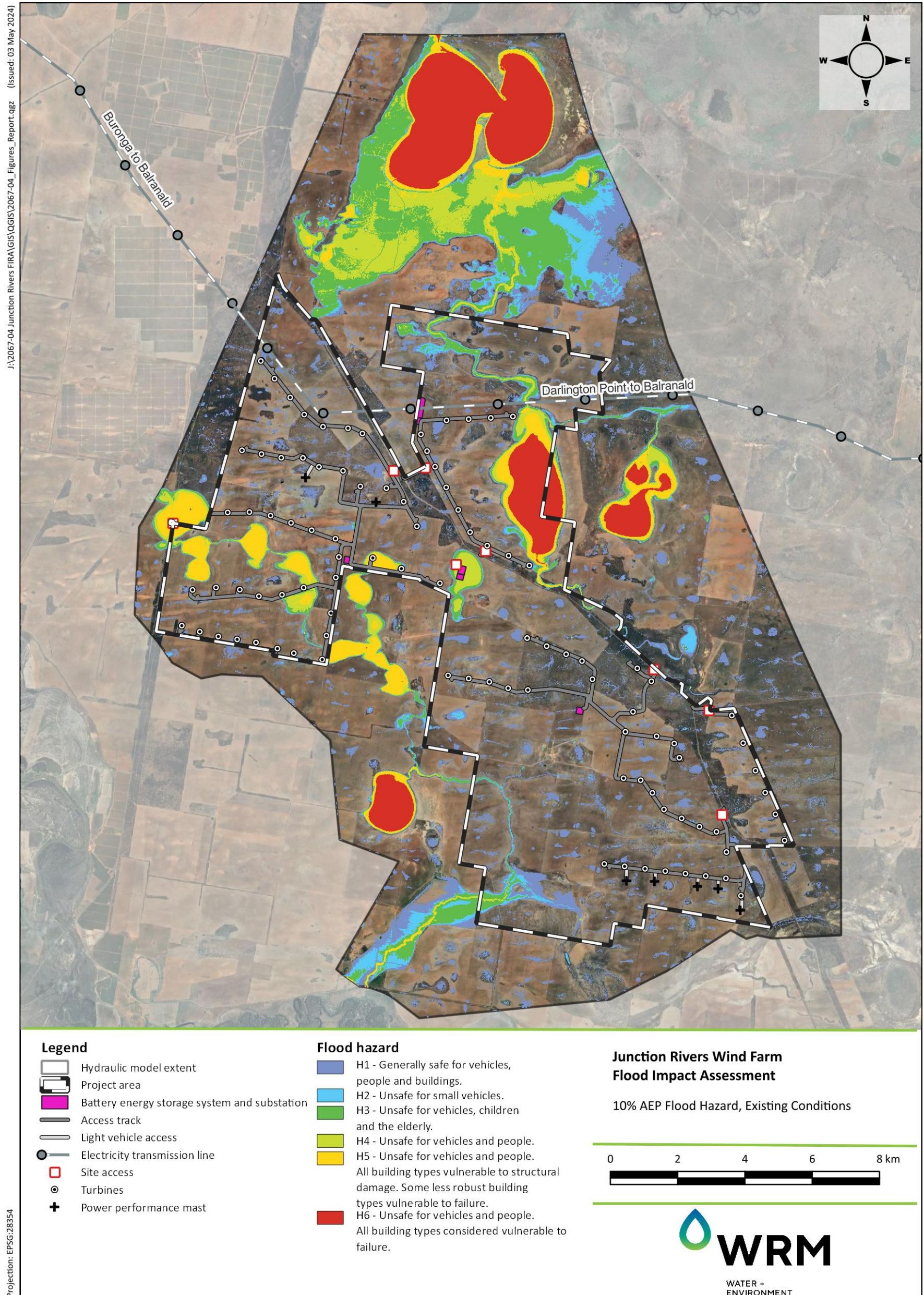


Figure A.13 10% AEP flood hazard, existing conditions

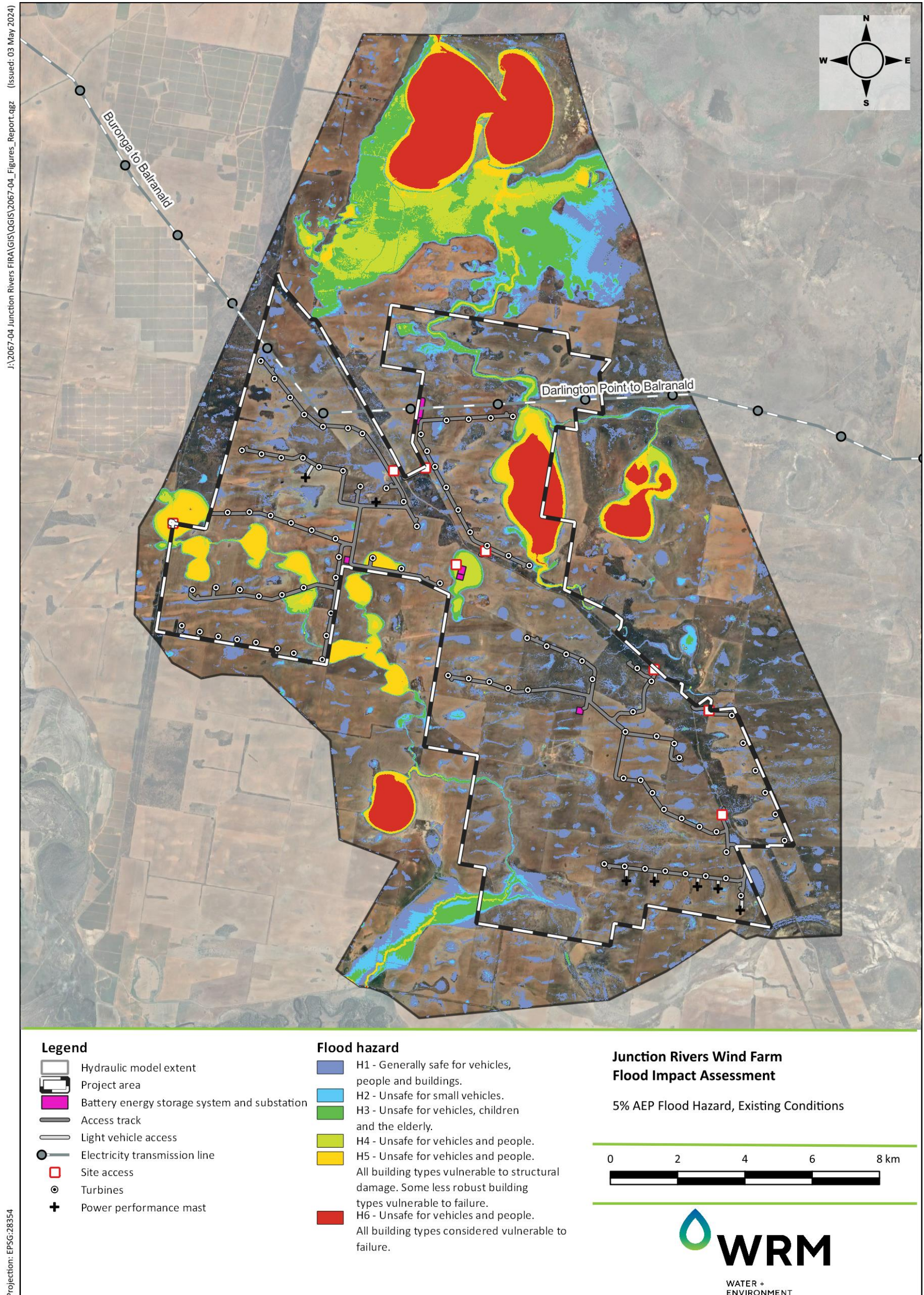


Figure A.14 5% AEP flood hazard, existing conditions

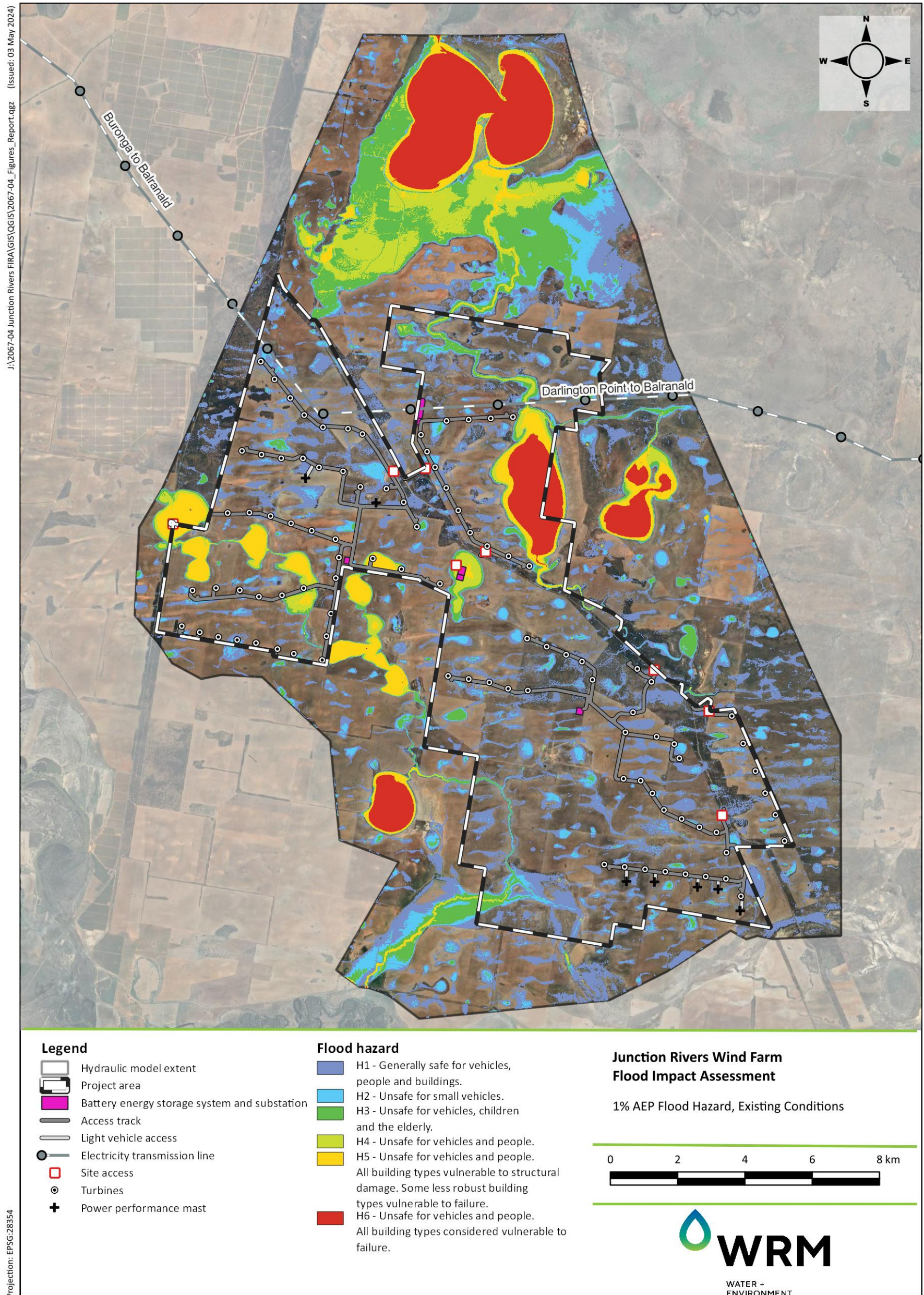


Figure A.15 1% AEP flood hazard, existing conditions

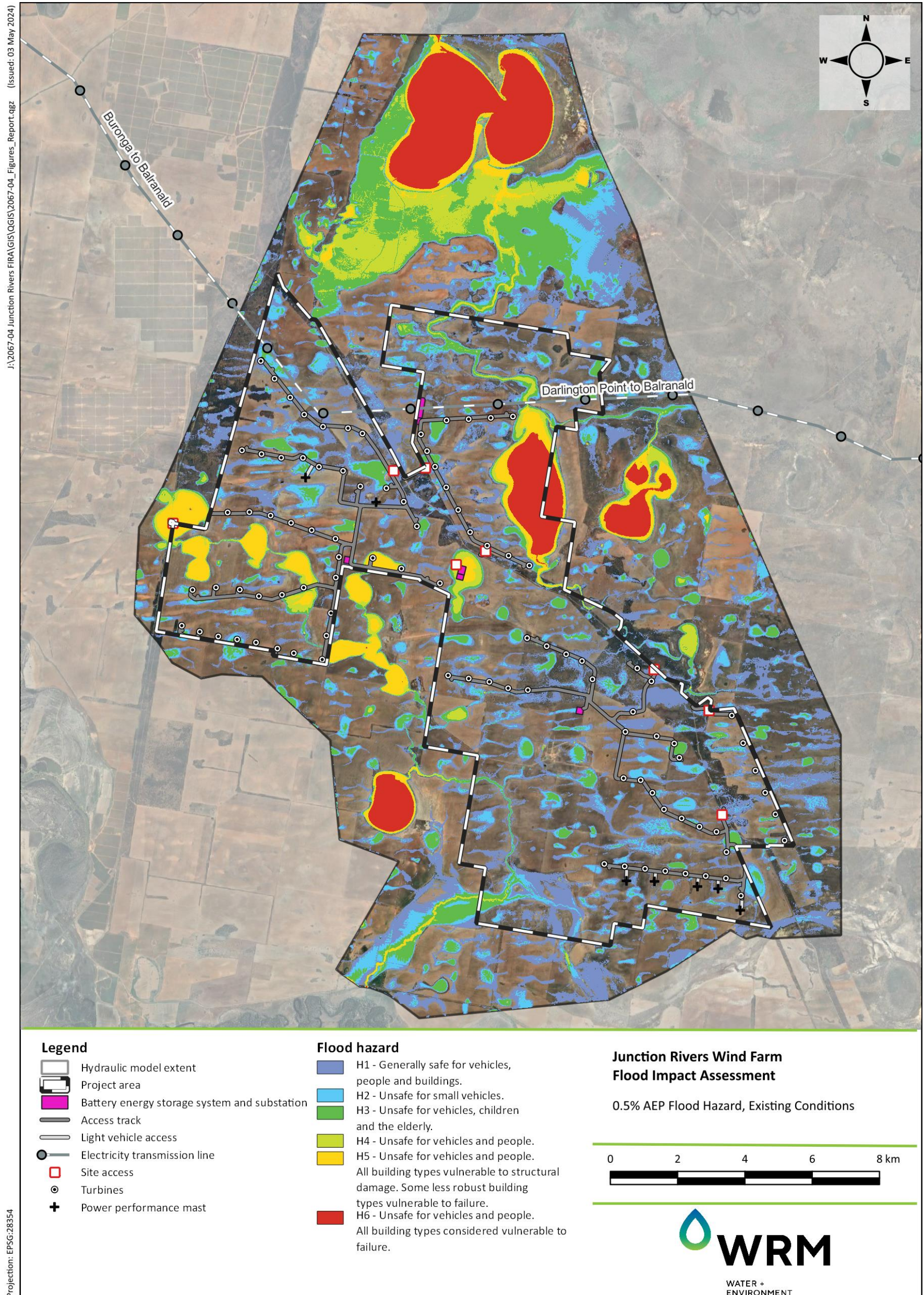


Figure A.16 0.5% AEP flood hazard, existing conditions

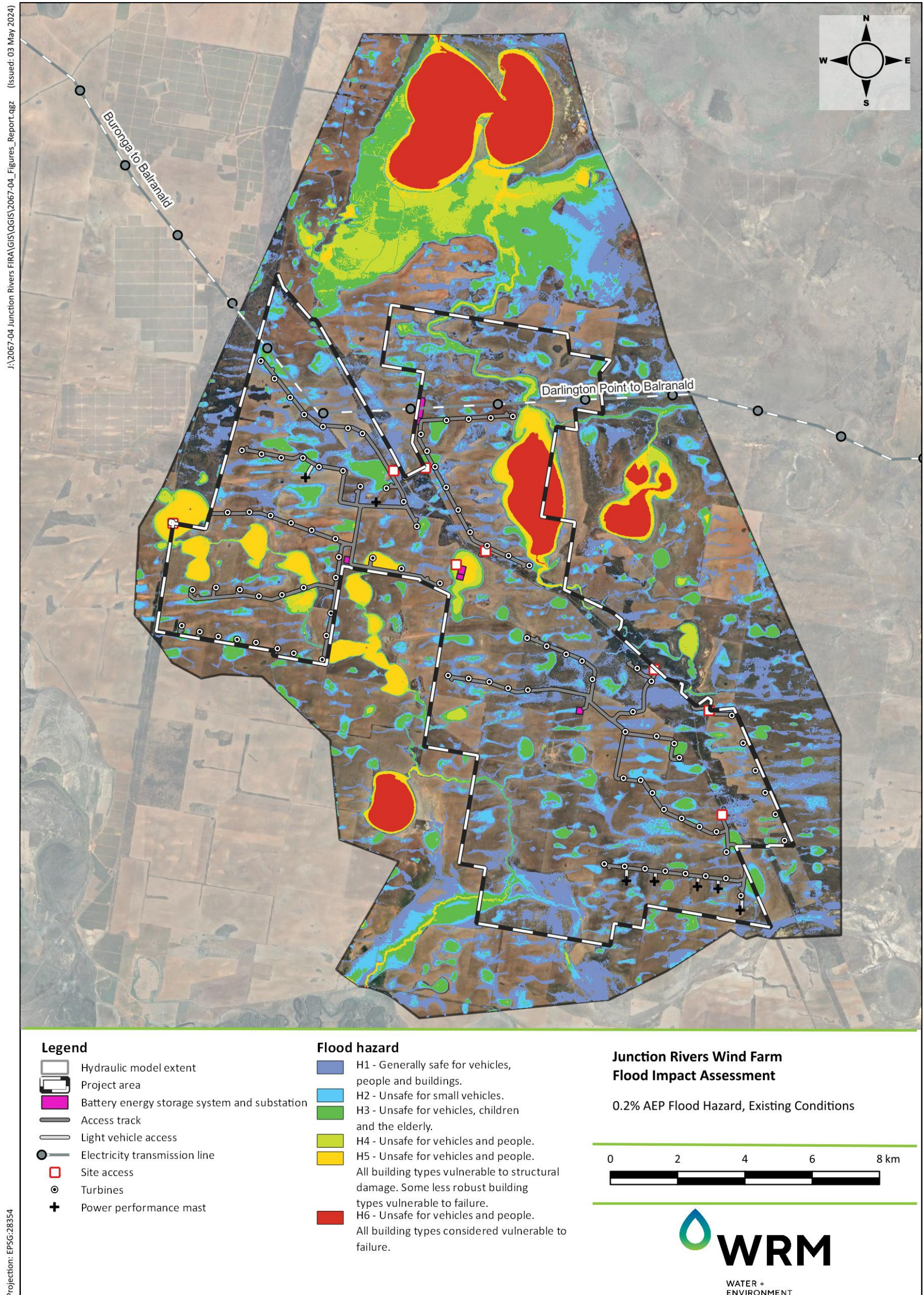


Figure A.17 0.2% AEP flood hazard, existing conditions

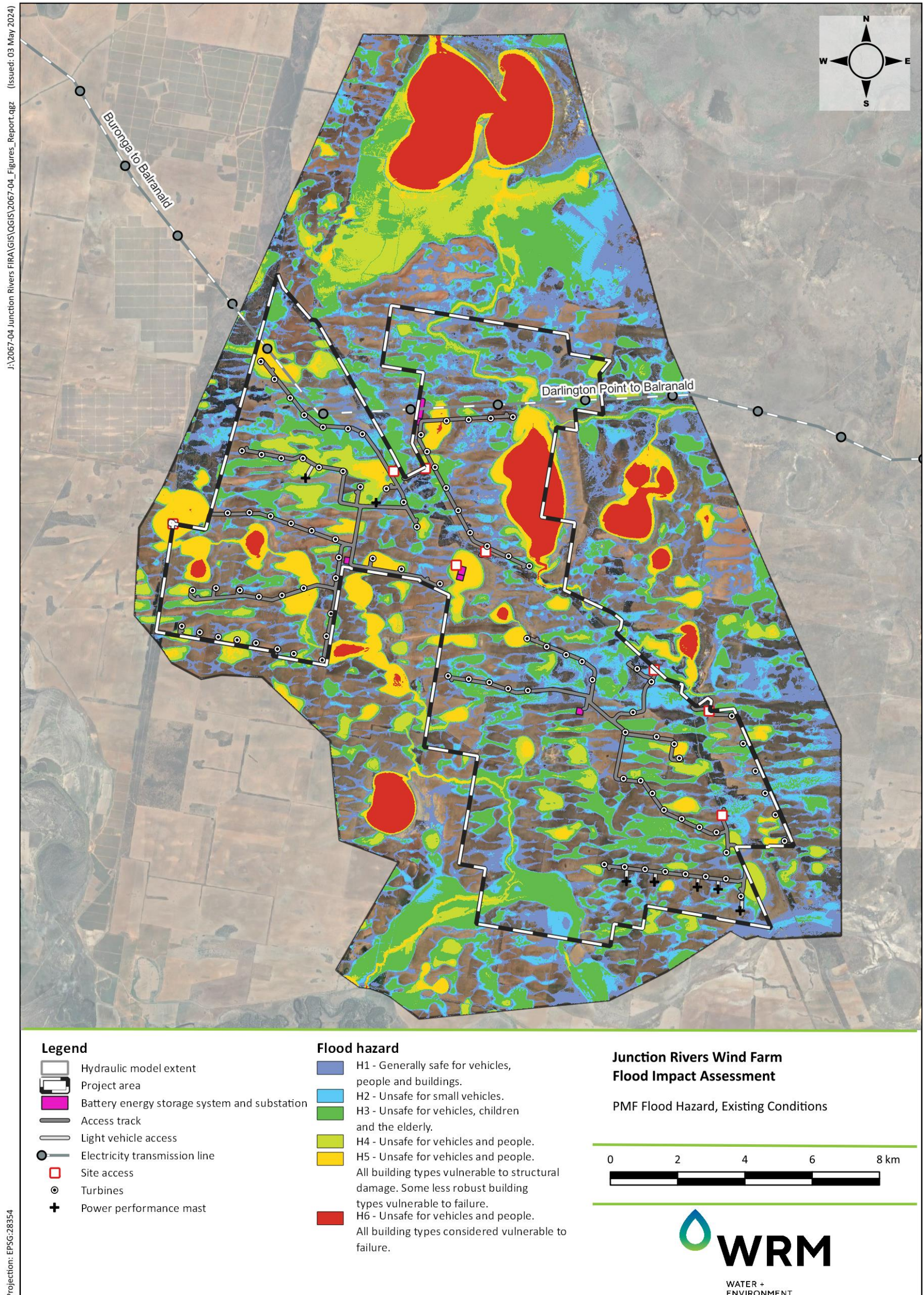


Figure A.18 PMF flood hazard, existing conditions



Level 1, 369 Ann Street Brisbane
PO Box 10703 Brisbane Adelaide Street Qld 4000
07 3225 0200

Level 5, 93 Mitchell Street Darwin
GPO Box 43348 Casuarina NT 0811
08 8911 0060

wrm@wrmwater.com.au
wrmwater.com.au

ABN 96 107 404 544