Appendix 13

WATER RESOURCES IMPACT ASSESSMENT

MALLEE WIND FARM

Water Resources Impact Assessment

Umwelt (Australia) Pty Ltd

20 September 2024

2067-03-B3

DETAILS

Report Title	Mallee Wind farm, Water Resources Impact Assessment
Client	Umwelt (Australia) Pty Ltd

THIS REVISION

Report Number	2067-03-B3
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NOTE ON FLOOD FREQUENCY TERMINOLOGY

A design flood is a probabilistic or statistical estimate, being generally based on some form of probability analysis of flood or rainfall data. An Annual Exceedance Probability (AEP) is attributed to the estimate. The frequency of flood events is expressed as an AEP, for example, a flood magnitude having 10% AEP, there is a 10% probability (or 1 in 10 chance) that there would be floods of that magnitude or greater each year. While a related concept Annual Recurrence Interval (ARI) is now outmoded due to the confusion it generates. A flood with a 10 year ARI, refers to floods that equal or of greater magnitude once in ten years on average. For very frequent events, the concept is referred to as Exceedances per Year (EY). The approximate correspondence between terminology, in particular the relationship between AEP and ARI applies to this study (ARR, 2019). The frequency of flood events can be grouped into five broad descriptive categories, as shown below.

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	0.5
	1	63.21	1.58	1
Frequent	0.69	50	2	1.44
	0.5	39.35	2.54	2
	0.22	20	5	4.48
	0.2	18.13	5.52	5
	0.11	10	10	9.49
Rare	0.05	5	20	19.5
	0.02	2	50	49.5
	0.01	1	100	99.5
Very Rare	0.005	0.5	200	199.5
	0.002	0.2	500	499.5
	0.001	0.1	1000	999.5
	0.0005	0.05	2000	1999.5
Extreme	0.0002	0.02	5000	4999.5
			↓	
			PMP/ PMP Flood	

Source: Australian Rainfall and Runoff Guidelines (Ball et al, 2019)

In this report, the frequency of flood events is referred to in terms of AEP for floods categorised as very rare, for example 1%, 0.2% or 0.5% AEP. These floods were calculated using the historical climate records. Over recent years, the climate record is showing the influence of non-stationarity. Evidence now exists that the magnitude of floods, i.e. those based on the historical record, are becoming more frequent. It is considered that this will continue as a warming climate will lead to more moisture being held in the atmosphere. For planning purposes, it is prudent to consider a 0.5% AEP based on the historical record as a proxy of the 1% AEP flood event based on future climate depths.

The 1 in 2000 (0.05%) AEP event is considered the limit of credible extrapolation of the historical record. These floods are categorised as extreme with the limit being the concept of the Probable Maximum Flood (PMF). The PMF occurs as a result of the Probable Maximum Precipitation (PMP). The PMP is the result of the maximum atmospheric carrying capacity of moisture and the efficiency of the storm mechanism to produce rainfall in a region. A PMF flood is not shown above as it is extreme and beyond the statistical limit. A PMF flood cannot have an AEP assigned to its magnitude as it applies the most conservative assumptions related to temporal patterns, losses and so on. Note also, that the PMF is not the same as the PMP Flood.

Very rare design events floods are useful for the purposes of planning as there is a remote chance that it may occur. Extreme floods are considered so far beyond the credible limit of record and contain so much inherent uncertainty that they exist only to provide a theoretical limit.

The approach to estimating an actual (or historic) flood from a particular rainfall event is quite different in concept and is of a deterministic nature. All causes and effects are directly related to the specific event under consideration. The actual antecedent conditions prevailing at the time of occurrence of the rain are directly reflected in the resulting flood and must be allowed for in its estimation. No real information on the probability of the historic flood can be gained from consideration of a single actual flood event.

ABBREVIATIONS AND DEFINITIONS

Term/ Abbreviation	Definition
ABS	Australian Bureau of Statistics
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.
ADWG	Australian Drinking Water Guidelines.
AHD (mAHD)	Australian Height Datum. A common national surface level datum approximately corresponding to mean sea level.
ARR	Australian Rainfall and Runoff. Guidelines prepared by Engineers Australia for the estimation of design floods. The latest being ARR2019 (Ball et al, 2019)
ASC	Australian Soil Classification (Isbell, R. F.,2021)
BESS	Battery Energy Storage System.
BFEMOP	Bush Fire Emergency Management and Operations Plan.
BGL (mBGL)	Below Ground Level. A relative datum used in bore holes to measure depth to groundwater.
BSAL	Biophysical Strategic Agricultural Land
CEMP	Construction Environment Management Plan
CSWMP	Construction Soil and Water Management Plan
DEM	Digital Elevation Model
Disturbance Footprint	This is the actual disturbance area required for the Project. Quantification of the Project impacts are to be based on the disturbance footprint as a realistic estimate of the disturbance required to construct the Project.
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/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).
DRP	Decommissioning and Rehabilitation Management Plan
EIS	Environmental Impact Statement
EP&A Act	*NSW Environmental Planning and Assessment Act* 1979
ESCP	Erosion Sediment Control Plan
EV	Environmental Value

Term/ Abbreviation	Definition
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.
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.
GDE	Groundwater Dependent Ecosystem.
GHG	Greenhouse Gas
GW	Gigawatts.
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.
LEP	Local Environmental Plan
LGA	Local Government Area

Term/ Abbreviation	Definition
LSC	Land and Soil Capability.
mAHD	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 "cumecs". 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.
MNES	Matters of Nationale Environmental Significance.
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 complete protection against this event. The probable maximum flood defines the extent of flood prone land, that is, the floodplain.
PMP (Probable maximum precipitation)	The greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends.
Project Area	The Project Area encompasses all land within and including the Project Boundary.
Project Boundary	The outer boundary of the Project Area. The Project Boundary is the maximum spatial extent of potential land access defined by the boundaries of the host landholder properties (i.e. all agreed lots owned by host landholders).
REZ	Renewable Energy Zone. The equivalent of modern-day power stations, combing new renewable energy infrastructure, including generators (such as solar and wind farms), storage (such as batteries and pumped hydro) and then high-voltage transmission infrastructure
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.
RUSLE	Revised Universal Soil Loss Equation.
Scour	Erosion by mechanical action of water, typically of soil.
SEARs	Secretary's Environmental Assessment Requirements
South-West REZ	South-West Renewable Energy Zone
SSD	State Significant Development

Term/ Abbreviation	Definition
SSP (Shared Socioeconomic Pathways)	SSPs are climate change scenarios of projected socioeconomic global changes up to 2100 as defined in the IPCC Sixth Assessment Report on climate change in 2021. In terms of quantitative elements, they provide data accompanying the scenarios on national population, urbanization and GDP (per capita). The five scenarios are: SSP1: Sustainability ("Taking the Green Road") SSP2: "Middle of the Road" SSP3: Regional Rivalry ("A Rocky Road") SSP4: Inequality ("A Road Divided") SSP5: Fossil-fuelled Development ("Taking the Highway").
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.
TWA	Temporary Workforce Accommodation
Umwelt	Umwelt (Australia) Pty Ltd
WM Act	*NSW Water Management Act* 2000
WRIA	Water Resources Impact Assessment
WSP	Water Sharing Plan
WTGs	Wind Turbine Generators

EXECUTIVE SUMMARY

This report documents the assessment and findings related to water resource related aspects associated with the construction, operation and decommissioning of the Mallee Wind Farm Project (the Project).

The Project is located in the Murray region of south western NSW, within the South West Renewable Energy Zone (South West REZ). The Project is situated within the Wentworth Shire Local Government Area (LGA). The location of the Project Area is shown in Figure 1.1.

This WRIA was prepared in accordance with the NSW Planning Secretary's Environmental Assessment Requirements (SEARs) (SSD-53293710, issued on 17/02/2023). This report addresses the SEARs relating to water resources as outlined in Section 1.2 and Appendix A. Section 1 provides an overview and context of the Project, as well as an outline of the purpose and structure of this report. Section 2 contains an outline of regulatory framework, legislation, policies and guidelines that were taken into consideration in the assessment.

This report has considered the potential impacts and appropriate measures to mitigate any potential impacts on water resources associated with the Project. The Project will have minimal impact on water resources as it involves limited ground disturbance, does not involve the storage or handling of large volumes of pollutants, and once constructed does not consume significant quantities of water.

Key potential issues relevant to the water resources impacts of the Project are summarised below:

- Potential impacts to surface water resources are primarily limited to the construction and decommissioning phases of the Project. These potential impacts can be mitigated to represent negligible risk as detailed in Section 7.
- The operational phase of the Project presents minimal risk provided that by the conclusion of the construction phase appropriate groundcover and drainage is established.
- The Project will not interact with the groundwater table and therefore, no impacts to groundwater resources or GDEs are expected.
- The Project Area does not contain any areas of major flood hazard relating to overland flows. However, due to the presence of shallow depressions typical of the regional landform, rain water will accumulate and pond creating temporary flood hazards until water infiltrates the surface.
- The large extent of the Project Area and distributed nature of minor impacts (if any) does not pose a risk to drainage features, downstream watercourses or receiving waters.

For these reasons, the key potential risks to surface water are only associated with the Project's construction. These risks can be adequately managed through the application of well-established construction environmental and safety management practices and appropriate design.

1 INTRODUCTION

1.1 OVERVIEW

Spark Renewables Pty Limited (Spark Renewables) proposes to develop the Mallee Wind Farm (the Project) to generate renewable wind energy and supply to the National Electricity Market (NEM). The Project will also contribute to reducing greenhouse gas (GHG) emissions associated with energy generation and provide significant economic benefits to the Murray region of New South Wales (NSW).

The Project is located approximately 16 kilometres (km) north east of Buronga in the Murray region of south western NSW within the Wentworth Local Government Area (LGA) and 17 km north east of Mildura, Victoria (VIC). It will include the installation, operation, maintenance and decommissioning of up to 76 wind turbine generators (WTGs), a single grid scale 100 megawatts (MW) /200 megawatt hour (MWh) Battery Energy Storage System (BESS), ancillary infrastructure and temporary facilities associated with construction of the Project. The Project design incorporates up to 76 WTGs, with a maximum blade-tip height of 280 metres (m) above ground level, and an installed capacity of up to 402 MW.

WRM Water & Environment Pty Ltd (WRM) has been engaged to prepare this Water Resources Impact Assessment (WRIA) to support the Environmental Impact Statement (EIS) for the Project.

1.2 PROJECT CONTEXT

The Project is located in the Murray region of south western NSW, within the South West Renewable Energy Zone (South West REZ). The Project is situated within the Wentworth Shire LGA. The Project is located approximately 16 km north east of Buronga, NSW (population 6,511), 2217 km north east of Mildura, VIC (population 32,738) and 40 km east of Wentworth, NSW (population 1,305) (ABS, 2021). Smaller localities of Mallee, Red Cliffs and Trentham Cliffs are located to the south and south west of the Project.

The Project Area encompasses 57,330.31 hectares (ha) of predominantly cropping and grazing land and adjoins the Mallee Cliffs National Park, which is located directly south and southeast. The Project Area is zoned as RU1 Primary Production, with some pockets of C2 Environmental Conservation within the Wentworth Local Environment Plan (LEP) 2011. The Project's local context is shown in Figure 1.2.

The Project is a State Significant Development (SSD) as defined under *State Environmental Planning Policy (Planning Systems)* 2021 (Planning Systems SEPP) and will require development consent under Part 4 of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act).

1.3 KEY PROJECT FEATURES

The Project will include the installation, operation, maintenance and decommissioning of up to 76 WTGs, BESS facility, ancillary infrastructure and temporary facilities associated with construction of the Project. The current design incorporates WTGs with a maximum blade-tip height of 280 m above ground level (AGL) with an installed capacity of up to 402 MW.

The key components of the Project include:

- Up to 76 (three (3) blade) WTGs, with a maximum blade-tip height of 280 m above ground.
- A single grid-scale 100 MW /200 megawatt hour (MWh) BESS.
- Permanent ancillary infrastructure including internal access tracks, hardstands, main and collector substations, switchyards, operations and maintenance facilities, underground and overhead electricity transmission lines and poles, telecommunications facilities and utility services, permanent meteorological masts and water storage tanks.

- Temporary facilities including temporary workforce accommodation (TWA), site offices, amenities, construction compounds and laydown areas, concrete or asphalt batching plants, minor 'work front' construction access roads, environmental management and monitoring, signage and temporary meteorological masts.
- Off-site road works, involving upgrades to the proposed local transport route and establishment of site access points to facilitate delivery of wind turbine components to the Project Area as required.

1.3.1 Disturbance Footprint

Within the Project Area, a Disturbance Footprint has been determined which includes all Project elements and temporary disturbance areas. The Disturbance Footprint within the Project Area is approximately 444.69 ha and has been established in consideration of environmental, social and engineering constraints in the immediate vicinity of the Project, including:

- proximity to Mallee Cliffs National Park
- biodiversity impacts including threatened ecological communities (TECs) and areas of remnant woodland vegetation
- heritage sites
- watercourses
- potential visual impacts
- slope and constructability constraints
- landholder's ongoing usage requirements; and
- Crown land.

Additionally, offsite road works are proposed at three (3) locations (in addition to the two (2) site access points). The offsite disturbance / road modifications are required at the following three (3) locations on the local transport route.

- Sturt Highway roundabout at intersection of Carey Street, Euston.
- Sturt Highway roundabout onto Silver City Highway, Buronga.
- Silver City Highway onto Arumpo Road.

The total "offsite" disturbance footprint of 0.25 ha. The total Disturbance Footprint for the Mallee Wind Farm, as assessed in the EIS, is 444.94ha.

1.3.2 Project Phasing

The Project comprises of four phases, pre-construction minor works, construction, operation and decommissioning. The proposed activities for each phase of the Project are outlined in Table 1.1 below:

Table 1.1 Project phases and associated activities

Project phase	Proposed Activities
Pre-construction Minor Works	• Surveys. • Off-site road works , involving upgrades to the proposed local transport route and establishment of site access points. • Building/ road dilapidation surveys. • Geotechnical investigative drilling and excavation of test pits and bore holes. • Minor clearing of native vegetation. • Establishment of temporary site office and compounds. • Installation of environmental impact mitigation measures, fencing, enabling works, meteorological masts. • Heritage artefact salvage, biodiversity investigations and pre-clearing surveys, inspections, specific habitat feature removal, and relocation. • Intersection and road upgrades on the public road network.. • Establishment of Project site access points, minor access roads and minor adjustments to services/ utilities signage, etc. • Minor clearing of native vegetation to facilitate the minor works described above.
Construction Works	Includes all physical works within the Disturbance Footprint to enable the operation, including, but not limited to the construction and installation of: • WTGs • Compounds • TWA facility • Electrical network lines • Battery storage • Construction of ancillary infrastructure; and Establishment or construction of any temporary facilities which are not already established as part of the pre-construction minor works.
Operation and Maintenance	• Ongoing operation, monitoring (on-site and remote monitoring) and maintenance of all Project infrastructure and land within the Disturbance Footprint during the operational lifespan of the Project. • Replacement of major components as required, such as WTG blades, as required (including the use of cranes and ancillary equipment to enable replacement).
Decommissioning	• Includes all physical works required for the dismantling and transportation of Project infrastructure and rehabilitation of the Project Site. • If not required for ongoing farming/ fire access purposes, internal access tracks would be removed.

1.3.3 Proposed timeframes

It is anticipated that construction works will commence within one year of Project approval i.e. construction commencing in 2026. The timing of construction will be driven by additional permits and authorisations, contractor selection, detailed design and procurement processes, and a final investment decision. The construction phase of the Project is anticipated to be 3 years. The Project has an estimated operational life of 30 years after which it may be decommissioned or re-powered.

In summary the anticipated timeframes for the Project are:

- Planning and approvals (prior to commencement of construction): in progress, and aiming to be completed in Q2 2025.
- Construction and Commissioning: planned to commence in 2026, for approximately 3 years
- Operation: planned to commence in 2028, with an estimated operational life of 30 years.

1.3.4 Working hours and workforce

Standard working hours are proposed during construction and decommissioning between 7:00 am to 6:00 pm Monday to Friday, and 8:00 am to 1:00 pm Saturday. Works may be undertaken outside these hours where the activity is inaudible, for emergency works or time critical delivery of materials.

The Project will require a peak workforce of up to 400 full-time-equivalent (FTE) positions during construction and up to 30 (FTE) during operation.

![WRM logo]

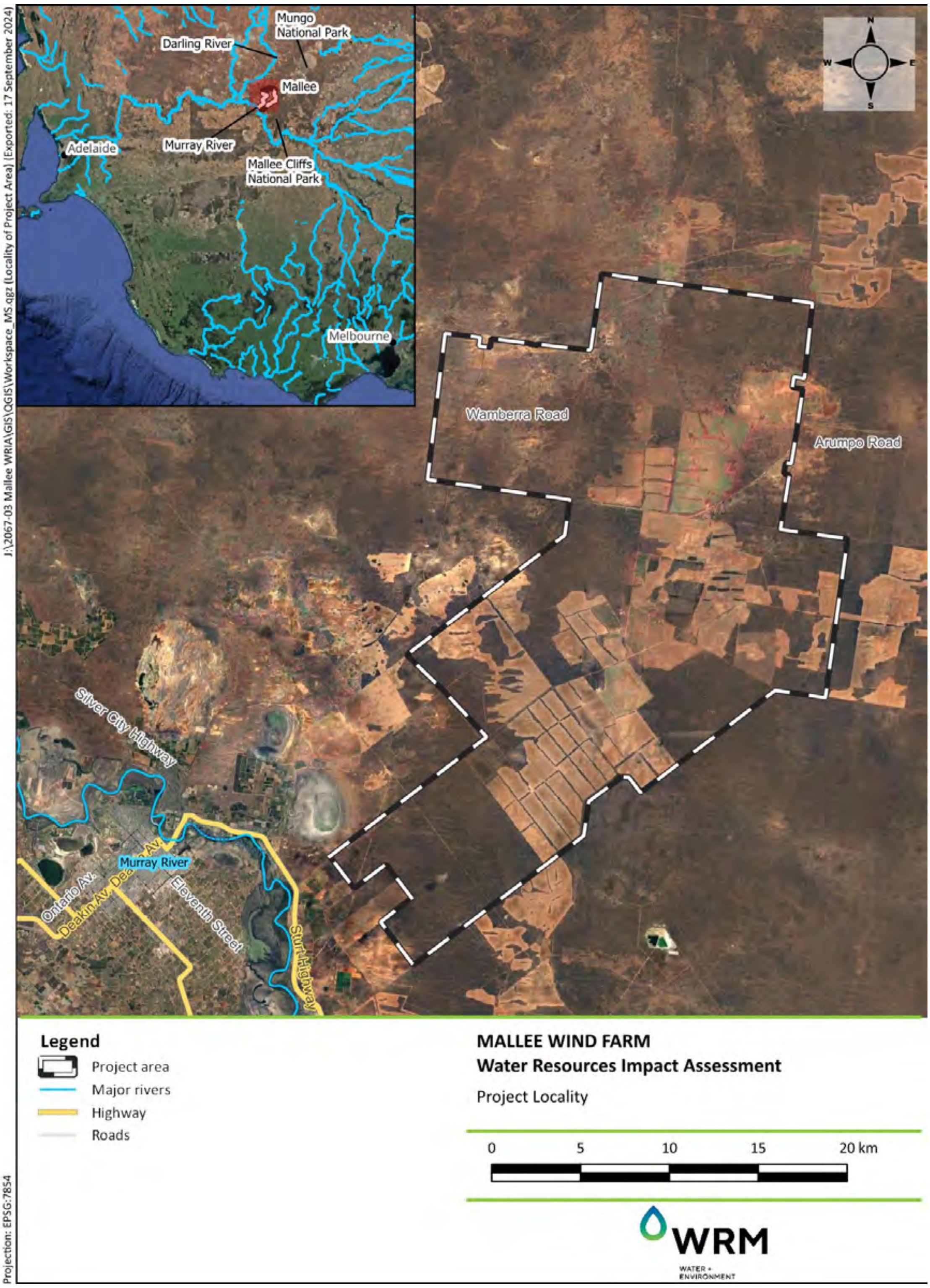

Figure 1.1 Locality

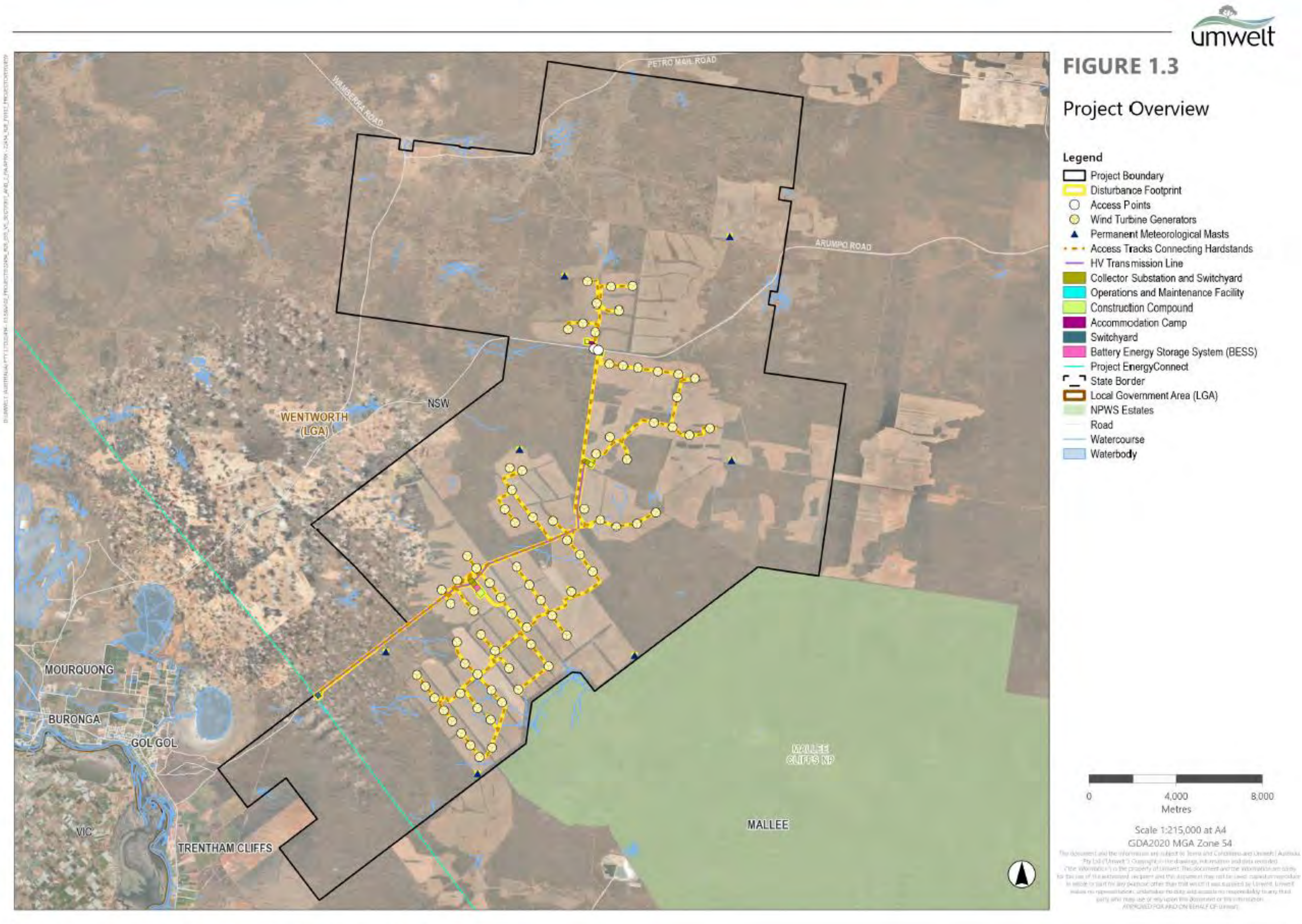

Image Source: ESRI Basemap (2024) **Data source:** NSW DFSI (2024), VIC DELWP (2023), Spark (2024)

Figure 1.2 Project Area

1.4 PURPOSE AND SCOPE

This WRIA was prepared by WRM in accordance with the Secretary's Environmental Assessment Requirements (SEARs) (Application Number SSD-53293710, issued on 17/02/2023). The requirements of the SEARs, as they relate to water resources, are presented in Table 1.2.

The WRIA provides an assessment of the potential impacts of the Project on the water resources in the vicinity of the Project Area. The assessment considers surface water, groundwater, water quality and hydrology impacts associated with the construction, operation and decommissioning 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;
  - future 1% AEP flood risk under a changing climate projected over 30 years depending on the actual emissions trajectory is likely to be between the bookends of:
    0.5% AEP current climate as a proxy for SSP1: very-low emissions
    0.2% AEP current climate as a proxy for SSP5: high emissions
  - Probable Maximum Flood (PMF), which was modelled using the Probable Maximum Precipitation (PMP) depths to determine the extreme flood event;
  - erosion and sedimentation;
  - surface water and groundwater quality; and,
  - water users and supply.
- Confirming the environmental values and water quality objectives associated with surface water resources;
- Describing appropriate mitigation measures to manage the potential impacts.

The SEARs for the Project identify key issues and reference guidelines that must be addressed in the Environmental Impact Statement (EIS). Table 1.2 outlines where the specific SEARs for water resources are addressed in this report. Appendix A summarises Agency Advice appended to the SEARs and outlines where this advice has been addressed in this Report.

Table 1.2 Planning Secretary's Environmental Assessment Requirements (SEARs)

SEARs Key Issues - Water and Soils:	Location
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 4
an assessment of the likely impacts of the development (including flooding and flood modelling) on surface water and groundwater resources traversing the site and surrounding watercourses (including their Strahler Stream Order), drainage channels, wetlands, riparian land, farm dams, groundwater dependent ecosystems and acid sulphate soils, related infrastructure, adjacent licensed water users and basic landholder rights, and measures proposed to monitor, reduce and mitigate these impacts;	Sections 4 to 6

SEARs Key Issues - Water and Soils:	Location
where the project involves works within 40 metres of the high bank of any river, lake or wetlands (collectively waterfront land), identify likely impacts to the waterfront land, and how the activities are to be designed and implemented in accordance with the DPI *Guidelines for Controlled Activities on Waterfront Land* (2018) and (if necessary) *Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (DPI 2003); and *Policy & Guidelines for Fish Habitat Conservation & Management* (DPI, 2013);	Sections 5 to 7
a description of the measures to minimise surface and groundwater impacts, including how works on erodible soil types would be managed and any contingency requirements to address residual impacts in accordance with the Managing Urban Stormwater: Soils and Construction series of guidelines.	Sections 4 to 7

1.5 REPORT STRUCTURE

This report is structured as follows:

- Section 2 provides details of the regulatory framework;
- Section 3 provides details of the existing surface water and groundwater environment;
- Section 4 describes water management and demand for the Project;
- Section 5 describes the methodology and results of the flood assessment;
- Section 6 presents an assessment of the potential impacts of the Project;
- Section 7 outlines the proposed management and mitigation measures;
- Section 8 presents the conclusions of the assessment;
- Section 9 is a list of references;
- Appendix A outlines and addresses Agency Advice on the Project SEARs;
- Appendix B contains flood mapping;
- Appendix C provides RUSLE data mapping
- Appendix D provides soil data for the Project Area.

2 REGULATORY FRAMEWORK

2.1 OVERVIEW

This section describes the regulatory framework (legislations, policies and standards) at Commonwealth and State level that would apply to surface water management at this Project[1]:

- Water Management Act 2000 (WM Act) (NSW Government, 2000).
- Water Act 1912 (Water Act) (NSW Government, 1912).
- Flooding:
    - Australian Rainfall and Runoff Guidelines 2019 (Commonwealth of Australia (Geoscience Australia), 2019).
    - Floodplain Risk Management Manual and Guideline LU01[2] (NSW Government 2023)
- Surface Water:
    - NSW Government Water Quality and River Flow Objectives at http://www.environment.nsw.gov.au/ieo/
    - Australian Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia, 2018) (ANZG, 2018).
    - Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volume 2 (Department of Environment and Climate Change, 2008).
    - Storing and Handling Liquids: Environmental Protection – Participants Handbook (Department of Environment and Climate Change, 2007).
- Policy & Guidelines for Fish Habitat Conservation & Management (Department of Primary Industries, 2013).
- Guidelines for Controlled Activities on Waterfront Land:
    - Guidelines for riparian corridors on waterfront land (Department of Planning and Environment (DPE) Water, 2018)
    - Guidelines for instream works on waterfront land (DPE Water, 2022).
    - Guidelines for vegetation management plans on waterfront land (DPE Water, 2022).
    - Guidelines for watercourse crossings on waterfront land (DPE Water, 2022).
    - Controlled Activities on Waterfront Land: Controlled activity exemptions on waterfront land (DPE Water, 2022).

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[1] https://www.planning.nsw.gov.au/policy-and-legislation/planning-reforms/rapid-assessment-framework/improving-assessment-guidance

https://www.planningportal.nsw.gov.au/major-projects/assessment/policies-and-guidelines

http://www.environment.gov.au/epbc/publications#assessments

[2] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Floodplains/flood-risk-management-impact-risk-assessment-230234.pdf

- Groundwater:
  - NSW State Groundwater Policy Framework Document and component policies (Department of Planning, Industry and Environment).
  - *NSW Aquifer Interference Policy* 2012 (Department of Primary Industries Office of Water).
  - National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC).

2.2 *Environment Protection and Biodiversity Conservation Act* 1999

The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) outlines the requirements relating to the management and protection of matters of national environmental significance (MNES).

'Controlled actions' are those actions that the Minister decides have, will have or are likely to have a significant impact on one or more protected matters and therefore require assessment and approval under the Act. The protected matters upon which the action may have a significant impact are called the 'controlling provisions' or 'triggers' for assessment and approval under the Act, for that controlled action.

The Project has been declared a controlled action (EPBC 2022/09500) under the controlling provisions i. World Heritage Properties. ii. National Heritage Places, iii. listed threatened species and communities and iv. listed migratory species under the EPBC Act. The Project's impacts to MNES have been assessed in the EIS and also the Biodiversity Development Assessment Report and Aboriginal Cultural Heritage Report prepared by others and are therefore not considered in detail in this Report.

2.3 *Water Management Act* 2000

The *Water Management Act* 2000 (WM Act) is the primary legislation for the management of water in the Project Area. The WM Act contains provisions for the licensing of water access and use. Groundwater quality protection is also achieved through consideration of both the objects and principles of the WM Act.

In general, the WM Act governs the issue of water access licences (WALs) and approvals for those water sources (rivers, lakes, estuaries and groundwater) in NSW where Water Sharing Plans (WSPs) exist. Additional groundwater sources and WSPs underly the upper-most groundwater source and WSP. However, these deeper groundwater sources and WSPs are not applicable as Project works are not proposed at depths of greater than a few metres below ground level and are unlikely to influence these deeper groundwater systems.

3 EXISTING ENVIRONMENT (SURFACE WATER AND GROUNDWATER)

3.1 CATCHMENT CHARACTERISTICS

The Project Area is located approximately 8.4 km north of the Murray River, within the Murray River Catchment in Southern NSW, see Figure 1.1. The Murray River flows in a southwest direction from its headwaters which originate in Queensland, NSW and Victoria, draining through South Australia into the Southern Ocean. The Mallee Cliffs National Park is immediately adjacent to the southeastern border of the Project Area. Mungo National Park is located approximately 65 km to northeast of the Project Area, and the Darling River is located approximately 45 km to the northwest.

No known flood prone land or flood management areas are identified within the Project Area. It is understood that no previous flood studies have been undertaken within the Project Area and it is not mapped as flood prone. No significant flooding in this reach of the Murray River has occurred since 1956.

3.1.1 Topography and drainage

As shown in Figure 3.1, the Project Area contains a 30 to 40 m high ridge running approximately northeast to southwest through the centre, with elevations along the high points ranging from 95 to 120 m AHD. Localised catchments either side of the ridge naturally drain to numerous local depressions and poorly defined discontinuous waterway networks. The minor streams, local depressions and overland flow path networks eventually drain into the Murray River, to the south of the site.

3.1.2 Land Use

The Project Area is located primarily on land zoned as RU1 Primary Production, with some pockets of C2 Environmental Conservation within the Wentworth Local Environmental Plan (LEP) 2011. The majority of land that surrounds the Project Area is also zoned RU1 Primary Production. There are pockets of land surrounding the Project Area zoned as C2 Environmental Conservation, all of which are outside of the proposed WTG locations. Mallee Cliffs National Park to the southeast is zoned as C1 National Parks and Nature Reserves.

The agricultural land within the Project Area is primarily used for non-irrigated cropping and produces several grains and pulses crops such as wheat, beans and chickpeas. A site inspection undertaken by Minesoils Pty Ltd (Minesoils) identified that a limited area in the north of the Project Area (north of Arumpo Road) a herd of goats was observed to be grazing on native pastures and shrubs. It is also noted that sheep are the current and historically dominant livestock venture within the wider locality.

Agricultural research activities are also undertaken throughout the year within the Project Area. This research helps the region enhance the understanding of effective productive land management.

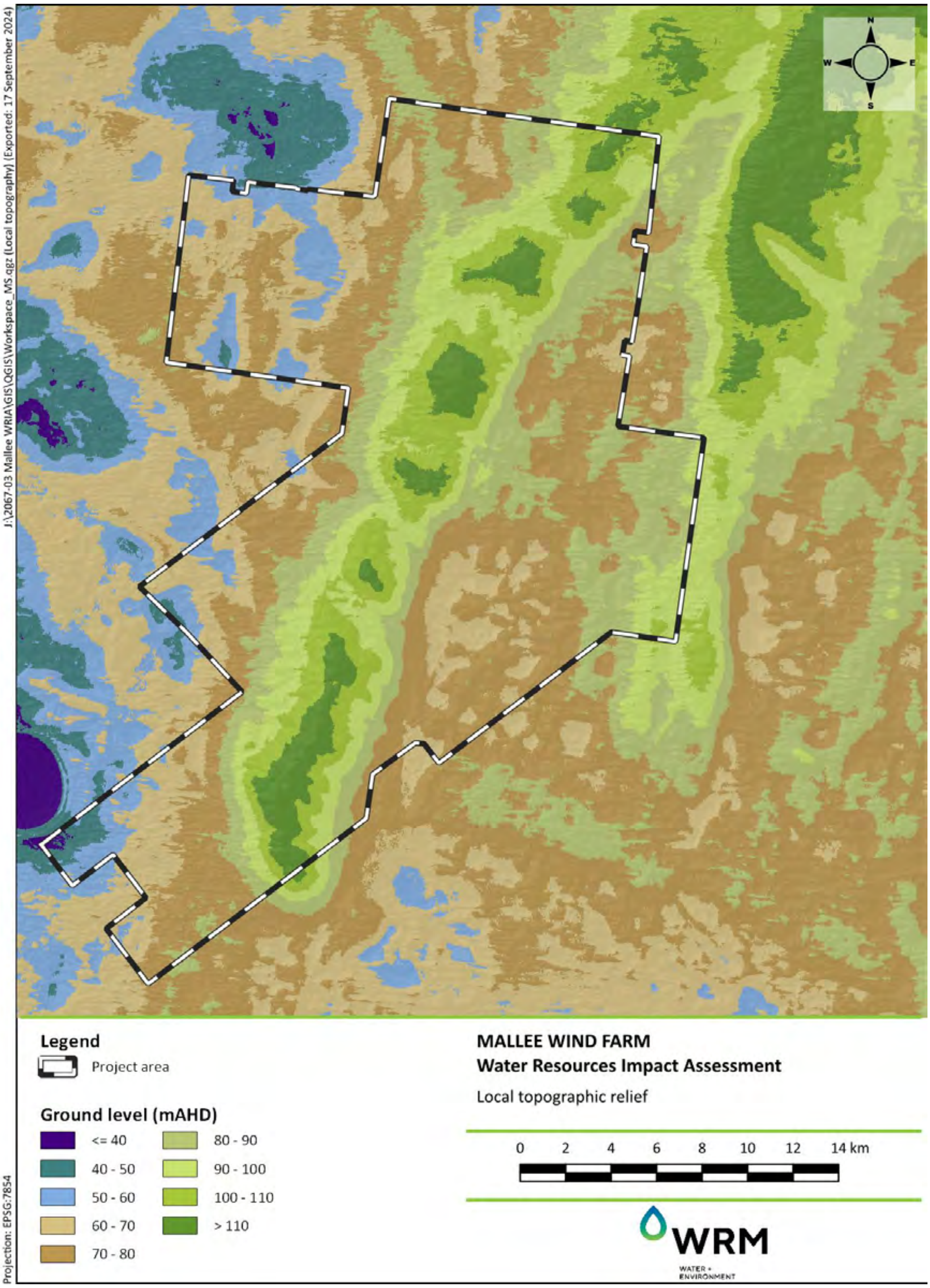

Figure 3.1 Local topography

3.2 CLIMATE

The nearest open Bureau of Meteorology (BoM) daily rainfall gauge to the Project Area is 30 km to the southwest of the Project Area at Mildura Airport (76031). The Airport gauge opened in September 1946 and remains open. 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 also 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 SILO grid point -34.047 Latitude and 142.4405 Longitude which is the grid point closest to the Project Area between 01/01/1889 to 31/01/2024.

Table 3.1 and Figure 3.2 present the annual rainfall and evaporation statistics based on the Project Area climate data sourced for SILO grid point. Table 3.2 and Figure 3.3 present the monthly rainfall and evaporation statistics based on data for the SILO grid point. The median annual rainfall is 273 millimetres and median evaporation is 1977 mm.

Utilising the climate database, the average total rainfall for each calendar month from 1889 to 2024 was calculated and is summarised in Table 3.2. Figure 3.3 shows there is only a moderate level of seasonality to rainfall within the Project Area, and that rainfall is typically low in most months. Lowest average rainfall is recorded in March. Highest monthly rainfall is recorded in October.

Table 3.1 Annual Rainfall and Evaporation (mm) for Project Area

Statistic	Annual Rainfall (mm) [a]	Annual Evaporation (Class A Pan) [a]
10th percentile	166	1945
50th percentile	273	1977
90th percentile	396	2185

[a] Data source: https://www.longpaddock.qld.gov.au/silo/

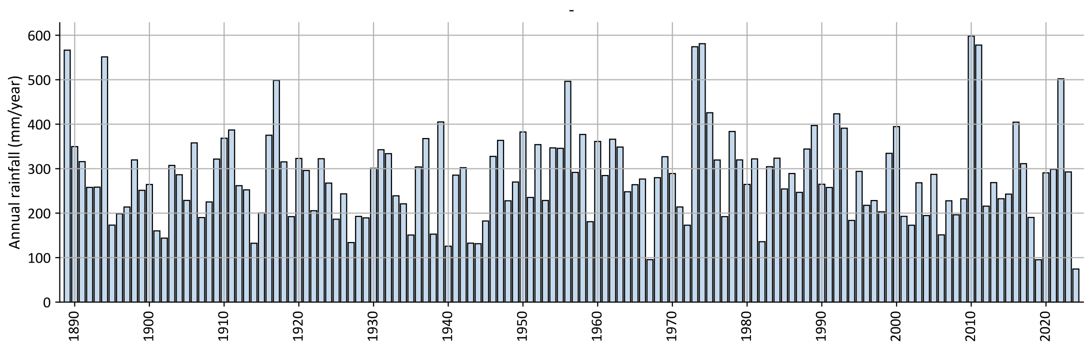

Figure 3.2 Annual rainfall totals at Project Area

(Source: SILO,2024)

Table 3.2 Monthly climate statistics (mm), 1890 to 2024

Month	Evaporation (Class A Pan)	Rainfall (mm)
October	185.2	29.7
November	239.8	23.7
December	295.7	21.7
January	310.3	21.6
February	249.6	21.1
March	206.5	18.1
April	126.7	19
May	74.4	26.1
June	49.5	28.1
July	56.8	23.3
August	86.1	28
September	127.2	24.7

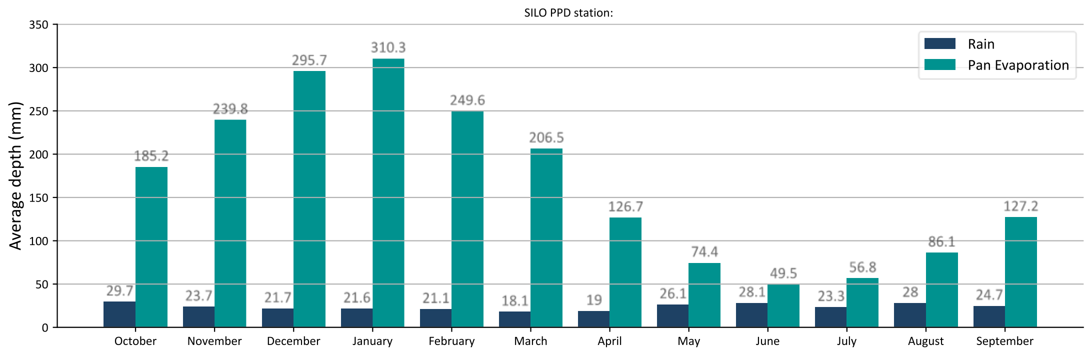

Figure 3.3 Monthly rainfall and evaporation
(Source: SILO, 2024)

Figure 3.4 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 approximately four times the median rainfall, as occurred in the 2010/11 water year.

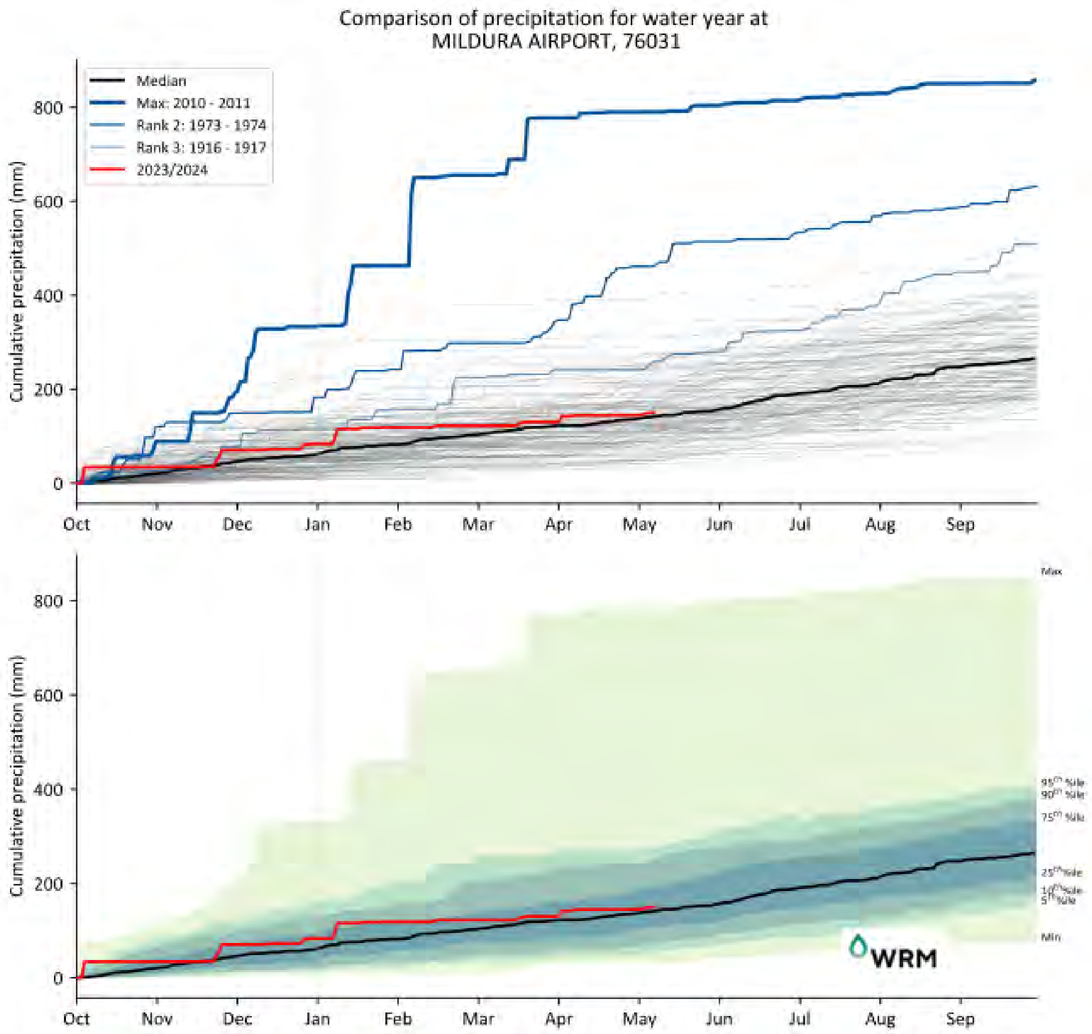

Figure 3.4 Rainfall variability at Project Area

(Original Source: QLD Govt SILO and Bureau of Meteorology as at 14 Mar 2024)

3.3 WATERCOURSES

There are numerous local depressions with the Project Area. The waterway network traversing the Project Area is shown in Figure 3.5, based on NSW hydroline spatial data. As shown, there are limited mapped streams within the Project Area and no major watercourses. Where streams are identified, most are minor streams of 1st and 2nd Strahler order.

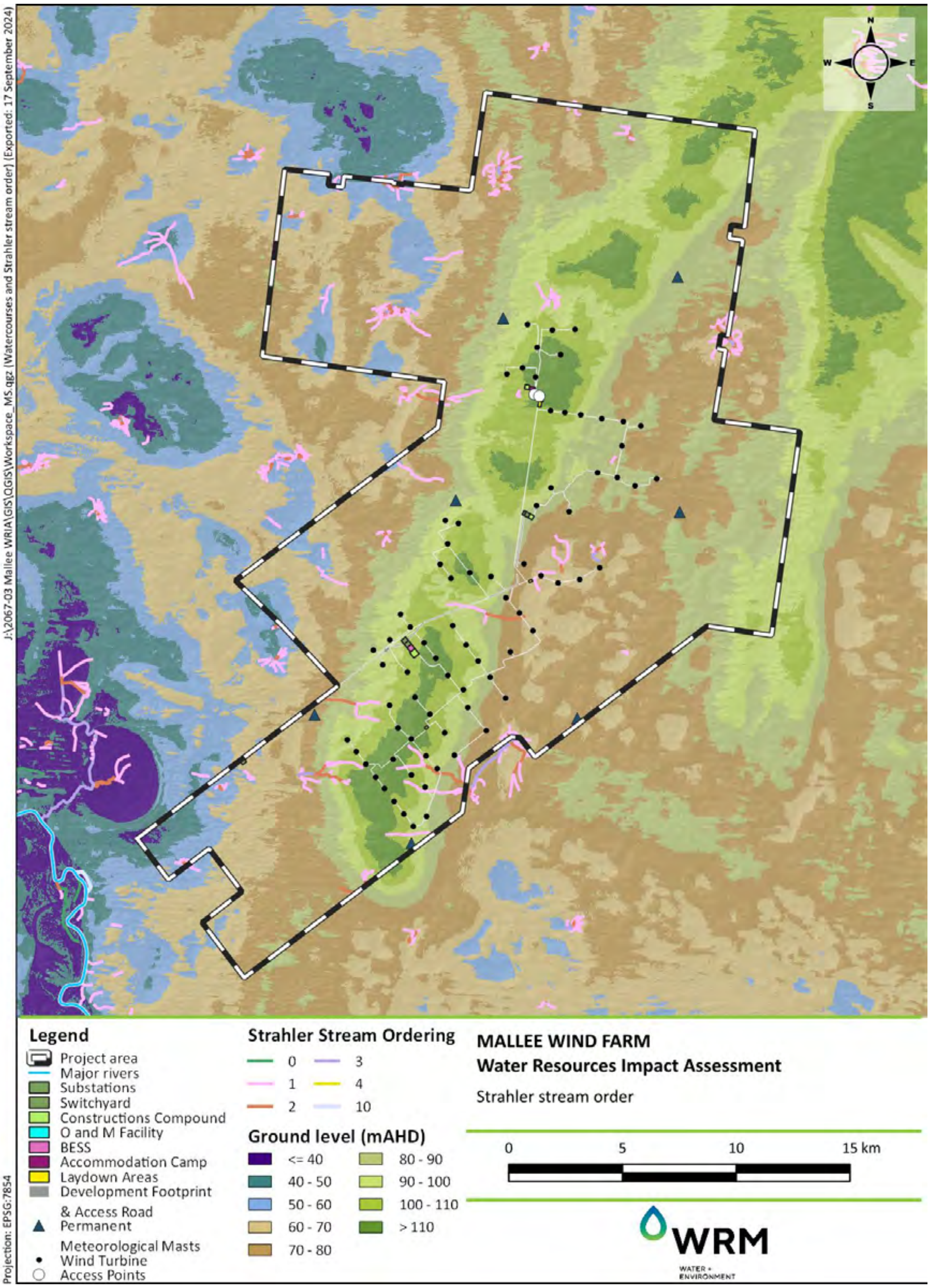

Figure 3.5 Watercourses and Strahler stream order

3.4 SOIL LANDSCAPES

The following section presents the NSW state government regional mapping data for soil types, inherent soil fertility and Land and Soil Capability (LSC) as applied to the Project Area (NSW and Department of Planning, Industry and Environment, 2022). Minesoils Pty Ltd (Minesoils) was engaged by Umwelt to conduct a Soil, Land and Agricultural Impact Assessment of the Project. The baseline soil and agriculture resources are detailed within the *Soil and Agricultural Impact Assessment* report (Minesoils, 2024).

3.4.1 Soil Types

A soil survey undertaken by Minesoils (2024) found the Project Area to contain two (2) dominant soil mapping units (as shown in Figure 3.6):

- Soil Unit 1: Calcarosols – covering 499 ha.
- Soil Unit 2: Rudosols – covering 134 ha.

Advice from Minesoils (2024) is summarised:

- Calcarosols are either calcareous throughout the solum - or calcareous at least directly below the A1 or Ap horizon, or within a depth of 0.2 m (whichever is shallower). Carbonate accumulations must be judged to be pedogenic, ie. are a result of soil forming processes in situ (either current or relict). Soils dominated by non-pedogenic calcareous materials such as fragments of limestone or shells are excluded. Calcarosols do not have deep sandy profiles that have a field texture of sand, loamy sand or clayey sand in 80% or more of the upper 1.0 m.
- Rudosols are defined as soils with little, if any, (rudimentary) pedologic organisation apart from (a) minimal development of an Al horizon or (b) the presence of less than 10% of B horizon material (including pedogenic carbonate) in fissures in the parent rock or saprolite. The soils are apedal or only weakly structured in the A1 horizon and show no pedological colour changes apart from the darkening of an A1 horizon. There is little or no texture or colour change with depth unless stratified or buried soils are present.

3.4.2 Inherent Soil Fertility

NSW regional mapping provides an estimation of the inherent fertility of soils in NSW. It uses the best available soils and natural resource mapping developed for LSC dataset. The mapping describes soil fertility in NSW according to a five-class system: Low (1), Moderately Low (2), Moderate (3), Moderately High (4), High (5).

Minesoils (2024) found that the Study Area is dominated by soils with Low (1) and Moderately Low (2) fertility, as shown in Figure 3.7.

3.4.3 Land and Soil Capability

Land capability, as detailed in LSC scheme, is the inherent physical capacity of the land to sustain a range of land uses and management practices in the long term without degradation to soil, land, air and water resources. Failure to manage land in accordance with its capability risks degradation of resources both on- and off-site, leading to a decline in natural ecosystem values, agricultural productivity, and infrastructure functionality.

As shown in Figure 3.8 from Minesoils (2024), the verified land and soil capability mapping indicates that the Project Area contains six (6) classes:

- LSC class 3: high capability land
- LSC class 4: moderate capability land
- LSC class 5: moderate-low capability land

- LSC class 6: low capability land
- LSC class 7: very low capability land
- LSC class 8: extremely low capability land

3.4.4 Biophysical Strategic Agricultural Land

Minesoils (2024) found the Project Area to have no regionally mapped Biophysical Strategic Agricultural Land (BSAL).

3.4.5 Soil Erodibility

Minesoils (2024) undertook laboratory testing and site investigations of the Project Area. The following has been extracted from the Minesoils (2024) report and describes the erosion potential for the Project Areas.

"*Based on site observation, which included assessment for indicators of erodibility, such as sheet or gully erosion, it can be concluded that there is a minor wind erosion and sedimentation risk associated with the topsoils currently present in the Project Area and its surrounds, due to the nature of the landscape and exposure characteristics. In addition, the dispersion risk status of representative tested soils indicate there is moderate risk for dispersion in both soil units within the Project Area.*

The representative laboratory tested soils indicate high levels of sodicity in Soil Unit 1. While sodic soils are generally dispersive, it is important to acknowledge that not all sodic soils disperse, and that not all dispersive soils are sodic. However, given the ranges in salinity of the topsoils tested within the Project Area, all sodic soils should be considered dispersive.

Based on these results, there is a moderate potential risk for dispersion where soils are disturbed by Project construction works and activities within the Project Area. Higher impact activities such as where earthworks are necessary for construction of sub-station pads or site facilities are very likely to result in increased dispersive behaviour when soil is remoulded, compacted or pulverised.

In addition, due to very gently undulating nature of the landscape and low rainfall, the risk of soil erosion from surface water flows is generally low. However, the aeolian processes observed to be operational within the region, along with the chemical instability of the laboratory tested soils, indicate an erosion risk that must be considered and appropriately controlled by Project mitigation measures. Wind erosion has the potential to be exacerbated where soils are disturbed as a result of the Project.

Erosion and sediment control mitigation measures are available to be implemented as part of the Project, and the overall risk of erosion and sedimentation impacts on agriculture as a result of the Project should be considered low."

3.4.6 Acid Sulphate Soils

Minesoils (2024) found that the NSW Acid Sulphate Soil Planning Map does not show any acid sulphate soils classes within the Project Area.

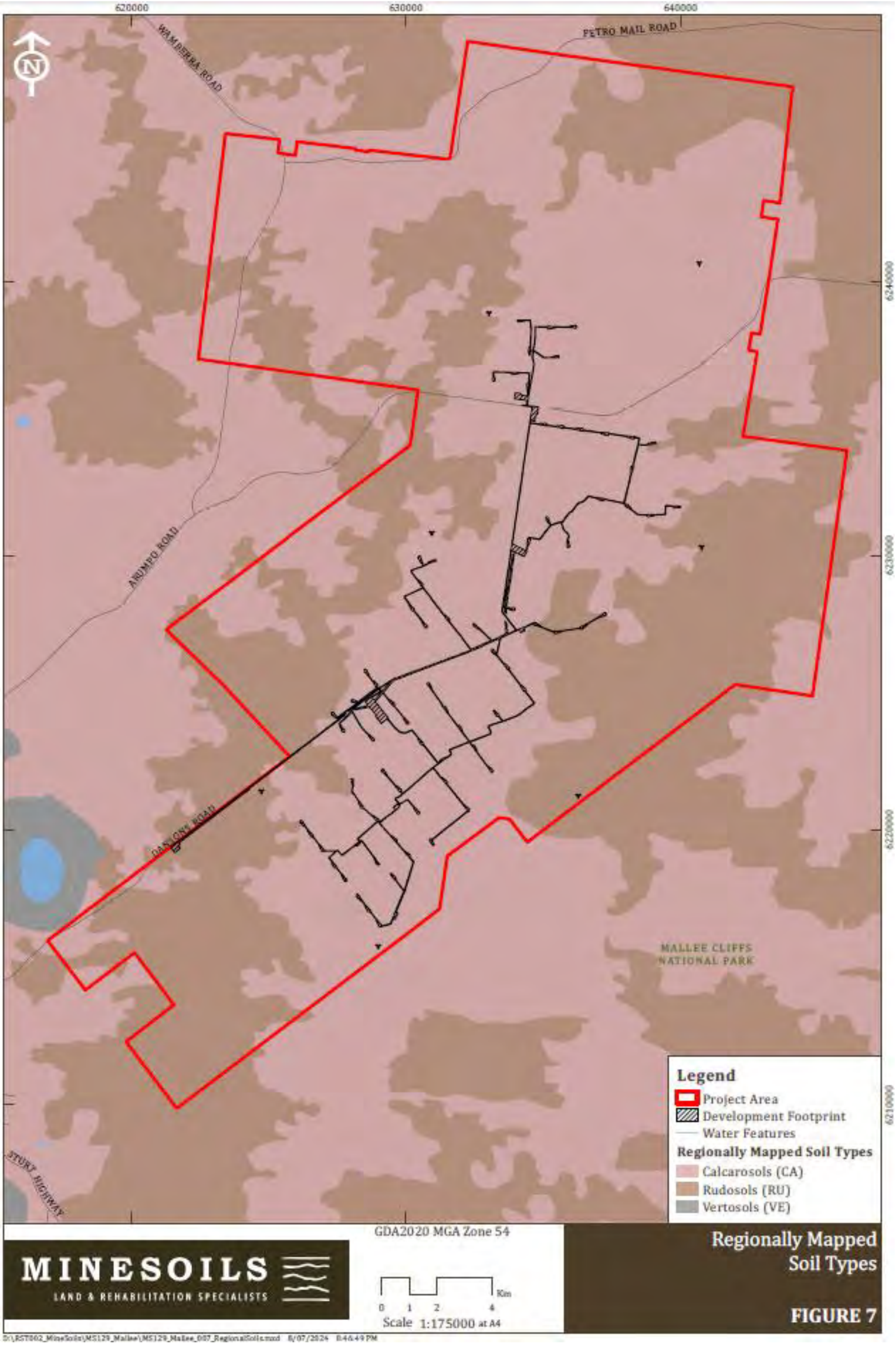

Figure 3.6 Regionally mapped soil types
(Source: Minesoils, 2024)

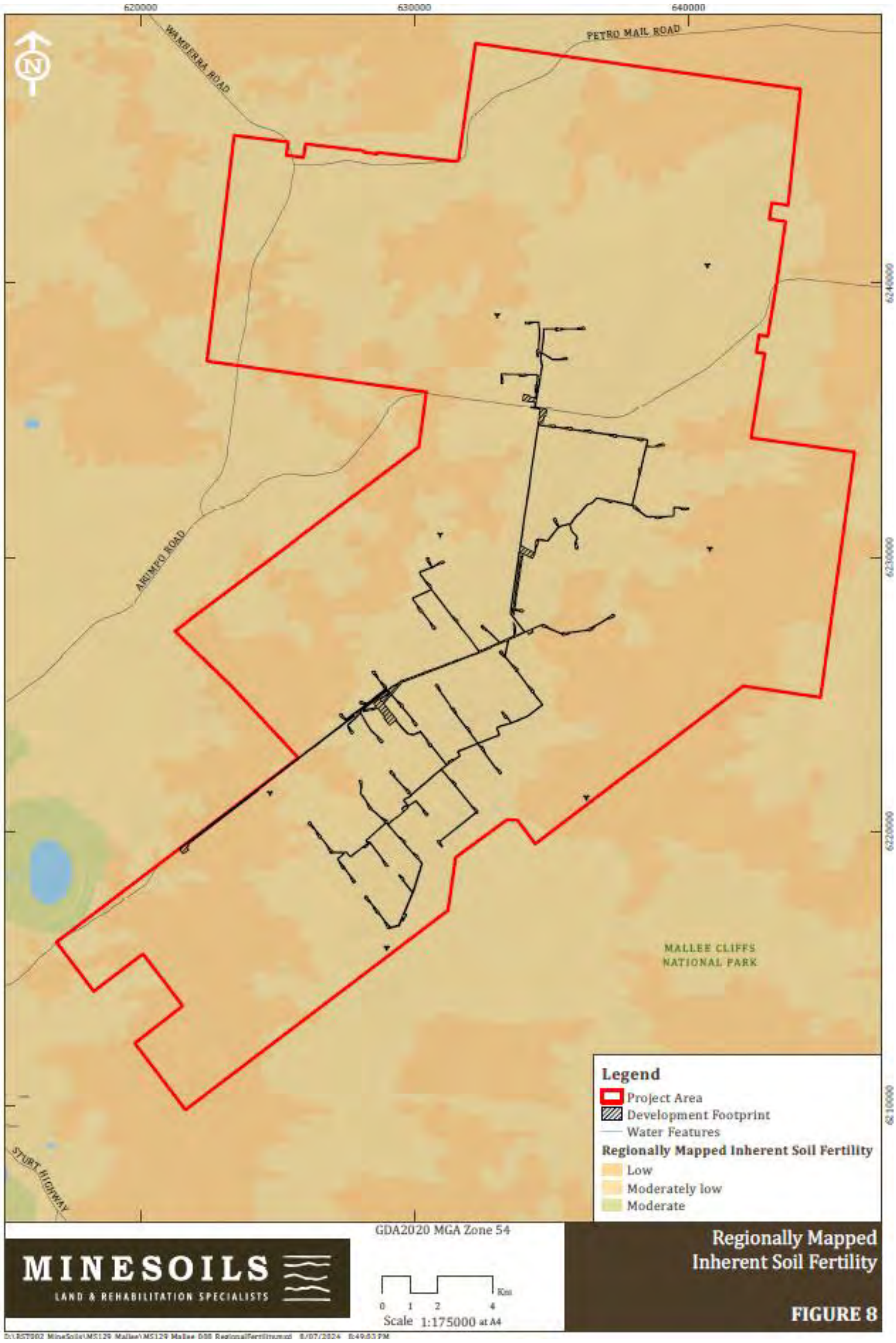

Figure 3.7 Regionally mapped inherent soil fertility
(Source: Minesoils, 2024)

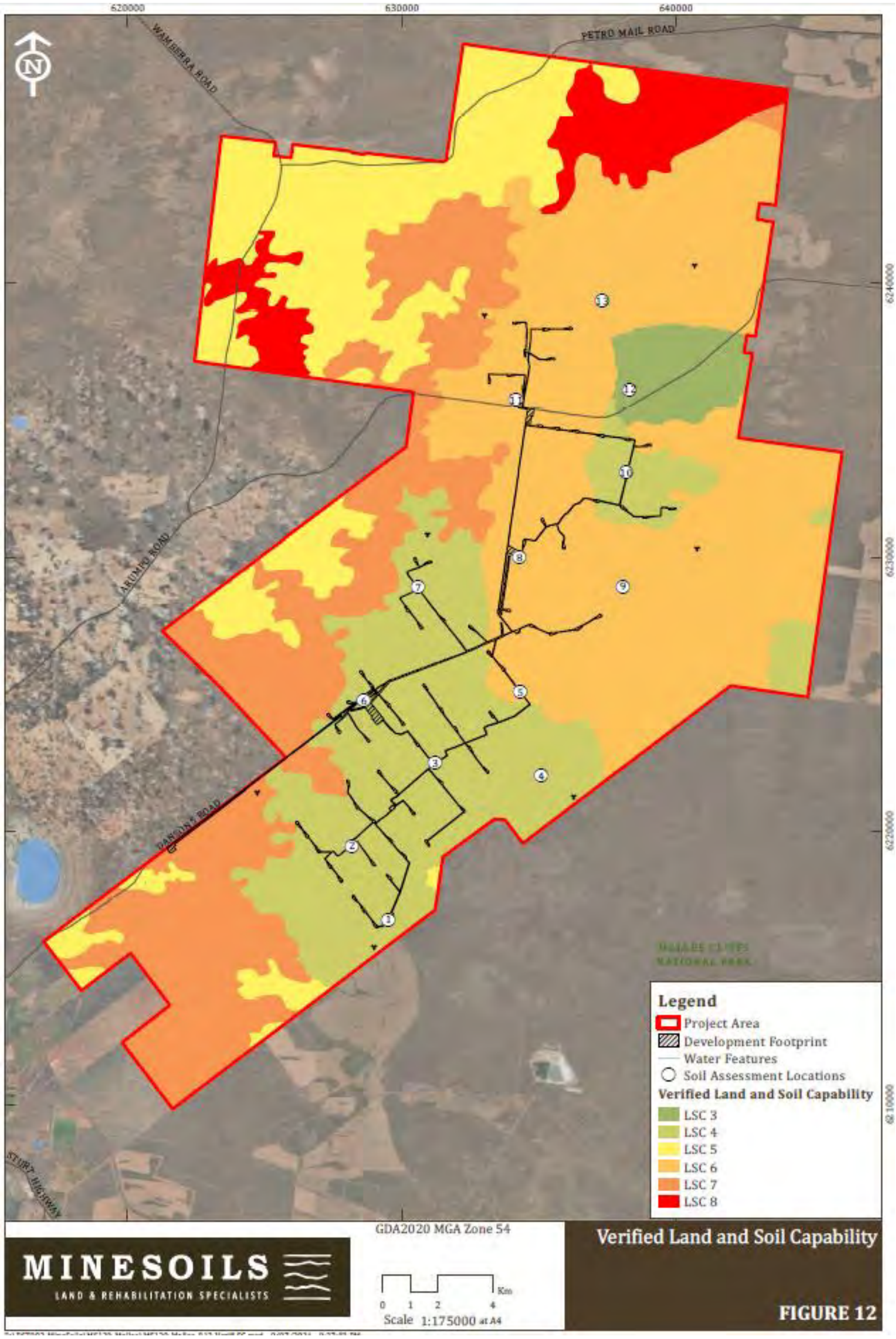

Figure 3.8 Regionally mapped land and soil capability
(Source: Minesoils, 2024)

3.5 WATER QUALITY

3.5.1 NSW Water Quality Objectives

The NSW Water Quality Objectives (WQOs) have been developed to guide plans and actions to achieve healthy waterways. The WQOs are based on measurable environmental values (EVs) for protecting aquatic ecosystems, recreation, primary industries, drinking water and industrial water. The site is located within the Barwon-Darling and Far Western Water Quality and River Flow catchment and has its own specific Water Quality Objectives (WQOs)[3].

The Objectives include the agreed high-level goals for surface water flow management. They identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses.

Specific environmental values for uncontrolled streams in the Barwon-Darling and Far Western catchment including the Project Area are protection of:

- aquatic ecosystems
- visual amenity
- primary and secondary contact recreation
- livestock water supply
- irrigation water supply
- homestead water supply
- drinking water at point of supply - disinfection only;
- drinking water at point of supply - clarification and disinfection;
- drinking water at point of supply - groundwater; and
- aquatic foods (cooked).

Default trigger values for water quality indicators relevant to the various environmental values from the Barwon-Darling and Far Western Water Quality and River Flow Objectives are shown in Table 3.3.

Based on the likely construction activities and operations for the Project and the environmental values listed above, the water quality objectives are considered relevant to the Project. An assessment of the potential impact on water quality is presented in Section 6.1 and considers the estimated pollutant concentrations and loads in stormwater discharging from the Project Area.

[3] https://www.environment.nsw.gov.au/ieo/FarWest/report-03.htm

Table 3.3 Water quality trigger values, Barwon Darling and Far Western

Parameter	Unit	Trigger Value						
		Irrigation	Livestock Drinking	Ecosystem[1]	Recreation	Homestead Water Supply	Drinking Water for Disinfection	Aquatic Foods
pH	pH	6.0 - 9.0	-	6.5 - 8.0	5.0 - 9.0	6.5 - 8.5	6.5 - 8.5	-
Electrical Conductivity (EC) (uncompensated)	µS/cm	1,000[2]	-	-	-	-	-	-
EC (25C)	µS/cm	-	-	30 - 350	-	-	<1500	-
Dissolved Oxygen (% Saturation)	%	-	-	90 - 110	-	-	-	-
Total Dissolved Solids (TDS)	mg/L	-	2,000[2]	-	1,000	<500 - 1000	-	-
Turbidity	NTU[7]	-	-	2 - 25	6	5	-	-
Calcium (Ca)	mg/L	-	1,000	-	-	-	-	-
Sodium (Na)	mg/L	115[3]		-	300	-	-	-
Magnesium (Mg)	mg/L	-	2,000[4]	-	-	-	-	-
Sulphate as SO_4	mg/L	-	1,000	-	400	-	-	-
Chloride as Cl	mg/L	175[3]	-	-	400	-	-	-
Aluminium	mg/L	5[6]	5	-	0.2	-	-	-
Arsenic	mg/L	0.1[6]	0.5[2]	0.013[2, 5]	0.05	-	-	-
Barium	mg/L	-	-	-	1	-	-	-
Beryllium	mg/L	0.1[6]	-	-	-	-	-	-
Cadmium	mg/L	0.01[6]	0.01	0.0002[5]	0.005	-	-	-
Chromium	mg/L	0.1[6]	1	0.001[5]	0.05	-	-	-
Cobalt	mg/L	0.05[6]	1	-	-	-	-	-
Copper	mg/L	0.2[6]	0.4[2]	0.0014[5]	1	-	-	0.005
Iron	mg/L	0.2[6]	-	-	0.3	-	-	-
Lead	mg/L	2[6]	0.1	0.0034[5]	0.05	-	-	-

Parameter	Unit	Trigger Value						
		Irrigation	Livestock Drinking	Ecosystem[1]	Recreation	Homestead Water Supply	Drinking Water for Disinfection	Aquatic Foods
Manganese	mg/L	0.2[6]	-	1.9[5]	0.1	-	-	-
Mercury	mg/L	0.002[6]	0.002	0.0006[5]	0.001	-	-	0.001
Nickel	mg/L	0.2[6]	1	0.011[5]	0.1	-	-	-
Selenium	mg/L	0.02[6]	0.02	0.011[5]	0.01	-	-	-
Vanadium	mg/L	0.1[6]	-	-	-	-	-	-
Zinc (Zn)	mg/L	2[6]	20	0.008[5]	5	-	-	0.005
Ammonia	mg/L	-	-	0.013	-	-	-	-
Total phosphorus (Total P)	mg/L	0.056	-	0.02	-	-	-	-
Total nitrogen (Total N)	mg/L	5[6]	-	0.25	-	-	-	-
NOx	mg/L	-	-	0.015	-	-	-	-
Nitrate-N	mg/L	-	400	0.7[5]	10	-	-	-
Nitrite-N	pH	-	30	-	1	-	-	-

Source: Barwon Darling and Far Western Water Quality and River Flow Objectives (https://www.environment.nsw.gov.au/ieo/FarWest/report-03.htm#P524_39032)

Notes: - No Trigger Value recommended

[1] Upland River

[2] Lowest recommended value

[3] Sensitive crops

[4] Cattle (insufficient information on other livestock)

[5] 95% of species protected

[6] Long term Trigger Value

[7] NTU = Nephelometric Turbidity Units

3.6 WATER EXTRACTION AND USERS

Water Sharing Plans (WSPs) have been developed under the *Water Management Act 2000* to protect the environmental health of water sources, whilst securing sustainable access to water for all users. The WSPs specify maximum water extractions and allocations and provide licensed and unlicensed water users with a clear picture of when and how water will be available for extraction. A check was undertaken for the Lot Plan numbers within the Project Area. Table 3.4 summarises the Water Access Licences (WAL) for the Lot Plan numbers within the Project Area.

Table 3.4 Water Sharing Plan and Water Access Licences near Project Area

WAL No.	Licence Category	Share components	Water Source
7529	Domestic and Stock	73	New South Wales Murray Regulated River Water Source

3.7 GROUNDWATER

In total there are six (6) registered groundwater bores located within the Project Area (BoM, 2023), as shown in Figure 3.9. Five groundwater bores (GW087124, GW087125, GW088040, GW600093, GW03664) are listed as currently functioning for monitoring purposes. The remaining bore (GW036844) is located in close proximity to GW036664 and is for water supply. The drilled depth of water supply and monitoring bores ranges between approximately 31 m and 72 m.

The regional water table is relatively deep located at around 20 to 50 metres below ground level (BGL). Localised perched groundwater systems are still possible. Based on salinity data for registered bores, groundwater quality in the Project Area has a salinity ranging from 3000 mg/L (slightly brackish) to 29,500 mg/l (very saline)[4].

3.7.1 Groundwater Dependent Ecosystem

A Groundwater Dependent Ecosystem (GDE) is an ecosystem which is dependent on the availability of groundwater to maintain structure and function. Terrestrial (including riparian vegetation) GDEs are dependent on the subsurface presence of groundwater to a depth of 10 m BGL. Aquatic GDEs are dependent on surface water's interaction with groundwater. Ecosystems are classified as:

- High potential ecosystems which have a high potential (strong possibility) of groundwater interaction
- Moderate potential ecosystems which have a moderate potential for groundwater interaction.
- Low potential ecosystems which have a low (unlikely) potential for groundwater interaction.

According to the GDE Atlas (BoM, 2018), the Project Area is not mapped as containing any GDEs. Refer to Figure 3.9 which shows no GDE in the vicinity of the site.

3.7.2 Groundwater Vulnerability

Groundwater vulnerability is described by the NSW Government (2023) as the vulnerability or risk of aquifers to contamination, relating to physical characteristics of the location, such as the depth to the water table and soil type. Mapping provided by the NSW Government was reviewed for groundwater vulnerability within and surrounding the Project Area. There are no groundwater vulnerability areas mapped for the Project Area (DPE, 2014). The geologic units are shown in Figure 3.10.

[4] bom.gov.au/water/groundwater/explorer/

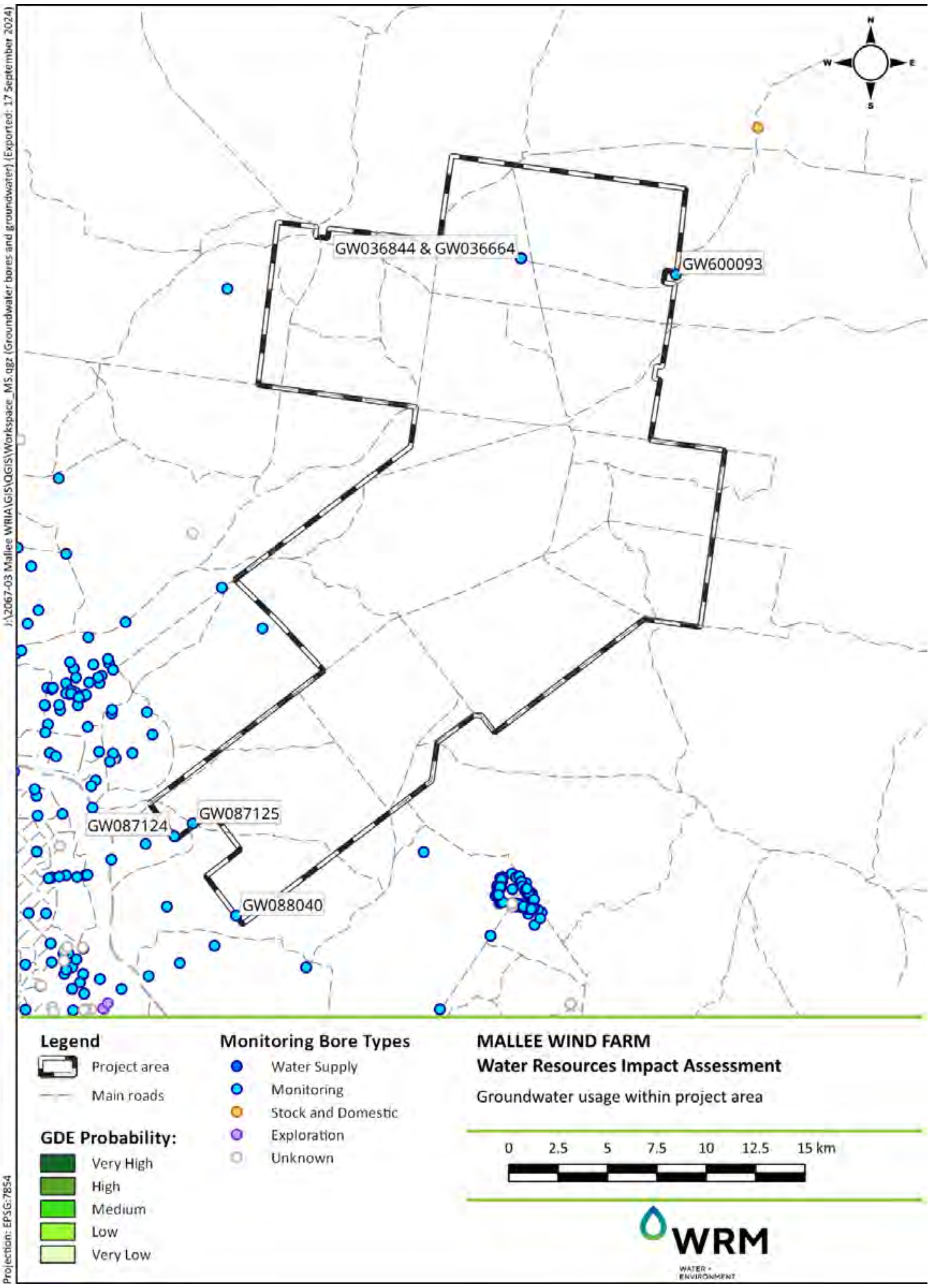

Figure 3.9 Groundwater bores and groundwater dependent ecosystems
(Data source: BOM, bom.gov.au/water/groundwater/explorer)

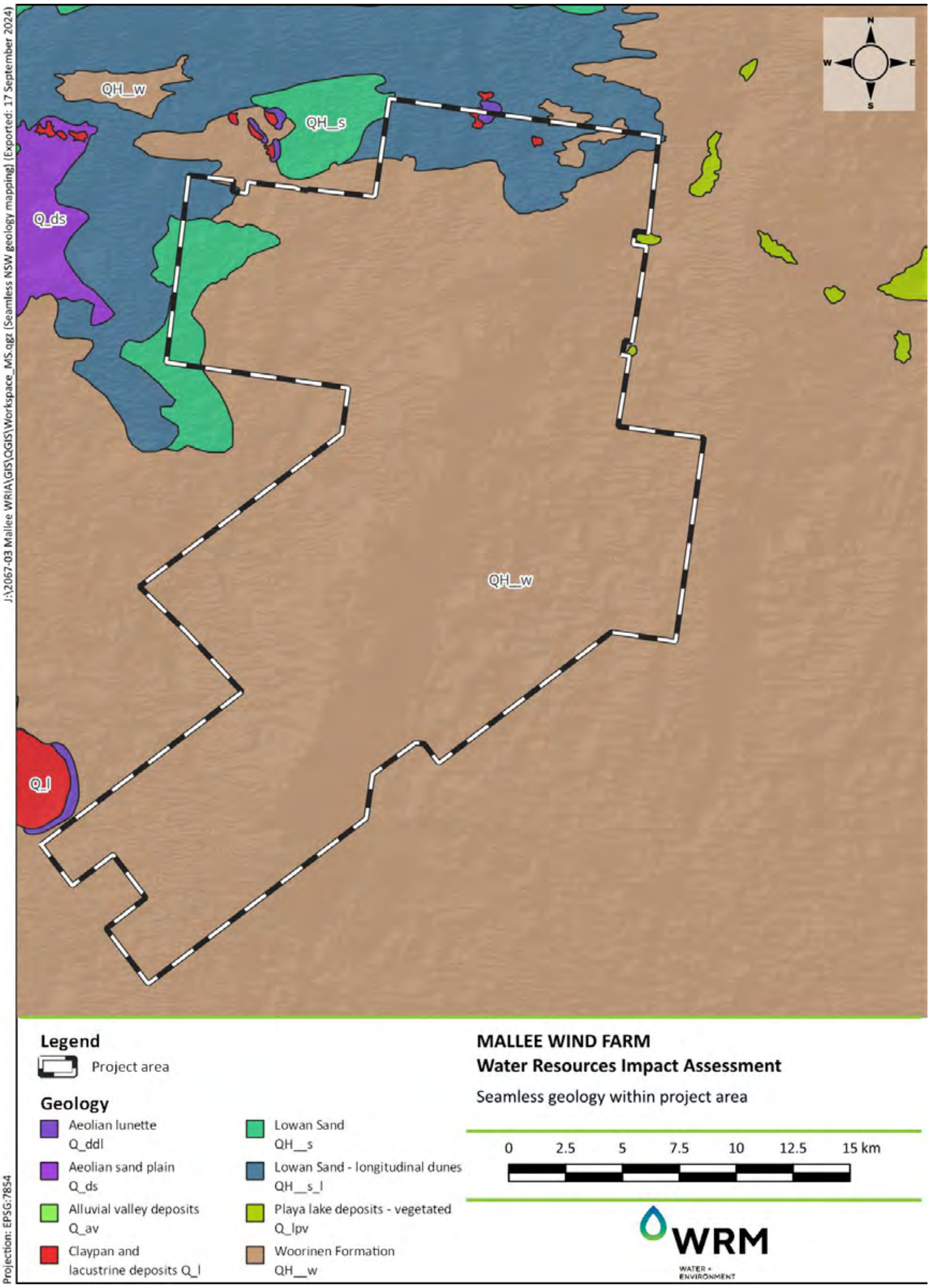

Figure 3.10 **Seamless NSW geology mapping**
(Data source: NSW, 2024)

4 WATER MANAGEMENT

4.1 OVERVIEW

The Project will require a water supply during the construction, operation and decommissioning phases. During construction, water will primarily be used for revegetation, dust suppression and potable use for the TWA. Per Section 4.2 below, the associated water demand during the construction phase is estimated to be approximately 140 ML for the entire duration of construction. The water demand during operations and decommissioning is expected to be significantly lower in the range of 1 to 3 ML per annum.

4.2 WATER DEMAND

4.2.1 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
- TWA and Amenities.

A preliminary assessment of water demands has been made based on the current design and a number of assumptions outlined in Table 4.1. 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, hardstand areas and TWA potable use. 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 are:

- Peak daily demand of 600 kL/day raw with 40 kL/day potable water; and
- Average daily demand of 250 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 4.1 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	Active work areas only - assume at 10% of total tracks at any one time Assume balanced with pan evaporation, refer Section 3.2
Construction – access tracks	Minimum 6m wide by 150 km. Rip to 500 mm and re-compact - add 8% water content to condition. 300 mm road base - add 12% water content to condition pro-rata over period of access track 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 3.2
Construction – Concrete	128,620 m^3 to cover transmission footings/ BESS/ main / Collector substations
Construction – Turbine Foundations	76 units excavation and foundation construction period 30 m dia (approx. 707 m^2) × 1m t of concrete (equivalent 2,291 m^3) – approx. 100 L water per tonne 1 week curing - 5 L/m^2 (mixing curing compound)
Potable	Construction workforce: 400 personnel, for the construction phase Allowance 40 L/pers/day - 7 day week

Table 4.2 Construction Phase Total Water Demand (indicative only)

Water Demand	Total Water Usage (ML)
Key assumption is that demand is evenly distributed over excavation and foundation construction period	
Dust suppression (nett. Evap)	38
Construction – Formed Access Track	57
Construction – BESS/switchyard/transmission	15
Construction - Concrete foundations	<1
Washdown - Concrete plant	<1
Washdown - Vehicle	11
Potable	18
Total demand	**140**

4.2.2 Operational Water Demand

During operations, up to 1 ML per year would be required for ongoing maintenance activities such as amenities and potable purposes by operational staff, and equipment wash 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.

4.3 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.

Water supply during construction, operation and decommissioning will be sourced primarily from Wentworth Shire Council commercial water supply and trucked to the Project Area. Potable and non-potable water supply would be sourced from existing water sources in Buronga and Wentworth that are currently also used to facilitate construction of Project EnergyConnect.

Potable water would be primarily sourced from Modica Crescent Buronga and supplied via filling through a metered hydrant from the existing water main. An alternative potable water source is also proposed via Beverley Street Wentworth and would be supplied via an overhead fill point.

Non-potable water would be sourced via River Drive Buronga and would also be supplied via an overhead fill point.

Spark Renewables are in active negotiations with Wentworth Shire Council in relation to the contractual sourcing of water from the Council's mains water supply. Negotiations and consultation are ongoing and that the agreement with Council will be finalised in the detailed design stage.

It is expected that water carting contractors will be available to provide carting and disposal services. Final agreements and any further confirmation requirements will be undertaken during the detailed design stage.

In addition to the above where feasible, water for construction purposes will also be opportunistically sourced from the following methods to minimise the need for imported water:

- use from existing dams where harvestable rights apply
- reuse from rainwater tanks collecting runoff from building roofs.

Based on the total Project Area of 57,330.31 ha, the Maximum Harvestable Right Dam Capacity (MHRDC), from which water can be used for any purpose, is 3153.17 ML based on the above Project Area's centroid of -34.144682, 142.422369. This value was calculated using the WaterNSW MHR calculator available at this link[5].

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 for concrete facility and vehicle washdown, would be recycled and reused as far as practical.

Where further licenses are needed to access water from these sources or license 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.

It is noted that the total water demand for the construction phase is 140 ML. The Project has a Maximum Harvestable Right that is twenty times larger than the construction demand. Subject to climatic variability and runoff collection, a network of reservoirs (tanks, small dams and so forth) could collect and recycle as much runoff as possible to minimise water supply demand from external sources.

[5] https://www.waternsw.com.au/customer-services/water-licensing/maximum-harvestable-rights-calculator

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

4.3.1 Potable Water Supply

Potable water demands for the Project would be primarily sourced from the existing water main on Modica Crescent Buronga, trucked to the site 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 water quality ADWG water quality standards are maintained.

4.3.2 Amenities Wastewater

Treatment of wastewater from TWA amenities during all phases of the Project will be provided by an on-site treatment system. The proposed treatment system will be a contained system and is anticipated to include mechanical screening, biological and chemical treatment, filtration and disinfection. The waste solids produced by the treatment system will be emptied by a licensed contractor and disposed of at a nearby council operated wastewater treatment plant or other appropriately licensed facility.

It is expected that local liquid contractors will be available to provide carting and disposal services. Final agreements and any further confirmation requirements will be undertaken during the detailed design stage.

Treated effluent suitable for reuse for construction purposes, which are anticipated to include dust suppression and earthworks conditioning, will be stored in sealed tanks or lined basins to avoid potential interaction with groundwater.

4.4 SITE WATER BALANCE

The Project will require water to be supplied from a variety of sources and qualities. The water demands were quantified in Section 4.2 and the possible supply sources were outlined in Section 4.3. An indicative summary site water balance is shown in Table 4.3.

All on-site storages required as part of the water supply were assumed to be constructed during the construction phase, i.e., prior to the commencement of operations. The purpose of each reservoir is determined by the water usage and quality. If there is insufficient on-site storage, an external water source would be required to meet site water demand during dry periods.

Table 4.3 Detailed site water balance (indicative)

Type	Feature	Construction Phase (total)	Operation (annual)
Water Demands	**TOTAL**	**140 ML**	**2 ML**
	Dust suppression (likely)	38	
	Construction input	73	-
	Washdown	11	< 1
	Potable	18	< 1

Type	Feature	Construction Phase (total)	Operation (annual)
Water Supply	Rainfall	24.4 ML Max Harvestable Right and refer Table 3.1	2 ML
	External raw water	Balance acquired from Wentworth Shire Council commercial water supply	Negligible.
	External potable water	11 ML (From Modica Crescent Buronga and supplied via filling through a metered hydrant from the existing water main & trucked to site)	~0.1 ML (From Modica Crescent Buronga and supplied via filling through a metered hydrant from the existing water main & trucked to site)

4.5 EROSION AND SEDIMENT CONTROL

Throughout the construction phase of the Project, erosion and sediment controls (ESCs) will be established in general accordance with *Managing Urban Stormwater – Soils and Construction Volume 1* (Landcom, 2004) and *Volume 2C: Unsealed Roads* (DECC, 2008) (i.e. the 'Blue Book'). The following sections outline the Project ESC design standards and anticipated ESCs to be implemented at the Project. Should the Project be approved and constructed, a detailed construction soil and water management plan (CSWMP) will be prepared by a suitably qualified person to facilitate implementation of best practice ESCs during all phases of the Project.

4.5.1 Construction on Waterfront Land

Approved SSD projects are exempt from the requirement to acquire Controlled Activity Approvals (CAAs) for works on waterfront land (works within 40 m of the top of bank of a waterway) under s.4.41(1)(g) of the *Environmental Planning and Assessment Act* 1979. While a CAA in not required, all works on waterfront land, if required, for the Project will be undertaken in accordance with DPEs *Guidelines for Controlled Activities on Waterfront Land*.

4.5.2 Erosion hazard assessment

An erosion hazard assessment has been undertaken in accordance with Chapter 4.4.1 of Volume 1 of the 'Blue Book'. The Australia Natural Resource Atlas provides gridded factor values within the Project Area. The Project Area slope was estimated based on the geospatial analysis to determine the average site slope of the existing landform. These gridded values were averaged and are presented in Table 4.4 and were used to assess erosion hazard for the entire Project Area.

The annual soil loss for the Project Area was estimated from the Revised Universal Soil Loss Equation (RUSLE). RUSLE mapping for the Project Area is provided in Appendix C. The annual soil loss rate is classified as a high or low erosion hazard. The erosion hazard assessment for the Project Area predicts that it can be classified as a very low erosion hazard. As such, standard erosion control measures will be applied during construction.

Table 4.4 Annual soil loss calculation

	Description	Value	Range
R	Annual average rainfall erosivity factor	450	435 - 485
k	Soil erodibility factor	0.058	0.035 - 0.075
LS	Slope length gradient factor based on Table A1 of *Managing Urban Stormwater Volume 1* (Landcom, 2004)	0.20	0.03 - 1.70
C	Ground cover factor sourced from Figure A5 of *Managing Urban Stormwater Volume 1* (Landcom, 2004)	0.065	0.014 – 0.336
P	Erosion control practise factor sourced from Table A2 of *Managing Urban Stormwater Volume 1* (Landcom, 2004).	1.3	Compacted and smooth
A	Calculated annual soil loss rate (RUSLE), tonnes/ha/year	0.442	0.014 - 6.438

The calculated annual soil loss rate for the Project Area corresponds to a very low erosion hazard, (soil loss class 1). Classification of soil loss is provided in Volume 1 of the Blue Book (Landcom, 2004) at Table 4.2. The Blue Book's Figure 4.9 indicates that the Project Area is located in rainfall distribution zone 12. Consulting *Lands where special erosion control measures apply* in the Blue Book's Table 4.3 indicates that for zone 12 and soil loss class 1, there are no time of year restrictions applicable to the Project Area.

The Blue Book instructs that all land within 40 m of the bank of a defined watercourse (Stream Order higher than 4) is to be considered as a very high erosion hazard (soil loss class 6). As the highest watercourse Stream Order within the Project Area is 3, no time of year restrictions are applicable to the Project Area.

Where scheduling of works during periods where the three-day forecast indicates that rain is likely, erosion control measures should aim to protect disturbed lands with 60% ground cover. Where non-forecast rainfall arrives, site management techniques should endeavour to ensure that site erosion is minimised and mitigated within 24 hours.

4.6 GENERAL EROSION AND SEDIMENT CONTROL STRATEGY

The detailed design phase will finalise drainage sizing and alignments. Once this information is known, and prior to construction, a detailed Erosion and Sediment Control plan will be developed. This will specify the locations of all necessary Erosion and Sediment Controls (ESCs) to achieve the principles outlined below. The ESCs are to be installed, managed and maintained in general accordance with the Blue Book Volume 1 (Landcom, 2004) and Volume 2C (DECC, 2008). This will be achieved using the following principles and strategies.

4.6.1 Principles of Site Management

- Clean water flows will be diverted and prevented from entering the site. Flows generated from runoff within the site will have their water velocity minimised and any sediments captured before discharge from site.
- Stockpiles of erodible material that have the potential to cause environmental harm if displaced will be located away from concentrated surface flow and excessive up-slope stormwater surface flows.
- Sediment removed from any trapping device is to be disposed of in locations where further erosion and consequent pollution to downslope lands and watercourses will not occur.
- Temporary soil and water management structures are to be removed only after the Disturbance Footprint is stabilised appropriately.

- Refuelling of plant and equipment is to be undertaken in an impervious bunded area located a minimum of 50 m from drainage lines or watercourses.
- Emergency spill kits are to be kept on site at all times. All workers are to be made aware of the location of the spill kits and trained in their use.
- All fuels, chemicals and liquids will be stored in an impervious bunded area, a minimum of 50 m away from drainage lines or watercourses.
- Any concrete washout undertaken on site (during construction phase) will be in a bunded area that is not on waterfront land and at least 10 m from drains.

4.6.2 Erosion Sediment Controls strategy

The following ESC management strategies will be implemented within the Project Area.

- To minimise ground disturbance, construction and operational activities including vehicle and machinery movements, stockpiling, temporary vehicle parking and material laydown will be restricted to designated work areas. The Disturbance Footprint boundary is to be clearly delineated with construction fencing or barrier tape.
- Where possible, topsoil will be stripped and handled only when it is moist (not wet or dry) to avoid decline of soil structure.
- Topsoil stockpiles will be stabilised with vegetation (seeded) if they are to be inactive for long periods.
- Sediment traps should be located as close to the source of the sediment as practicable.
- Sediment control devices must be de-silted and made fully operational as soon as reasonable and practicable after a sediment-producing event. Sediment traps should be maintained to ensure that no more than 30% of their design capacity is lost to accumulated sediment.

As the Project Area is predominantly flat and the annual soil loss rate is very low, the Blue Book considers sediment basins as having limited practicality to drain and protect disconnected areas. The use of sediment basins will depend on the practicality of draining flat, disconnected and disturbed areas to a single sediment basin. The Blue Book suggests a contiguous disturbance area threshold of around 2 ha. Other more effective sediment controls are possible, and they would protect receiving waters from sediment generated within the Disturbance Footprint.

4.6.3 Drainage Controls

- All temporary drainage controls are to be designed to have non-erosive hydraulic capacity to convey runoff from a 10% AEP critical duration storm event.
- Wherever reasonable and practicable, “clean” surface waters must be diverted away from sediment control devices and any untreated, sediment-laden waters.
- All runoff from the works is to be passed through sediment controls.

4.6.4 Monitoring and Maintenance

- Monitoring will be undertaken by a construction supervisor or a designated representative of the contractor during all work to ensure that the proposed ESC measures are functioning as intended.
- Any erosion and sediment control failures or excess sediment build up identified during the site inspections is to be rectified as soon as practicable following identification. Any sediment removed from devices should be disposed of in a lawful manner that does not cause ongoing soil erosion or environmental harm.

5 EXISTING FLOOD BEHAVIOUR

5.1 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% and 0.2% AEPs and the Probable Maximum Flood (PMF) for current climate.

It is noted that the 0.5% and 0.2% AEPs are modelled as proxies for sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change in accordance with the recommended SEARs from NSW Biodiversity, Conservation and Science of DCCEEW (BCS).

There is no recorded water level data or anecdotal information available within the Project Area, and therefore model calibration was not possible.

Model topography was based on a 5 metre Digital Elevation Model (DEM) supplied by Spark Renewables and 30 metre (2013) Copernicus Data for a small north-north east extent at the top of the ridge (see Section 5.5 for accuracy details). The model grid size was 30 m. Used in combination with TUFLOW's sub-grid sampling (SGS) functionality, the 30 m model grid size provided adequate resolution to capture key drainage features and overland flow paths, while maintaining reasonable simulation times.

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

- Site runoff: Short duration (< 60 minutes) intense rain failing directly on the Project Area; and
- Local catchment flooding: Medium duration (1 hour – 6 hours) rain falling on land draining to the Project Area.

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 generally flat nature of the lower area precluded the use of a semi-distributed hydrologic model (URBS or RORB) from defining upstream catchments. The required extent of the hydraulic model domain was assessed by applying direct rainfall and assessing flow directions across the floodplain and interconnected watercourses. 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.

5.2 DESIGN EVENTS

Design rainfall depth data, as well as design losses, and storm pre-burst details were obtained from Australian Rainfall and Runoff (ARR) datahub[6], in accordance with the current ARR guidelines. 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 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.

Design event modelling results were post-processed to derive design flood parameters (e.g. peak flood depths and extents) for each AEP and design scenario.

[6] https://data.arr-software.org/

5.2.1 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. These depths are summarised in Table 5.1 and Table 5.2.

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.

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 5.3 and Table 5.4. These losses are relevant to the pervious catchment areas noting that there is no significant proportion of impervious area within the modelled catchments.

Table 5.1 Design Rainfall Depths (mm) for Various Event Durations and AEPs

Duration (min)	10% AEP	1% AEP	0.5% AEP	0.2% AEP
60	29.6	55.2	62.6	73
90	33.3	62	70.3	82
120	36.1	66.9	75.9	88.6
180	40.4	74.2	84.2	98.4
270	45.1	81.7	92.9	109
360	48.9	87.4	99.4	117
540	54.7	95.7	109	128
720	59.1	102	116	136
1080	65.7	111	126	148
1440	70.4	117	133	155
1800	74.1	122	139	162
2160	76.9	126	143	166
2880	81.1	131	149	172
4320	86.2	138	155	178

Table 5.2 PMP Design Rainfall Depths (mm) for Various Event Durations

Duration (min)	PMP Depth	Derivation Method
60	180	GSDM
90	240	GSDM
120	290	GSDM
180	330	GSDM
270	350	GSDM
360	380	GSDM
540	400	-*
720	410	-*
1080	440	-*
1440	470	GSAM
2160	540	GSAM
2880	580	GSAM
4320	610	GSAM
5760	620	GSAM

*Line of best fit to distribution curve of GSDM and GSAM rainfalls.

5.2.2 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 portal[7]. Key design rainfall parameters include:

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

5.2.3 Design rainfall losses and pre-burst rainfall

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

[7] https://data.arr-software.org/

Table 5.3 provides the initial and continuing losses used for the 1% AEP event rainfall losses. Table 5.4 provides the Probability Neutral Burst Initial Loss values referred to by Table 5.3.

Table 5.3 Losses Used in the Developed Hydraulic Model

Losses	Frequent and infrequent (≤ 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 5.4 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	24.9	23.9
90	0	0	24.9	23.5
120	0	0	24.9	24.7
180	0	0	24.9	24.9
270	0	0	24.9	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

5.2.4 Temporal Patterns

Temporal patterns are the distribution of the total rainfall in different periods within a given duration. A suite of 10 temporal patterns for the Murray Darling, appropriate for the Project Area, were downloaded from ARR 2019 Data Hub and used to simulate the temporal distribution of rainfall depths during each storm duration modelled (see Table 5.5). The suite of temporal patterns has been applied to estimate the critical design event for flood estimation in accordance with ARR 2019 procedures.

Table 5.5 Murray Darling Temporal Patterns

Temporal Pattern Number	Event ID
1	3683
2	3801
3	3916
4	3990
5	3991
6	3992
7	3993
8	3994
9	3996
10	3997

5.2.5 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. Critical durations varied across the model domain depending upon the size of the upstream catchment. The critical duration and temporal pattern for the 1% AEP storm through the main southern flow path is the 3 hour duration for temporal pattern 8.

5.3 HYDRAULIC MODELLING

5.3.1 Topography and grid cell size

The 5 m topographic data supplied by the client and Copernicus Data for a small north-north east extent at the top of the ridge was adopted as the base model topography. A 25 m grid size resolution was adopted for hydraulic modelling. In combination with TUFLOW's sub-grid sampling (SGS) functionality, the 25 m cell size provides adequate resolution to capture key drainage features (SGS frequency of 5) and overland flow paths, while maintaining reasonable simulation times.

5.3.2 Boundary conditions

Figure 5.1 shows the locations of inflow and outflow boundaries in the local catchment TUFLOW model. The model includes:

- Direct rainfall boundary covering the entire hydraulic model extent;
- 31 outflow boundaries.

Normal flow (HQ) type boundary conditions were implemented for the downstream model boundaries. The flows through the downstream boundaries are controlled by a normal depth rating curve. The downstream boundaries of the models were set well downstream of the Project Area to minimise influence on flood behaviour predicted near the Project Area. The downstream boundary conditions assumed depth slopes of 0.066 to 0.002 m/m, calculated from the flow path water surface slope. This normal depth slope is typical of the water surface slopes.

5.3.3 Hydraulic resistance

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance. Analysis of available aerial imagery showed that there are two 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 5.6.

Depth varying Manning's 'n' values were adopted as recommend by the TUFLOW manual for the direct rainfall (rain on grid) approach. For flood depths up to 100 mm, hydraulic roughness values are linearly interpolated by the TUFLOW software. The spatial discretisation of roughness values in the Study Area is shown in Figure 5.2. Light vegetation was used as the default roughness for areas not covered by a material layer in Figure 5.2.

Table 5.6 Depth-Varying Manning's Roughness used in the Hydraulic Model

Land Use	Manning's 'n'	
	Depth < 100 mm	Depth > 100 mm
light vegetation	0.080	0.045
Medium vegetation / crops	0.080	0.060

5.3.4 Hydraulic structures

No hydraulic structures were included in the model.

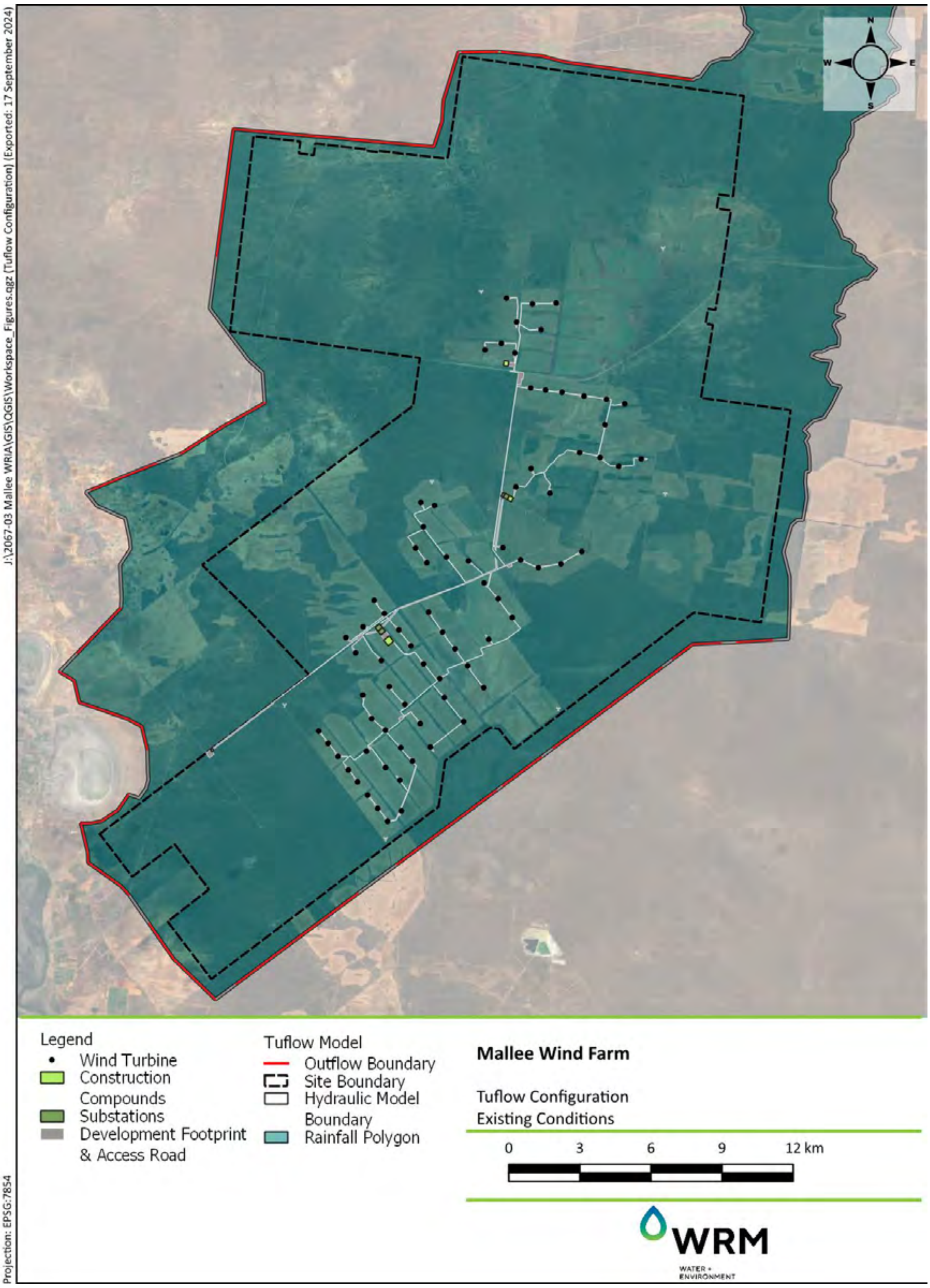

Figure 5.1 Hydraulic model configuration

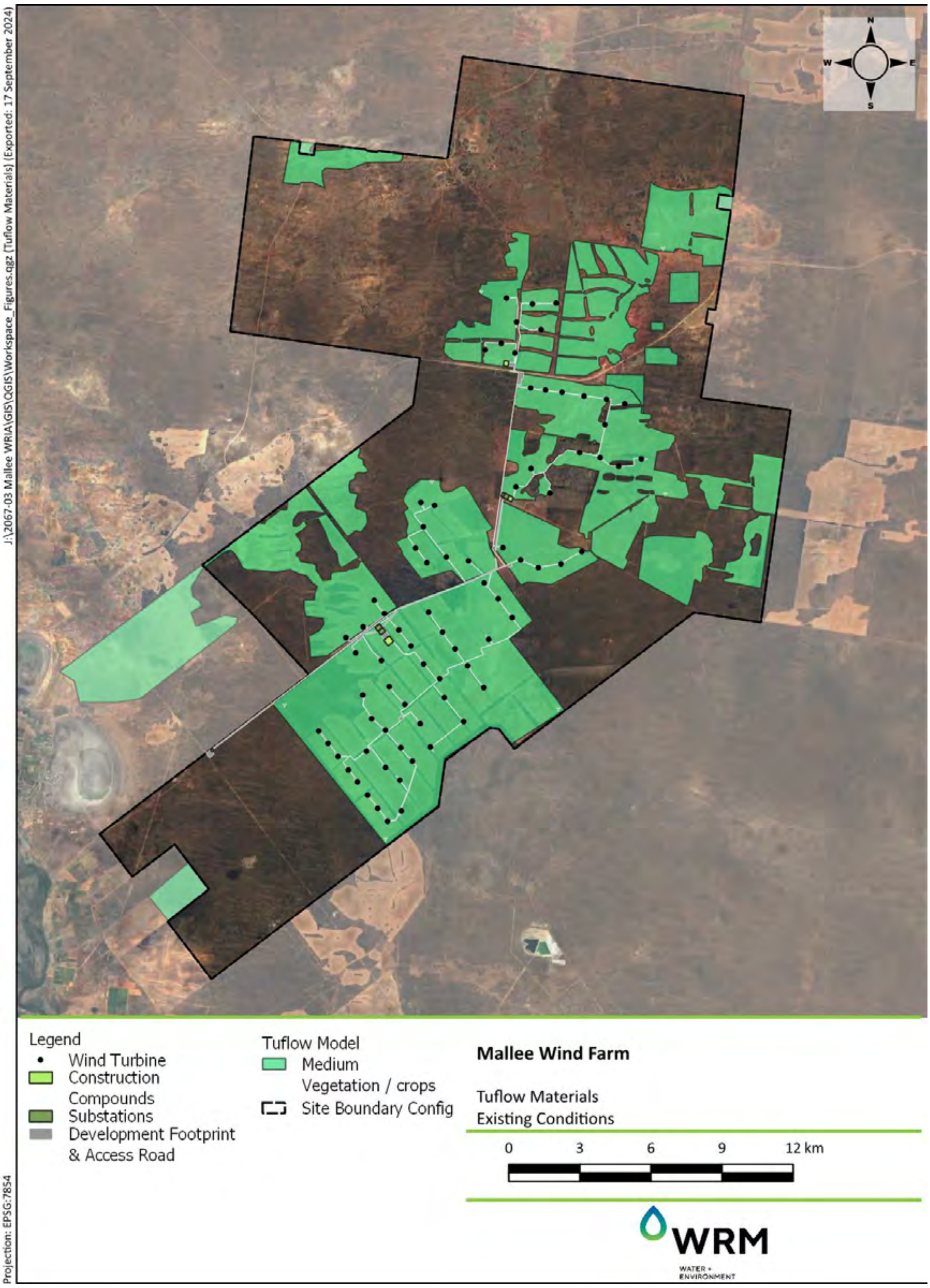

Figure 5.2 Hydraulic model roughness configuration

5.4 EXISTING FLOOD BEHAVIOUR

5.4.1 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. Due to the nature of the direct rainfall model results, 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 B. The figures show that the peak flood extent is largely confined to the local depressions either side of the ridge which traverses the Project Area, and overland flow paths to discontinuous watercourse networks. The local depressions and watercourse networks have gradually lowering topography which eventually drain from the Project Area to the south or west.

The modelled flood events are indicative of conditions as outlined below:

- 10 % AEP event – representative of an infrequent flood event;
- 1 % AEP event – representative of a rare event and forming the principal flood planning event;
- 0.5 % and 0.2 % AEP events – representative of extreme events and indicative of the 1% AEP event including climate change; and
- PMF – representative of the probable maximum flood event.

5.4.2 Flood Hazard

The flood hazard at the Project Area was assessed in accordance with ARR 2019. Flood hazard (or hydraulic hazard) defines the nature of a flood for a specific event, for example depth, depth x velocity and velocity. 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 5.7 and flood hazard colour coded curves are shown in Figure 5.3. The flood hazard mapping is provided in Appendix B**.**

Table 5.7 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*V ≤ 0.3	0.3	2.0	Generally safe for vehicles, people and buildings.
H2	D*V ≤ 0.6	0.5	2.0	Unsafe for small vehicles.
H3	D*V ≤ 0.6	1.2	2.0	Unsafe for vehicles, children, and the elderly.
H4	D*V ≤ 1.0	2.0	2.0	Unsafe for vehicles and people.
H5	D*V ≤ 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*V ≥ 4.0	-	-	Unsafe for vehicles and people. All building types considered vulnerable to failure.

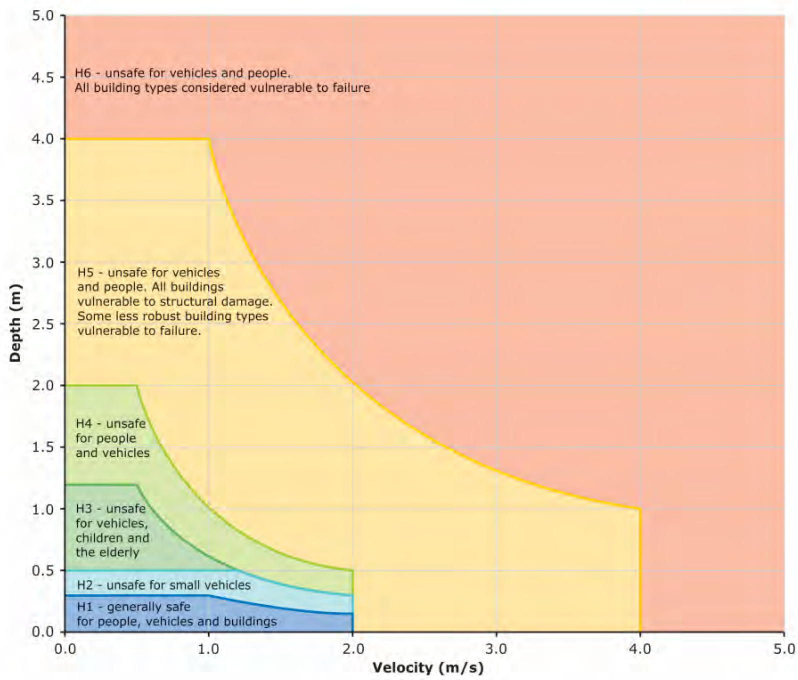

Figure 5.3 Combined Flood Hazard Curves
(Smith et al. 2014)

5.4.3 Design Flood Events

The flood modelling results are discussed below, mapped results are available in Appendix B. The modelled flood behaviour within the hydraulic model's domain is shown in Figure 5.1. Summary observations about flood behaviour are as follows:

- 10% AEP: Results show that flooding within the Project Area is within local depressions either side of the ridge which traverses the Project Area and within discontinuous watercourse networks. The local depressions and watercourse networks have gradually lowering topography which eventually drain from the Project Area to the south or west. Overland flow paths draining to the local depressions are typically shallow with flow depths of up to approximately 0.15m. The median depth of flow is 0.10 m and the greatest depths within the local depressions within the Project Area are up to 2.62 m.
- 1% AEP: The general flood inundation extents are increased from the 10% AEP event, with increasing depths associated with the higher flows. Flow depths within the overland flow paths draining to the local depressions are typically up to approximately 0.35m. The median depth of flow is 0.11 m and the greatest depths within the local depressions within the Project Area are up to 4.2 m. *This is the parameter adopted for planning purposes and utilised here to derive all necessary mitigation measures. Based on the Project design utilised for this assessment the 1% AEP flood extent has minimal interaction with the Disturbance Footprint, and where infrastructure interacts with the 1% AEP flood extent depths of flows and velocities are generally less than 0.25 m and 0.5 m/s, respectively. The hazard assessment has identified that the inundated areas of the Project Area are primarily classified as 'generally safe' (H1), with only isolated local depressions of H4 and H5 hazard where water accumulates or ponds, refer Section 6.2 of this report.*
- 0.5% AEP and 0.2% AEP: The flood depths are only marginally larger than those of more frequent conditions, with a median depth of 0.121 and 0.126, respectively and experience peak depths of

6.1 m and 7 m, respectively. 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 PMF is the extreme upper limit of the design event window. Arumpo Road at the Project Area boundary is inundated. Depths of flow at this location are approximately 5.3 and trafficable access to the Project Area is therefore not possible. The general flood inundation extents have significantly increased from the 0.2% AEP event, with increasing depths predicted throughout the Project Area. Depths of flow within the Project Area are typically up to approximately 1.0 m with a median depth of 0.23 m and a peak depth in one local depressions of up to 14.28 m. Despite the flood inundation extent increasing, only one (1) WTG is located within a local depression with significant depths (up to 5.64 m) and hazard up to H6 during the PMF event. The remainder of the WTGs, temporary and permanent structures are outside these significantly inundated areas. *It is reiterated that the PMF defines the upper limit of flooding that could reasonably be expected to occur and is much rarer than the 1% AEP flood which is the parameter adopted for planning purposes and utilised here to derive all necessary mitigation measures.*

5.5 LIMITATIONS

The modelling accuracy is subject to sources of uncertainty and limitations. Some potential sources of inaccuracy leading to uncertainty in the hydraulic model are as follows:

- Inaccurate topographic information – The hydraulic model relies upon representation of the ground topography to model the movement of water across the land. The DEM used to inform the model topography has a 5 m resolution grid provided by the client, however vertical and horizontal accuracy was not provided for survey. The Copernicus LiDAR data captured in 2013 with an absolute accuracy of <4 m (90% linear error) in the vertical and <6 m (90% circular error) in the horizontal. Accuracy of model results may be impacted by the accuracy of the DEM. For example, flowpaths smaller than 5 m in width (the limit of the DEM resolution) may not be well-represented be the model.
- No calibration to historical events – It is best practice to calibrate a hydraulic model to an historical event/s. However, calibration data for historical events is not available, making model calibration not possible. While the model parameters have been chosen in line with ARR 2019 recommendations and within industry accepted bounds, the ability of the model to reproduce actual flood behaviour is untested.
- Critical duration – a representative critical duration and temporal pattern has been selected to represent the flood behaviour across the project area. Given the broadscale nature of this impact assessment, this is an appropriate simplification. However, future detailed design (e.g. of waterway crossings) may need to model additional durations to determine whether the critical duration at the location of interest should be updated.

6 ASSESSMENT OF POTENTIAL IMPACTS

The Project has the potential to impact receiving surface water and groundwater quality, flood regimes, soil resources, available water supply to existing users and aquatic habitat. However, the potential impacts listed below would be contained to a small area, and there are numerous mitigation measures possible that reduce the risk to an acceptable level. In the absence of appropriate controls and assuming the worst possible case, the potential impacts to surface water resources associated with the Project may include:

- degradation of downstream surface water quality (primarily during construction and decommissioning but also potentially during operation) due to:
  - elevated concentrations of sediment and nutrients bound to sediment in any runoff;
  - elevated pH and fine sediment concentrations in runoff from mobile concrete batching plant areas;
  - chemical spills/leaks entering streams (e.g. diesel fuel or hydraulic oils from mobile plant);
- increased erosion within waterways due to:
  - damage to stream bed and bank from construction activities adjacent to and in-stream (e.g., stream crossings);
  - damage to riparian vegetation from construction activities on waterfront land;
  - runoff being concentrated by impervious areas associated with the Project;
- potential for alteration of flood flows and levels due to infrastructure located in close proximity to overland flow paths, local depressions and minor streams;
- loss of catchment yield during construction due to capture of water in sediment dams;
- depressurisation of groundwater aquifers and a reduction in bore yields to existing groundwater source users due to project water use (if groundwater is used to supply Project demands);
- degradation of groundwater quality due to chemical spills/leaks during construction;
- loss of catchment yield associated with sourcing water (licensed harvesting on-site or via agreement with host or local landholders) to meet construction water demands.

This WRIA has considered and assessed each of these potential impacts and where there is the potential for impacts to occur, has identified appropriate management measures to mitigate these risks. With respect to the three (3) offsite roadworks locations, there are negligible impacts to surface water aspects. As these works are to be undertaken within the existing established road corridor the impacts are anticipated to be negligible for the following aspects:

- surface water resources,
- groundwater quality,
- flooding regimes,
- soil resources,
- available water supply to existing users, and
- aquatic habitat .

6.1 SOIL AND WATER QUALITY IMPACTS

Potential impacts relating to soil and water quality are proportional to land disturbance. Minimising total land disturbed significantly reduces the risk of the following impacts. The impacts listed here are intended to provide an exhaustive summary only. Inclusion within this list is not intended to indicate actual or likely outcomes as a result of this Project.

The Project Area was assessed through soil surveys and desktop studies, which has ensured a comprehensive understanding of the soil resources. Appendix D contains summary information from extensive evaluation of the current soils resources and their tolerance to the Project. Additionally, the Project has a strong commitment to minimal surface disturbance and a clear strategy to restore the land to its pre-disturbance agricultural capability and usage after the Project's completion.

6.1.1 Construction and Decommissioning

During construction and decommissioning of the Project, soils would be subject to disturbance, during the removal of vegetation, excavation works and stockpiling of materials, potentially leading to sediments and/or pollutants being entrained in rainfall runoff and entering local watercourses. Discharge of polluted rainfall runoff from the Project has the potential to result in the deterioration of EVs and WQOs, for example:

- Pollutants such as sediments, pH, oils/grease and other nutrients bound to sediment or dissolved form. The Project would aim as far as practicable to achieving the Barwon-Darling and Far Western WQOs for protection of aquatic ecosystems.
- Works within or near local depressions and watercourse networks are a risk to downstream water quality due to the disturbance of the streambed and the mobilisation of sediments and pollutants. Work occurring outside of local depressions and watercourse networks may also indirectly mobilise sediment and pollutants via the action of wind then rainfall. Construction of the Project would not require controlled discharges to watercourses.
- Mobilised high concentration nutrients (fertilisers) may trigger algal blooms that result in anoxic conditions within any fish habitat. Mobilised heavy metals and contaminant concentration could result in degradation for aquatic habitats, irrigation and drinking water.
- Soils within the Project Area may contain residual herbicides/pesticides from historical or present day farming practices.
- Loss of topsoil resources on the land and ongoing erosion reducing the area of usable land and/or damage to private property for involved landholders.
- Water quality in farm dams is impacted and not suitable for stock watering, health or aquatic fauna and flora, as well as increased turbidity and decrease in water quality to downstream watercourses.

With the implementation of erosion and sediment control measures as well as appropriate measures to manage hazardous materials such as oils, fuels and other chemicals potential construction-related stormwater pollution impacts can be appropriately managed and are expected to be negligible.

During the construction phase, access through the Disturbance Footprint and broader Project Area will require the crossing of minor streams, overland flow paths and local depression. The Strahler stream orders within the Project Area are between one to three. It is noted that minor streams are identified as first and second Strahler Streams. The rainfall-runoff model results have captured areas likely defined as minor drainage features (overland flow paths and inundated local depressions) that are not mapped with a Strahler Stream Order of one (1). All crossings of these minor steams and drainage features are referred to as a 'waterway crossing'.

On review of the Strahler Stream Order mapping and the flood mapping in Appendix B, fifteen (15) waterway crossings were identified within the Disturbance Footprint. The location of each is shown in Figure 6.1 to Figure 6.4.

Arumpo Road crosses the Project Area providing site access to the Disturbance Footprint of the Project Area. Arumpo Road is an existing public road that may experience flooding in specific sections during rainfall. This assessment does not include the identification of waterway crossing locations in Arumpo Road as it is not within the Disturbance Footprint.

Waterway crossings 5, 6, 10, 11, 12 and 14 represent access track locations within the Disturbance Footprint that cross a minor stream (first and second Strahler Streams). The remaining locations represent internal access tracks within the Disturbance Footprint that cross existing overland flow paths/inundated local depressions where the depth of flow is greater than 300mm during the 1% AEP event. This 300mm depth has been selected as at this depth it begins to become unsafe for vehicles per the combined flood hazard classification in AIDR, 2017 (see Section 5.4.2 above).

Waterway crossings will warrant consideration of the flood conditions at each location with appropriate design of cross drainage to achieve flood immunity requirements for the access roads and internal access tracks. Requirements include:

- Adequately sized pipe drainage at the minor streams or drainage features are to allow for the conveyance of overland flow under and/or across the access tracks.
- Adequate erosion protection across and downstream of the access track crossing should be provided.
- An energy dissipator should be included at the pipe outlet or downstream of the minor stream or drainage feature to prevent potential erosion undermining the pipe/culvert and batters.
- Planned works are to be scheduled for forecasted dry weather periods.

Provided the waterway crossings are designed and constructed in accordance with relevant guidelines and in consultation with DPI Fisheries, the Project waterway crossings are not expected to result in any measurable impacts to stream health including water quality and fish passage.

With the implementation of measures outlined in Section 7, the potential water quality impacts would be adequately managed during the Project's construction and decommissioning phases.

6.1.2 Operation

During the operational phase, the potential impacts on water quality relate to the establishment of additional infrastructure, hardstands and access tracks. Due to the distribution of infrastructure throughout the Disturbance Footprint, the impacts of increased impervious areas are likely to have minimal noticeable impact. An additional water quality treatment measure that could be considered as part of the Project's detailed design is to identify if any existing eroding gullies are located within the Disturbance Footprint and rehabilitate them as part of the Project if required. This could further improve post-development stormwater quality.

Other potential water quality impacts during the operational phase associated with the day-to-day activities during this phase would be limited to:

- Stormwater runoff from impervious surfaces resulting in localised erosion.
- Accidental spills or discharge through the use and storage of chemicals such as fuel.

The potential for ongoing erosion post construction is conserved to be low provided appropriate rehabilitation of disturbed areas is undertaken and any areas identified as exhibiting signs of erosion above expected background levels are addressed.

All hazardous materials and chemicals will be stored in accordance with relevant Australian standards and other state and local guidelines including the NSW EPA's *Storing and Handling Liquids: Environmental Protection – Participants Handbook*.

Based on the above, and with the implementation of management measures outlined in Section 7, water quality impacts during the operational phase are expected to be negligible.

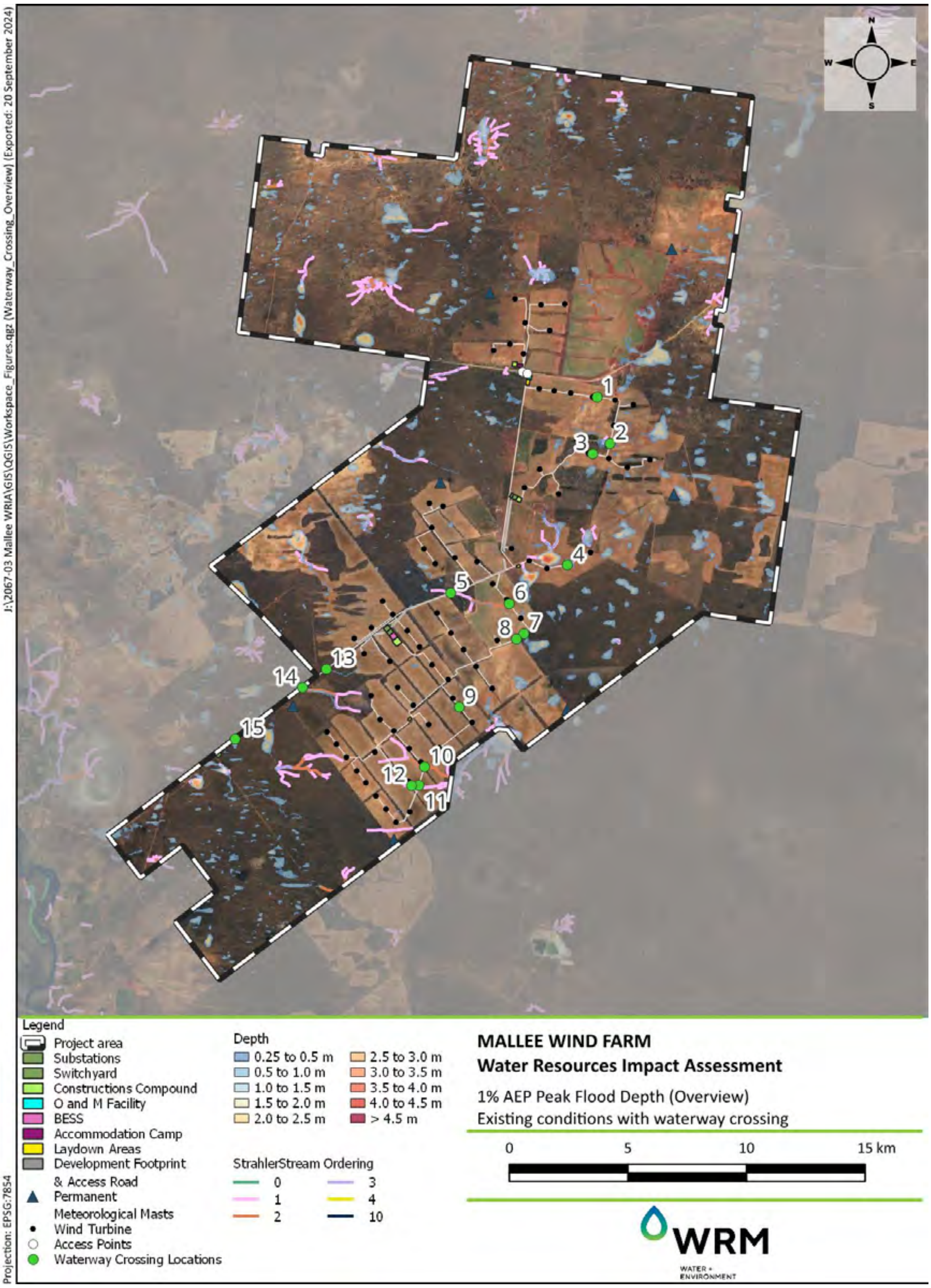

Figure 6.1 Waterway crossing locations (Overview)

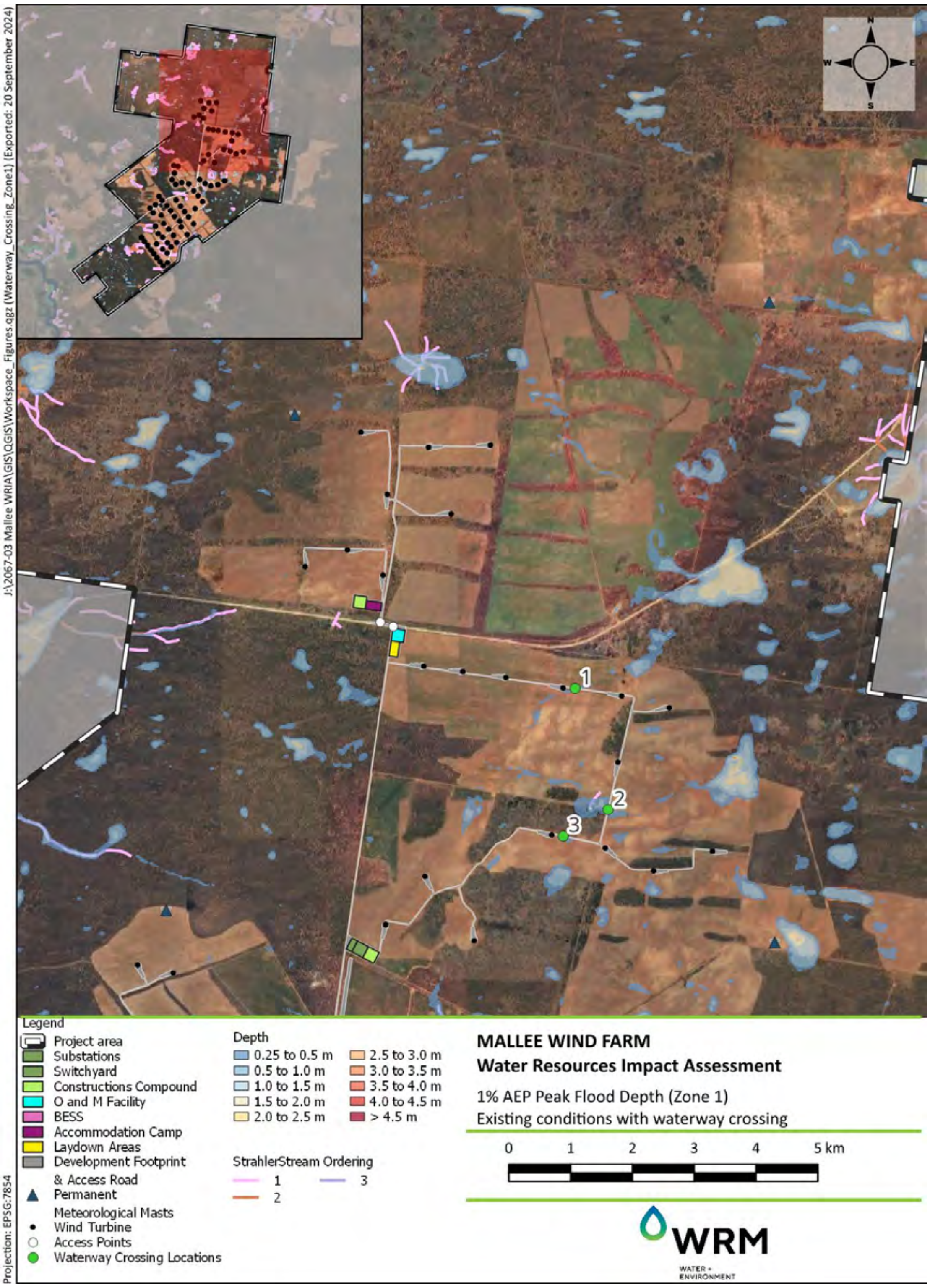

Figure 6.2 Waterway crossing locations (Zone 1)

Figure 6.3 Waterway crossing locations (Zone 2)

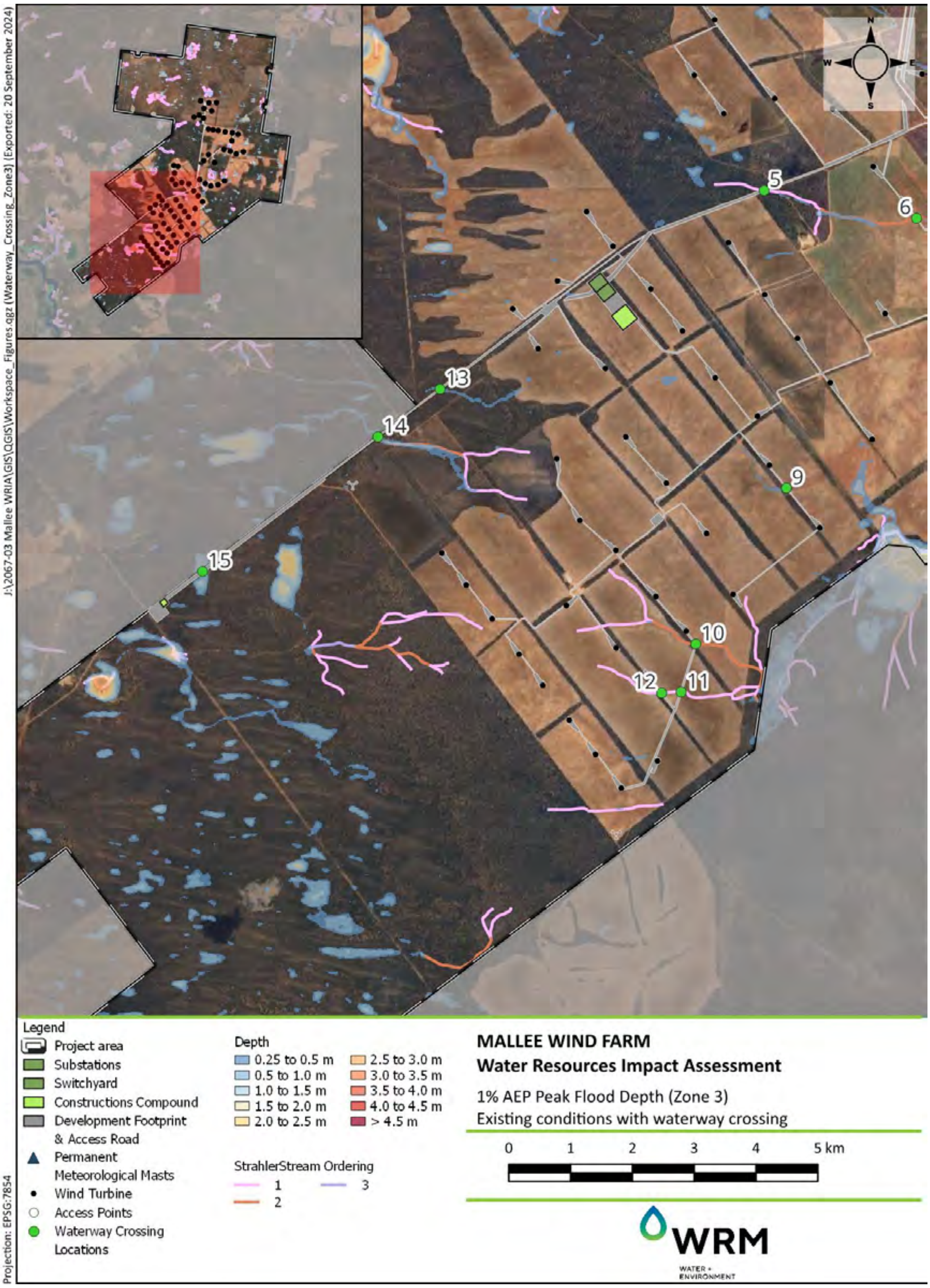

Figure 6.4 Waterway crossing locations (Zone 3)

6.2 FLOODING IMPACTS

6.2.1 Operation, Construction and Decommissioning

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 generally be of a low flood hazard with minimal risk of changes in internal or external flows.

The Project Area boundary at Arumpo Road and access tracks are inundated by minor streams and minor drainage features. Design of any waterway crossings for minor streams (first and second Strahler Streams) and minor drainage features (overland flow paths and inundated local depressions) at access points to the Project Area and access tracks within the Disturbance Footprint will be undertaken at the detailed design phase. Waterway crossing locations are shown in Figure 6.1 and are to be designed in consideration of requirements of *Guidelines for Controlled Activities on Waterfront Land*, to reduce construction impacts to any riparian corridors within the Disturbance Footprint.

The results of the 1% AEP flood hazard assessment have identified that the Project Area is classified as generally safe (H1). Isolated local depressions of H4 and H5 hazard exist where water accumulates/ponds. The peak modelled velocities were notably slow due to the flat topography below the ridge that traverses the Project Area and ponding within local depressions.

Peak stormwater discharges from the Disturbance Footprint for impervious areas may increase slightly through the creation of compacted gravel roads, WTG hardstands and some small operational buildings. However, potential impacts to drainage features and downstream watercourses are considered likely to be minimal due to the relative size of the Disturbance Footprint 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 difficult to estimate but a conservative upper bound, assuming the entire Disturbance Footprint is impervious, is of the order of 444.94 ha within the 57,330.31 ha of Project Area. The impervious surfaces include:

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

This total impervious area represents less than 0.8% 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. Subject to the management and mitigation measures outlined in Section 7 being implemented the Project is unlikely to have any residual impacts on surface water. This will require the development of various Management Plans developed prior to construction.

6.3 IMPACTS ON STREAM STABILITY, RIPARIAN HEALTH AND FISH PASSAGE

6.3.1 Construction, Operation and Decommissioning

As a SSD, the Project, if approved, will be exempt from the requirement to acquire Controlled Activity Approvals (CAAs) for works on waterfront land (works within 40 m of the top of bank of a waterway) under s.4.41(1)(g) of the *Environmental Planning and Assessment Act 1979*. Notwithstanding the exemption from requiring CAAs, if any works are required on waterfront land it will be undertaken in accordance with DPEs *Guidelines for Controlled Activities on Waterfront Land.*

Ephemeral flow paths and local depressions are located within the Project Area. While the Project design has aimed to avoid works close to or within inundated areas, waterway crossings will be required where access tracks and Arumpo Road within the broader Project Area cross minor streams (first and second Strahler Streams) and minor drainage features (overland flow paths and inundated local depressions). Refer to Figure 6.1. Project waterway crossings will be designed to minimise impacts on stream stability in accordance with DPEs *Guidelines for Controlled Activities on Waterfront Land*, if required.

It is noted that consultation with DPI Fisheries has determine that no Key Fish Habitat is located with the Project Area. Therefore, the *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (NSW DPI, 2013) and *Why Do Fish Cross the Road? Fish Passage Requirements for Waterway Crossings* (NSW Department of Primary Industries (DPI) Fisheries, 2003) are not required to be addressed when designing project waterway crossings.

6.4 IMPACTS ON WATER SUPPLY

6.4.1 Construction, Operation and Decommissioning

Water required for the Project will be sourced from:

- A metered hydrant from the existing water main in Modica Cresent Buronga and Beverly Street Wentworth (Potable water) (all phases).
- A metered hydrant from the existing water main in River Drive Buronga (non-potable water) (all phases).

Spark Renewables are in active negotiations with Wentworth Shire Council in relation to the contractual sourcing of water from the Council's mains water supply. Negotiations and consultation are ongoing and that the agreement with Council will be finalised in the detailed design stage.

The maximum water demand will be during construction (refer Section 4.2). Reduced volumes of water are likely to be required during the decommissioning phase.

As water will be obtained from existing mains and trucked to the site, no impacts to surface water or groundwater availability in the vicinity of the Project are anticipated. Similarly, impacts on surface water availability to downstream water users are expected to be negligible.

6.5 GROUNDWATER QUALITY

6.5.1 Construction and Decommissioning

Generally, impacts to groundwater resources are not expected given the groundwater table is unlikely to be intercepted during Project construction. Further, the anticipated depth to groundwater (i.e. at least 20 m BGL) within the Project Area means that any hydrocarbon/chemical spills are unlikely to infiltrate to the groundwater table, noting that appropriate spill management measures will be implemented during all phases of the Project.

Should the final Project design identify that construction activities will result in the interception of the groundwater table, further assessment will be undertaken in accordance with the *NSW Aquifer*

Interference Policy (NSW Government, 2012) and appropriate management measures be developed to mitigate any potential impacts.

6.5.2 Operation

There is limited scope and no conceivable mechanism for the Project to alter groundwater behaviour. Project operation and maintenance is not anticipated to intersect the regional water table. Footing excavations are also unlikely to have lasting impact on groundwater level drawdown. Should interception of localised perched groundwater occur during construction, groundwater is expected to recover by the time the Project reaches its operational phase. As such, no impacts to groundwater resources and registered bores are expected during the operational phase of the Project.

6.6 CUMULATIVE IMPACTS

6.6.1 Overview

Related development, as outlined in the NSW Government State Significant Development Guidelines, refers to any existing or approved development that would be incorporated into, or operated in conjunction with the Project. Related development can also include development by a Proponent that is required for a Project; but is subject to a separate development approval process. At this stage, there are no existing or approved developments that would need to be incorporated into the assessment of the Project.

Energy Corporation of NSW (EnergyCo), a NSW statutory authority, seeks to maximise opportunities created by the transformation of the NSW electricity system by coordinating investment in REZs across NSW. A REZ is the equivalent of modern-day power stations, combining new renewable energy infrastructure, including generators (such as solar and wind farms), storage (such as batteries and pumped hydro) and then high-voltage transmission infrastructure. Five dedicated REZs have already been identified in NSW.

The region is traversed by Project EnergyConnect, an interconnector being built by Transgrid and ElectraNet between Wagga Wagga in NSW and Robertstown in South Australia, with a connection to Red Cliffs in Victoria. Project EnergyConnect also involves an upgrade to the 330 kV transmission line between Wagga Wagga and Dinawan to 500 kV, which links to the eastern edge of the South-West REZ and south of the indicative Project location. The completion of Project EnergyConnect would support the South-West REZ and more broadly support the Project by unlocking additional transmission capacity, transporting electricity from the South-West REZ to homes and businesses across NSW. The South-West REZ would be further boosted by the construction of the Victoria-NSW Interconnector West, a 500kV interconnector proposed by TransGrid which is expected to be completed by 2031.

The Project is located wholly within the South-West REZ. Because of this, and the REZ benefits anticipated by EnergyCo, the South-West REZ has the potential to see strong interest for renewable energy development.

Based on information available within the public domain, specifically the NSW Government – Major Projects website, the following developments are identified in the vicinity of the Project:

The list of Projects for consideration is based on projects within 75 km to Mallee Wind Farm and include:

- Mallee Solar Farm: Mallee Solar Farm | Planning Portal - Department of Planning and Environment (nsw.gov.au)
- Euston Mineral Sands Project: Euston Mineral Sands Project | Planning Portal - Department of Planning and Environment (nsw.gov.au)

- Gol Gol Solar Farm: Gol Gol Solar Farm | Planning Portal - Department of Planning and Environment (nsw.gov.au)
- Gol Gol Wind Farm: Gol Gol Wind Farm | Planning Portal - Department of Planning and Environment (nsw.gov.au)
- Gol Gol Battery Energy Storage System: Gol Gol Battery Energy Storage System | Planning Portal - Department of Planning and Environment (nsw.gov.au)
- Project EnergyConnect (NSW - Eastern Section): Project EnergyConnect (NSW - Eastern Section) | Planning Portal - Department of Planning and Environment
- Buronga Landfill Expansion: Buronga Landfill Expansion | Planning Portal - Department of Planning and Environment (nsw.gov.au)
- Euston Wind Farm: Euston Wind Farm | Planning Portal - Department of Planning and Environment (nsw.gov.au)
- Koorakee Energy Park: Koorakee Energy Park | Planning Portal - Department of Planning and Environment (nsw.gov.au)
- Lake Victoria Wind Farm: Lake Victoria Wind Farm | Planning Portal - Department of Planning and Environment (nsw.gov.au)

At the time of writing, there are two related developments that occur immediately adjacent to, or within, the vicinity of the Project, being the Euston Critical Minerals Project and the Mallee Solar Farm.

6.6.2 The Euston Mineral Sands Project

The Euston Critical Minerals Project (ECM) is located within the southern extent of the Project Area. The Applicant Iluka Resources Limited (Iluka) are proposing to develop a mineral sands resource. The ECM would involve open pit strip mining of six (6) mineral sands deposits. The Castaway deposit comprising of Castaway Pits 1 and 2 are located within the Project Area. ECM is currently at Prepare EIS stage on the Major Projects Portal.

6.6.3 Mallee Solar Farm

The Mallee Solar Farm, also proposed by Spark Renewables, is a large-scale solar photovoltaic (PV) generation facility and BESS, supported by associated infrastructure. The proposed solar farm is located adjacent to the southern extent of the Project Area. Mallee Solar Farm is currently at Prepare EIS stage on the Major Projects Portal.

6.6.4 Gol Gol Renewable Energy Hub

Squadron Energy are in the process of applying for a development application for a suite of renewable energy projects adjacent to the Project Area. These include the Gol Gol Solar Farm, Gol Gol Wind Farm and Gol Gol Battery Energy Storage System. The solar farm is proposed to have an installed capacity of up to approximately 600 MW, the wind farm proposed to have an installed capacity of up to approximately 840 MW and the storage system proposed to have a storage capacity of up to 1,500 MW / 12 GWh. These are collectively referred to as the Gol Gol Renewable Energy Hub. Each project proposes to share ancillary infrastructure such as a transmission network, internal roads, substations and temporary construction facilities. The three components of the Gol Gol Renewable Energy Hub are undergoing separate development applications although are expected to be constructed simultaneously. Each project is currently at Prepare EIS stage on the Major Projects Portal.

6.6.5 Cumulative Impact Assessment

Given the proximity of the above-mentioned developments to the Project, and the limited potential for interactions to occur with respect to water resources, cumulative impacts are considered highly unlikely to occur. Specifically:

Water Management (erosion and sedimentation): given the Project will incorporate appropriate erosion and sediment control mitigation measures during construction and decommissioning phases, refer Section 7, cumulative impacts to receiving water quality are expected to be negligible, assuming other projects in the region do the same.

Flooding and Surface water: the abovementioned projects exist within the Murray region of south western NSW, but few connections exist to the watercourses within the Mallee Wind Farm Project Area. Where projects are on interconnected watercourses to those of the Project Area (i.e. Mallee Solar Farm and The Euston Mineral Sands Project) implementing appropriate mitigation measures into the Project Area (refer Section 7) and incorporating similar measures at the abovementioned projects in the region, will ensure that cumulative impacts on flood behaviour are negligible.

Water Management (demand, supply and balance): Project water demands will be limited to relatively short periods of time with respect to the overall Project lifespan during both the construction and decommissioning phases. Additionally, it is noted that most, if not all, non-potable water demand can be met by supply from, and with agreement of, the LGA, on-site groundwater resources under existing licences (with agreement from the landholders) or from the Harvestable Right Dam Capacity.

As noted in Sections 4 and 6.4.1, active discussions are underway with Wentworth Shire Council in relation to the sourcing of water from the mains water supply. The contractual instrument will be finalised with Council during the detailed design stage.

Water demands during the operational phase will be relatively small. Therefore, and with the successful implementation of mitigation measures within the Project Area (refer Section 7) and similar measures incorporated at the above-mentioned projects in the region, cumulative impacts to surface water or groundwater availability are not anticipated.

It is noted that because of the development activity in the South West REZ, the above list may not address all potential sites being privately developed and not yet in the public domain. Information pertaining to any developments not yet in the public domain is therefore unavailable and excluded for this study.

7 MANAGEMENT AND MITIGATION MEASURES

Table 7.1 lists the principal management measures required to manage the potential surface water impacts that are considered likely for the Project. The primary objective is ensuring downstream waterways are protected during construction and operation of the Project. The proposed erosion and sediment controls, as part of the broader management measures and strategies, are necessary to achieve this objective.

For the construction phase of the Project, measures are to be captured in the Construction Environment Management Plan (CEMP). This would include the preparation of a Construction Soil Water Management Plan (CSWMP) and Erosion and Sediment Control Plan (ESCP).

For the operational phase of the Project, the measures outlined are to be documented in the Bush Fire Emergency Management and Operations Plan (BFEMOP) 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 on the receiving environment surface water quality and flooding during the operational phase. The BFEMOP will outline the flood hazards, evacuation and warning procedures to ensure the safety of all onsite.

Construction works will again be required during the decommissioning phase of the Project such as removal of TWA facilities and reinstatement works. The CSWMP and ESCP should be amended and incorporated into a Decommissioning and Rehabilitation Management Plan (DRP).

Table 7.1 Management and Mitigation Measures relating to Water Resources

Potential Risk	Proposed Management and Mitigation Measure	Phase
6.1 Soil and water quality	Maintaining the natural state of the drainage flow paths whenever possible. Access tracks, where crossing minor streams and drainage features, will be designed for 10% AEP design flow and may include compacted rock causeways to provide low maintenance access with limited impact on the minor streams, drainage features or culvert structures	Detailed design & Construction
6.1 Soil and water quality	The design and construction of cable crossings and all access tracks crossing minor streams and drainage features within the proposed disturbance footprint should be in line with best practice procedures. Where possible, the current best practice would be to design and construct in general accordance with the *Guidelines for controlled activities on waterfront land – riparian corridors*, *Guidelines for watercourse crossings on waterfront land* and *Guidelines for laying pipes and cables in watercourses on waterfront land.*	Detailed design & Construction
6.1 Soil and water quality	A CSWMP will be prepared to outline measures to manage soil and water impacts associated with the construction and decommissioning works.	Prior to construction & during Decommissioning
6.1 Soil and water quality	Creation of catch/diversion drains and sediment fences at the downstream boundary of construction activities where practicable to support containment of sediment-laden runoff.	Prior to construction & during Decommissioning
6.1 Soil and water quality	Erosion and sediment control measures will be implemented and maintained at all work sites in accordance with the principles and requirements in *Managing Urban Stormwater – Soils and Construction, Volume 1* and *Volume 2D* of Blue Book.	Prior to construction & during Decommissioning

Potential Risk	Proposed Management and Mitigation Measure	Phase
6.1 Soil and water quality	Measures to minimise/manage erosion and sediment transport both within the construction footprint and offsite including requirements for the preparation of (ESCP) for all progressive stages of construction and decommissioning	Prior to construction & during Decommissioning
6.1 Soil and water quality	The best practice principles for stormwater and sediment control outlined in the *Managing Urban Stormwater* Blue Book guidelines will be incorporated into the design, construction and operation phases as part of a SWMP and ESCP.	Construction, Operation & Decommissioning
6.1 Soil and water quality	BESS components will be located on hardstand areas and will be aligned with local overland flow paths to prevent flows being redirected which could lead to localised increased in flood level and higher risk of scour and erosion.	Construction & Operation
6.1 Soil and water quality	Maintenance of stormwater infrastructure including any stormwater treatment devices (e.g. bioretention basins and culverts (e.g. clearing debris).	Operation
6.1 Soil and water quality	Maintenance of suitable ground cover and grassed table drains near access tracks to minimise the potential for erosion and export of sediment.	Operation
6.2 Flooding	During construction design flood risk will be considered and include, as a minimum, a review of temporary infrastructure layouts and arrangements to a) avoid and/or minimise obstruction of overland flow paths, b) limit the extent of flow diversion, c) include stormwater management controls to avoid/minimise the impact of flooding, and d) consider measures to mitigate alterations to local runoff conditions due to on-site works and activities.	Construction
6.2 Flooding	During construction, design stockpiles would be located outside areas anticipated to flood and experience velocities above 0.5 m/s. Where reasonable/feasible located outside the mapped 10% AEP flood extents.	Construction
6.2 Flooding	Based on the Project design utilised for this assessment, temporary construction compounds, laydown areas, concrete batching plants and workforce accommodation have been located away from areas where depths of flow are deeper than 250mm during the modelled 1% AEP event. This mitigation will persist if any future design revisions occur.	Construction
6.2 Flooding	Flood emergency management measures for the construction phase would be prepared and included in applicable environmental and safety management documentation i.e. the CEMP, CSWMP and ESCP noted above, as relevant. As a minimum this would include identification of flood related risks and their management, and processes to monitor and communicate weather warnings. In this regard, construction 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 storm events and to ensure on-site personnel and visitors are aware of potential flooding events and road closures.	Construction
6.2 Flooding	Flood emergency management measures for the operational phase would be prepared and included in applicable environmental and	Operation

Potential Risk	Proposed Management and Mitigation Measure	Phase
	safety management documentation i.e. the BFEMOP and OEMP noted above, as relevant. In this regard, 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 storm events and to ensure on-site personnel and visitors are aware of potential flooding events and road closures	
6.2 Flooding	Evacuation routes will be designed during the detailed design phase and will consider zones of flood hazard. These routes would be included in applicable environmental and safety management documentation i.e. the BFEMOP and OEMP noted above, as relevant.	Detailed design
6.2 Flooding	Flood behaviour as a result of the Project would be confirmed during detailed design, inclusive of climate change. In this regard foundations for the WTGs and transmission lines, their footings are located away from areas of erosive behaviour such as flood depths of 0.3 m and flow velocities greater than 1.5 m/s. Detailed design of the Project will consider the results of the 1% AEP scenario. Based on the Project design utilised for this assessment, this mitigation is achieved and should persist if any future design revisions occur.	Detailed design
6.3 Stream stability, riparian health and fish passage	Infrastructure with the potential to cause pollution to watercourses in the event of flooding, 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, raising these small fill pads is highly unlikely to result in any adverse impacts offsite.	Detailed design
6.3 Stream stability, riparian health and fish passage	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 500mm freeboard to the 1% AEP flood level. Based on the Project design utilised for this assessment, this mitigation is achieved and should persist if any future design revisions occur.	Detailed design
6.3 Stream stability, riparian health	Controls for receiving watercourses which may include designation of 'no go' zones for construction plant and equipment.	Prior to construction
6.4 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 will be prepared as part of the CEMP.	Prior to construction

8 CONCLUSION

This Water Resources Impact Assessment has considered the potential impacts and appropriate measures to mitigate any potential impacts on water resources associated with the Project.

The Project will have minimal impact on water resources as it involves limited ground disturbance, does not store or handle large volumes of pollutants, and once constructed does not consume significant quantities of water.

For these reasons, the key potential risks to surface water are only associated with the Project's construction. These risks can be adequately managed through the application of well-established construction environmental management practices and appropriate design.

Key issues relevant to the water resources impacts of the Project are summarised below:

- Impacts to surface water resources occur during the construction. These potential impacts can be mitigated to represent negligible risk as detailed in Section 7.
- The operational phase of the Project presents minimal risk provided that by the conclusion of the construction phase appropriate groundcover and drainage is established.
- The Project will not interact with the groundwater table and therefore, no impacts to groundwater resources or GDEs are expected.
- The Project Area does contain areas of major flood hazard relating to the presence of depressions that accumulate rainfall. The flood hazard will be short lived as the water will infiltrate into existing groundwater stores.
- The large extent of the Project Area and distributed nature of minor impacts (if any) does not pose a risk to drainage features, downstream watercourses or receiving waters.

9 REFERENCES

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APPENDIX A SEARS AGENCY ADVICE TABLE

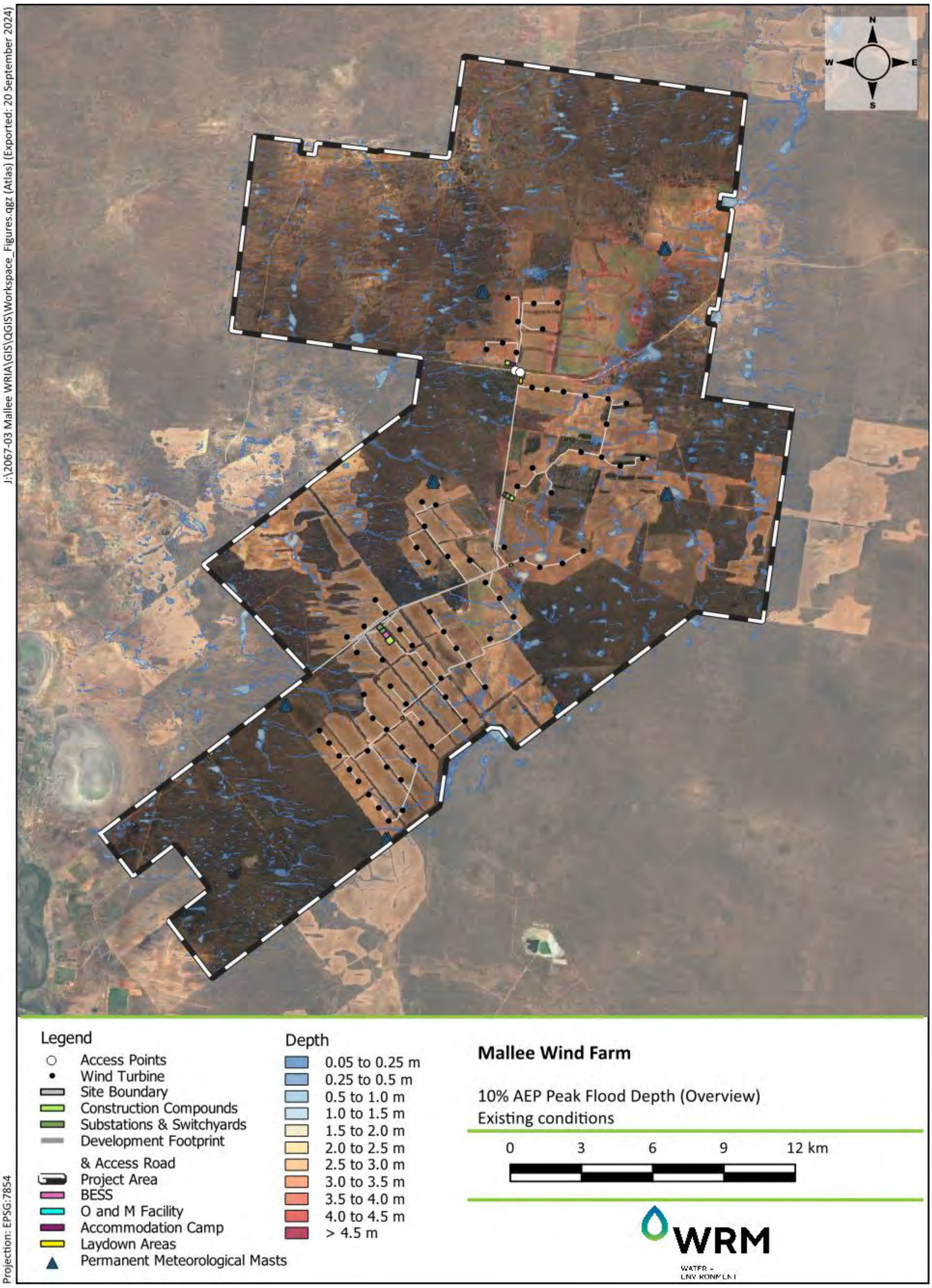
Table 9.1 SEARs Agency Advice Table

DPE - Biodiversity and Conservation Division (BCD) and the NSW National Parks and Wildlife Service (NPWS)		
7	The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including: a. Flood prone land. b. Flood planning area, the area below the flood planning level. c. Hydraulic categorisation (floodways and flood storage areas). d. Flood hazard.	Refer to Sections 5 and Section 6.2.
8	The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 5% Annual Exceedance Probability (AEP), 1% AEP flood levels and the probable maximum flood, or an equivalent extreme event.	Refer to Sections 5 and Section 6.2 and Appendix A and B
9	The EIS must 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 as identified in 7 above. 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.	Refer to Sections 5 and Section 6.2 and Appendix A and B
10	Modelling in the EIS must 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. Relevant provisions of the NSW Floodplain Development Manual 2005	Refer to Sections 5 and Section 6.2 and Appendix A and B

DPE - Biodiversity and Conservation Division (BCD) and the NSW National Parks and Wildlife Service (NPWS)		
11	The EIS must assess the impacts on the proposed development on flood behaviour, including: a. Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure. b. Consistency with Council 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 or a reduction in the stability of river banks 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 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 or 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.	For all refer to Sections 5 and Section 6.2 and Appendix A and B For 11G. refer to Sections 3 and Section 6.0.
DPE - Water		
1	A detailed and consolidated site water balance	Refer to Sections 4.2, 4.3 and 4.4
2	Description of all works/activities that may intercept, extract, use, divert or receive surface water and/or groundwater. This includes the description of any development, activities or structures that will intercept, interfere with or remove groundwater, both temporary and permanent.	Refer to Section 4
3	Details of all water take for the life of the project and post closure where applicable. This is to include water taken directly and indirectly, and the relevant water source where water entitlements are required to account for the water take. If the water is to be taken from an alternative source confirmation should be provided by the supplier that the appropriate volumes can be obtained.	Refer to Section 4.3

DPE - Biodiversity and Conservation Division (BCD) and the NSW National Parks and Wildlife Service (NPWS)		
4	Details of Water Access Licences (WALs) held to account for any take of water where required, or demonstration that WALs can be obtained prior to take of water occurring. This should include an assessment of the current market depth where water entitlement is required to be purchased. Any exemptions or exclusions to requiring approvals or licenses under the Water Management Act 2000 should be detailed by the proponent	Refer to Section 3.6, 4, 5 and 6
5	A description of groundwater conditions that provides an understanding of groundwater level across the site under a range of wet and dry conditions.	Refer to Section 3.7, 5 and 6
6	Assessment of impacts on surface and ground water sources (both quality and quantity) including flooding, related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, groundwater dependent ecosystems, and ground water levels; including measures proposed to reduce and mitigate these impacts	Refer to Section 4, 5 and 6
7	Proposed surface and groundwater monitoring activities and methodologies.	Refer to Section 4, 5 and 6
8	Identification and impact assessment of all works/activities located on waterfront land including an assessment against Guidelines for Guidelines for Controlled Activities on Waterfront Land (NOW 2012) Controlled Activities on Waterfront Land (NRAR 2018).	Refer to Section 4, 5 and 6
9	Assessment of project against relevant policies and guidelines	Refer to Section 4, 5 and 6

APPENDIX B FLOOD MAPPING



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Permanent Meteorological Masts
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Mallee Wind Farm
10% AEP Peak Flood Depth (Overview)
Existing conditions
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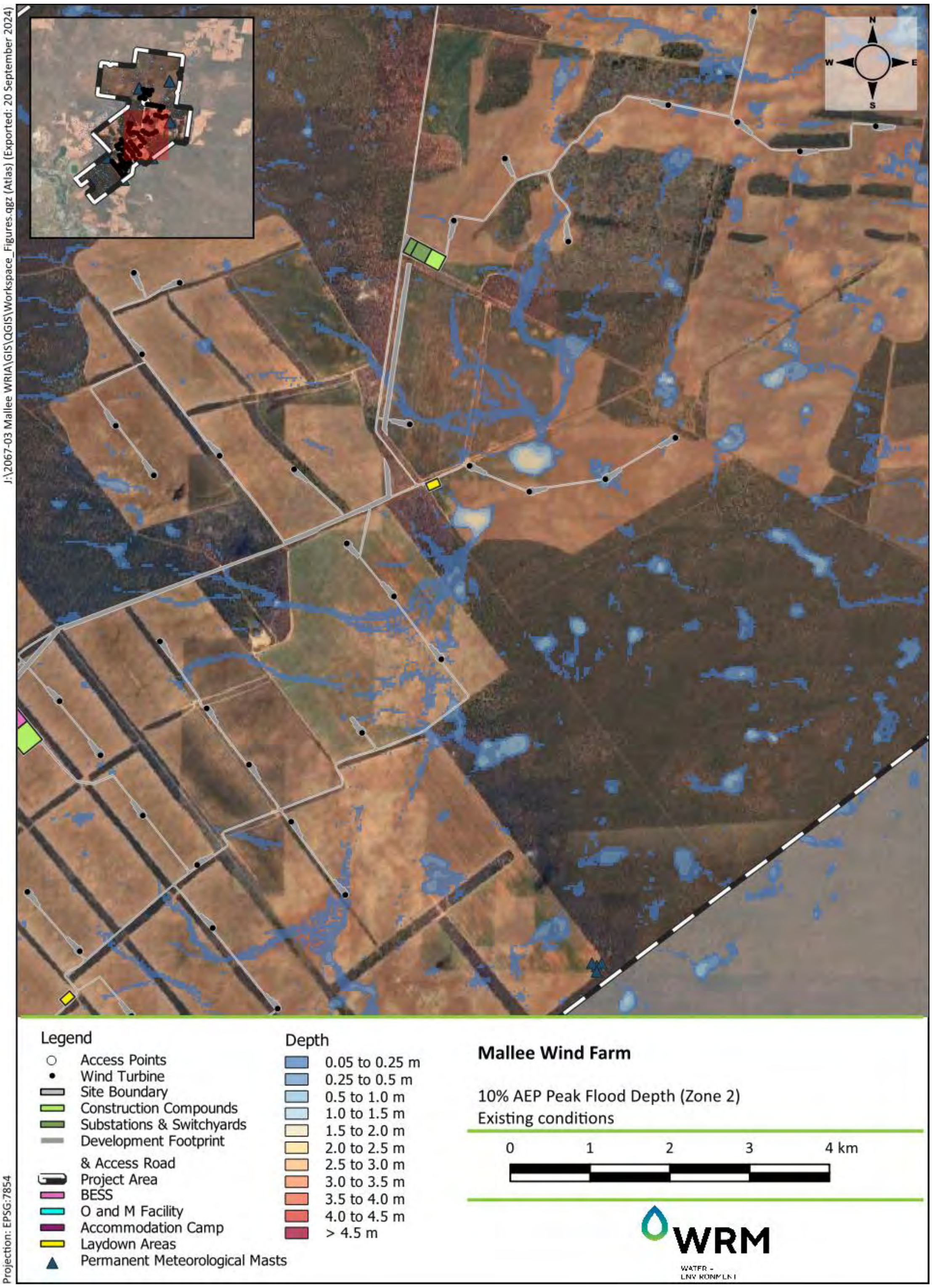
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Mallee Wind Farm
10% AEP Peak Flood Depth (Zone 2)
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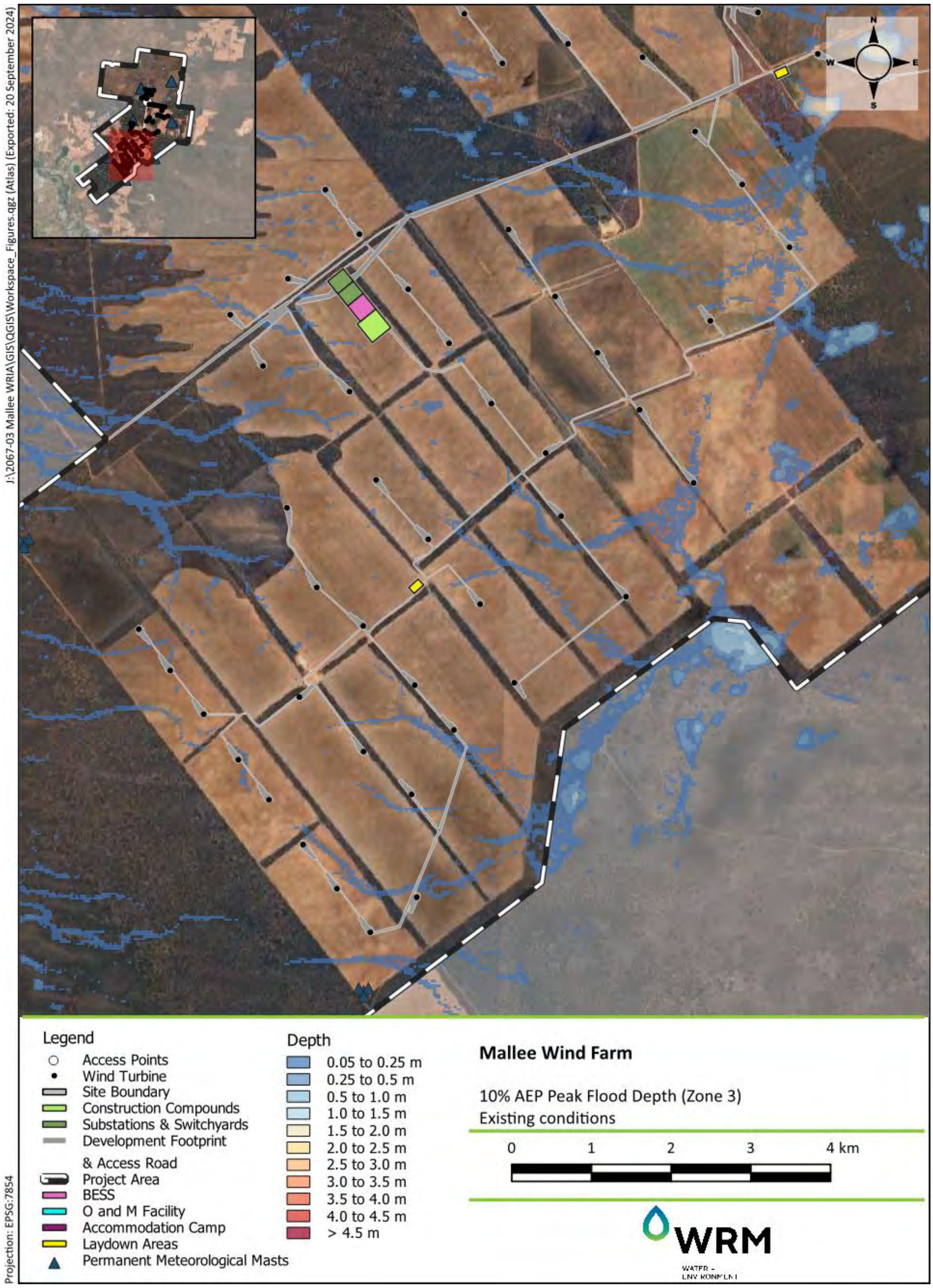

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Mallee Wind Farm
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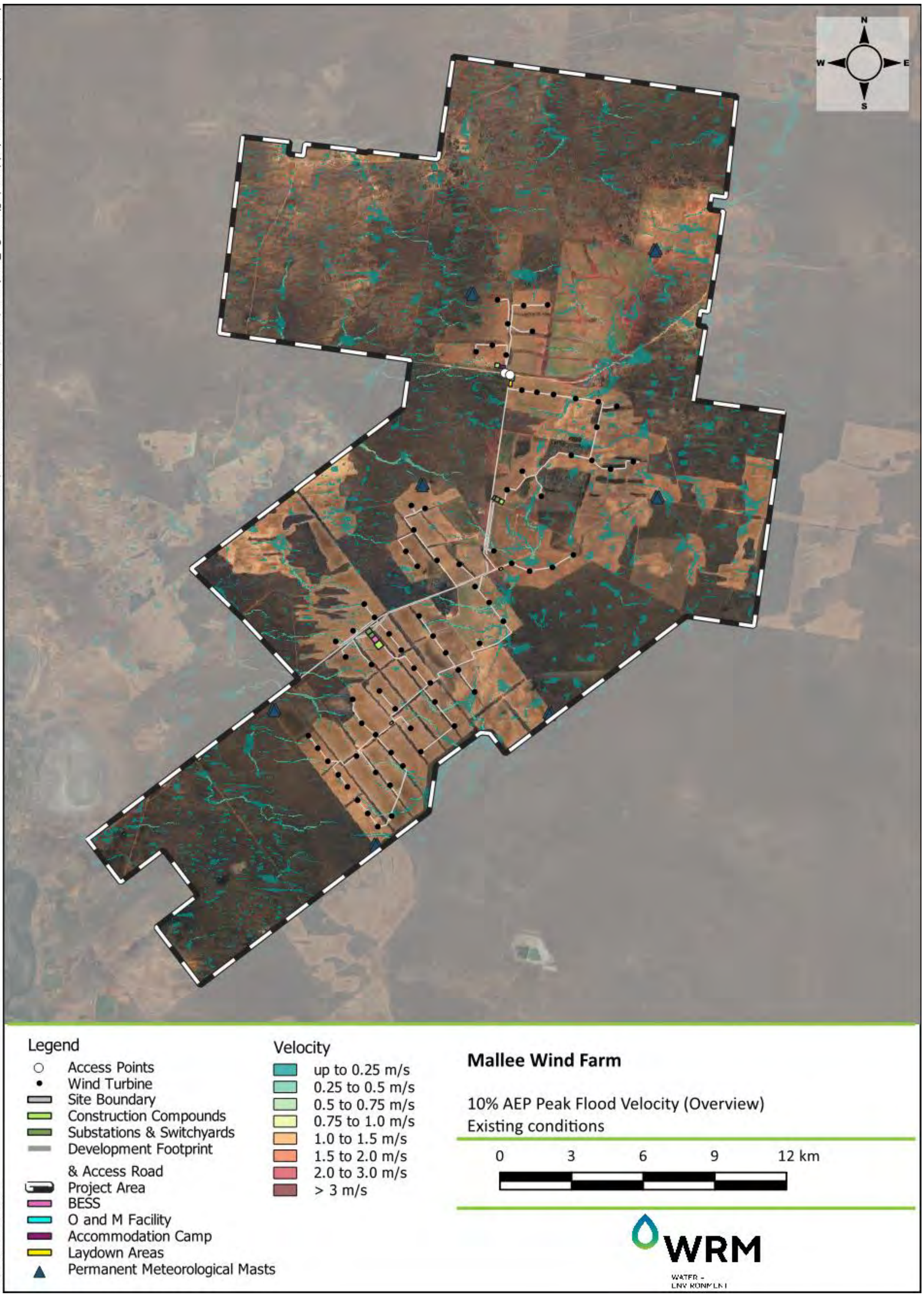

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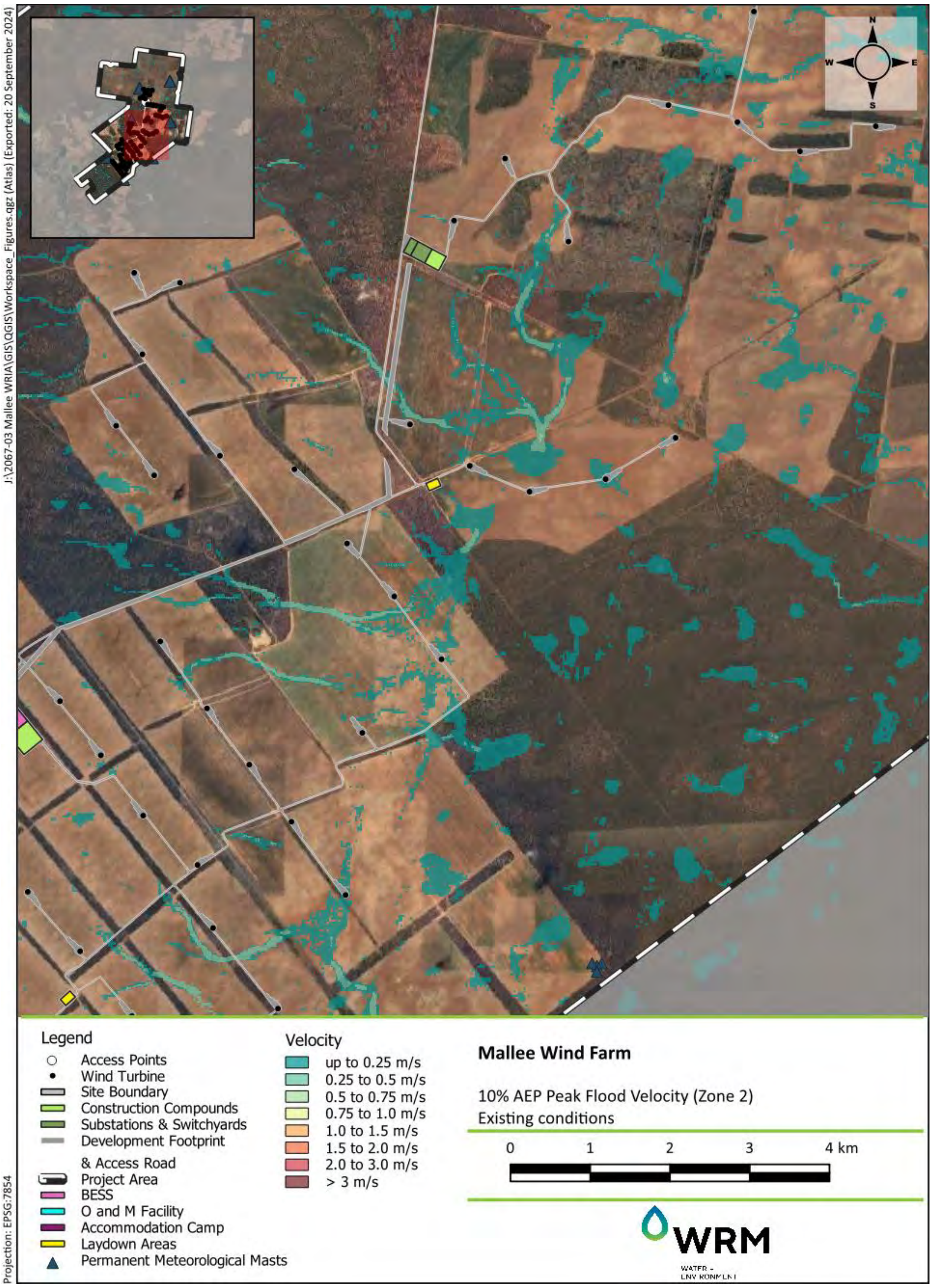
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2.0 to 3.0 m/s
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Mallee Wind Farm
10% AEP Peak Flood Velocity (Zone 2)
Existing conditions
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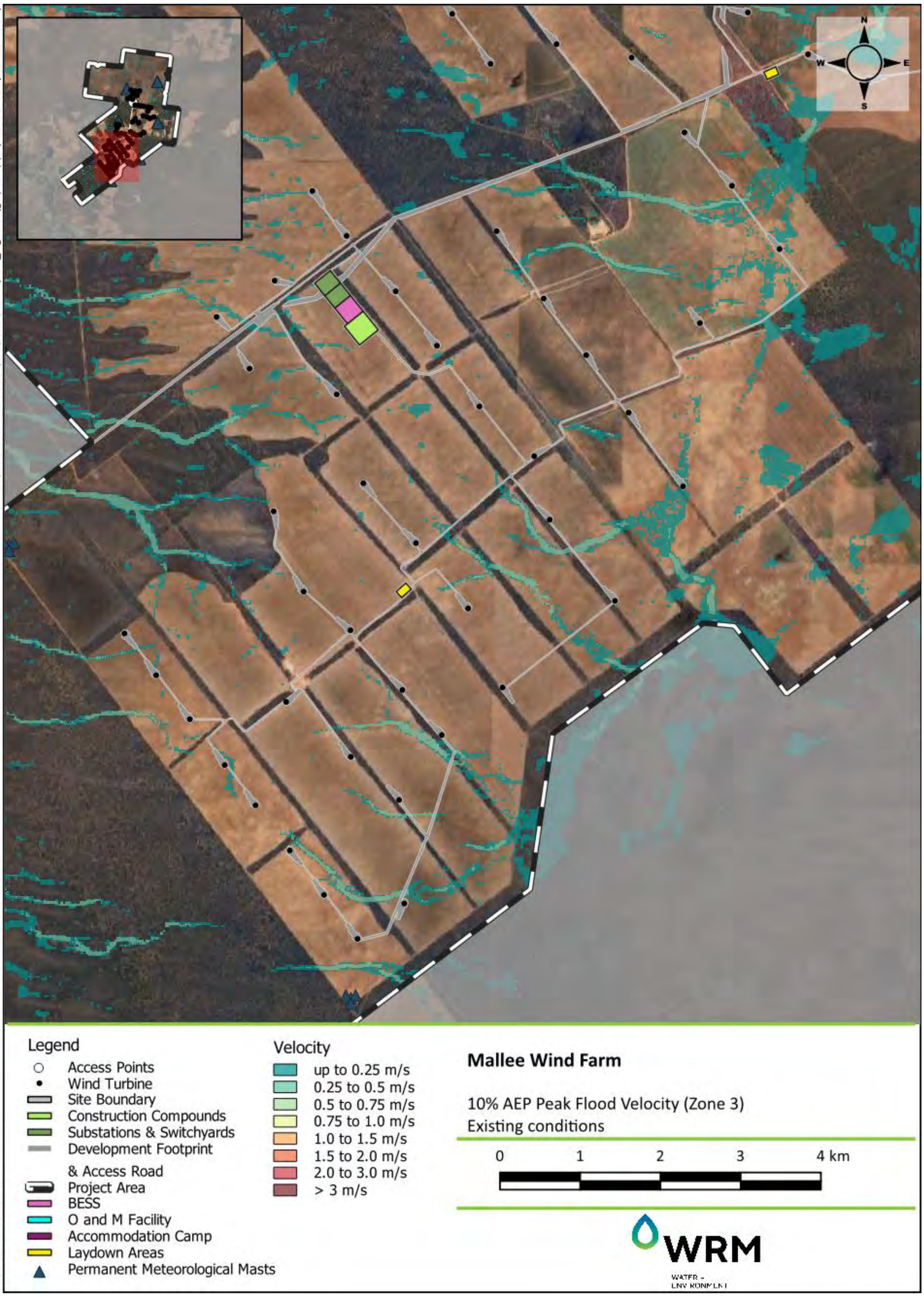
Projection: EPSG:7854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Mallee Wind Farm
10% AEP Peak Flood Velocity (Zone 3)
Existing conditions
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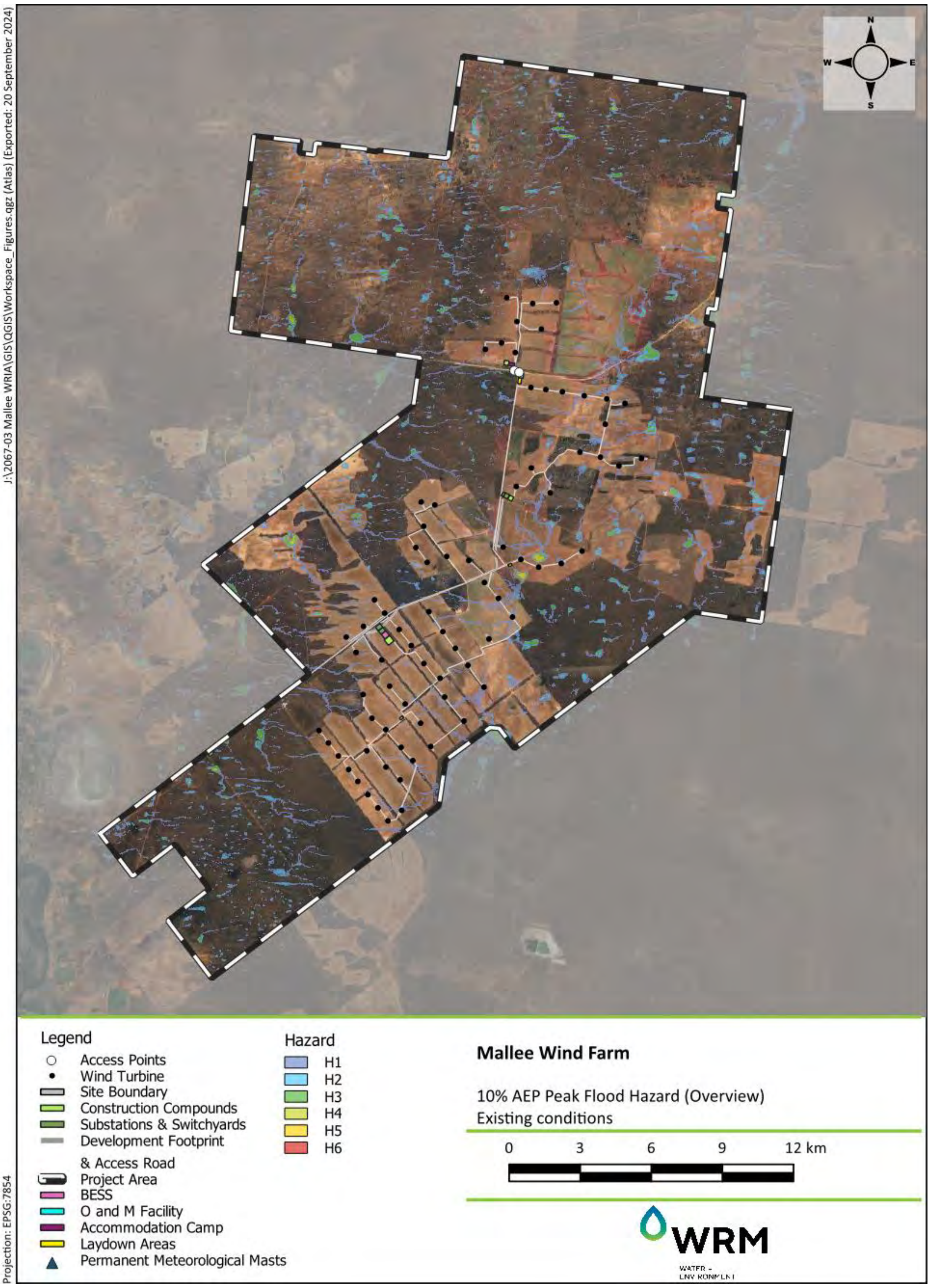
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Mallee Wind Farm
10% AEP Peak Flood Hazard (Overview)
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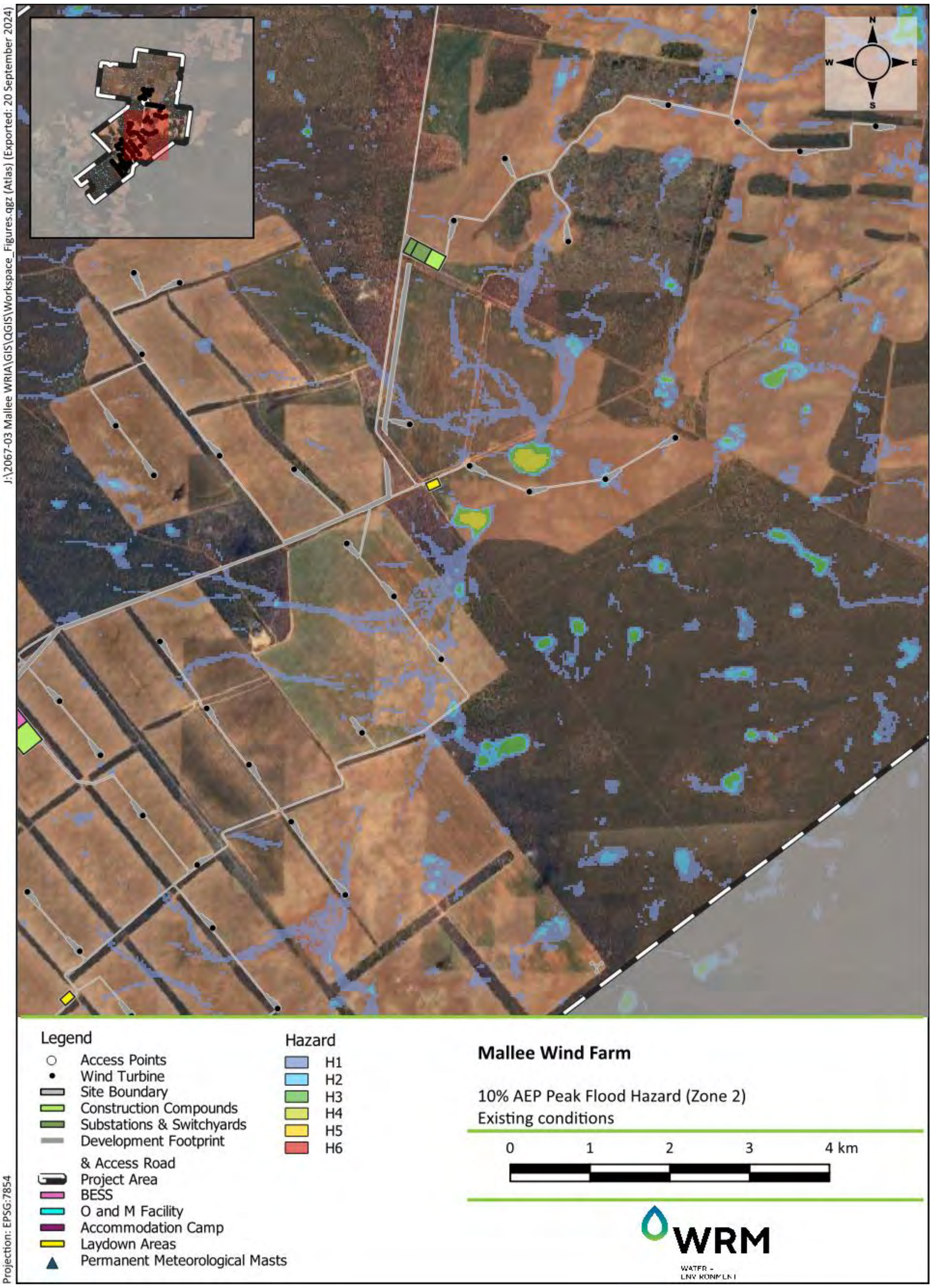
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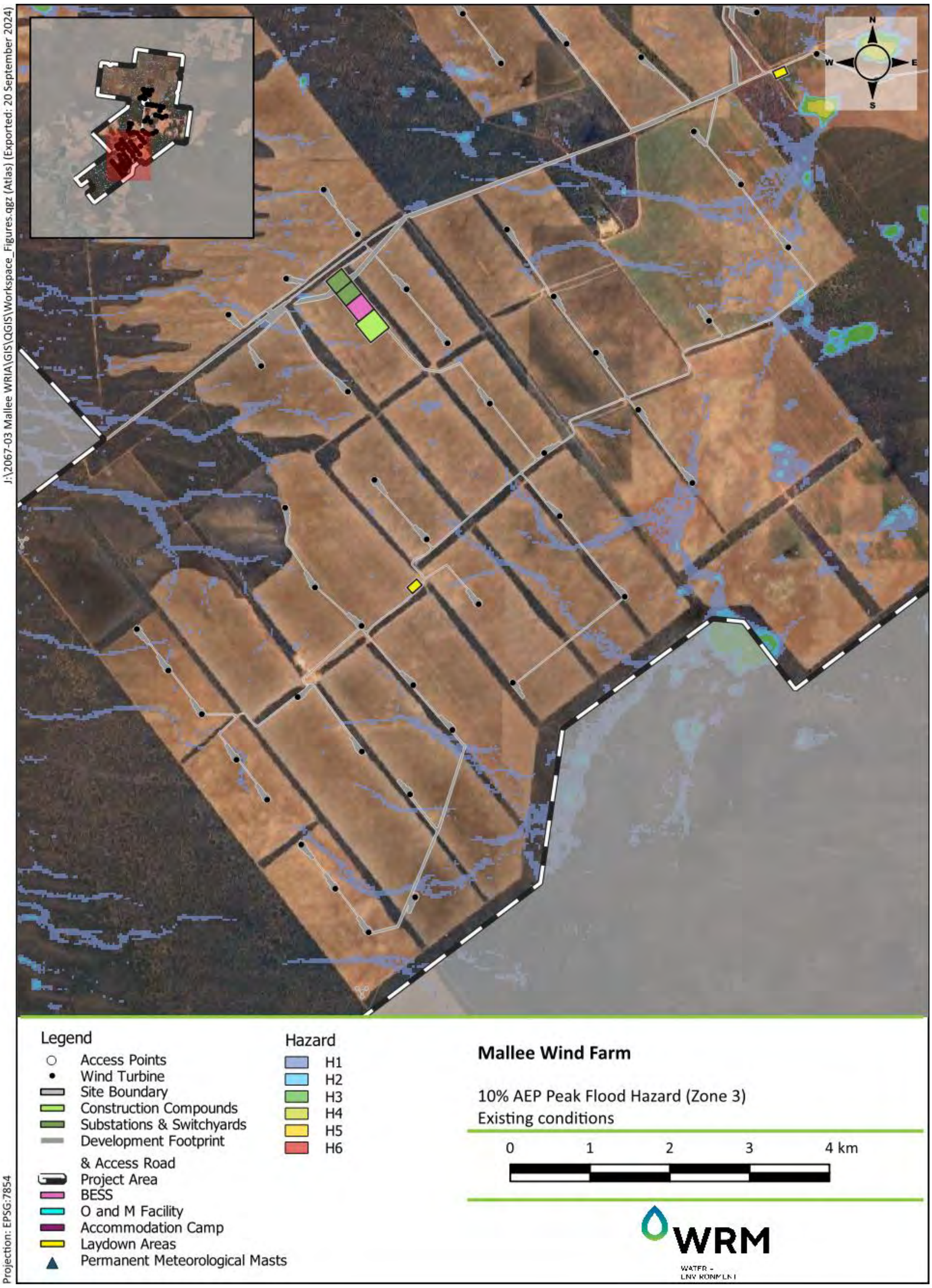
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Mallee Wind Farm
10% AEP Peak Flood Hazard (Zone 3)
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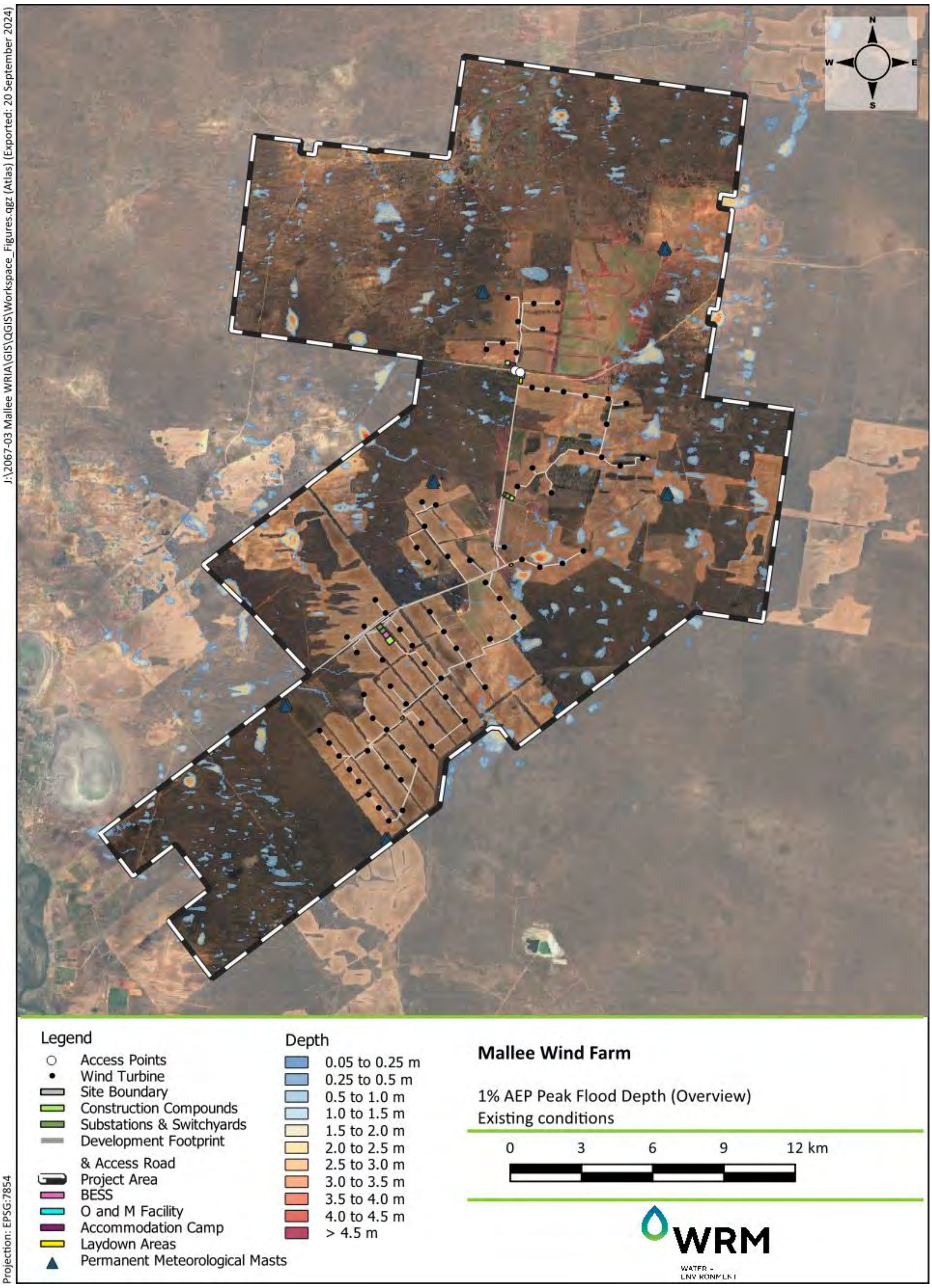
Projection: EPSG:7854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Mallee Wind Farm
1% AEP Peak Flood Depth (Overview)
Existing conditions
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Projection: EPSG:7854


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> 4.5 m
Mallee Wind Farm
1% AEP Peak Flood Depth (Zone 1)
Existing conditions
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4 km
WRM
Projection: EPSG:7854

WRM

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Mallee Wind Farm
1% AEP Peak Flood Depth (Zone 2)
Existing conditions
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WRM
Projection: EPSG:7854

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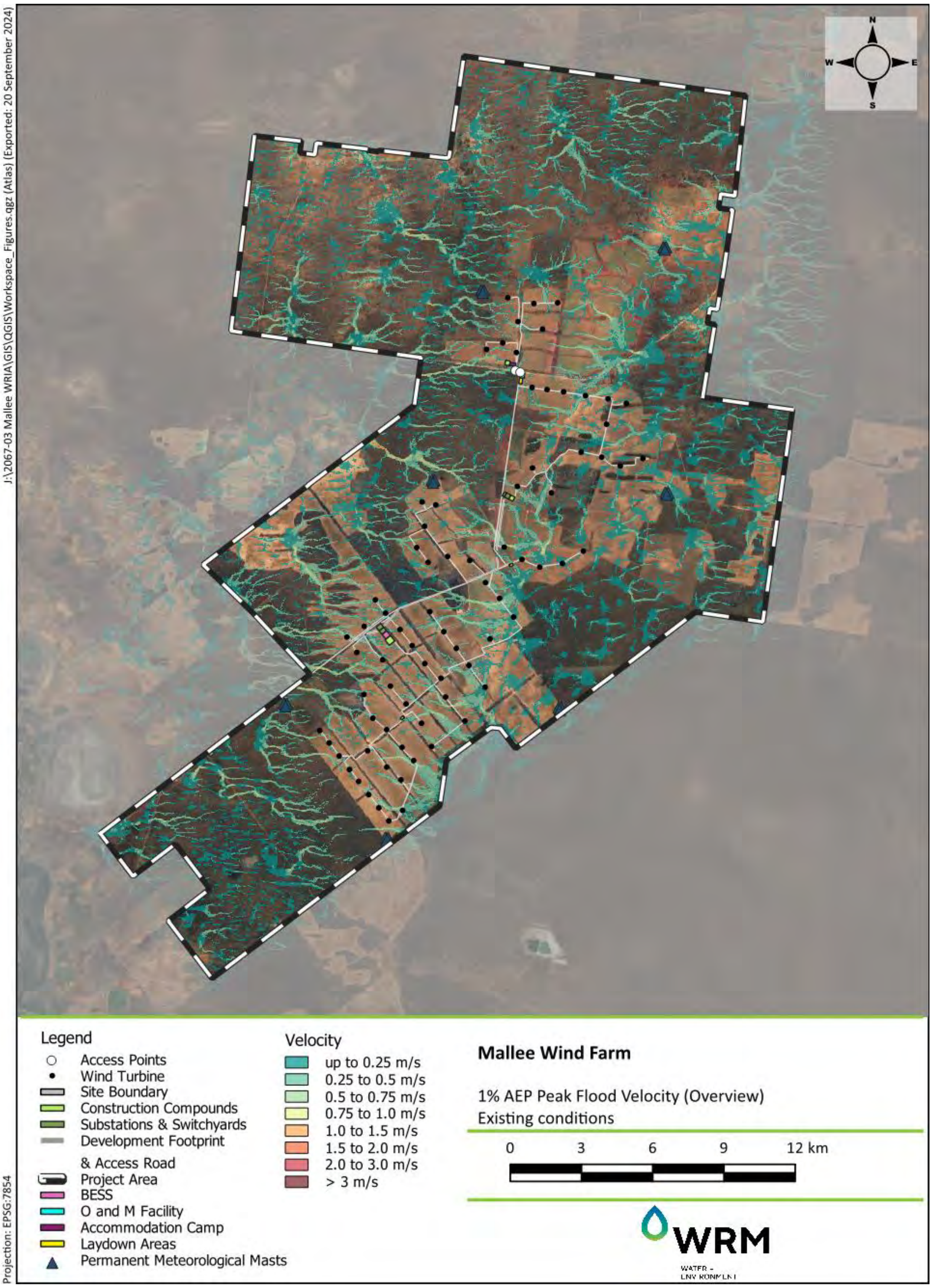
Laydown Areas
Permanent Meteorological Masts
Depth
0.05 to 0.25 m
0.25 to 0.5 m
0.5 to 1.0 m
1.0 to 1.5 m
1.5 to 2.0 m
2.0 to 2.5 m
2.5 to 3.0 m
3.0 to 3.5 m
3.5 to 4.0 m
4.0 to 4.5 m
> 4.5 m
Mallee Wind Farm
1% AEP Peak Flood Depth (Zone 3)
Existing conditions
0 1 2 3 4 km
WRM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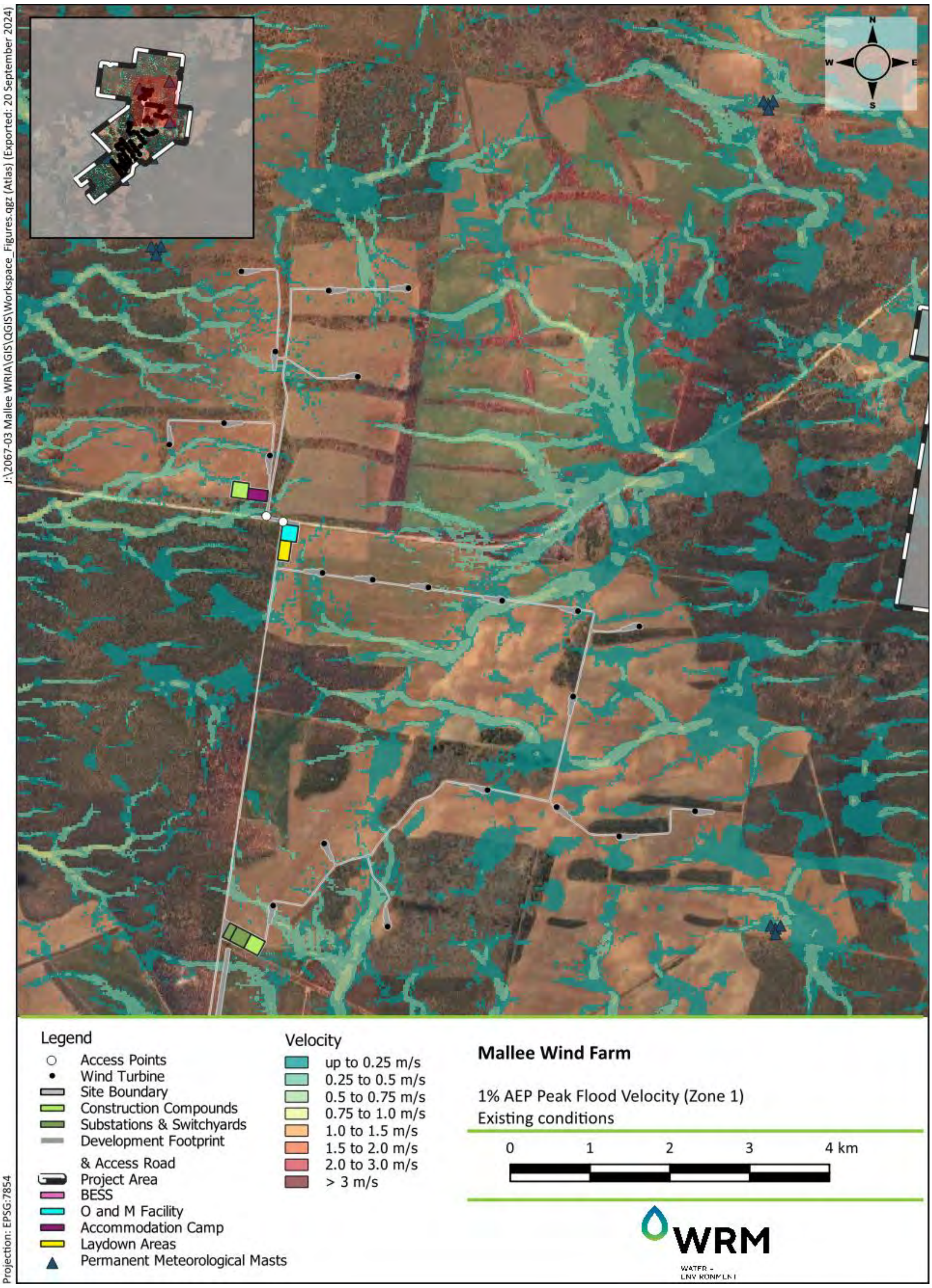
N
W
E
S
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
1% AEP Peak Flood Velocity (Overview)
Existing conditions
0
3
6
9
12 km
WRM
Projection: EPSG:7854



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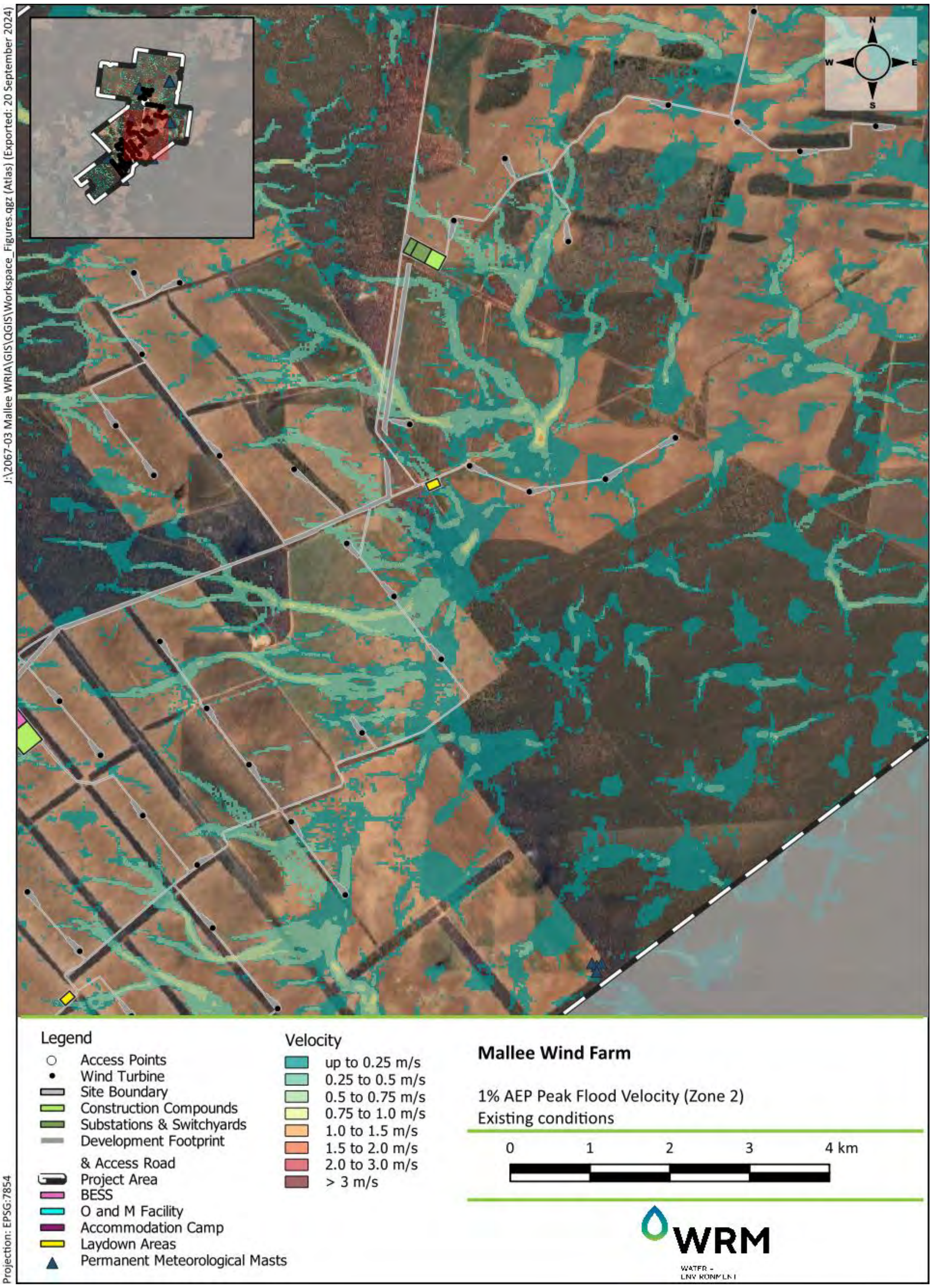
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
1% AEP Peak Flood Velocity (Zone 1)
Existing conditions
0 1 2 3 4 km
Projection: EPSG:7854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Projection: EPSG:7854
N
S
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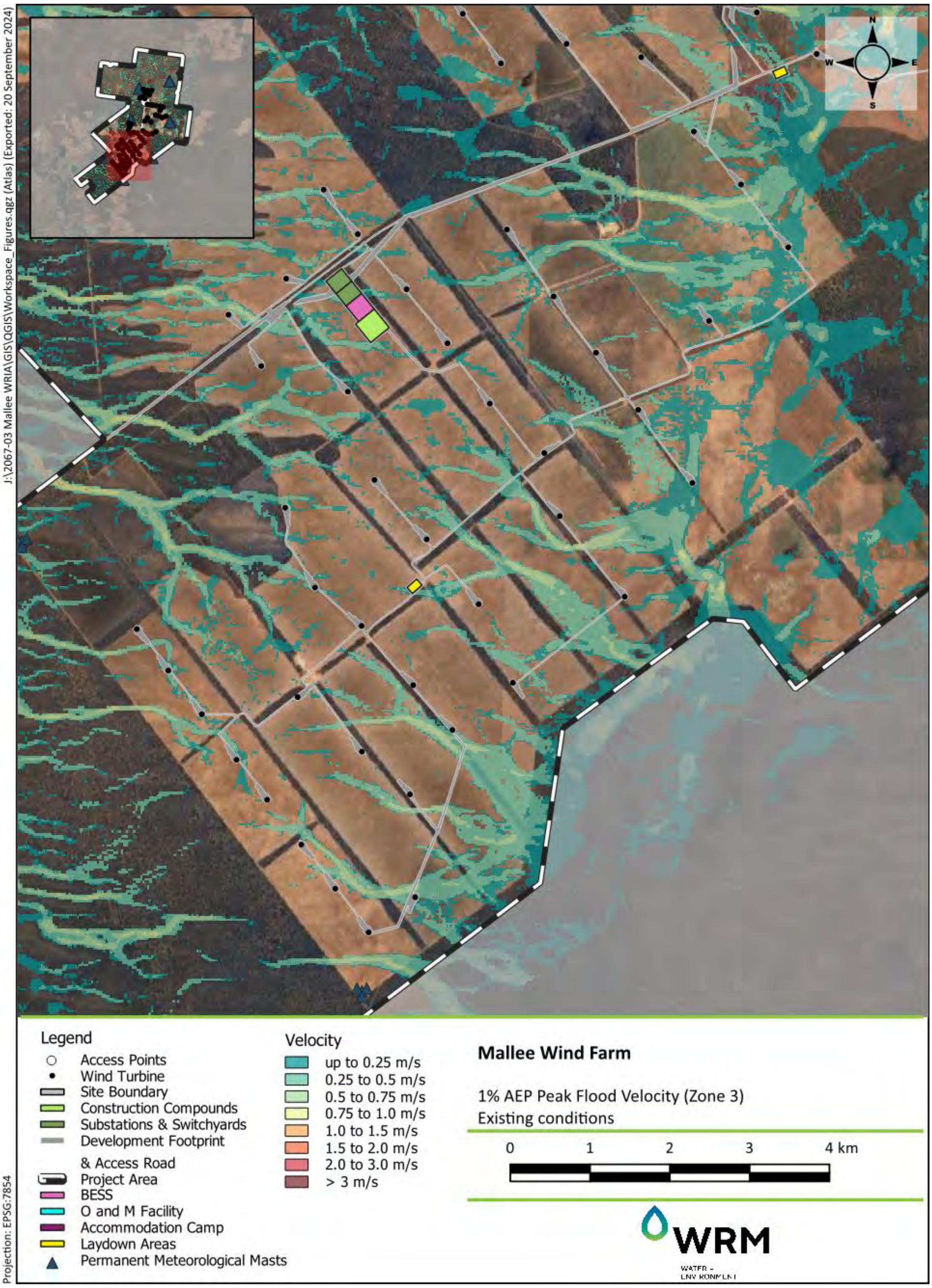
W
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
1% AEP Peak Flood Velocity (Zone 2)
Existing conditions
0
1
2
3
4 km
WRM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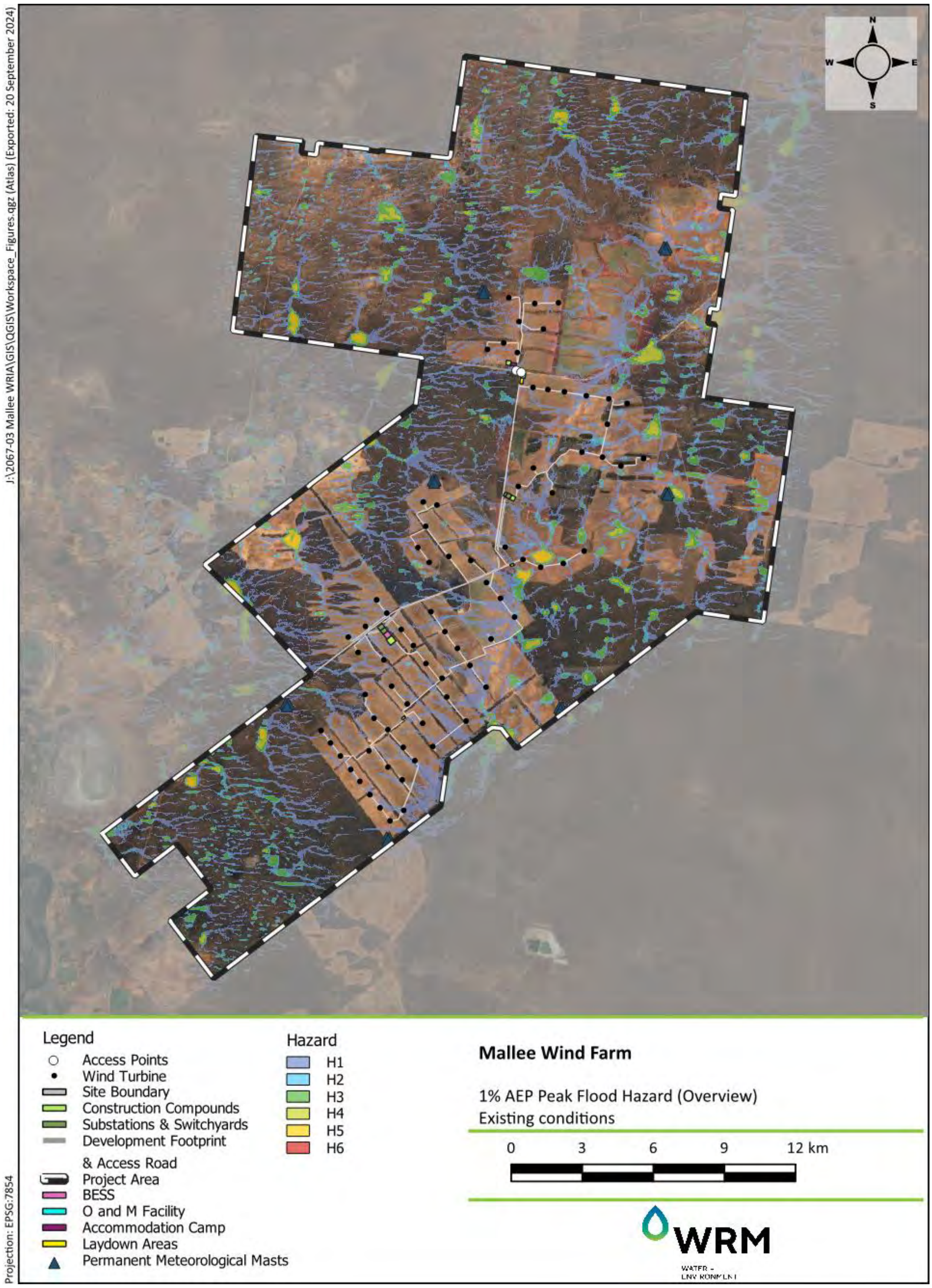
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
1% AEP Peak Flood Velocity (Zone 3)
Existing conditions
0
1
2
3
4 km
Projection: EPSG:7854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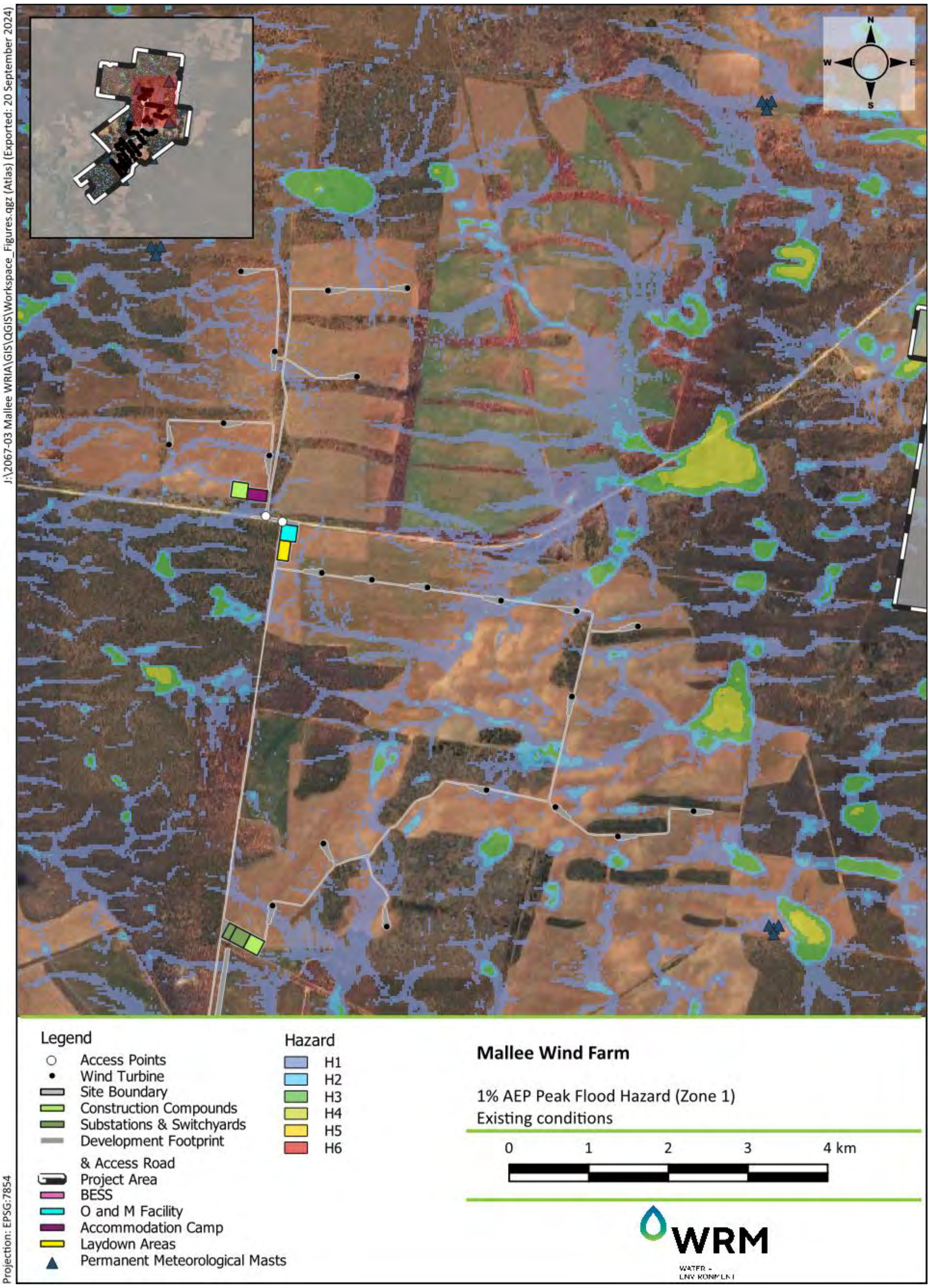
N
E
S
W
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
1% AEP Peak Flood Hazard (Overview)
Existing conditions
0
3
6
9
12 km
WRM
Projection: EPSG:7854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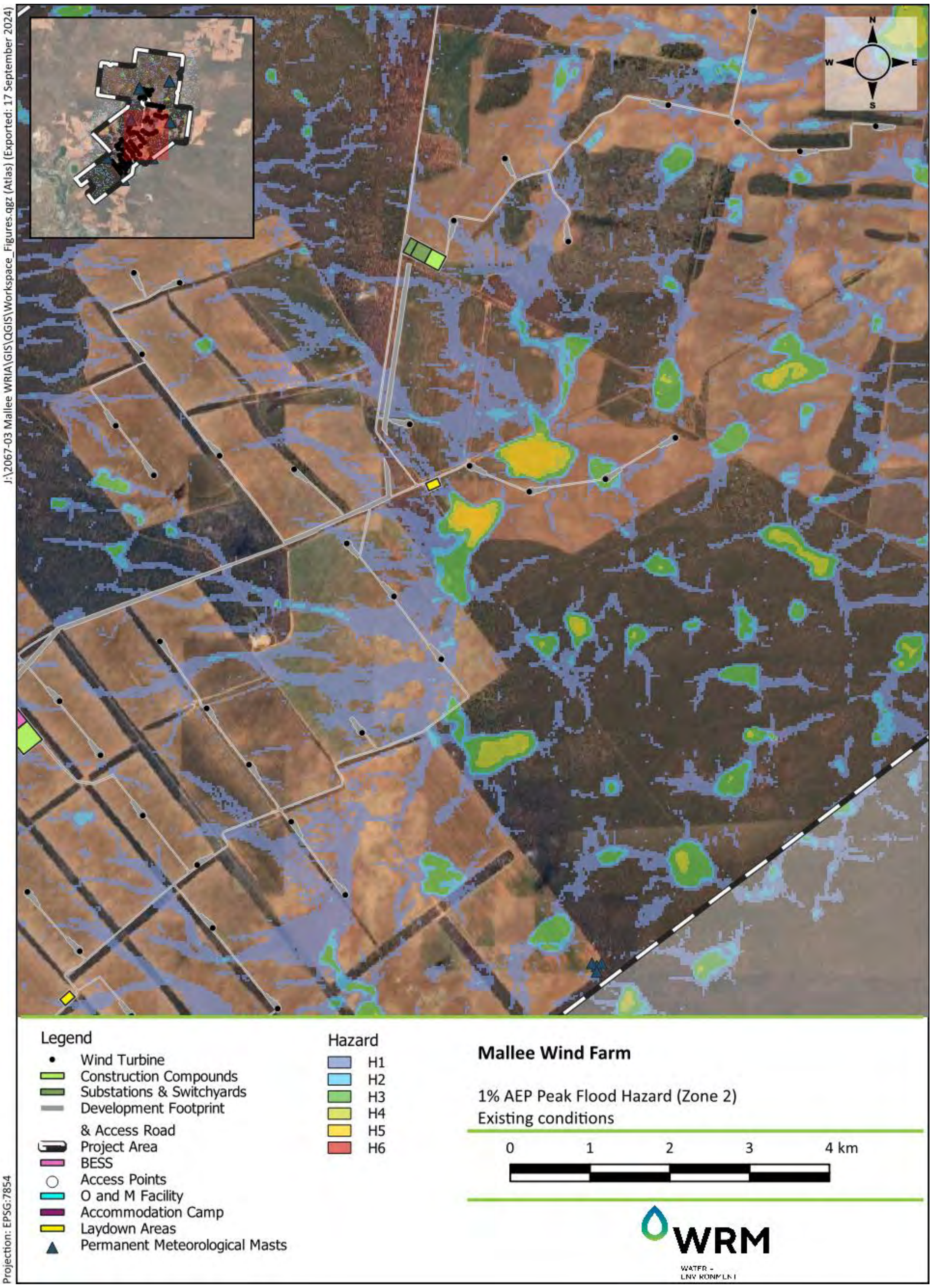
Projection: EPSG:7854
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
1% AEP Peak Flood Hazard (Zone 1)
Existing conditions
0
1
2
3
4 km
WRM



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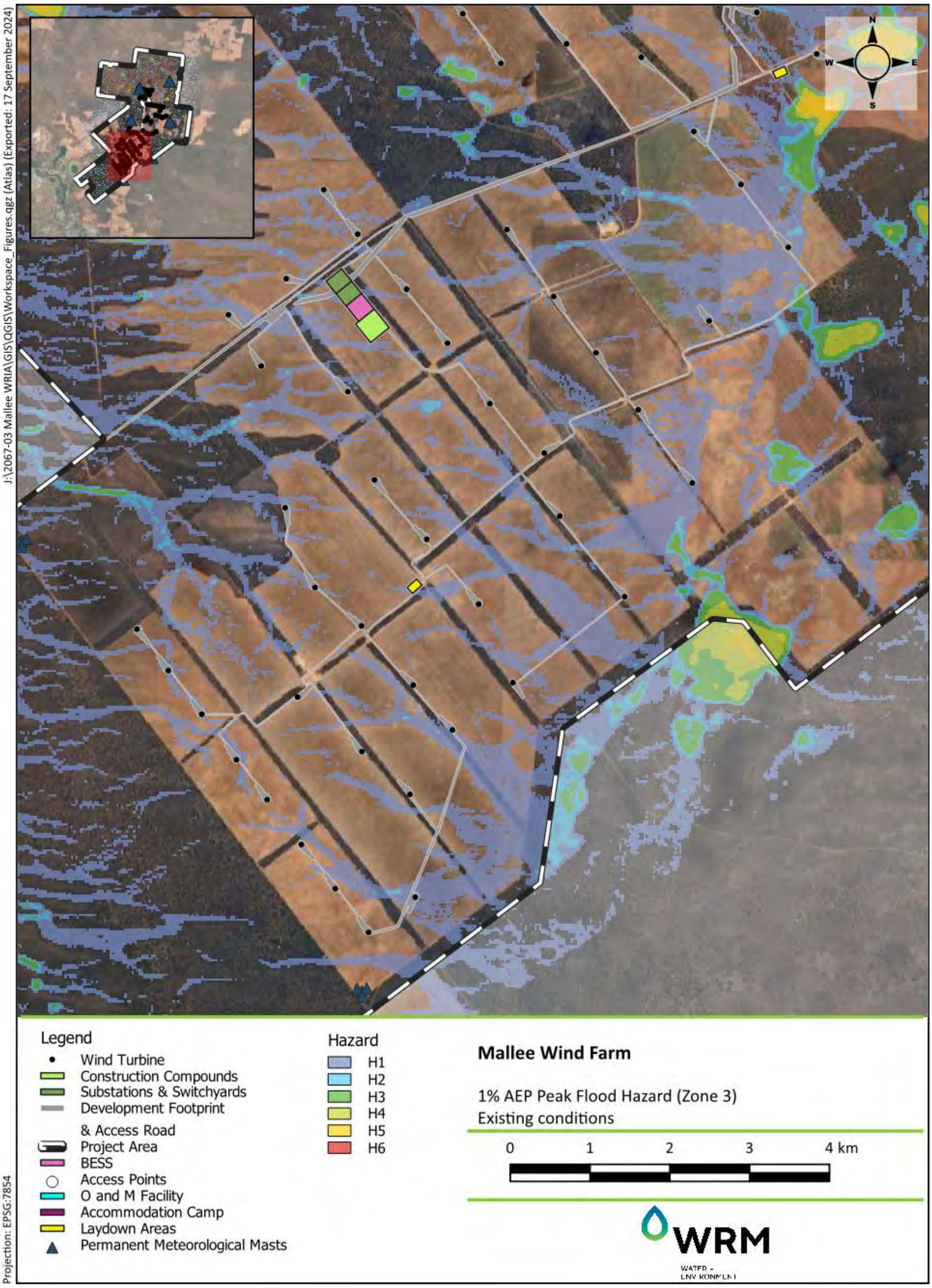
Legend
Wind Turbine
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
Access Points
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
1% AEP Peak Flood Hazard (Zone 2)
Existing conditions
0
1
2
3
4 km
WRM
Projection: EPSG:7854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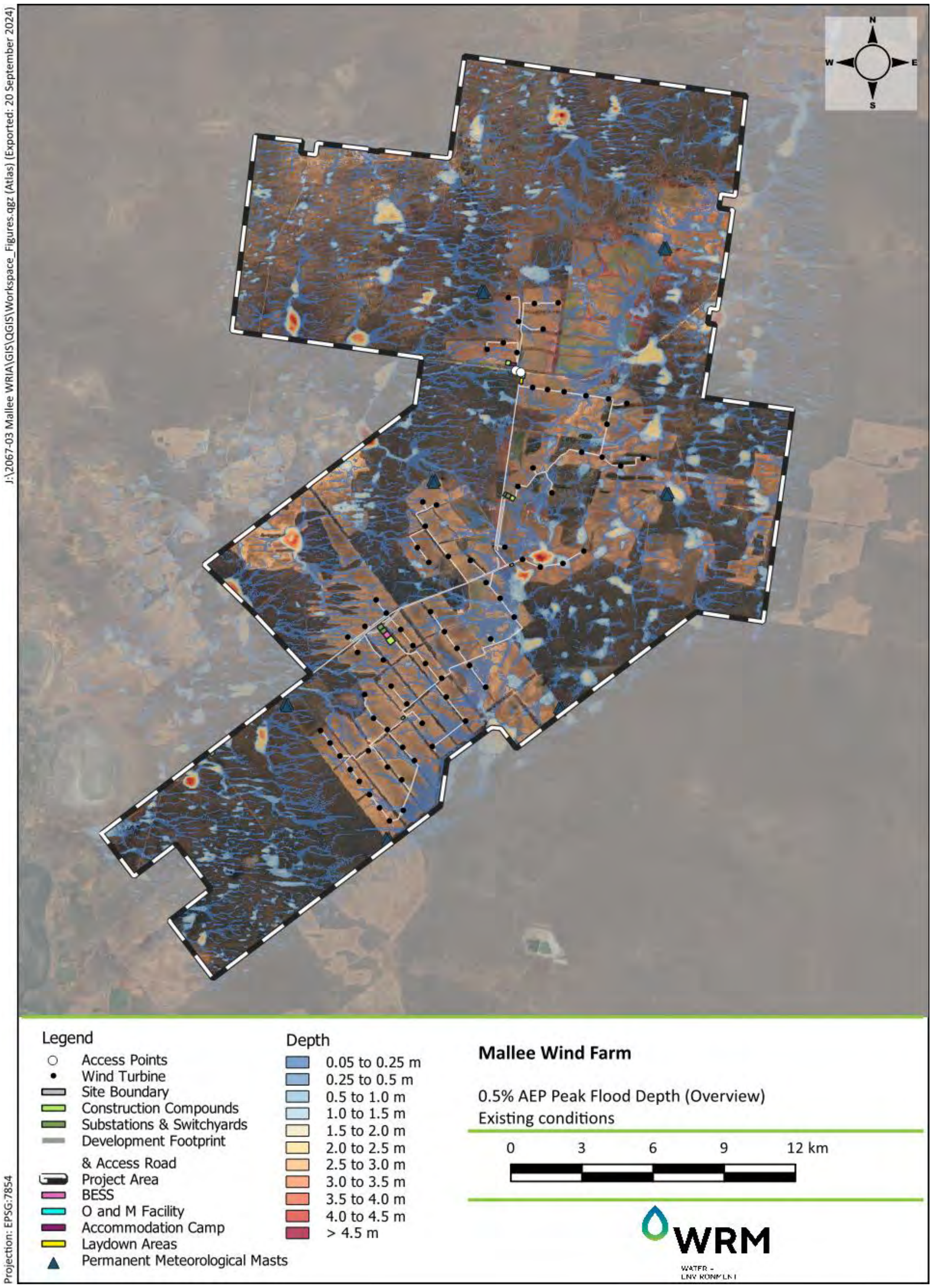
Projection: EPSG:7854
Legend
Wind Turbine
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
Access Points
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
1% AEP Peak Flood Hazard (Zone 3)
Existing conditions
0
1
2
3
4 km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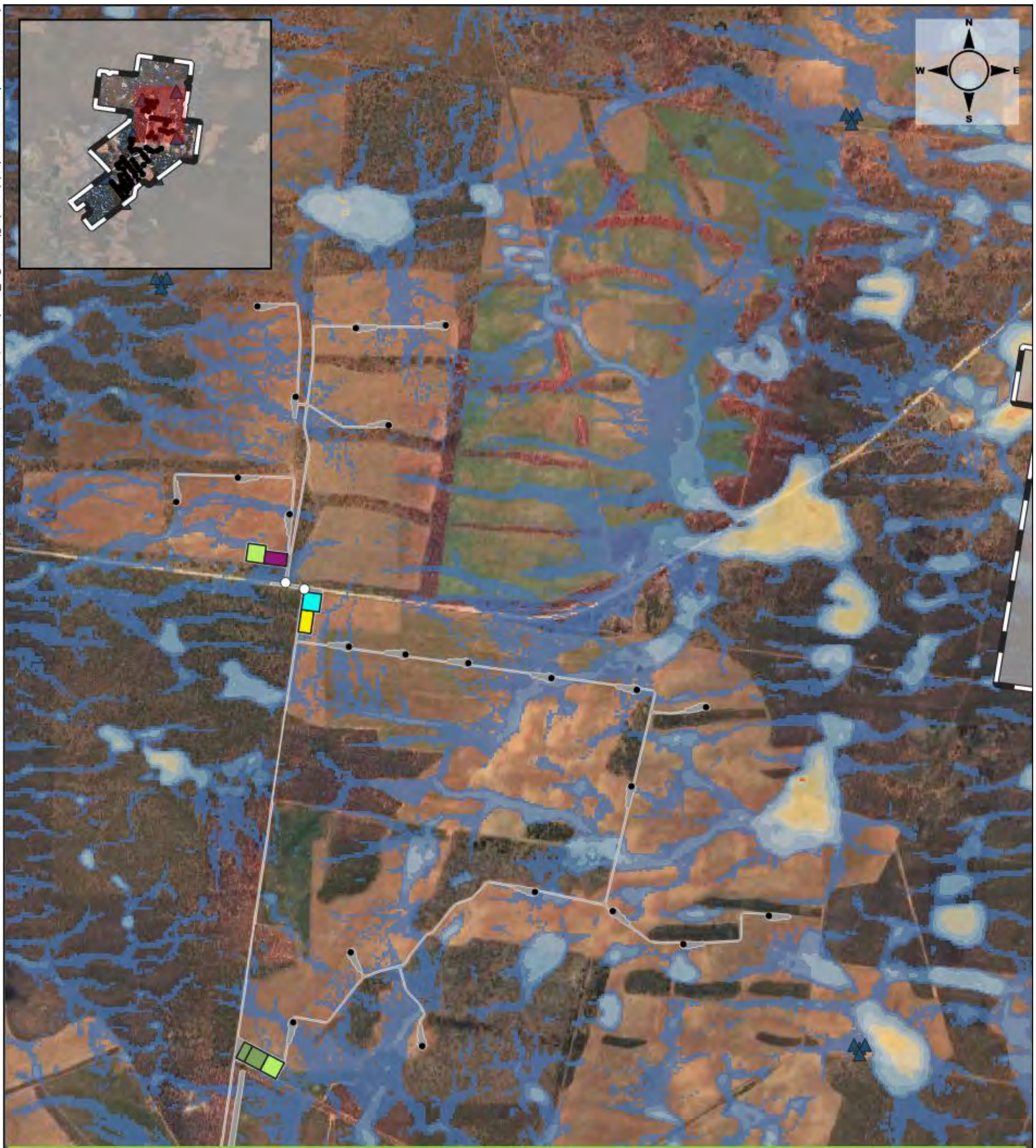
N
E
S
W
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Depth
0.05 to 0.25 m
0.25 to 0.5 m
0.5 to 1.0 m
1.0 to 1.5 m
1.5 to 2.0 m
2.0 to 2.5 m
2.5 to 3.0 m
3.0 to 3.5 m
3.5 to 4.0 m
4.0 to 4.5 m
> 4.5 m
Mallee Wind Farm
0.5% AEP Peak Flood Depth (Overview)
Existing conditions
0
3
6
9
12 km
WRM
Projection: EPSG:7854



Legend

- ○ Access Points
- • Wind Turbine
- Site Boundary
- Construction Compounds
- Substations & Switchyards
- Development Footprint & Access Road
- Project Area
- BESS
- O and M Facility
- Accommodation Camp
- Laydown Areas
- ▲ Permanent Meteorological Masts

Depth

- 0.05 to 0.25 m
- 0.25 to 0.5 m
- 0.5 to 1.0 m
- 1.0 to 1.5 m
- 1.5 to 2.0 m
- 2.0 to 2.5 m
- 2.5 to 3.0 m
- 3.0 to 3.5 m
- 3.5 to 4.0 m
- 4.0 to 4.5 m
- > 4.5 m

Mallee Wind Farm

0.5% AEP Peak Flood Depth (Zone 1)
Existing conditions

0 1 2 3 4 km

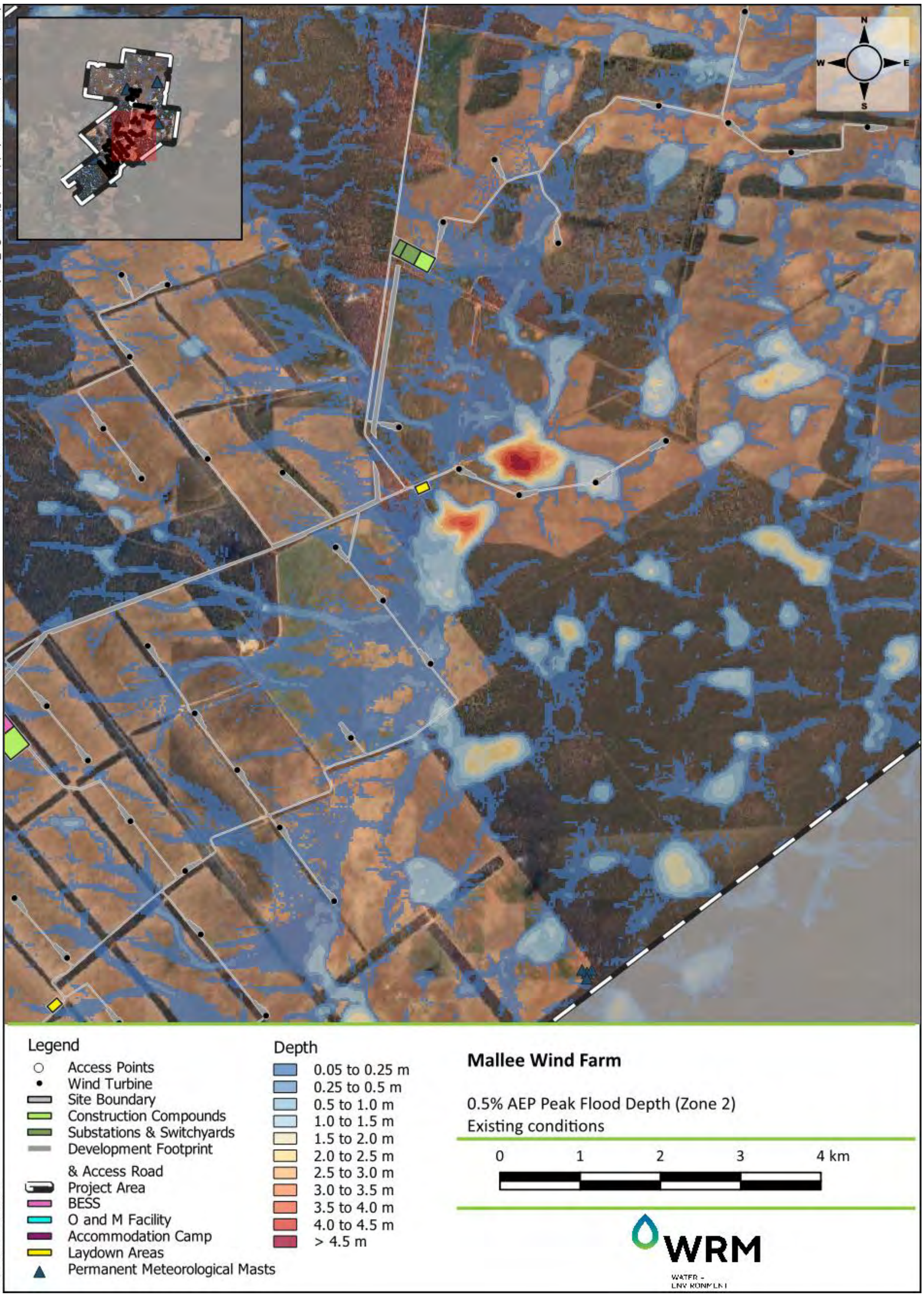
WRM
WATER + ENVIRONMENT

J:\2067-03 Mallee WRIA\GIS\QGIS\Workspace_Figures.qgz (Atlas) (Exported: 20 September 2024)

Projection: EPSG:7854

WRM

J:\2067-03 Mallee WRIA\GIS\QGIS\Workspace_Figures.qgz (Atlas) (Exported: 20 September 2024)



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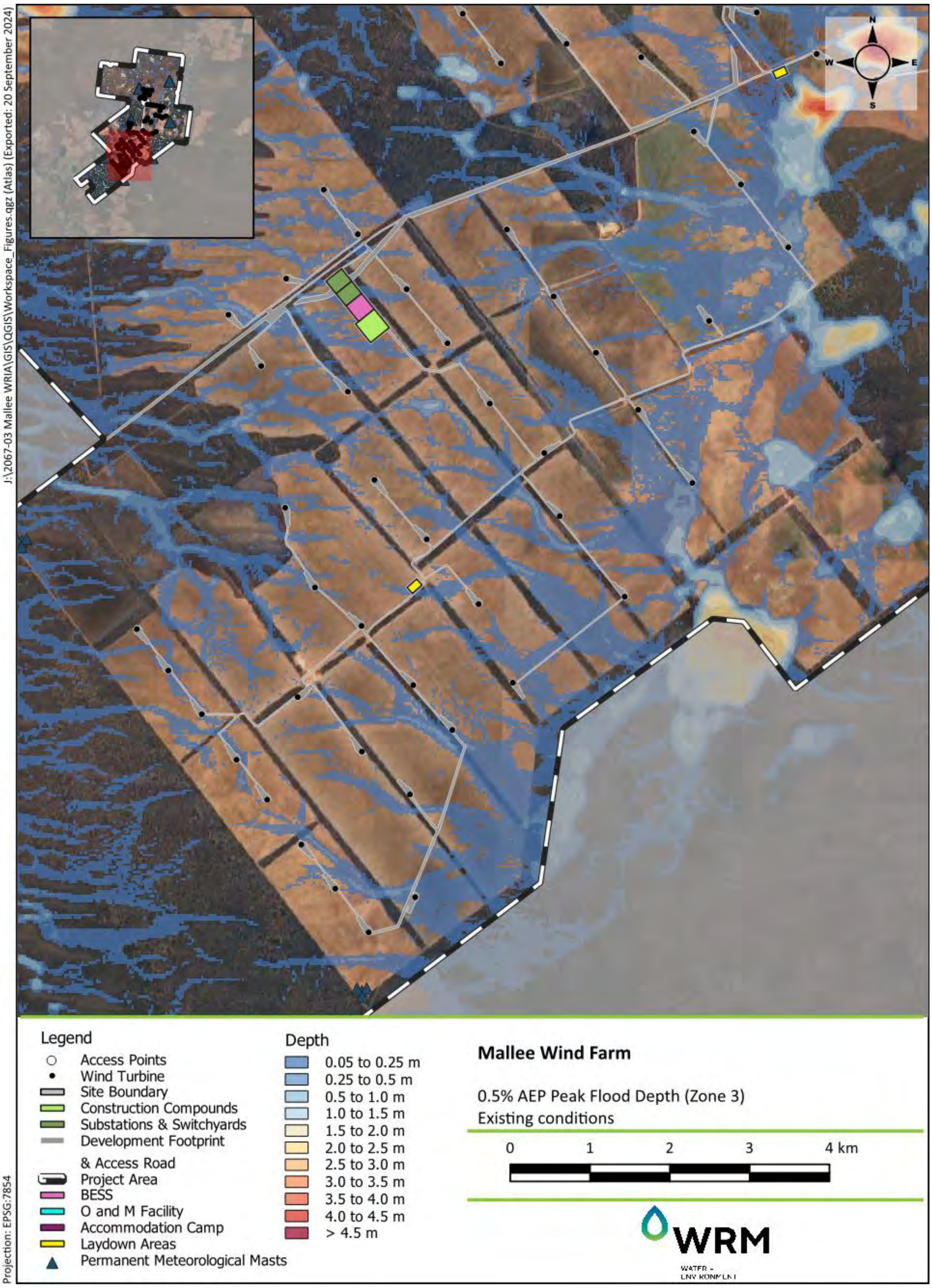
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Projection: EPSG:7854
N
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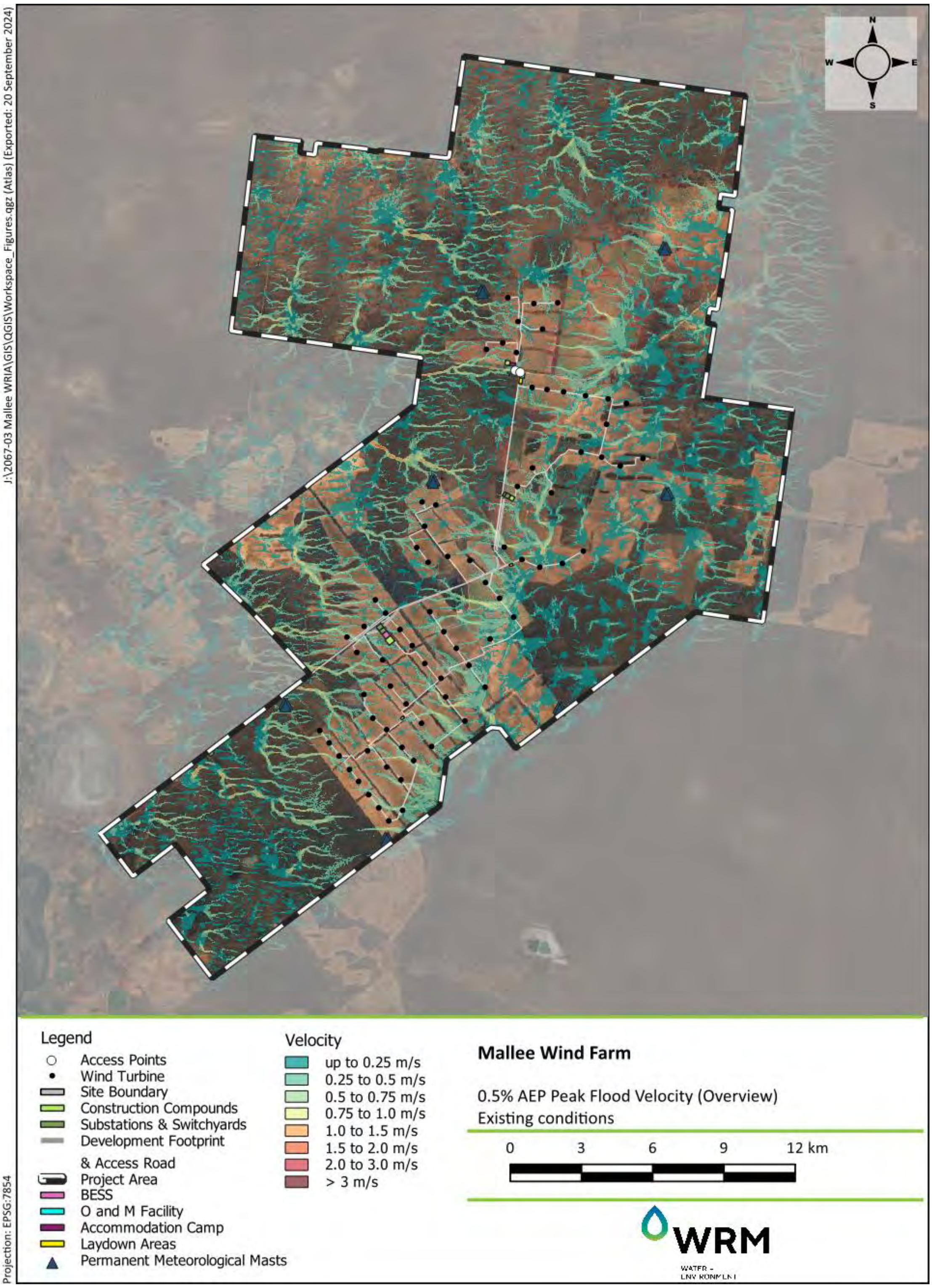
W
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Depth
0.05 to 0.25 m
0.25 to 0.5 m
0.5 to 1.0 m
1.0 to 1.5 m
1.5 to 2.0 m
2.0 to 2.5 m
2.5 to 3.0 m
3.0 to 3.5 m
3.5 to 4.0 m
4.0 to 4.5 m
> 4.5 m
Mallee Wind Farm
0.5% AEP Peak Flood Depth (Zone 3)
Existing conditions
0
1
2
3
4 km
WRM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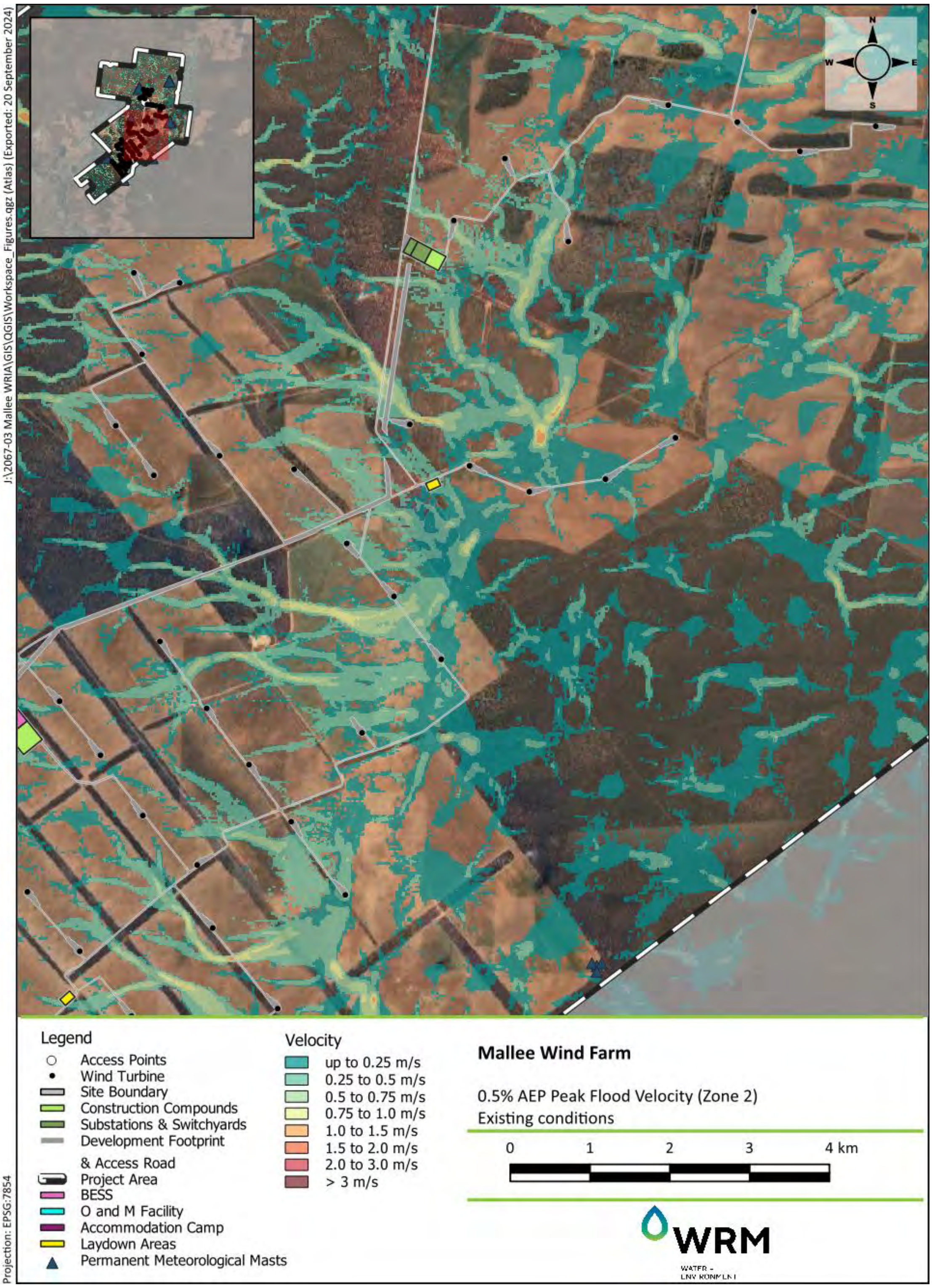
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
0.5% AEP Peak Flood Velocity (Overview)
Existing conditions
0
3
6
9
12 km
Projection: EPSG:7854


J:\2067-03 Mallee WRIA\GIS\QGIS\Workspace_Figures.qgz (Atlas) (Exported: 20 September 2024)
Projection: EPSG:7854
N
E
S
W
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
0.5% AEP Peak Flood Velocity (Zone 1)
Existing conditions
0
1
2
3
4 km
WRM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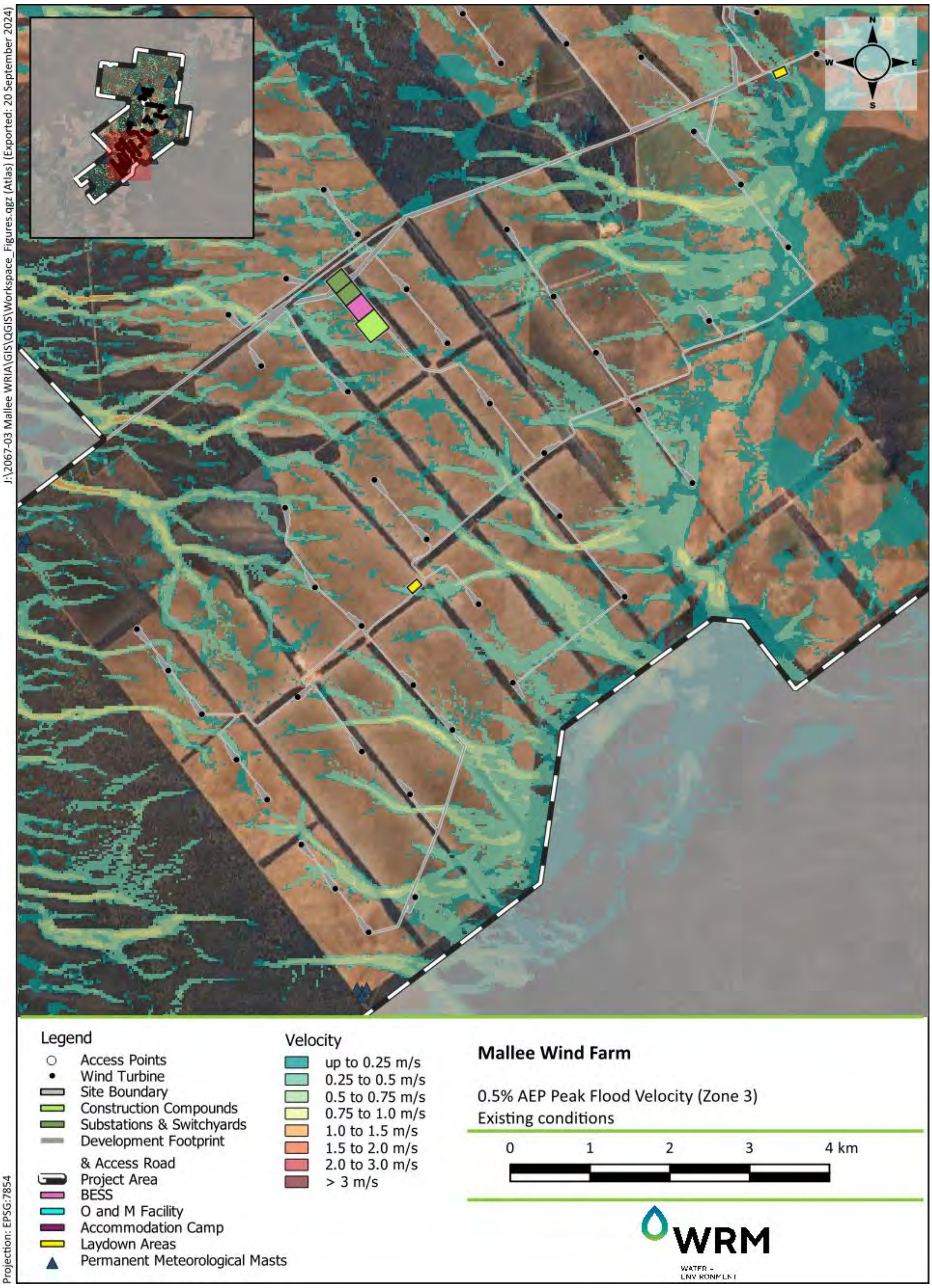
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
0.5% AEP Peak Flood Velocity (Zone 2)
Existing conditions
0
1
2
3
4 km
WRM
Projection: EPSG:7854



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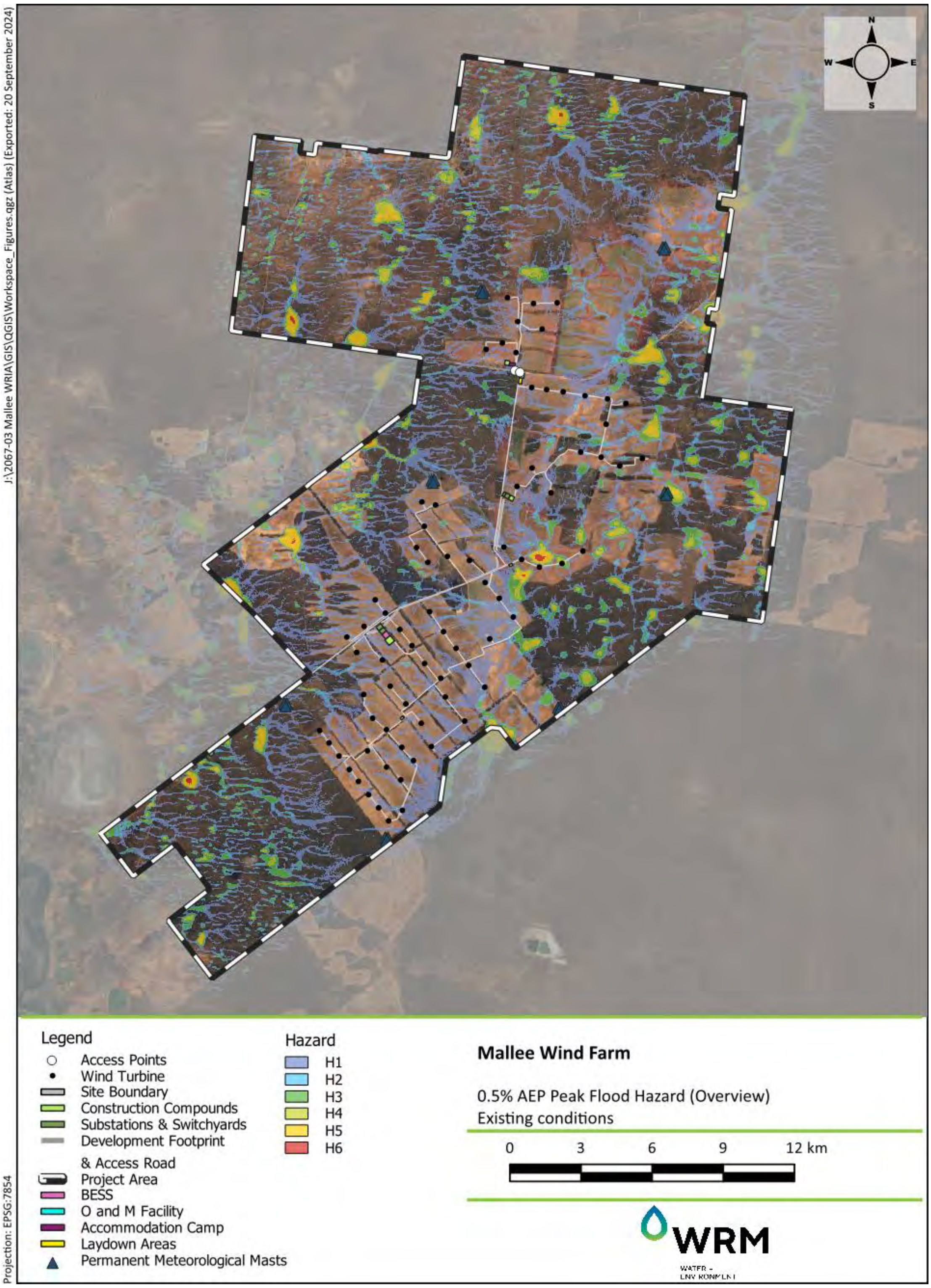
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
0.5% AEP Peak Flood Velocity (Zone 3)
Existing conditions
0 1 2 3 4 km
WRM
Projection: EPSG:7854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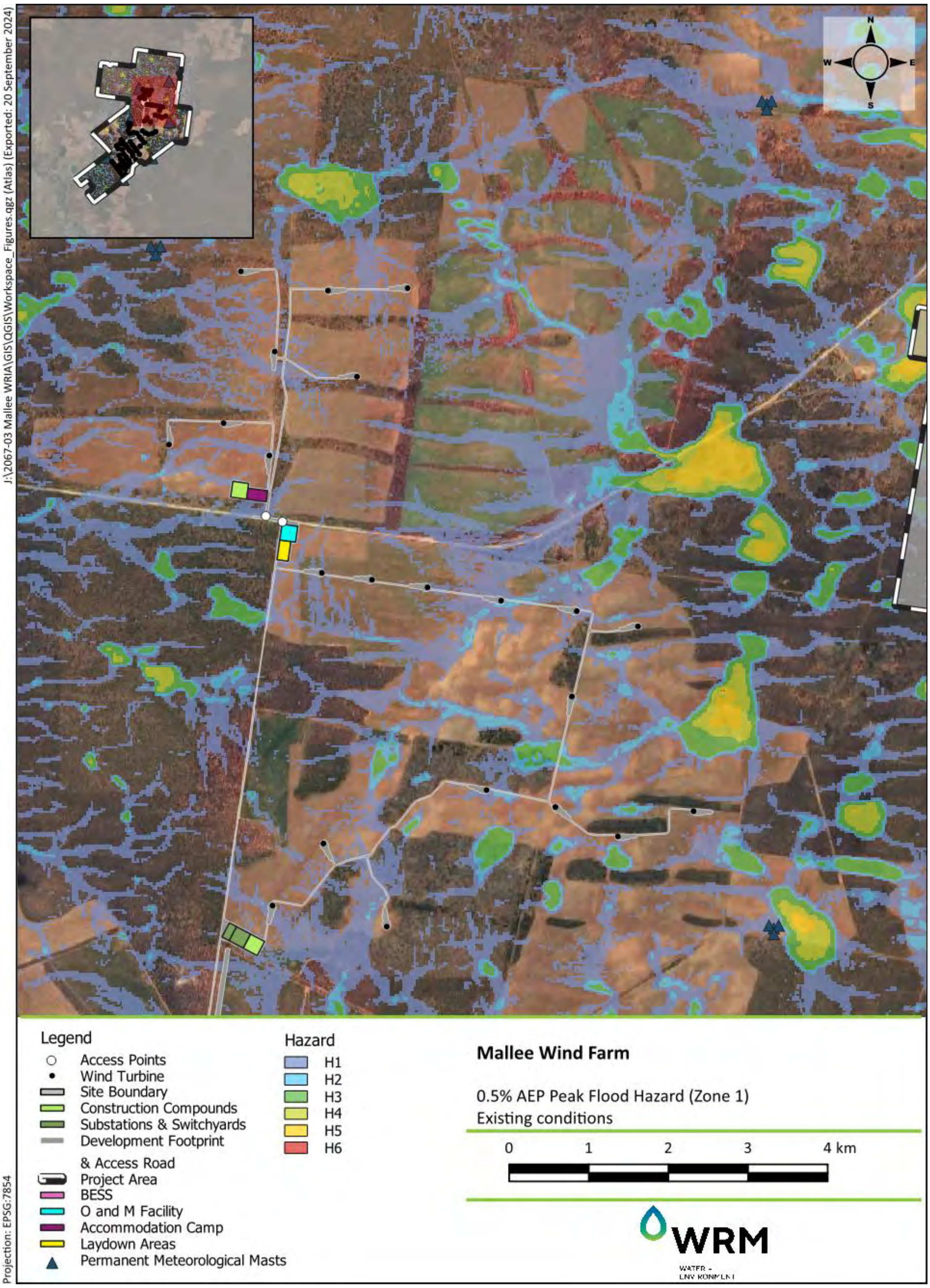
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
0.5% AEP Peak Flood Hazard (Overview)
Existing conditions
0
3
6
9
12 km
WRM
Projection: EPSG:7854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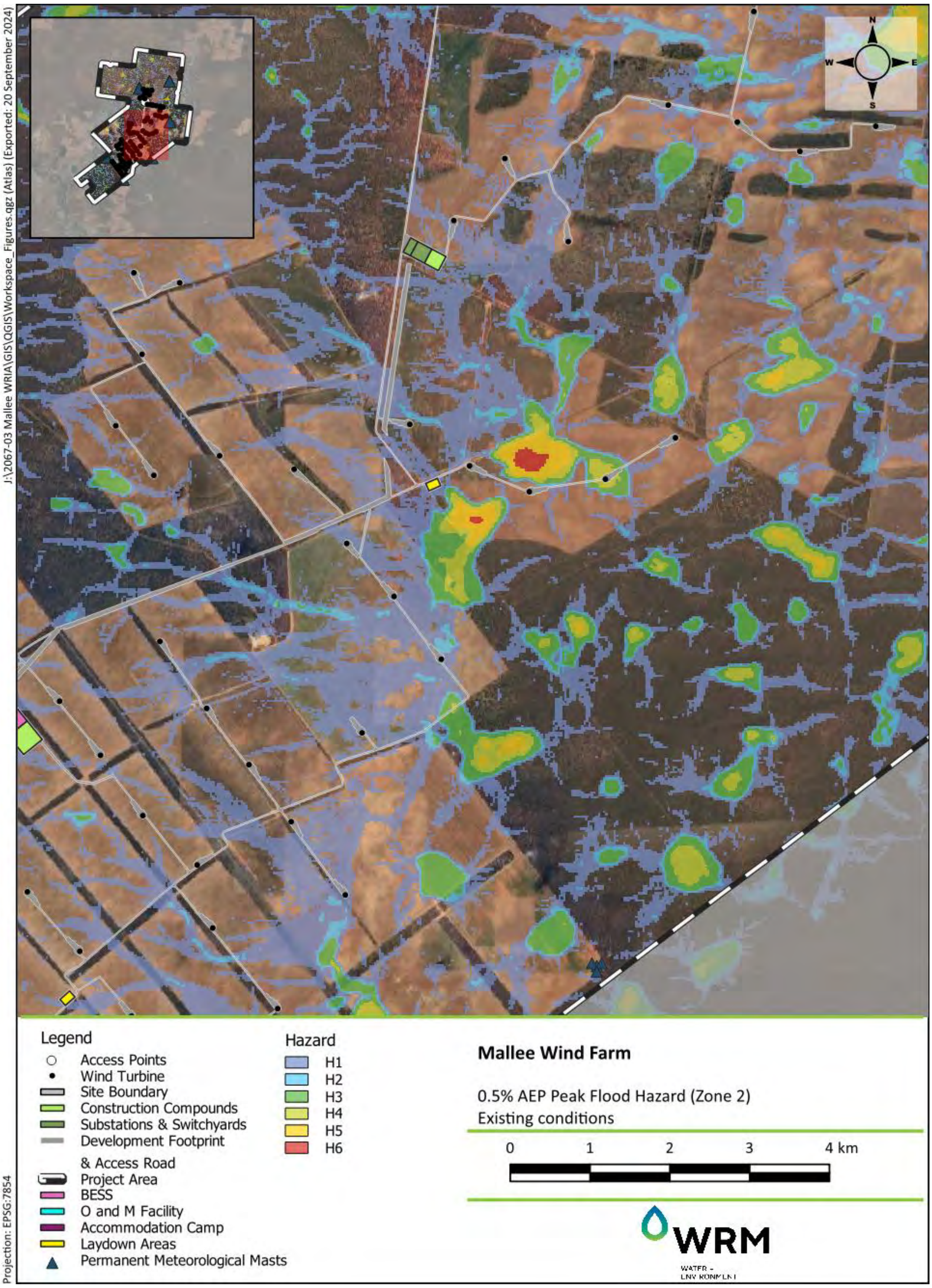
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
0.5% AEP Peak Flood Hazard (Zone 1)
Existing conditions
0
1
2
3
4 km
WRM
Projection: EPSG:7854



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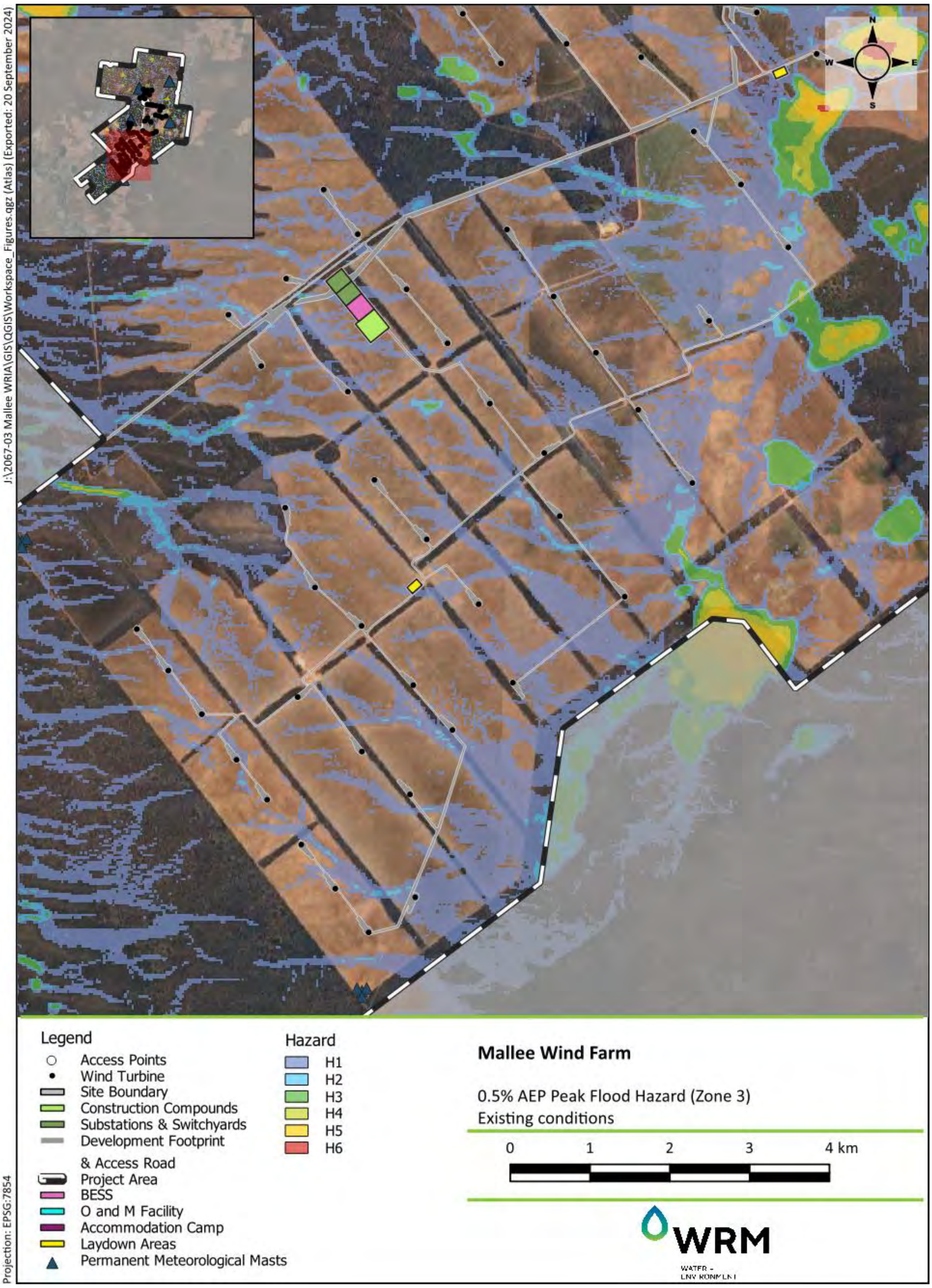
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
0.5% AEP Peak Flood Hazard (Zone 2)
Existing conditions
0
1
2
3
4 km
Projection: EPSG:7854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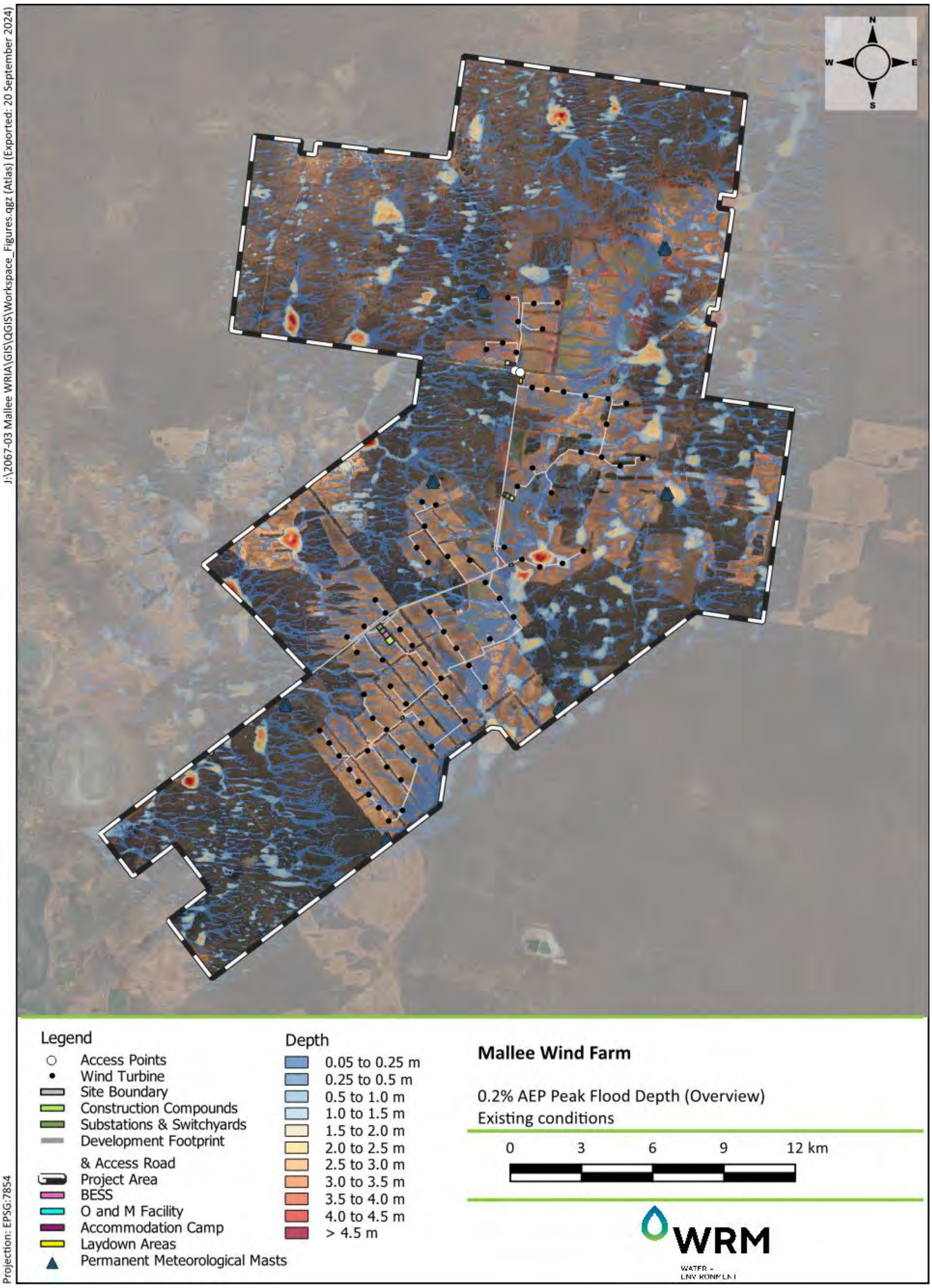
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
0.5% AEP Peak Flood Hazard (Zone 3)
Existing conditions
0
1
2
3
4 km
WRM
Projection: EPSG:7854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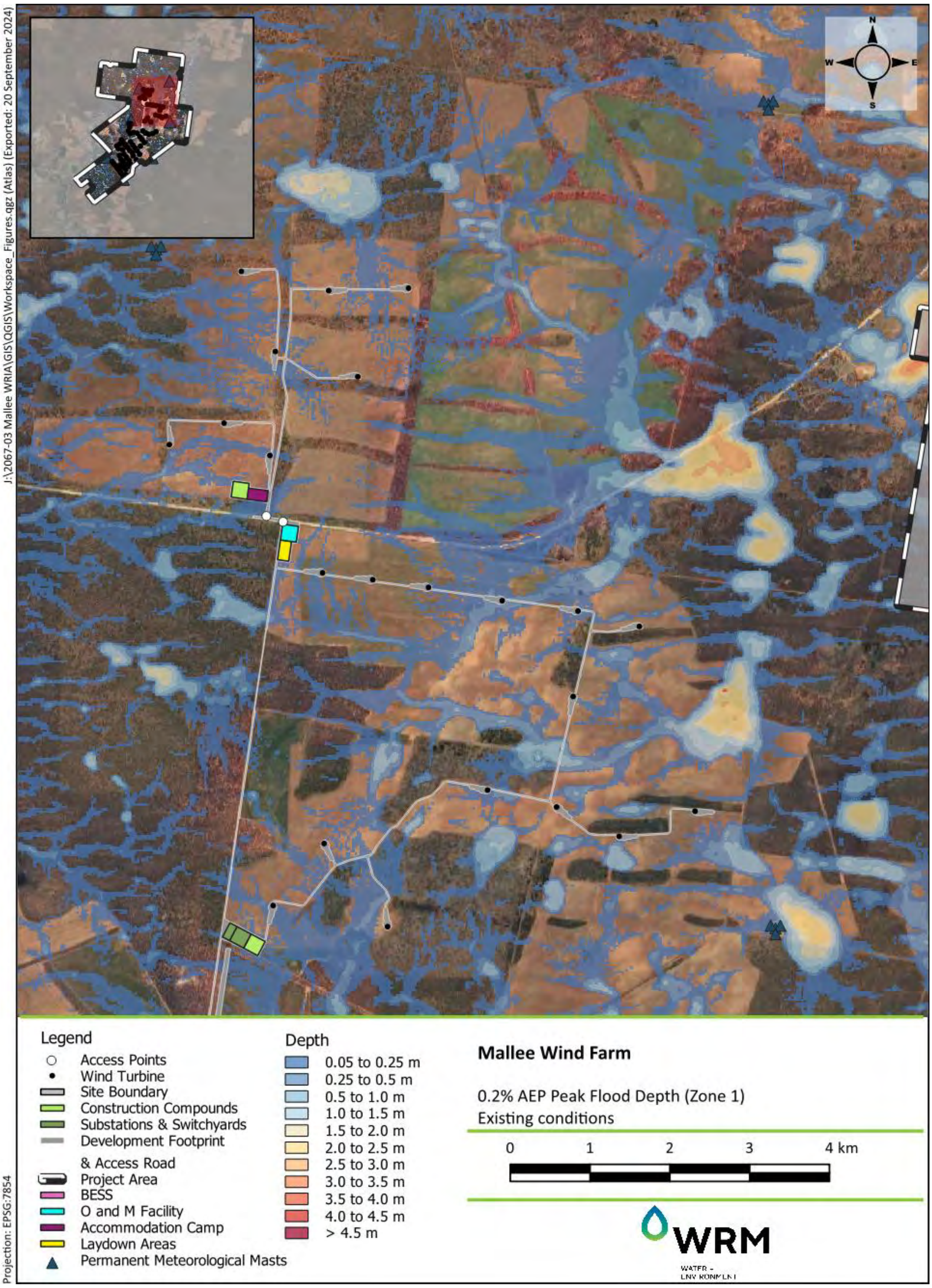
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Depth
0.05 to 0.25 m
0.25 to 0.5 m
0.5 to 1.0 m
1.0 to 1.5 m
1.5 to 2.0 m
2.0 to 2.5 m
2.5 to 3.0 m
3.0 to 3.5 m
3.5 to 4.0 m
4.0 to 4.5 m
> 4.5 m
Mallee Wind Farm
0.2% AEP Peak Flood Depth (Overview)
Existing conditions
0
3
6
9
12 km
Projection: EPSG:7854



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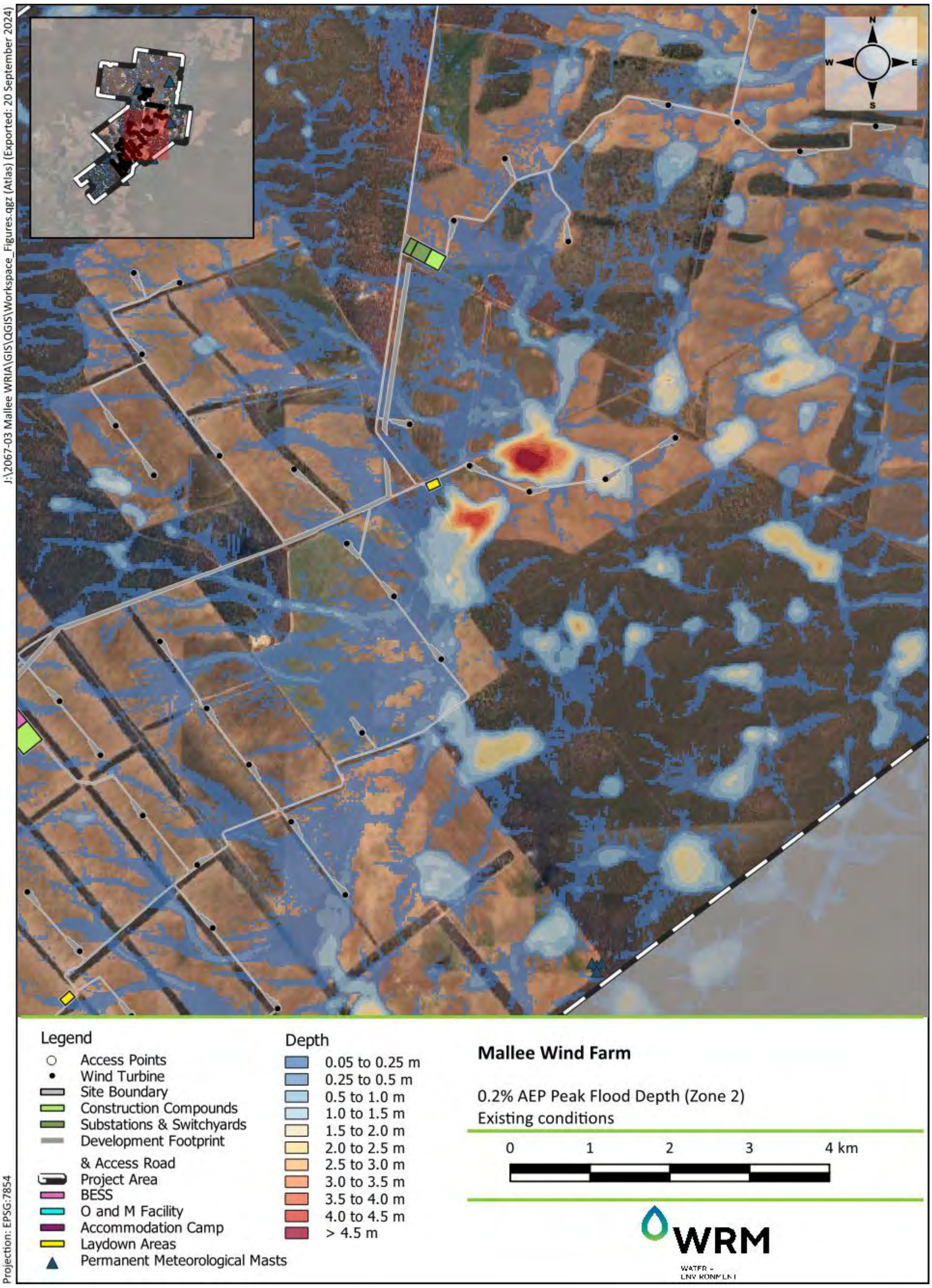
Projection: EPSG:7854
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Depth
0.05 to 0.25 m
0.25 to 0.5 m
0.5 to 1.0 m
1.0 to 1.5 m
1.5 to 2.0 m
2.0 to 2.5 m
2.5 to 3.0 m
3.0 to 3.5 m
3.5 to 4.0 m
4.0 to 4.5 m
> 4.5 m
Mallee Wind Farm
0.2% AEP Peak Flood Depth (Zone 1)
Existing conditions
0 1 2 3 4 km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Legend
Access Points
Wind Turbine
Site Boundary
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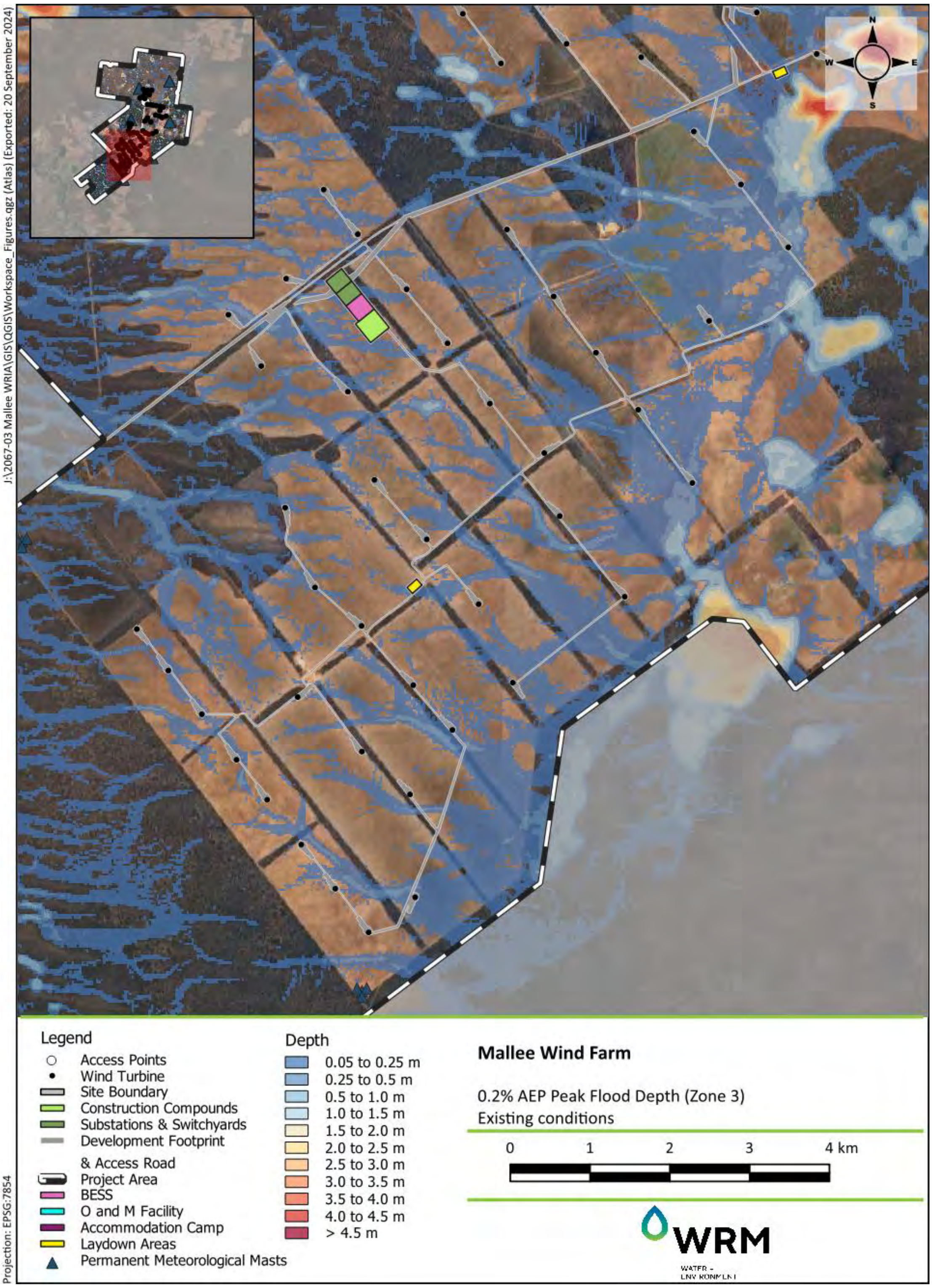
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Depth
0.05 to 0.25 m
0.25 to 0.5 m
0.5 to 1.0 m
1.0 to 1.5 m
1.5 to 2.0 m
2.0 to 2.5 m
2.5 to 3.0 m
3.0 to 3.5 m
3.5 to 4.0 m
4.0 to 4.5 m
> 4.5 m
Mallee Wind Farm
0.2% AEP Peak Flood Depth (Zone 2)
Existing conditions
0
1
2
3
4 km
WRM
Projection: EPSG:7854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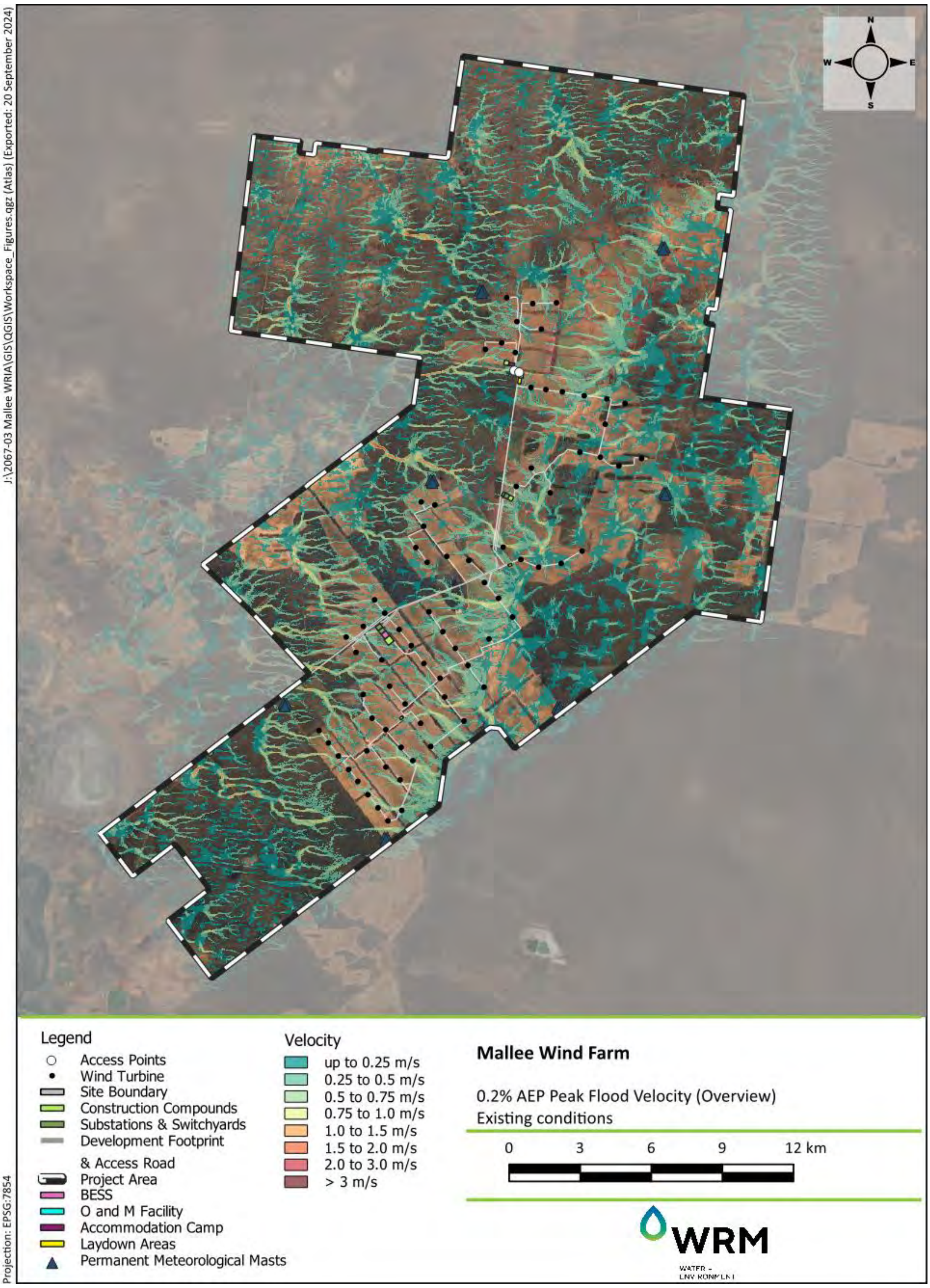
Projection: EPSG:7854
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Depth
0.05 to 0.25 m
0.25 to 0.5 m
0.5 to 1.0 m
1.0 to 1.5 m
1.5 to 2.0 m
2.0 to 2.5 m
2.5 to 3.0 m
3.0 to 3.5 m
3.5 to 4.0 m
4.0 to 4.5 m
> 4.5 m
Mallee Wind Farm
0.2% AEP Peak Flood Depth (Zone 3)
Existing conditions
0
1
2
3
4 km
N
E
S
W
WRM



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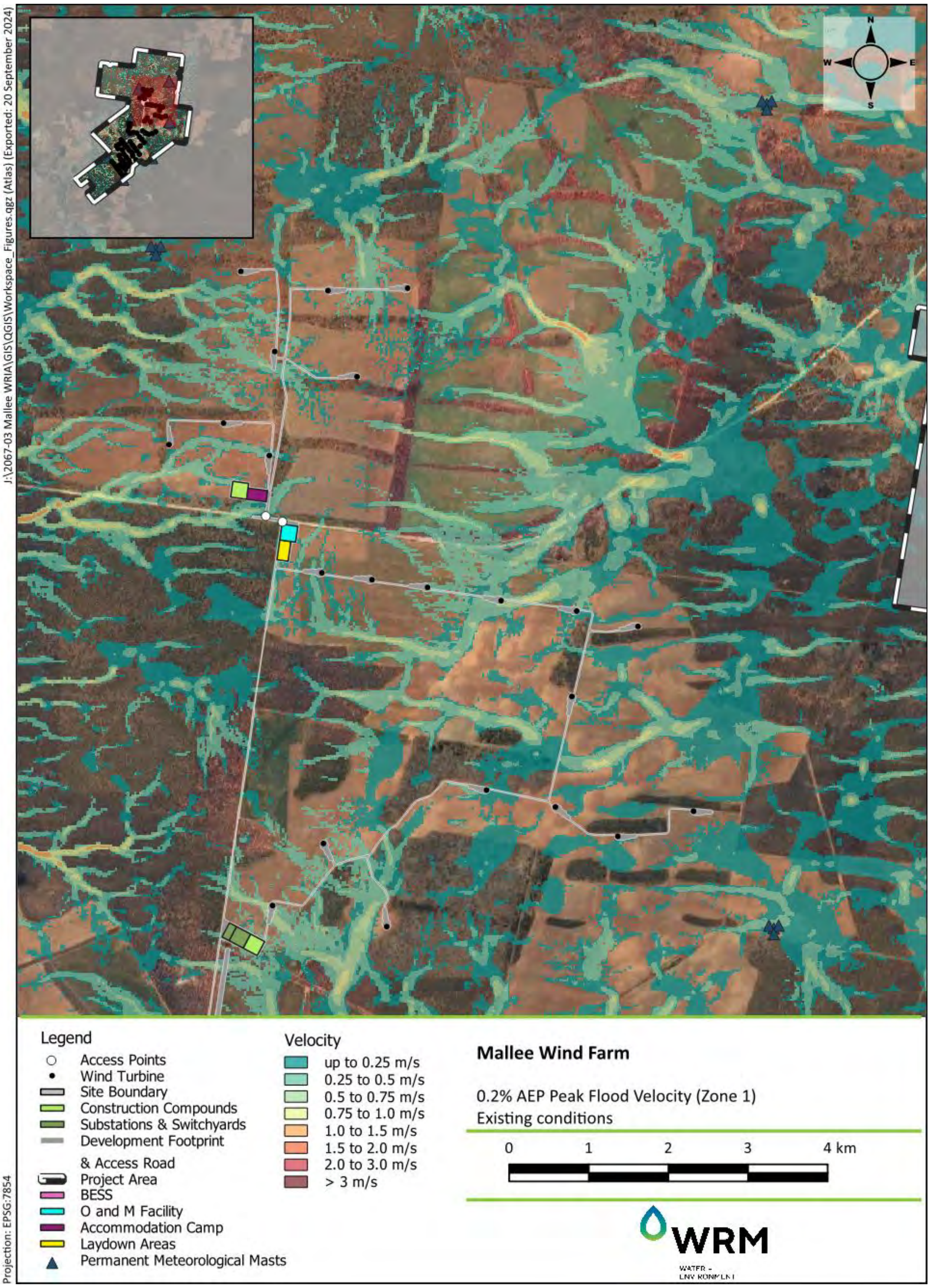
N
W
E
S
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
0.2% AEP Peak Flood Velocity (Overview)
Existing conditions
0
3
6
9
12 km
Projection: EPSG:7854



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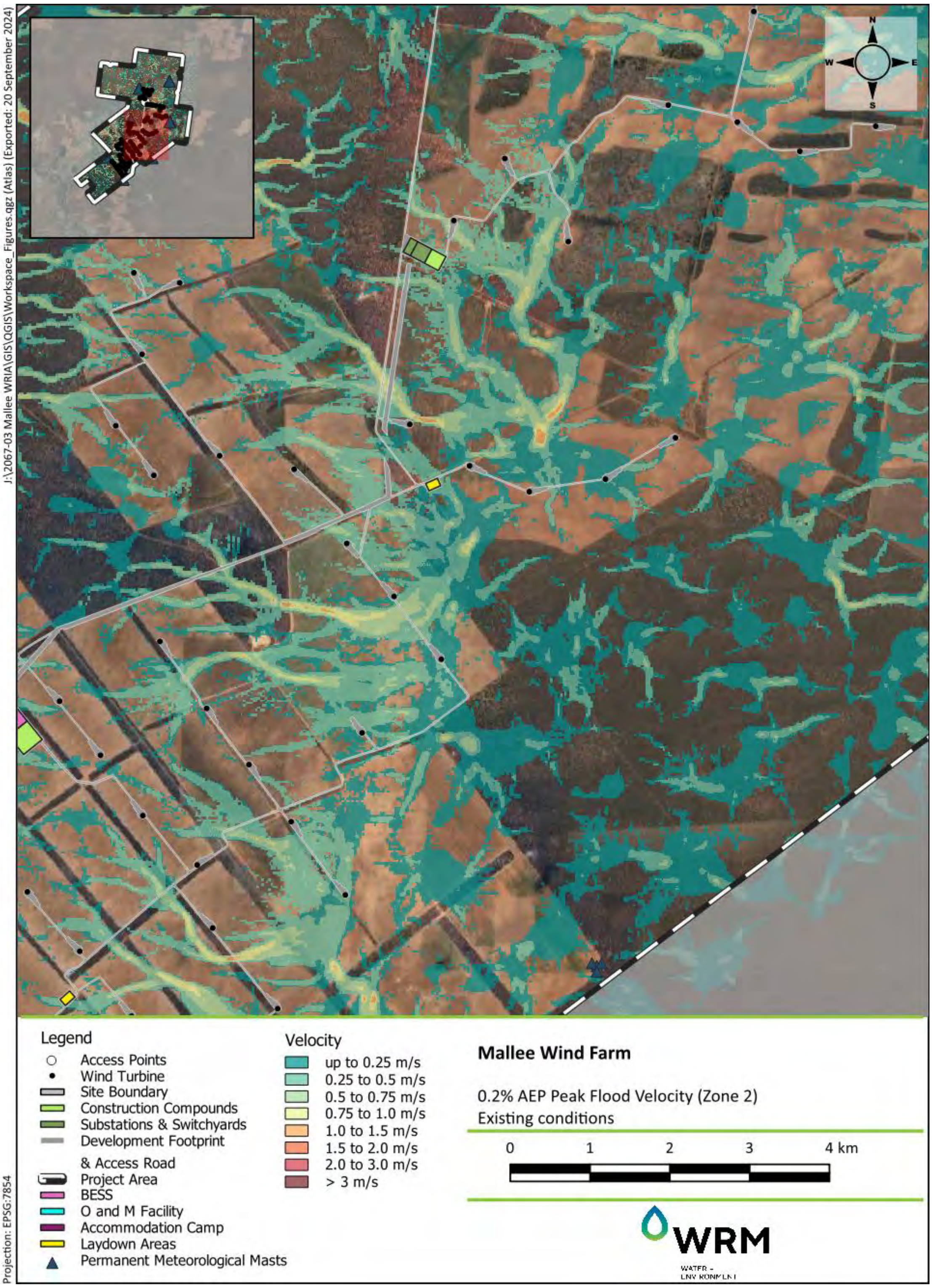
Projection: EPSG:7854
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
0.2% AEP Peak Flood Velocity (Zone 1)
Existing conditions
0
1
2
3
4 km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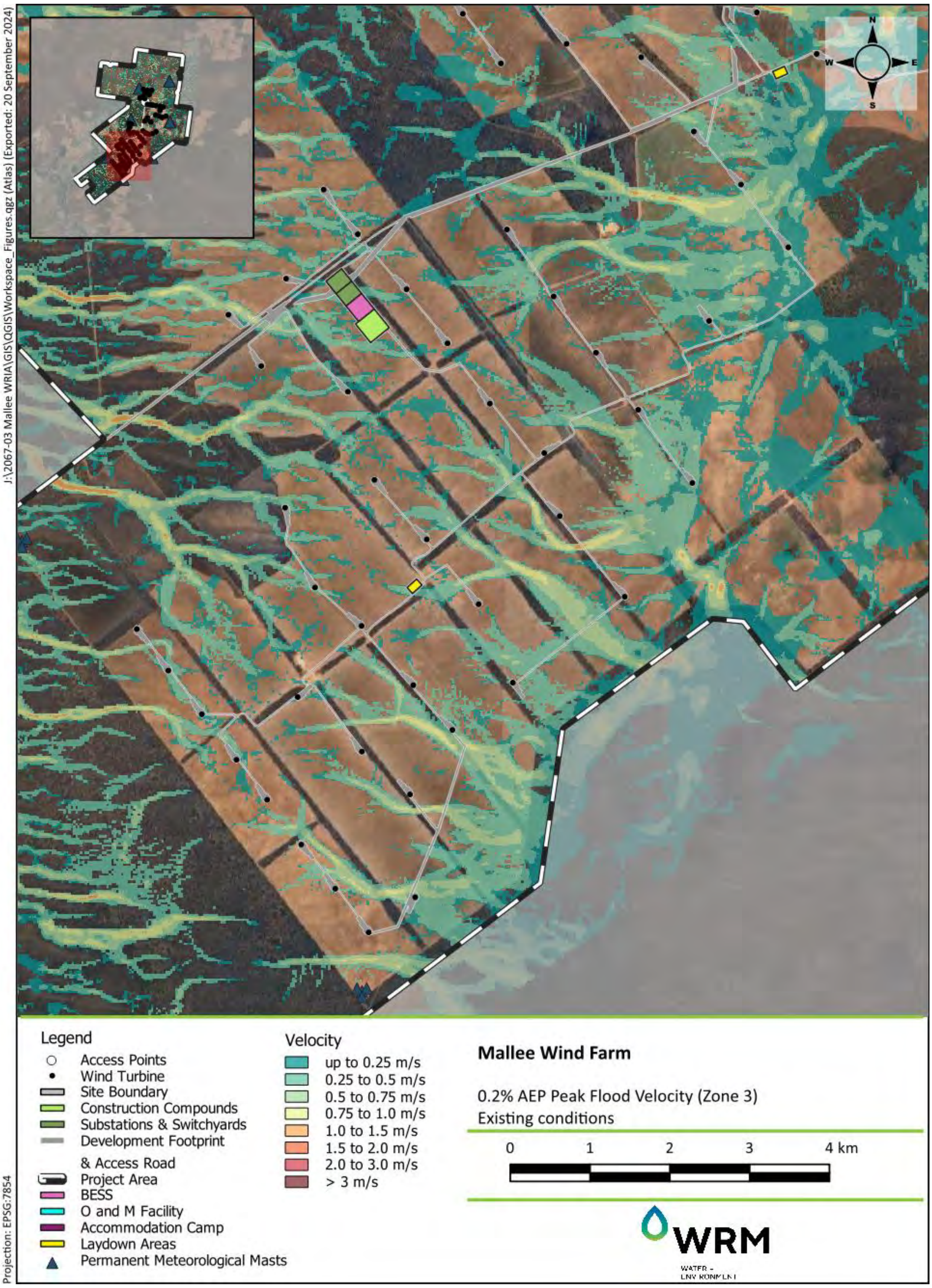
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
0.2% AEP Peak Flood Velocity (Zone 2)
Existing conditions
0 1 2 3 4 km
WRM
Projection: EPSG:7854



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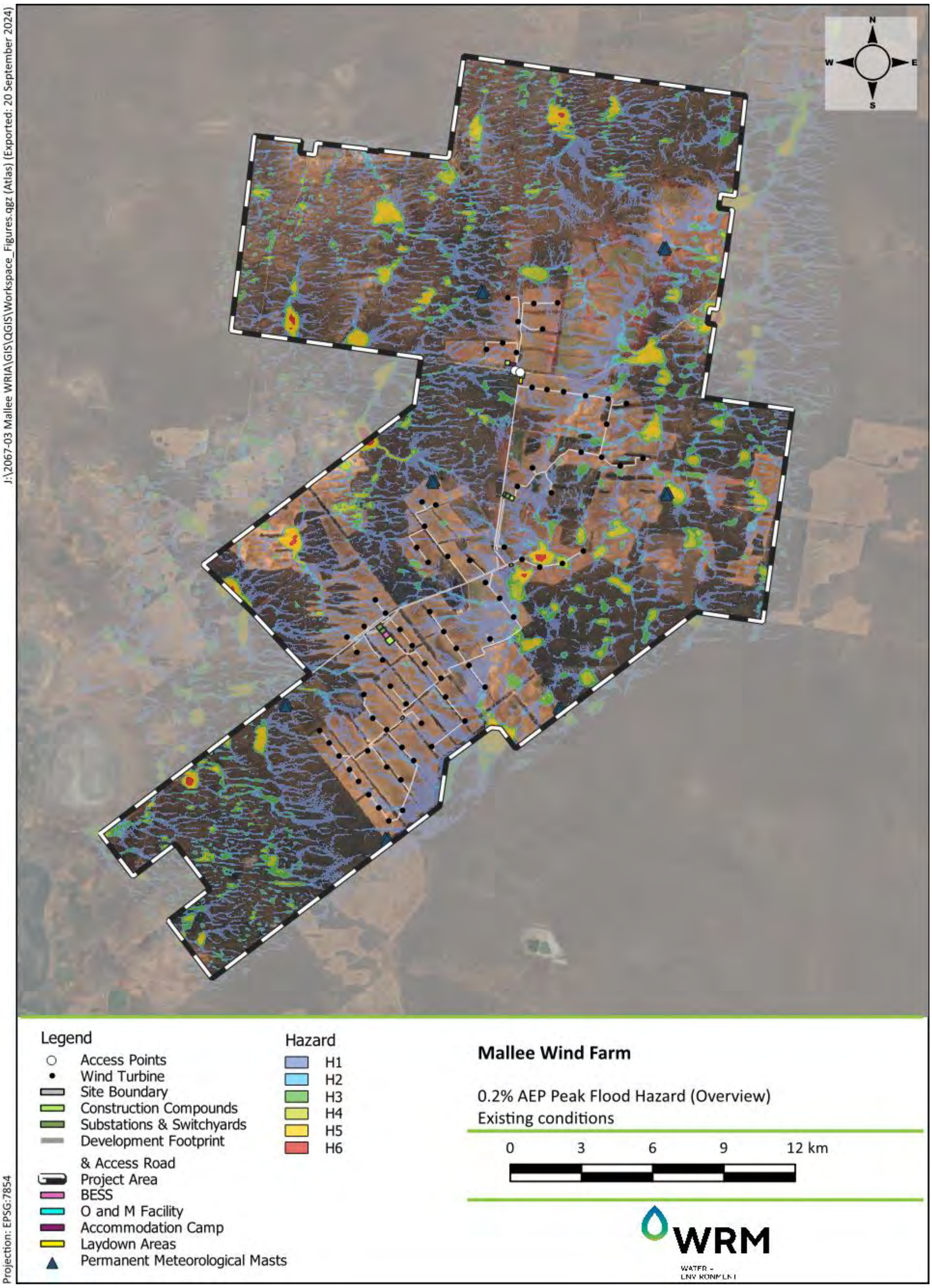
Projection: EPSG:7854
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
0.2% AEP Peak Flood Velocity (Zone 3)
Existing conditions
0
1
2
3
4 km
WRM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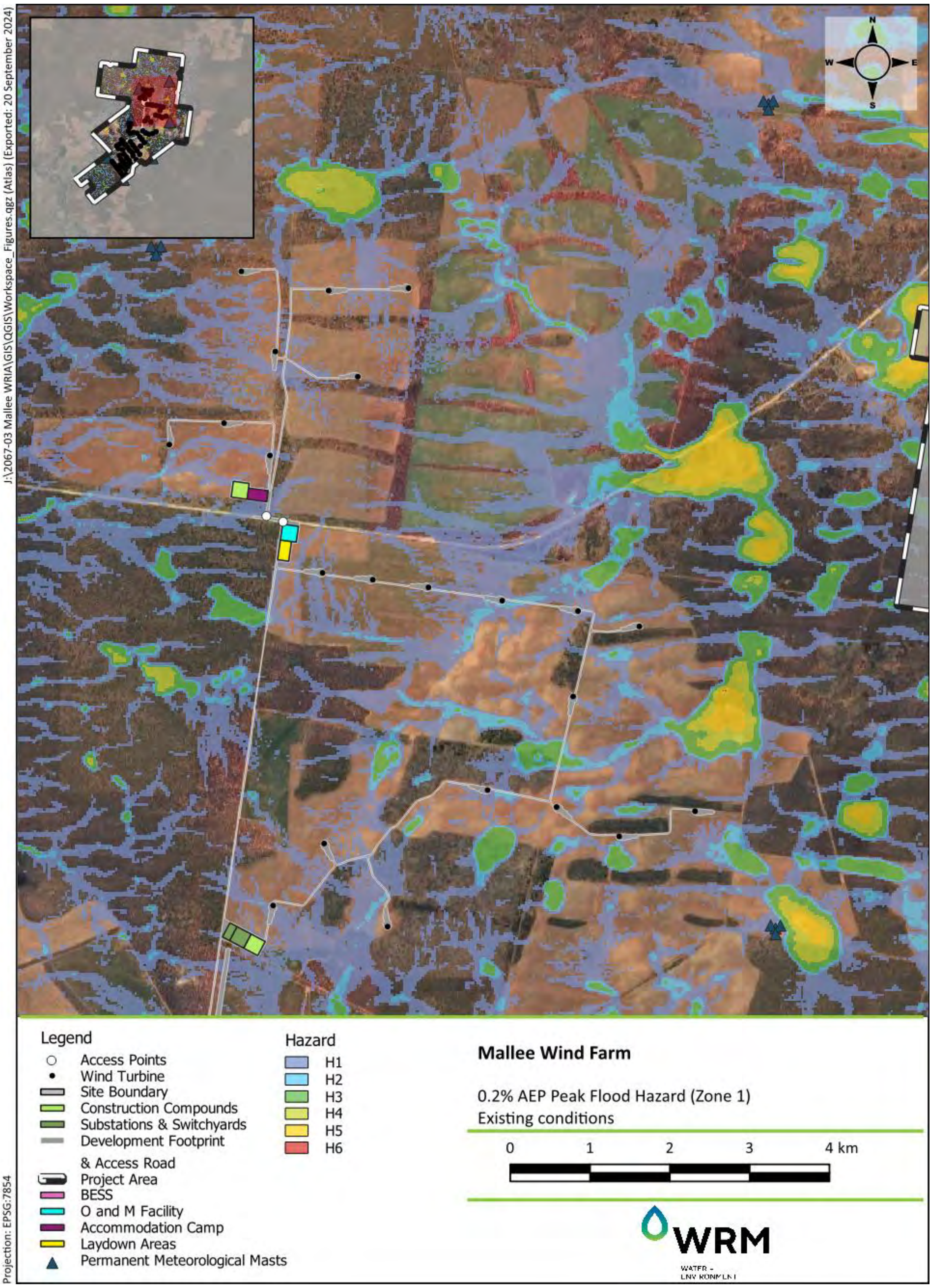
N
E
S
W
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
0.2% AEP Peak Flood Hazard (Overview)
Existing conditions
0
3
6
9
12 km
Projection: EPSG:7854



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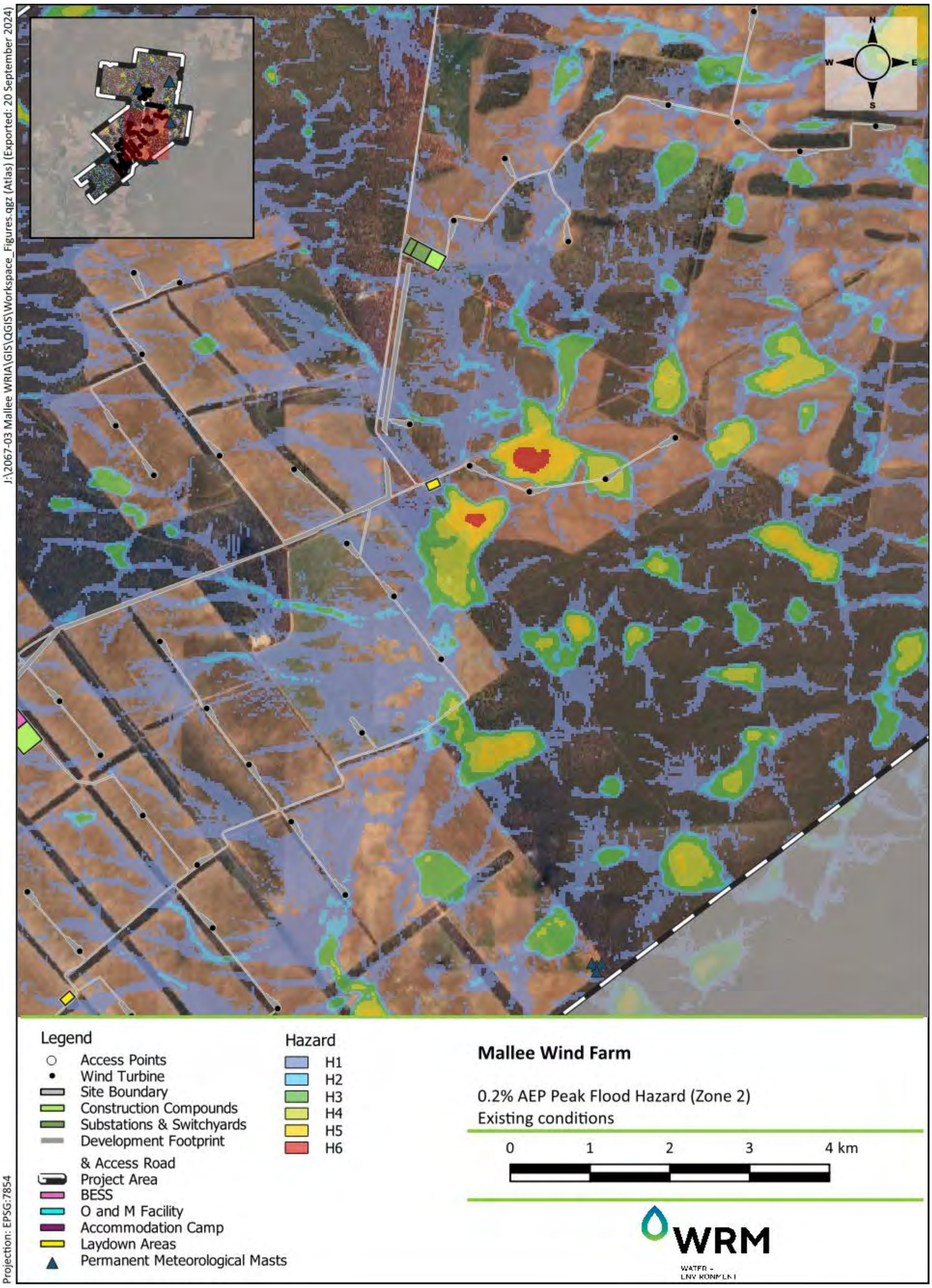
N
W
E
S
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
0.2% AEP Peak Flood Hazard (Zone 1)
Existing conditions
0
1
2
3
4 km
Projection: EPSG:7854


J:\2067-03 Mallee WRIA\GIS\QGIS\Workspace_Figures.qgz (Atlas) (Exported: 20 September 2024)
N
W
E
S
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
0.2% AEP Peak Flood Hazard (Zone 2)
Existing conditions
0
1
2
3
4 km
WRM
Projection: EPSG:7854

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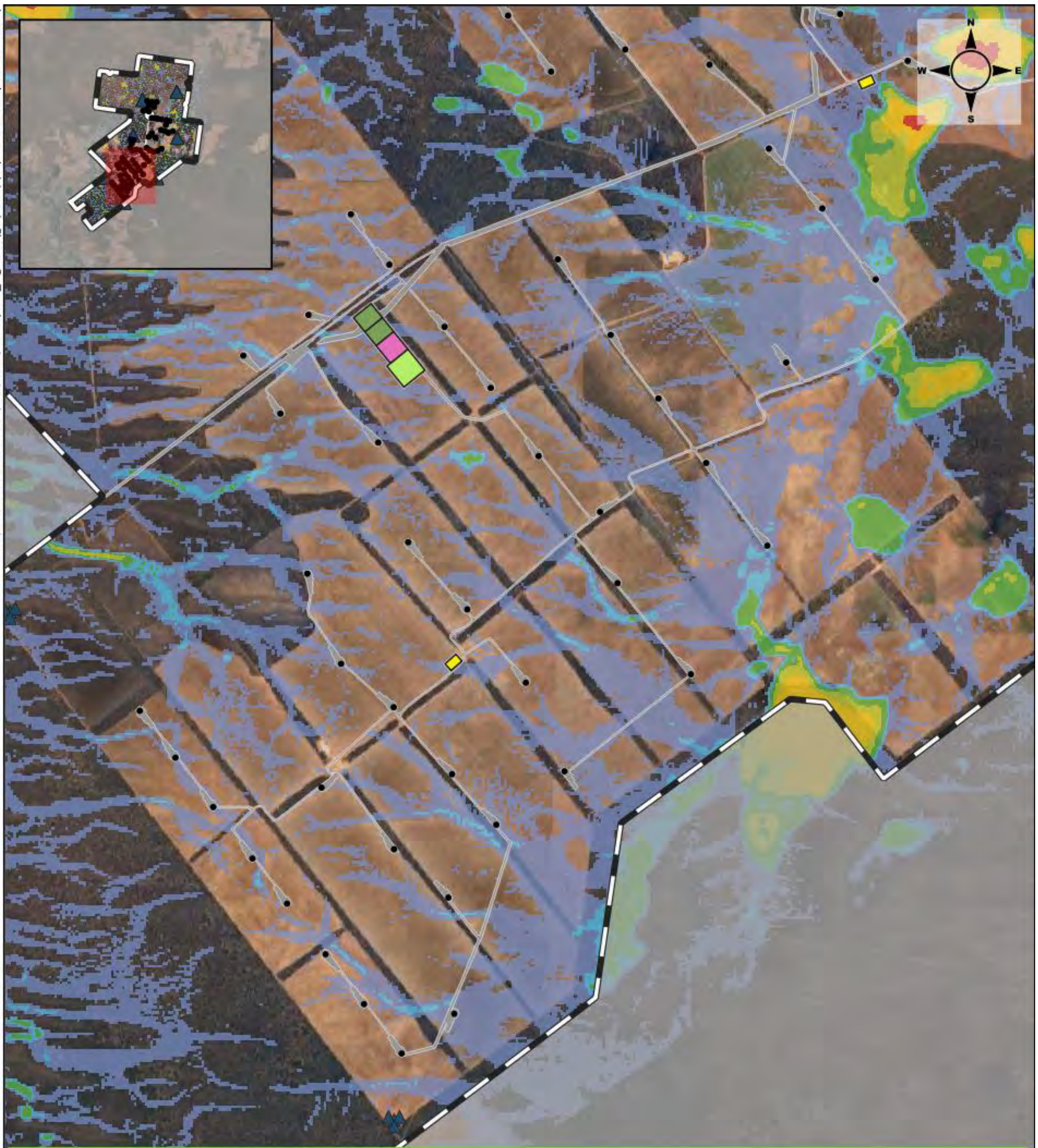


Legend

- Access Points
- Wind Turbine
- Site Boundary
- Construction Compounds
- Substations & Switchyards
- Development Footprint & Access Road
- Project Area
- BESS
- O and M Facility
- Accommodation Camp
- Laydown Areas
- Permanent Meteorological Masts

Hazard

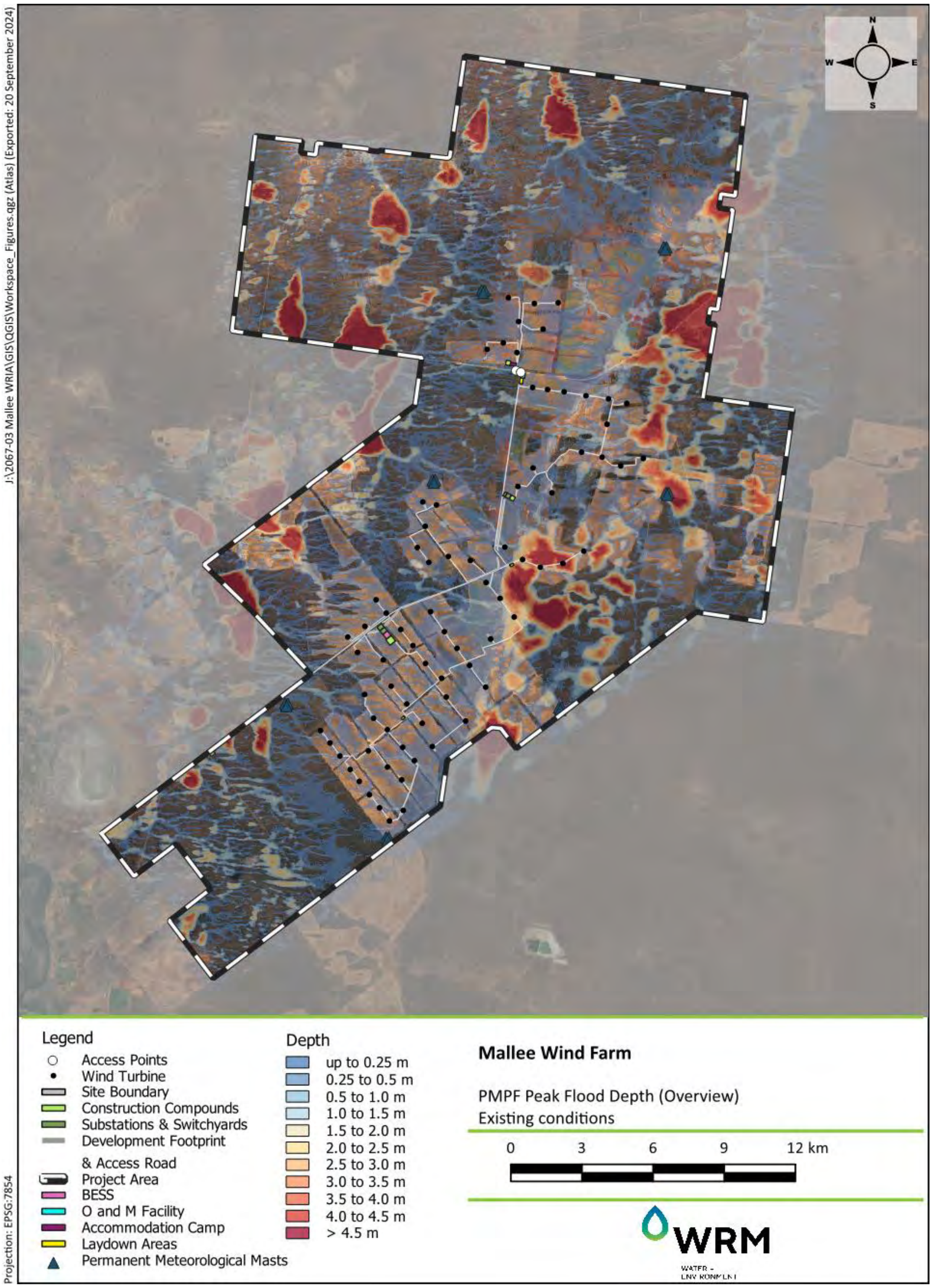
- H1
- H2
- H3
- H4
- H5
- H6

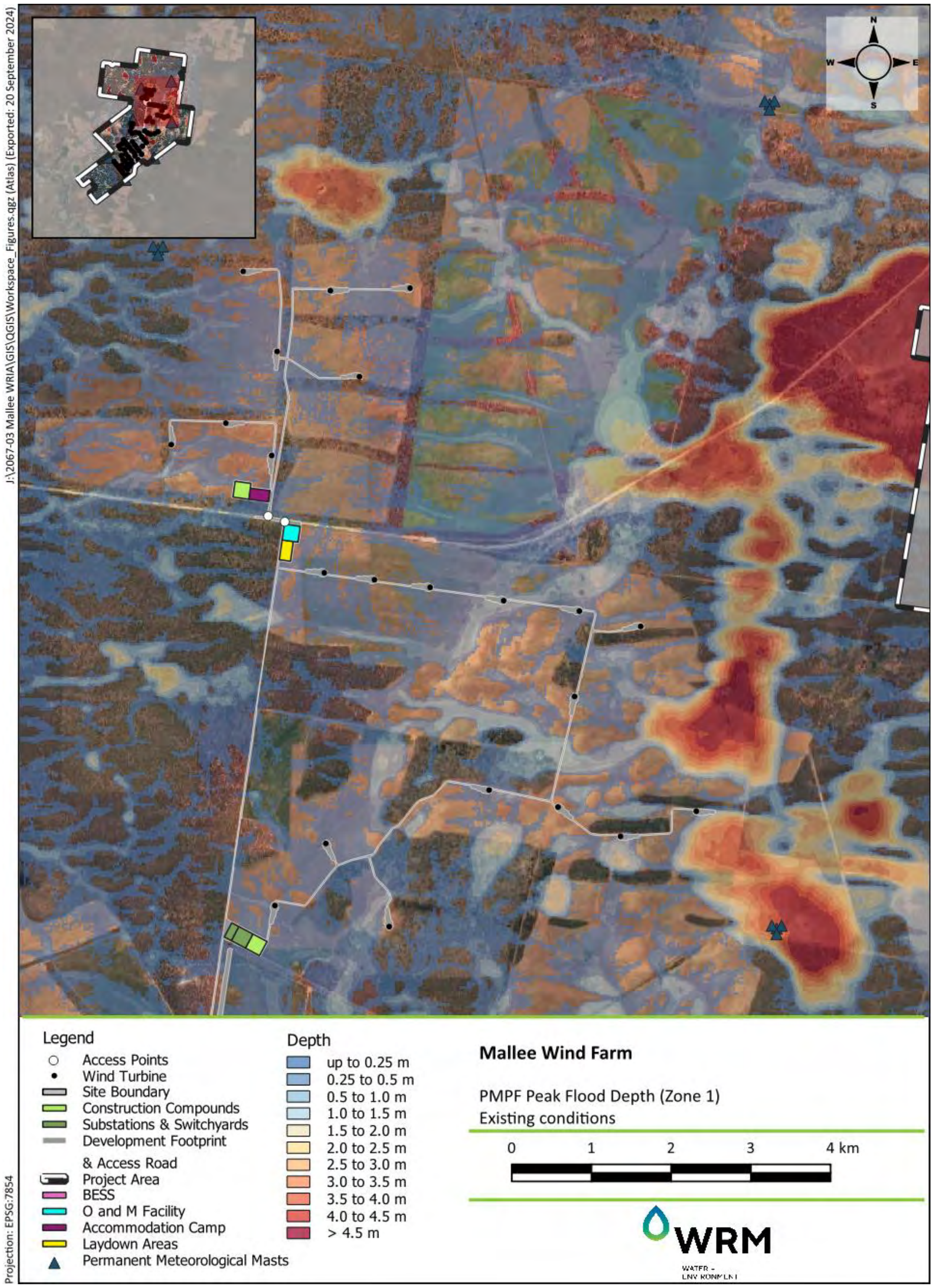
Mallee Wind Farm

0.2% AEP Peak Flood Hazard (Zone 3)
Existing conditions

0 1 2 3 4 km

Projection: EPSG:7854


J:\2067-03 Mallee WRIA\GIS\QGIS\Workspace_Figures.qgz (Atlas) (Exported: 20 September 2024)
N
W
E
S
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Depth
up to 0.25 m
0.25 to 0.5 m
0.5 to 1.0 m
1.0 to 1.5 m
1.5 to 2.0 m
2.0 to 2.5 m
2.5 to 3.0 m
3.0 to 3.5 m
3.5 to 4.0 m
4.0 to 4.5 m
> 4.5 m
Mallee Wind Farm
PMPF Peak Flood Depth (Overview)
Existing conditions
0
3
6
9
12 km
WRM
Projection: EPSG:7854



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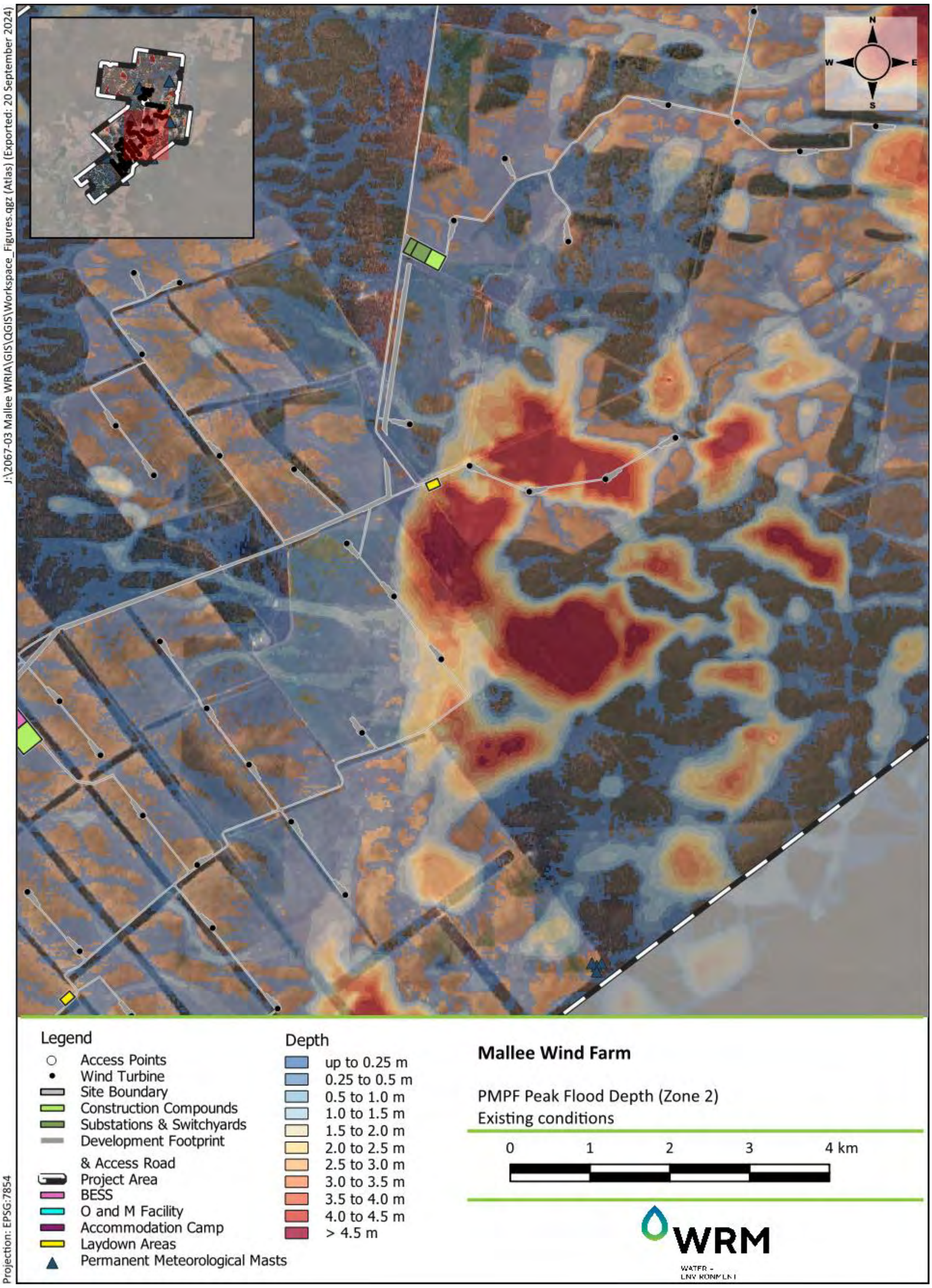
N
E
S
W
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Depth
up to 0.25 m
0.25 to 0.5 m
0.5 to 1.0 m
1.0 to 1.5 m
1.5 to 2.0 m
2.0 to 2.5 m
2.5 to 3.0 m
3.0 to 3.5 m
3.5 to 4.0 m
4.0 to 4.5 m
> 4.5 m
Mallee Wind Farm
PMPF Peak Flood Depth (Zone 1)
Existing conditions
0
1
2
3
4 km
WRM
Projection: EPSG:7854



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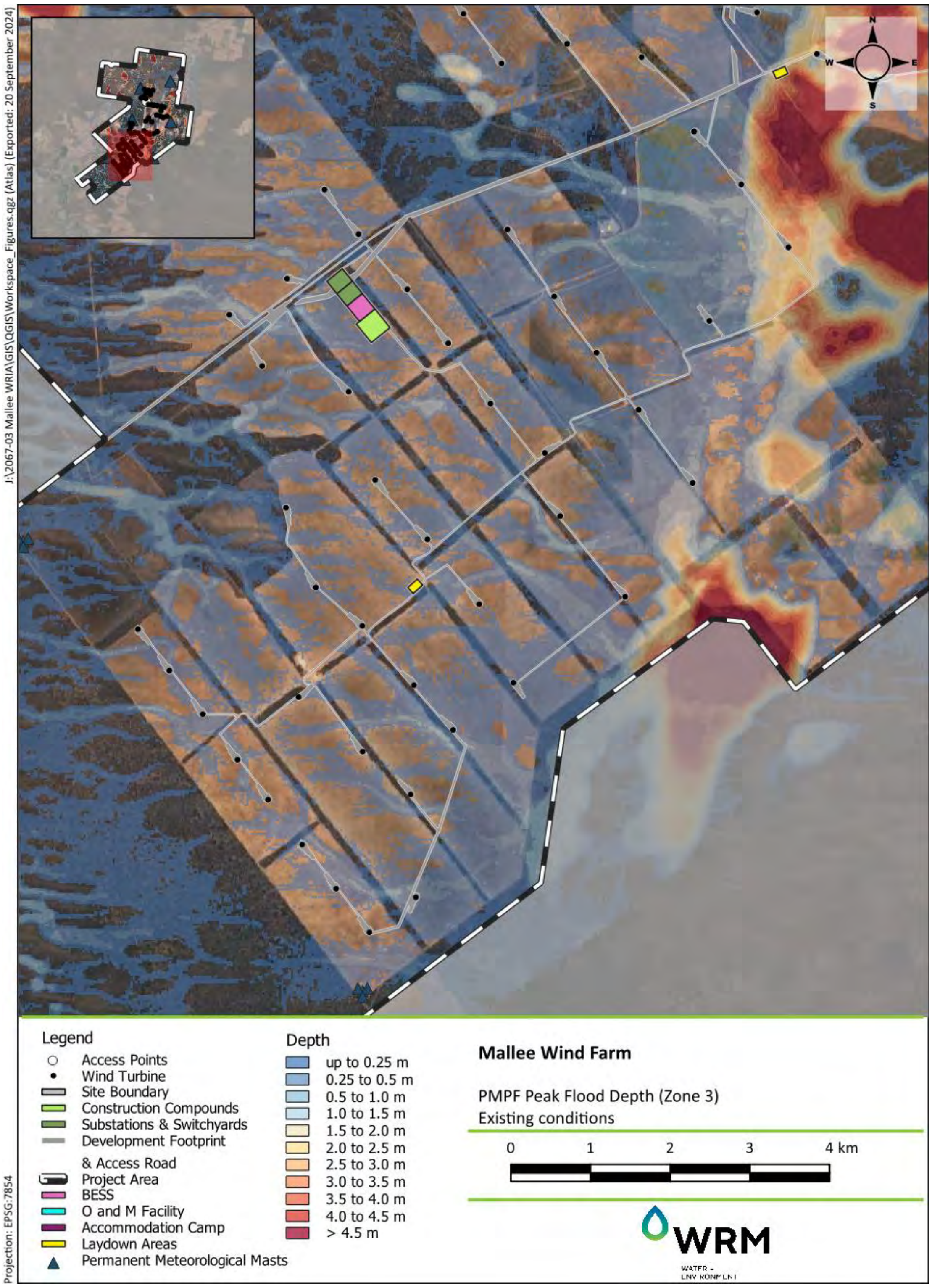
N
W
E
S
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Depth
up to 0.25 m
0.25 to 0.5 m
0.5 to 1.0 m
1.0 to 1.5 m
1.5 to 2.0 m
2.0 to 2.5 m
2.5 to 3.0 m
3.0 to 3.5 m
3.5 to 4.0 m
4.0 to 4.5 m
> 4.5 m
Mallee Wind Farm
PMPF Peak Flood Depth (Zone 2)
Existing conditions
0
1
2
3
4 km
WRM
Projection: EPSG:7854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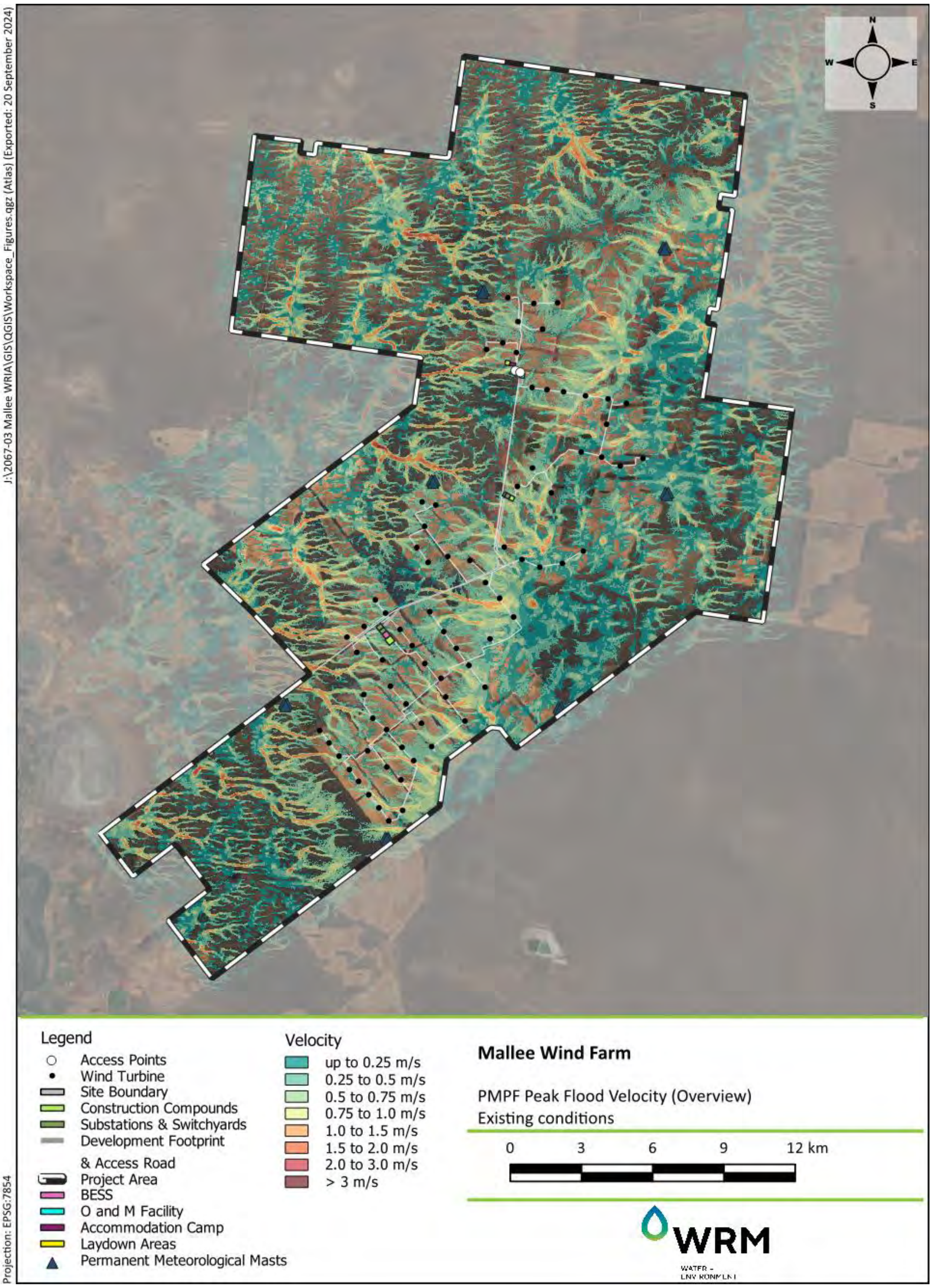
N
E
S
W
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Depth
up to 0.25 m
0.25 to 0.5 m
0.5 to 1.0 m
1.0 to 1.5 m
1.5 to 2.0 m
2.0 to 2.5 m
2.5 to 3.0 m
3.0 to 3.5 m
3.5 to 4.0 m
4.0 to 4.5 m
> 4.5 m
Mallee Wind Farm
PMPF Peak Flood Depth (Zone 3)
Existing conditions
0
1
2
3
4 km
WRM
Projection: EPSG:7854



Legend

- Access Points
- Wind Turbine
- Site Boundary
- Construction Compounds
- Substations & Switchyards
- Development Footprint & Access Road
- Project Area
- BESS
- O and M Facility
- Accommodation Camp
- Laydown Areas
- Permanent Meteorological Masts

Velocity

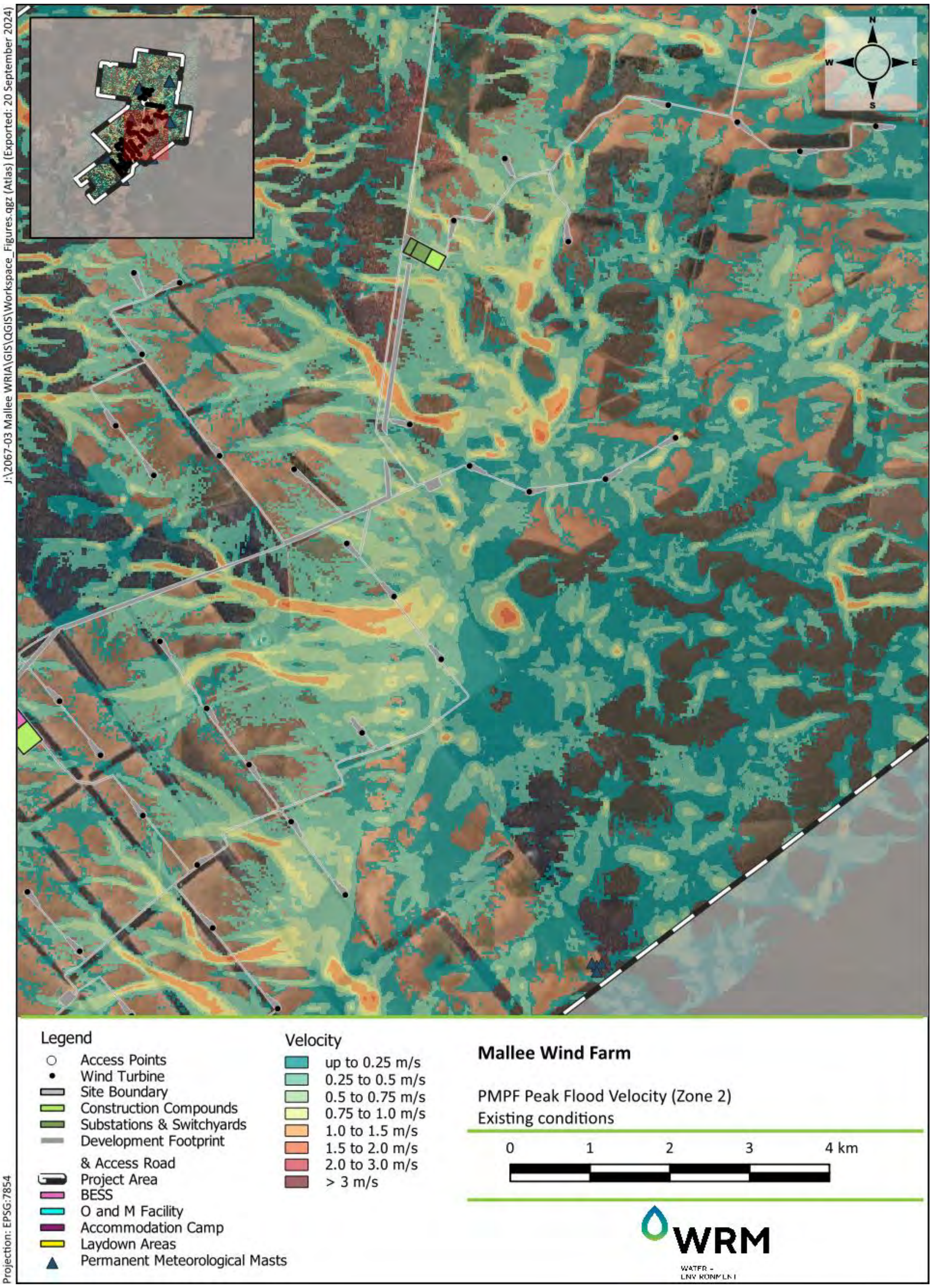
- up to 0.25 m/s
- 0.25 to 0.5 m/s
- 0.5 to 0.75 m/s
- 0.75 to 1.0 m/s
- 1.0 to 1.5 m/s
- 1.5 to 2.0 m/s
- 2.0 to 3.0 m/s
- > 3 m/s

Mallee Wind Farm

PMPF Peak Flood Velocity (Overview)
Existing conditions

0 3 6 9 12 km


J:\2067-03 Mallee WRIA\GIS\QGIS\Workspace_Figures.qgz (Atlas) (Exported: 20 September 2024)
Projection: EPSG:7854
N
W
E
S
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
PMPF Peak Flood Velocity (Zone 1)
Existing conditions
0
1
2
3
4 km
WRM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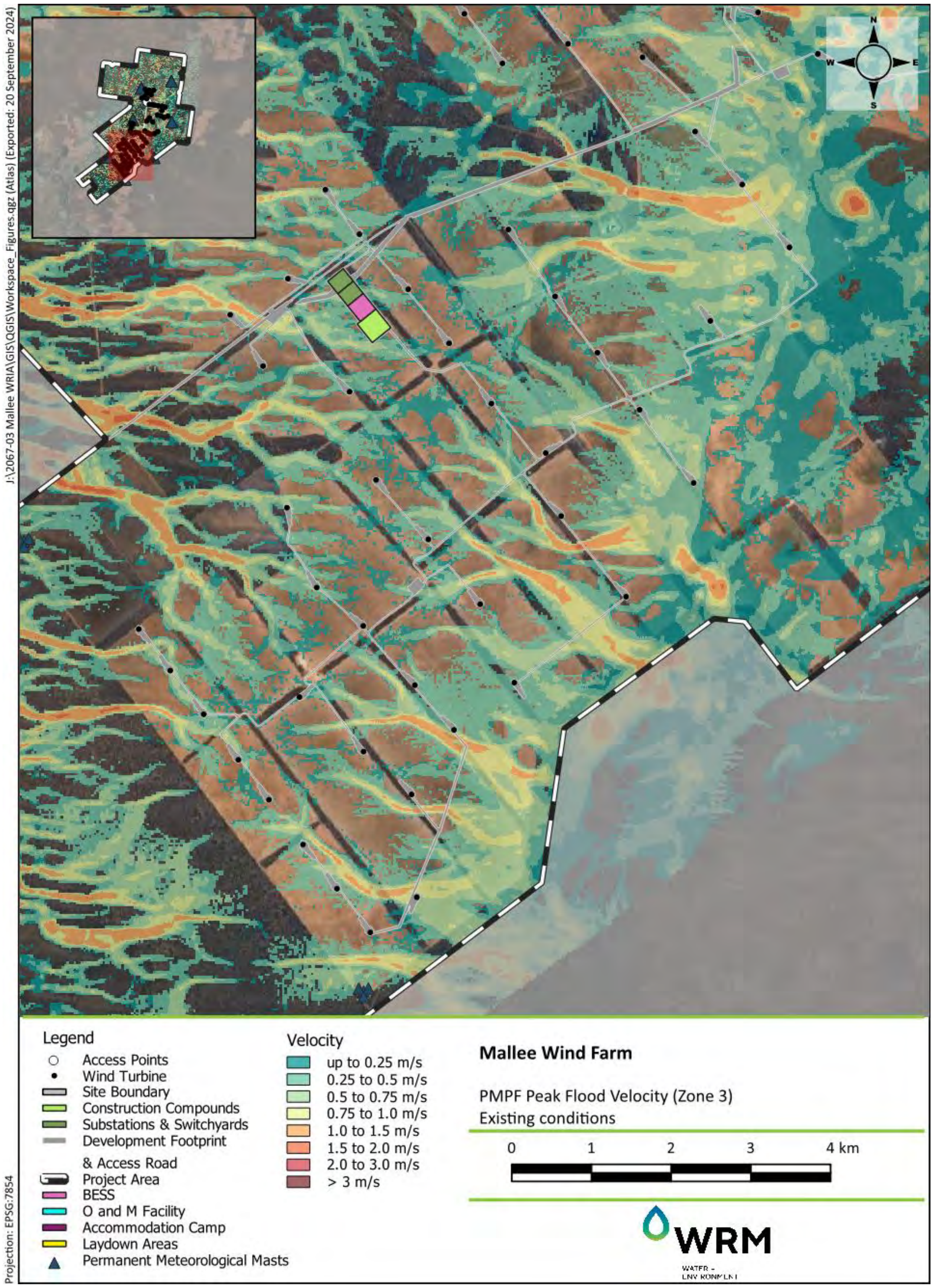
Projection: EPSG:7854
N
E
S
W
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
PMPF Peak Flood Velocity (Zone 2)
Existing conditions
0
1
2
3
4 km
WRM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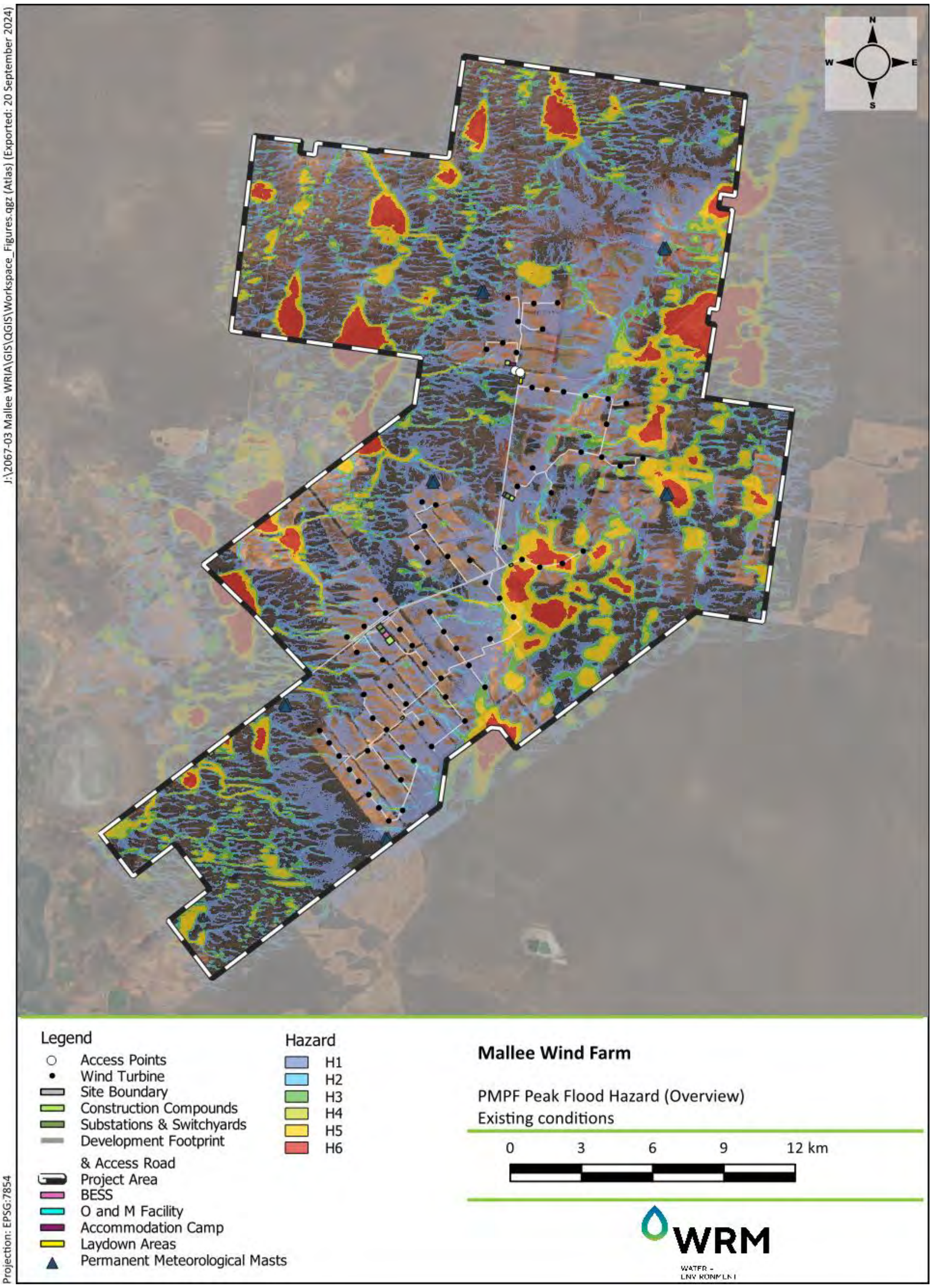
Projection: EPSG:7854
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Velocity
up to 0.25 m/s
0.25 to 0.5 m/s
0.5 to 0.75 m/s
0.75 to 1.0 m/s
1.0 to 1.5 m/s
1.5 to 2.0 m/s
2.0 to 3.0 m/s
> 3 m/s
Mallee Wind Farm
PMPF Peak Flood Velocity (Zone 3)
Existing conditions
0
1
2
3
4 km
WRM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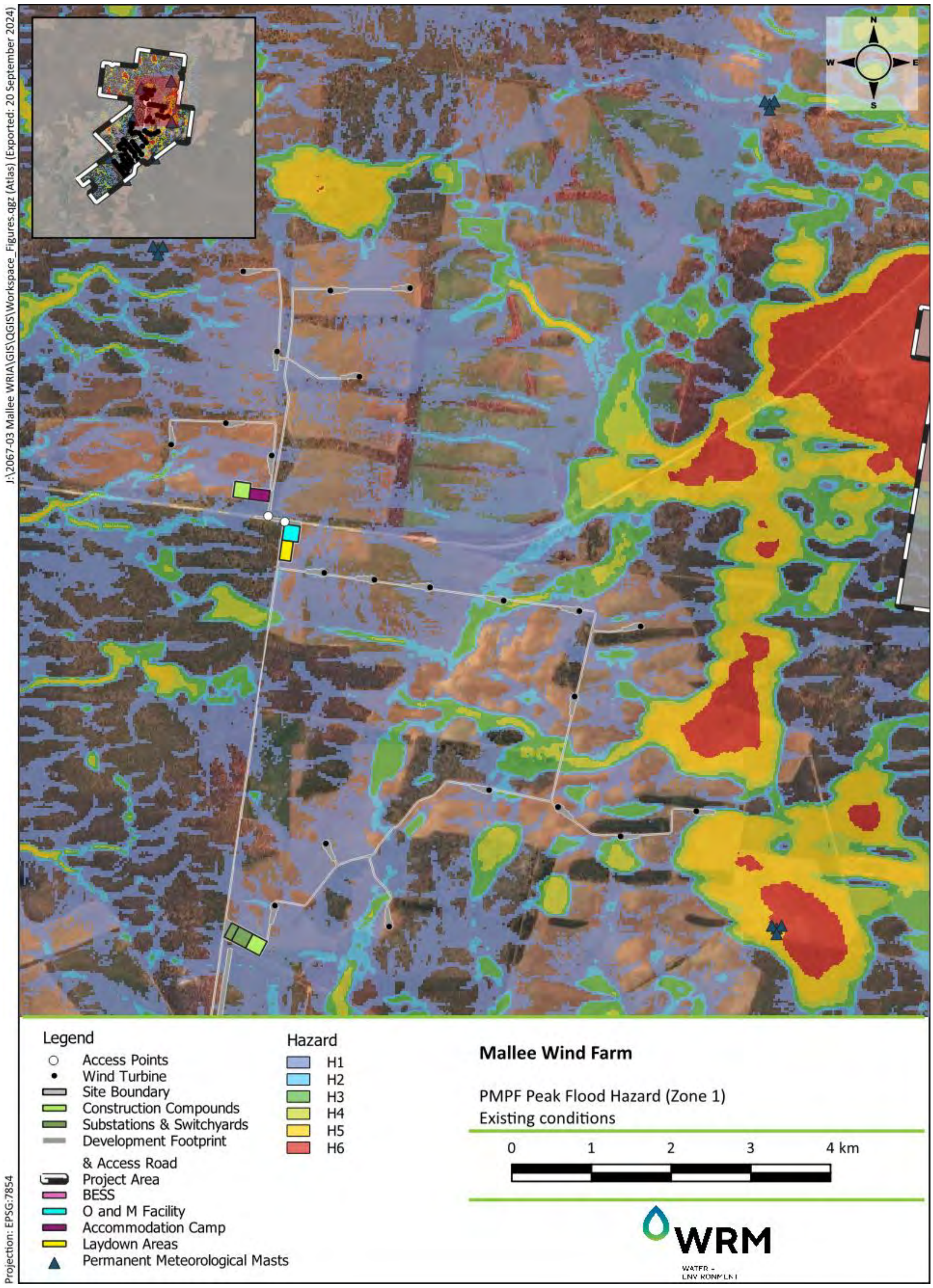
N
W
E
S
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
PMPF Peak Flood Hazard (Overview)
Existing conditions
0
3
6
9
12 km
Projection: EPSG:7854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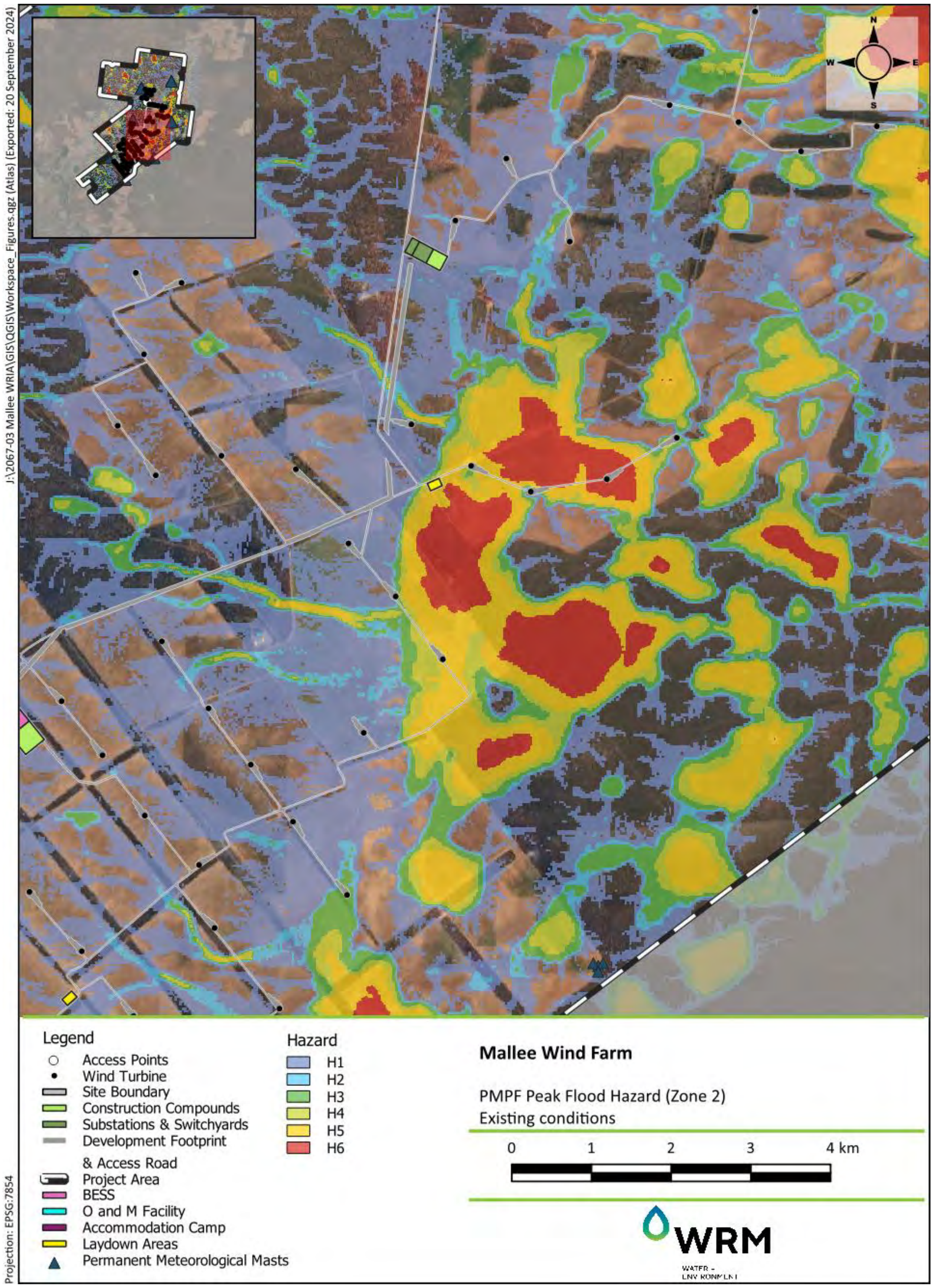
Projection: EPSG:7854
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint & Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
PMPF Peak Flood Hazard (Zone 1)
Existing conditions
0
1
2
3
4 km
WRM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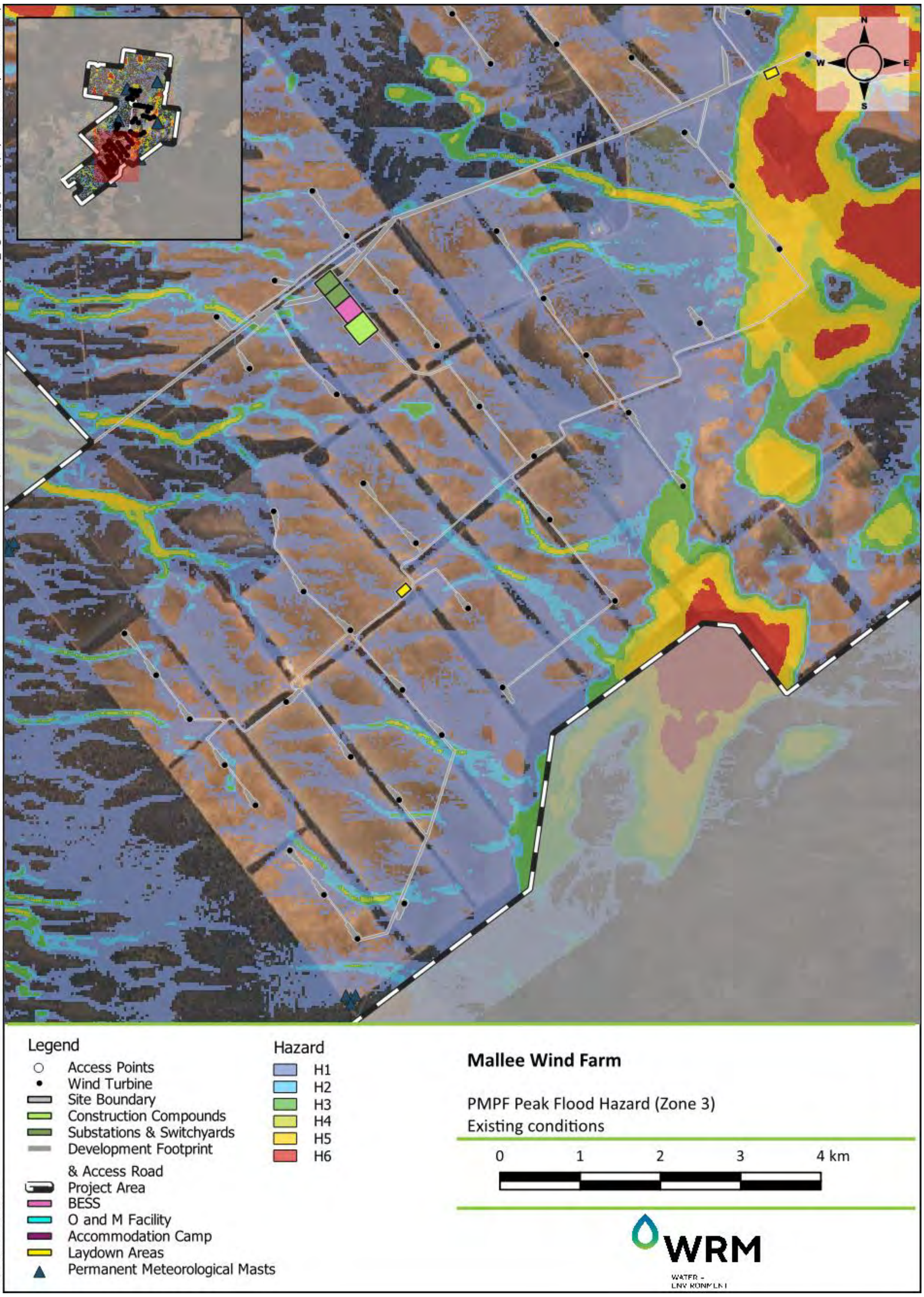
Projection: EPSG:7854
N
E
S
W
Legend
Access Points
Wind Turbine
Site Boundary
Construction Compounds
Substations & Switchyards
Development Footprint
& Access Road
Project Area
BESS
O and M Facility
Accommodation Camp
Laydown Areas
Permanent Meteorological Masts
Hazard
H1
H2
H3
H4
H5
H6
Mallee Wind Farm
PMPF Peak Flood Hazard (Zone 2)
Existing conditions
0
1
2
3
4 km
WRM



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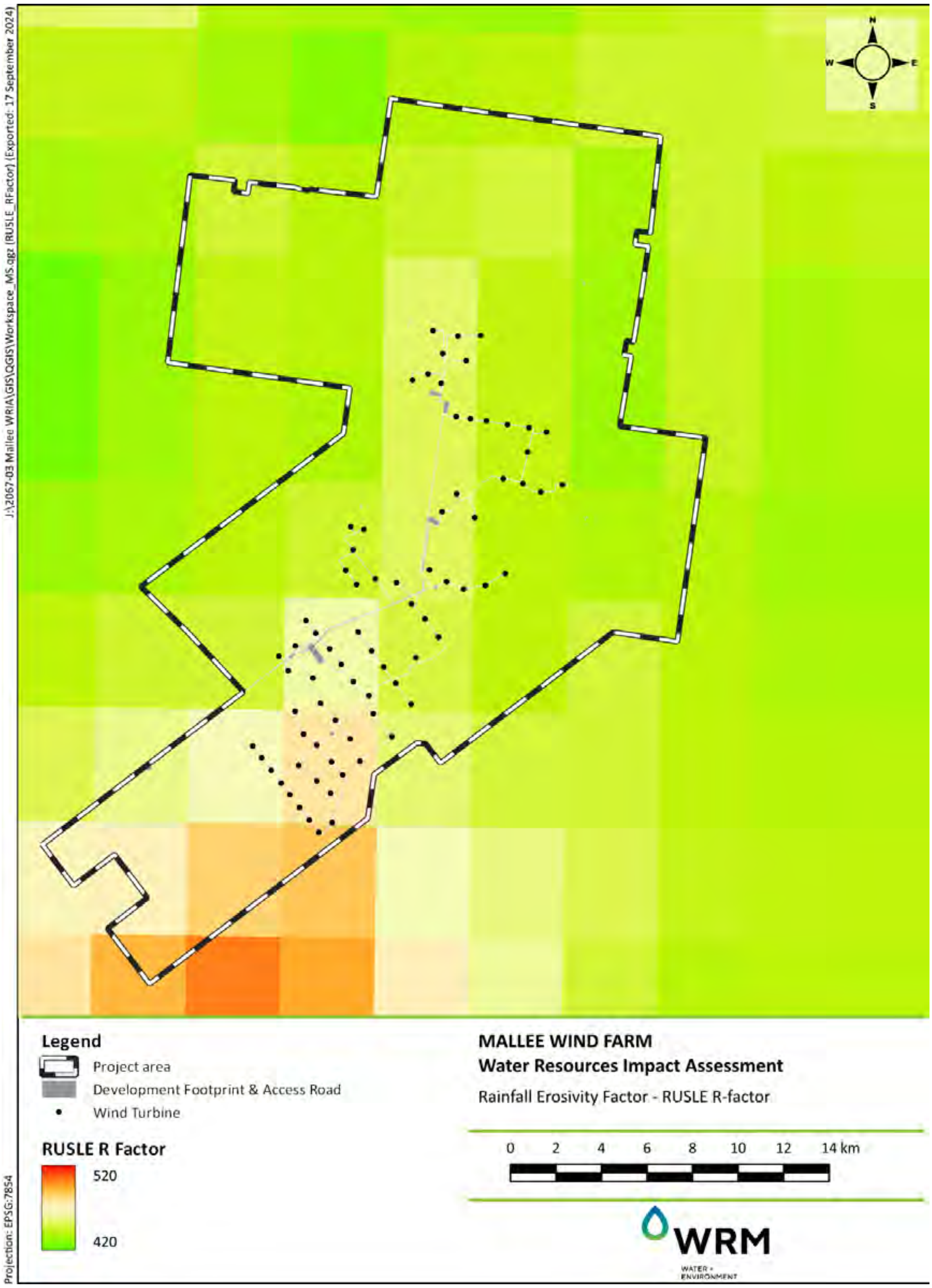
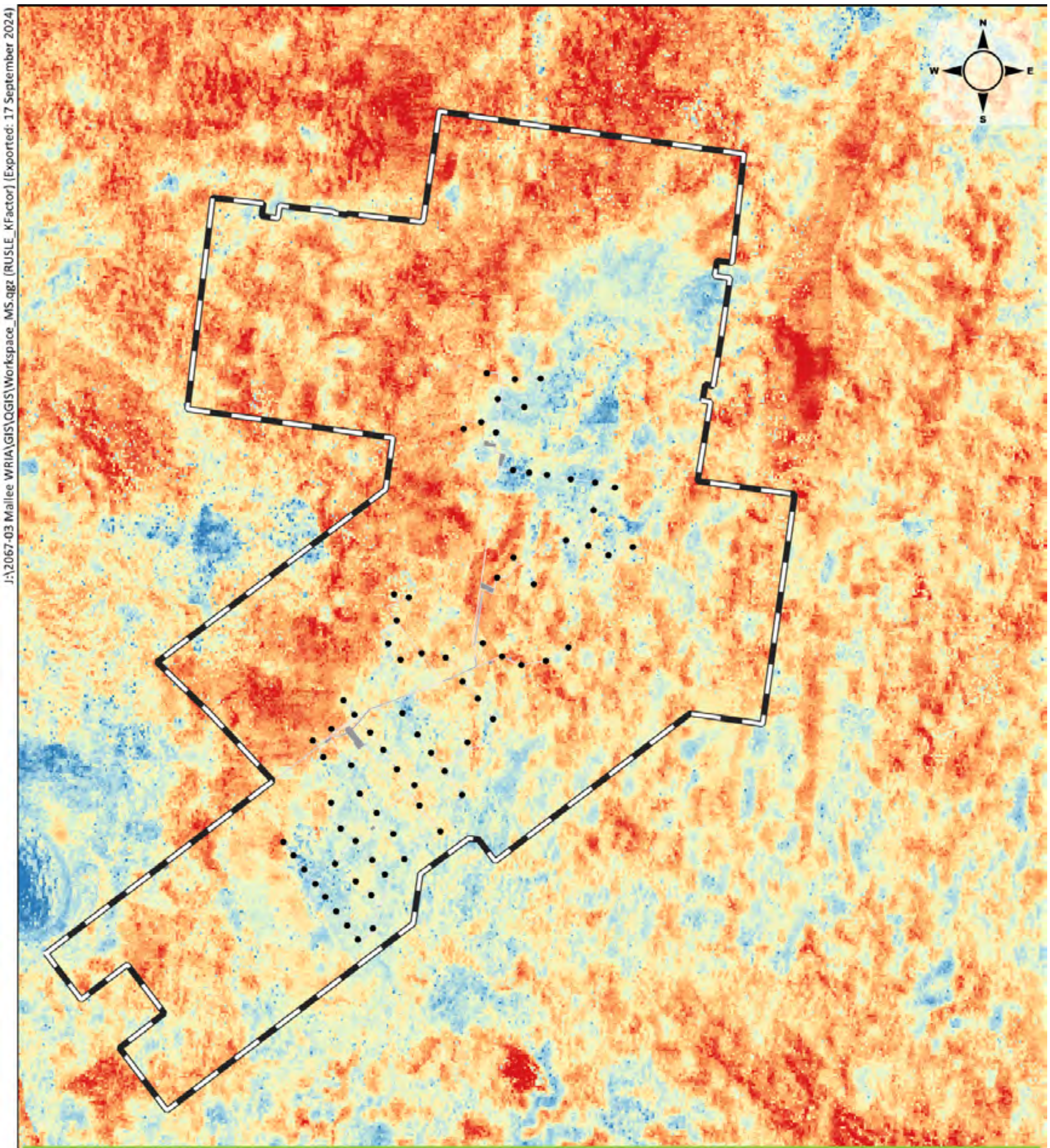
Projection: EPSG:7854

APPENDIX C RUSLE DATA MAPPING


J:\2067-03 Mallee WRIA\GIS\QGIS\Workspace_MS.qgz (RUSLE_RFactor) (Exported: 17 September 2024)
N
W
E
S
Legend
Project area
Development Footprint & Access Road
Wind Turbine
RUSLE R Factor
520
420
MALLEE WIND FARM
Water Resources Impact Assessment
Rainfall Erosivity Factor - RUSLE R-factor
0 2 4 6 8 10 12 14 km
WRM
Projection: EPSG:7854



J:\2067-03 Mallee WRIA\GIS\QGIS\Workspace_MS.qgz (RUSLE_KFactor) (Exported: 17 September 2024)

Legend

- Project area
- Development Footprint & Access Road
- Wind Turbine

RUSLE K Factor

0.07

0.04

MALLEE WIND FARM

Water Resources Impact Assessment

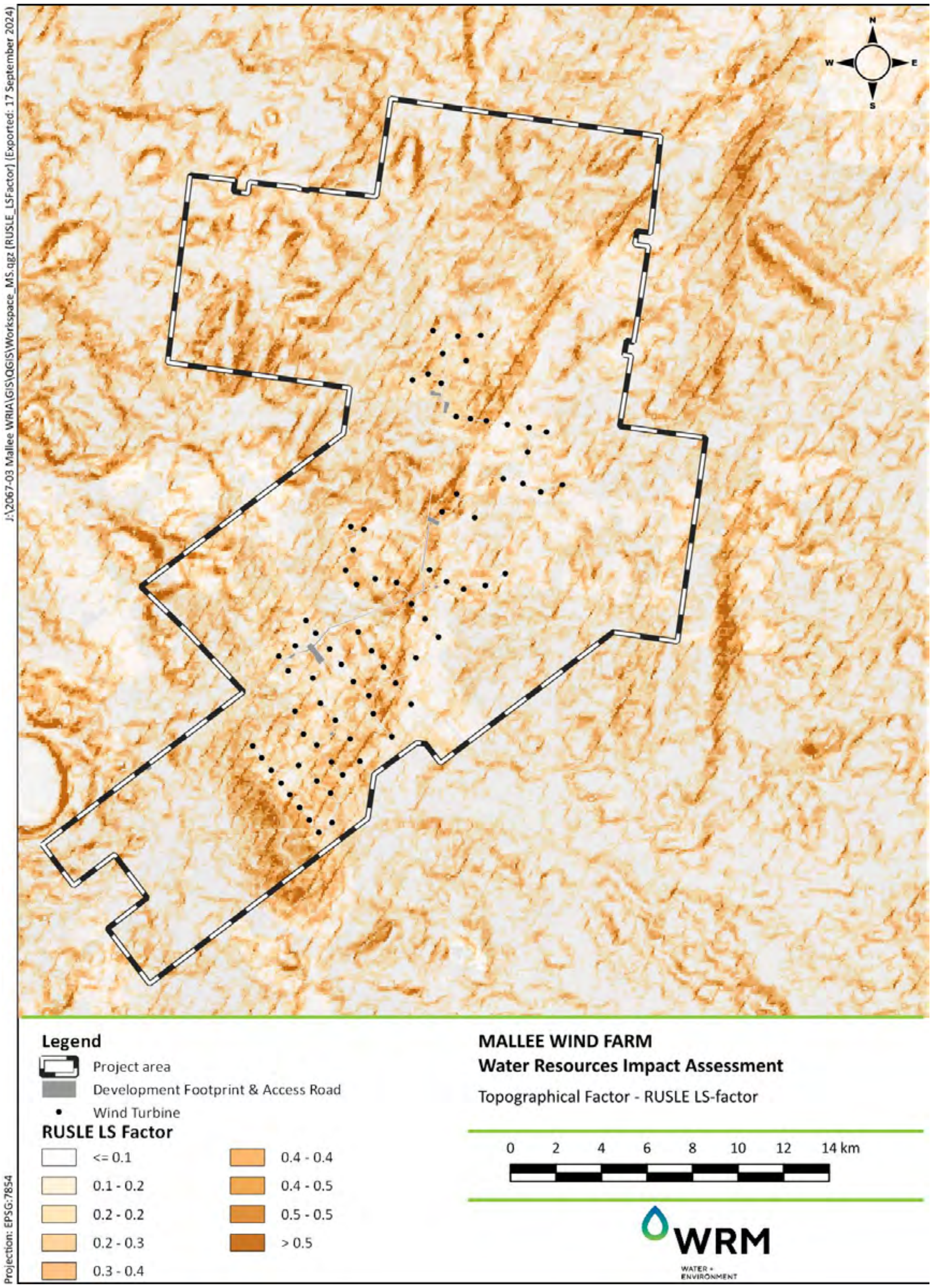
Soil Erodibility Factor - RUSLE K-factor

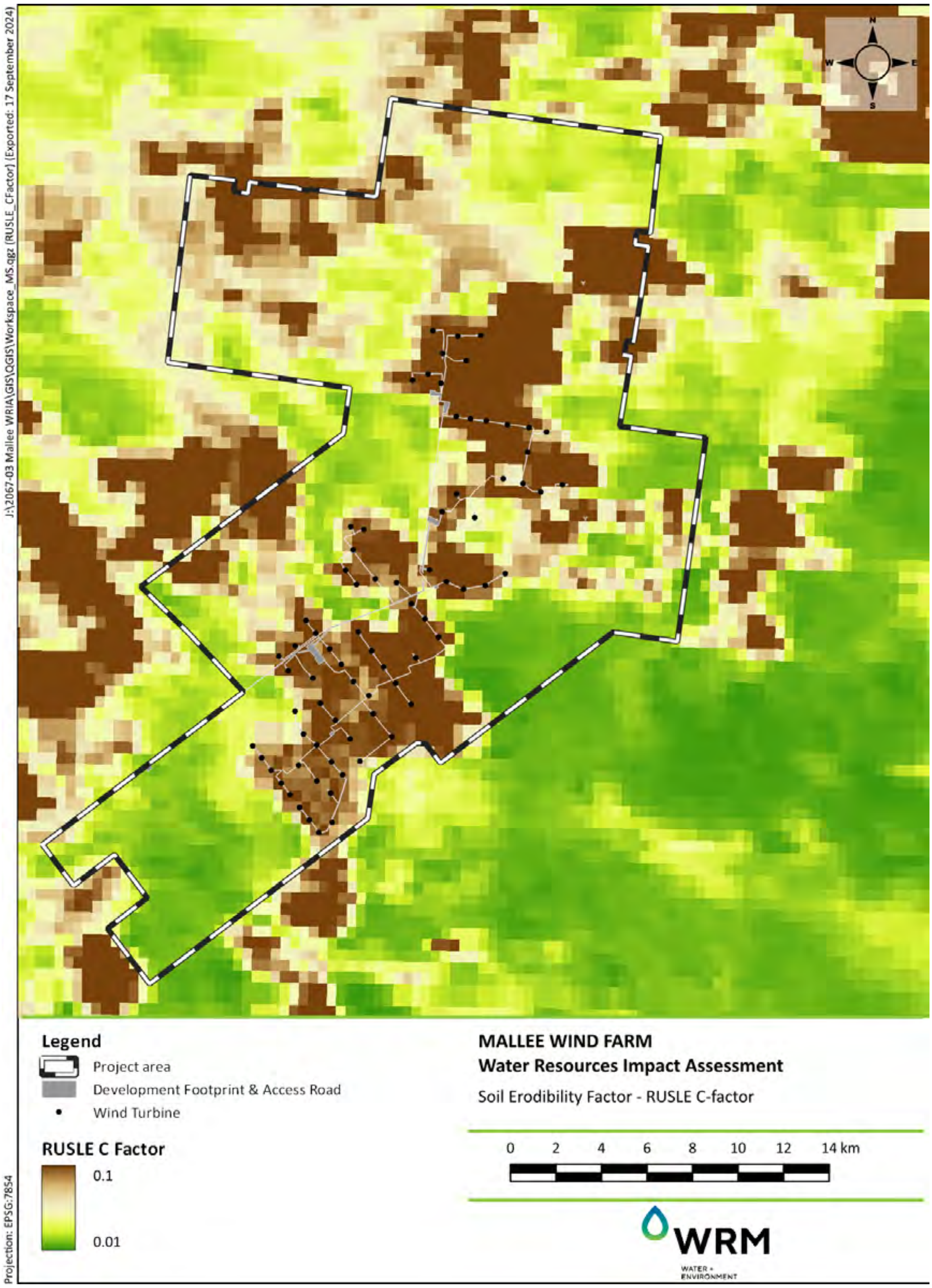
0 2 4 6 8 10 12 14 km

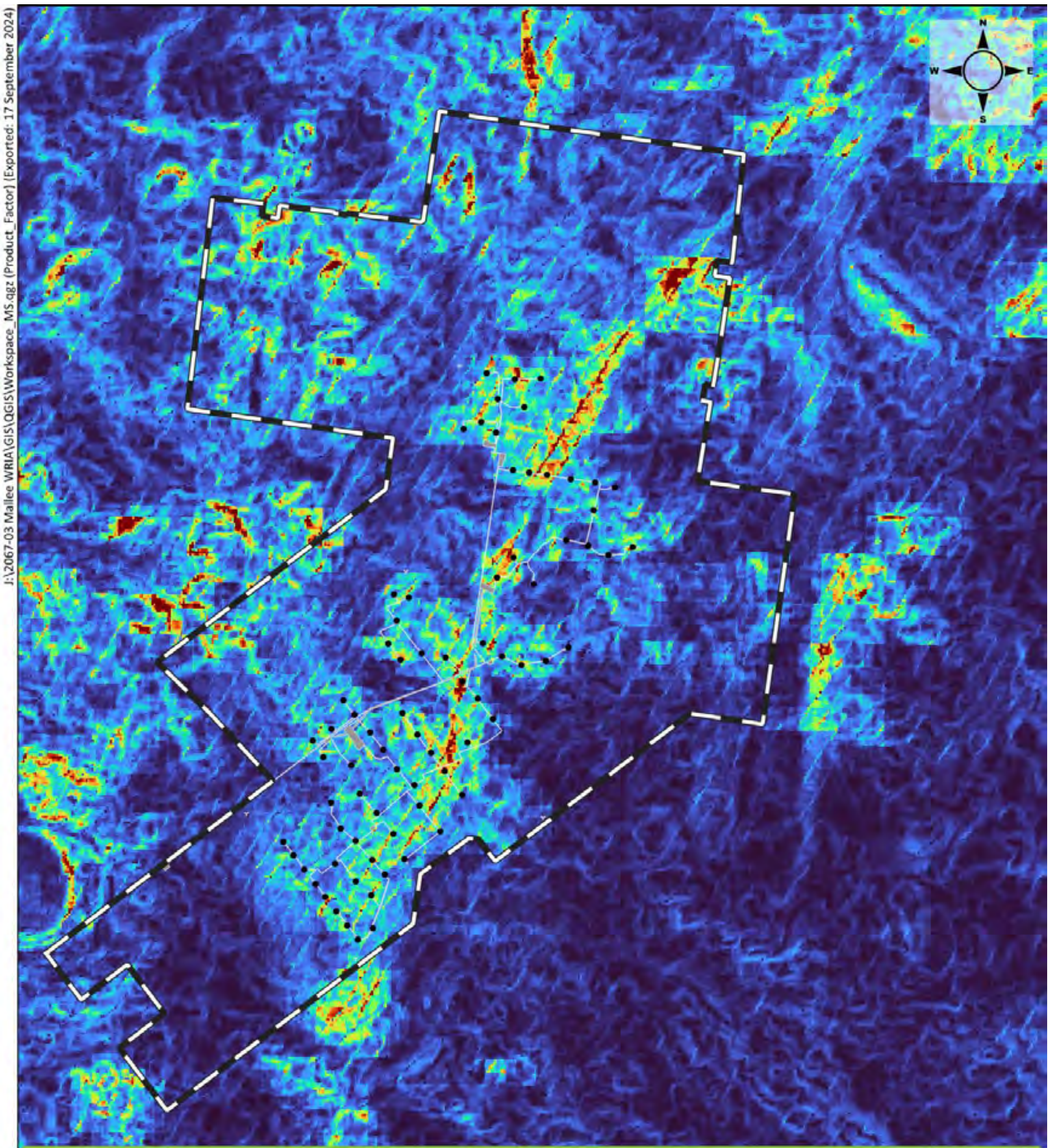
WRM

WATER + ENVIRONMENT

Projection: EPSG:7854


N
W
E
S
J:\2067-03 Mallee WRIA\GIS\QGIS\Workspace_MS.qgz (RUSLE_LSFactor) (Exported: 17 September 2024)
Legend
Project area
Development Footprint & Access Road
Wind Turbine
RUSLE LS Factor
<= 0.1
0.1 - 0.2
0.2 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.4
0.4 - 0.5
0.5 - 0.5
> 0.5
MALLEE WIND FARM
Water Resources Impact Assessment
Topographical Factor - RUSLE LS-factor
0 2 4 6 8 10 12 14 km
WRM
WATER + ENVIRONMENT
Projection: EPSG:7854


J:\2067-03 Mallee WRIA\GIS\QGIS\Workspace_MS.qgz (RUSLE_CFactor) (Exported: 17 September 2024)
N
W
E
S
Legend
Project area
Development Footprint & Access Road
Wind Turbine
RUSLE C Factor
0.1
0.01
MALLEE WIND FARM
Water Resources Impact Assessment
Soil Erodibility Factor - RUSLE C-factor
0 2 4 6 8 10 12 14 km
WRM
WATER + ENVIRONMENT
Projection: EPSG:7854



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Legend

Project area

Development Footprint & Access Road

Wind Turbine

RUSLE array product

2

0.02

MALLEE WIND FARM

Water Resources Impact Assessment

RUSLE array product

0 2 4 6 8 10 12 14 km

WRM

WATER + ENVIRONMENT

Projection: EPSG:7854

APPENDIX D SOIL DATA

(Source: Minesoils 2024)

Site Description – Site 1					
Site Reference	1	**ASC Name**	Hypercalcic Calcarosol		
Average Slope	3%	**Land Use**	Cropping	**Coordinates**	
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54	
Landform Element	Midslope	**Drainage**	Well Drained	X: 629499	
Surface Condition	Loose	**Permeability**	High	Y: 6216770	

Plate 1 – Soil Profile

Plate 2 – Landscape

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	0.00 – 0.30	Dark reddish brown (Munsell 2.5YR 2.5/4) Sandy Loam with weak pedality, sandy fabric and weak consistence. No coarse fragments. Few roots and well drained. 5% calcium carbonate. Clear boundary.
A2	0.30 – 0.50	Reddish-brown (Munsell 5YR 4/4) Sandy Loam with massive structure, sandy fabric and weak consistence. No coarse fragments. Trace roots and well drained. 15% calcium carbonate. Gradual boundary.
B2	0.50 +	Yellowish red (Munsell 5YR 5/6) Clay Loam with massive structure, sandy fabric and weak consistence. No coarse fragments. No roots and well drained. 25% calcium carbonate.

Site Description – Site 2				
Site Reference	2	**ASC Name**	Calcic Calcarosol	
Average Slope	2%	**Land Use**	Cropping	**Coordinates**
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54
Landform Element	Upper Slope	**Drainage**	Well Drained	X: 628189
Surface Condition	Loose	**Permeability**	High	Y: 6219461

Plate 2 – Landscape

Plate 1 – Soil Profile

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	**0.00 – 0.25**	Dark reddish brown (Munsell 2.5YR 2.5/4) Sandy Loam with weak pedality, sandy fabric and weak consistence. No coarse fragments. Few roots and well drained. 5% calcium carbonate. Gradual boundary.
A2	**0.25 – 0.45**	Reddish-brown (Munsell 5YR 4/4) Sandy Loam with massive pedality, sandy fabric and weak consistence. 5% coarse fragments 5 – 10mm. Very few roots and well drained. Gradual boundary. 10% calcium carbonate.
B2	**0.45 +**	Reddish-brown (Munsell 5YR 4/4) Clay Loam with massive pedality, sandy fabric and weak consistence. No coarse fragments. No roots and well drained. 20% calcium carbonate.

Site Description – Site 3				
Site Reference	3	**ASC Name**	Epibasic Hypercalcic Calcarosol (BELMXNR)	
Average Slope	2%	**Land Use**	Cropping	**Coordinates**
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54
Landform Element	Midslope	**Drainage**	Well Drained	X: 631226
Surface Condition	Loose	**Permeability**	High	Y: 6222487

Plate 2 – Landscape

Plate 1 – Soil Profile

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	**0.00 – 0.15**	Reddish-brown (Munsell 5YR 4/4) apedal Sandy Loam with sandy fabric. Strongly alkaline pH, non-saline and non-sodic. No coarse fragments. Few roots and well drained. Gradual boundary.
A2	**0.15 – 0.55**	Yellowish red (Munsell 5YR 4/6) Sandy Loam with massive pedality, sandy fabric and weak consistence. Strongly alkaline pH, non-saline and non-sodic. No coarse fragments. Trace roots and well drained. 10% calcium carbonate. Gradual boundary.
B22	**0.55 +**	Yellowish red (Munsell 5YR 5/6) Clay Loam with massive pedality, sandy fabric and weak consistence. Very strongly alkaline pH, moderately saline and sodic. No coarse fragments. No roots and well drained. 30% calcium carbonate.

Sample Depth	ECe		$pH_{(1\text{-}5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	1.7	Non-saline	8.6	Strongly Alkaline	0.3	Non sodic
0.30 – 0.40	1.9	Non-saline	8.8	Strongly Alkaline	1.0	Non sodic
0.60 – 0.70	4.4	Moderately saline	9.8	Very Strongly Alkaline	10.3	Sodic

Site Description – Site 4				
Site Reference	4	**ASC Name**	Calcic Calcarosol	
Average Slope	1%	**Land Use**	Cropping	**Coordinates**
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54
Landform Element	Upper Slope	**Drainage**	Well Drained	X: 635081
Surface Condition	Loose	**Permeability**	High	Y: 6222004

Plate 1 – Soil Profile

Plate 2 – Landscape

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	**0.00 – 0.30**	Reddish brown (Munsell 5YR 4/4) Sandy Loam with weak pedality, sandy fabric and weak consistence. No coarse fragments. Few roots and well drained. 10% calcium carbonate toward base of horizon. Gradual boundary.
B21	**0.30 – 0.60**	Yellowish red (Munsell 5YR 4/6) Sandy Loam with massive pedality, sandy fabric and weak consistence. 5% coarse fragments 5 – 10mm. Trace roots and well drained. Gradual boundary. 10% calcium carbonate.
B22	**0.60 +**	Yellowish red (Munsell 5YR 4/6) Sandy Loam with massive pedality, sandy fabric and weak consistence. No coarse fragments. No roots and well drained. 15% calcium carbonate.

Site Description – Site 5					
Site Reference	5	**ASC Name**	Hypercalcic Calcarosol		
Average Slope	0%	**Land Use**	Cropping	**Coordinates**	
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54	
Landform Element	Plain	**Drainage**	Well Drained	X: 634323	
Surface Condition	Loose	**Permeability**	High	Y: 6225087	

Plate 2 – Landscape

Plate 1 – Soil Profile

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	**0.00 – 0.15**	Yellowish red (Munsell 5YR 4/6) apedal Sand with sandy fabric. No coarse fragments. Few roots and well drained. Gradual boundary.
B21	**0.15 – 0.50**	Yellowish red (Munsell 5YR 5/6) Loamy Sand with massive pedality, sandy fabric and weak consistence. 15% coarse fragments 5 – 10mm. Trace roots and well drained. Gradual boundary. 15% calcium carbonate.
B22	**0.50+**	Dark reddish brown (Munsell 2.5YR 2.5/4) Sandy Loam with massive pedality, sandy fabric and weak consistence. 5% coarse fragments 5 – 10mm. No roots and well drained. 30% calcium carbonate.

Site Description – Site 6				
Site Reference	6	**ASC Name**	Calcic Calcarosol	
Average Slope	1%	**Land Use**	Cropping	**Coordinates**
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54
Landform Element	Midslope	**Drainage**	Well Drained	X: 628620
Surface Condition	Loose	**Permeability**	High	Y: 6224742

Plate 2 – Landscape

Plate 1 – Soil Profile

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	**0.00 – 0.25**	Dark reddish brown (Munsell 2.5YR 2.5/4) Sandy Loam with weak pedality, sandy fabric and weak consistence. No coarse fragments. Few roots and well drained. 10% calcium carbonate at base of horizon. Gradual boundary.
B21	**0.25 – 0.50**	Yellowish red (Munsell 5YR 4/6)) Sandy Loam with massive pedality, sandy fabric and weak consistence. 5% coarse fragments 5 – 10mm. Trace roots and well drained. Gradual boundary. 10% calcium carbonate.
B22	**0.50 +**	Yellowish red (Munsell 5YR 4/6) Sandy Loam with weak pedality, sandy fabric and moderate consistence. No coarse fragments. No roots and well drained. 15% calcium carbonate.

Site Description – Site 7				
Site Reference	7	**ASC Name**	Ceteric Calcic Calcarosol (BELLXNR)	
Average Slope	3%	**Land Use**	Cropping	**Coordinates**
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54
Landform Element	Midslope	**Drainage**	Well Drained	X: 630599
Surface Condition	Loose	**Permeability**	High	Y: 6228928

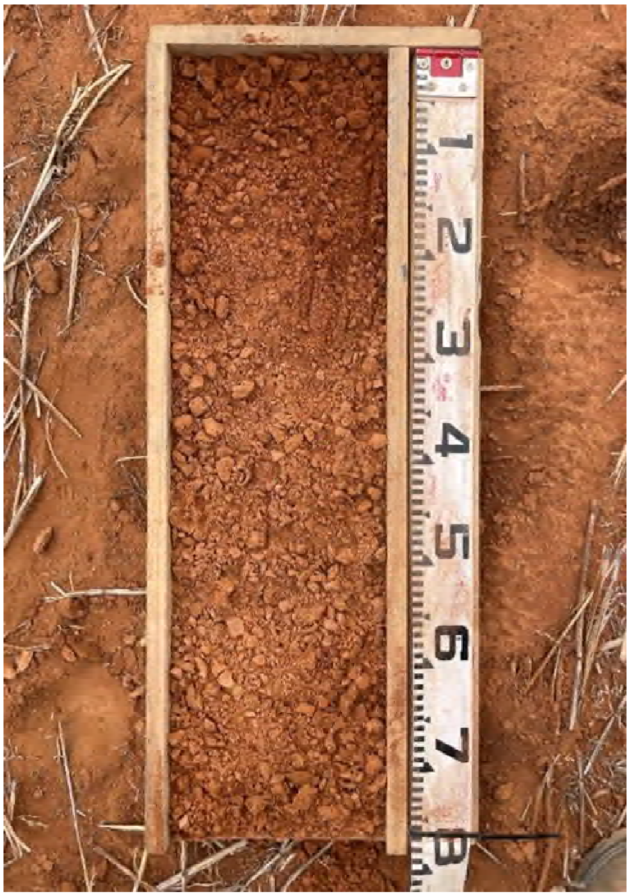

Plate 1 – Soil Profile

Plate 2 – Landscape

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	**0.00 – 0.20**	Dark reddish brown (Munsell 2.5YR 2.5/4) Sandy Loam with weak pedality, sandy fabric and weak consistence. Strongly alkaline pH, non-saline and non-sodic. No coarse fragments. Few roots and well drained. Gradual boundary.
B21	**0.20 – 0.55**	Yellowish red (Munsell 5YR 5/6) Sandy Loam with massive pedality, sandy fabric and weak consistence. Very strongly alkaline pH, non-saline and non-sodic. 15% soft calcium carbonate. 5% hard nodules. Trace roots and well drained. Gradual boundary.
B22	**0.55 +**	Yellowish red (Munsell 5YR 4/6) Sandy Loam with weak pedality, sandy fabric and moderate consistence. Very strongly alkaline pH, moderately saline and sodic. No coarse fragments. No roots and well drained. 5% calcium carbonate.

Sample Depth	ECe		pH$_{(1\text{-}5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	1.2	Non-saline	8.7	Strongly Alkaline	0.2	Non sodic
0.30 – 0.40	1.9	Non-saline	9.3	Very Strongly Alkaline	3.2	Non sodic
0.60 – 0.70	4.1	Moderately saline	9.8	Very Strongly Alkaline	10.1	Sodic

Site Description – Site 8				
Site Reference	8	**ASC Name**	Hypercalcic Calcarosol	
Average Slope	1%	**Land Use**	Cropping	**Coordinates**
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54
Landform Element	Midslope	**Drainage**	Well Drained	X: 634287
Surface Condition	Loose	**Permeability**	High	Y: 6230019

Plate 1 – Soil Profile

Plate 2 – Landscape

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Dark reddish brown (Munsell 2.5YR 2.5/4) apedal Loamy Sand with sandy fabric. No coarse fragments. Few roots and well drained. Gradual boundary.
B21	0.20 – 0.50	Reddish brown (Munsell 5YR 4/4) Sandy Loam with massive pedality, sandy fabric and weak consistence. 5% coarse fragments 5 – 10mm. Trace roots and well drained. Gradual boundary. 10% calcium carbonate.
B22	0.50 +	Reddish brown (Munsell 5YR 4/4) Clay Loam with weak pedality, sandy fabric and weak consistence. 5% coarse fragments 5 – 10mm. No roots and well drained. 30% calcium carbonate.

Site Description – Site 9				
Site Reference	9	**ASC Name**	Hypercalcic Calcarosol	
Average Slope	3%	**Land Use**	Cropping	**Coordinates**
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54
Landform Element	Midslope	**Drainage**	Well Drained	X: 638059
Surface Condition	Loose	**Permeability**	High	Y: 6228939

Plate 1 – Soil Profile

Plate 2 – Landscape

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark reddish brown (Munsell 2.5YR 2.5/4) apedal Sand with sandy fabric. No coarse fragments. Few roots and well drained. Gradual boundary.
B21	0.15 – 0.55	Reddish brown (Munsell 5YR 4/4) Sandy Loam with massive pedality, sandy fabric and weak consistence. No coarse fragments. Trace roots and well drained. Gradual boundary. 15% calcium carbonate.
B22	0.55 +	Strong brown (Munsell 7.5YR 5/6) Sandy Loam with massive pedality, sandy fabric and weak consistence. 5% coarse fragments 5 – 10mm. No roots and well drained. 30% calcium carbonate.

Site Description – Site 10				
Site Reference	10	**ASC Name**	Epibasic Calcic Calcarosol (BELLXNR)	
Average Slope	3%	**Land Use**	Cropping	**Coordinates**
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54
Landform Element	Midslope	**Drainage**	Well Drained	X: 638188
Surface Condition	Loose	**Permeability**	High	Y: 6233090

Plate 2 – Landscape

Plate 1 – Soil Profile

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	**0.00 – 0.15**	Dark red (Munsell 2.5YR 3/6) Sandy Loam with weak pedality, sandy fabric and weak consistence. Strongly alkaline pH, non-saline and non-sodic. No coarse fragments. Few roots and well drained. Gradual boundary.
B21	**0.15 – 0.55**	Reddish brown (Munsell 5YR 4/4) Sandy Loam with weak pedality, sandy fabric and weak consistence. Very strongly alkaline pH, slightly saline and non-sodic. No coarse fragments. Trace roots and well drained. Gradual boundary. 20% calcium carbonate.
B22	**0.55 +**	Red (Munsell 2.5YR 4/6) Loam with weak pedality, sandy fabric and weak consistence. Very strongly alkaline pH, slightly saline and sodic. No coarse fragments. No roots and well drained. 10% calcium carbonate.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	1.4	Non-saline	8.8	Strongly Alkaline	0.4	Non sodic
0.30 – 0.40	2.4	Slightly saline	9.4	Very Strongly Alkaline	4.6	Non sodic
0.60 – 0.70	3.7	Slightly saline	9.9	Very Strongly Alkaline	12.1	Sodic

Site Description – Site 11				
Site Reference	11	**ASC Name**	Calcareous Lutic Rudosol (BEKLXNR)	
Average Slope	3%	**Land Use**	Cropping	**Coordinates**
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54
Landform Element	Midslope	**Drainage**	Rapid	X: 634171
Surface Condition	Loose	**Permeability**	High	Y: 6235762

Plate 1 – Soil Profile

Plate 2 – Landscape

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark reddish brown (Munsell 2.5YR 3/4) apedal Sand with sandy fabric Strongly alkaline pH, non-saline and non-sodic. 10% coarse fragments 5 – 10mm. Few roots and rapidly drained. Gradual boundary.
A21	0.15 – 0.55	Yellowish red (Munsell 5YR 4/6) apedal Sandy Loam with sandy fabric. Very strongly alkaline pH, non-saline and non-sodic. 20% coarse fragments 10 – 20mm. Trace roots and rapidly drained. Gradual boundary.
A22	0.55 +	Strong brown (Munsell 7.5YR 5/6) apedal Sandy Loam with weak sandy fabric. Very strongly alkaline pH, slightly saline and sodic. 10% coarse fragments 10 – 20mm. No roots and rapidly drained. 10% calcium carbonate.

Sample Depth	ECe		$pH_{(1\text{-}5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	2.0	Non-saline	8.5	Strongly Alkaline	0.8	Non sodic
0.30 – 0.40	1.6	Non-saline	9.3	Very Strongly Alkaline	2.8	Non sodic
0.60 – 0.70	2.8	Slightly saline	9.6	Very Strongly Alkaline	6.9	Marginally Sodic

Site Description – Site 12				
Site Reference	12	**ASC Name**	Sodic Calcic Red Kandosol (BEOOXNR)	
Average Slope	2%	**Land Use**	Cropping	**Coordinates**
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54
Landform Element	Lower Slope	**Drainage**	Well Drained	X: 638311
Surface Condition	Hardset	**Permeability**	High	Y: 6236130

Plate 2 – Landscape

Plate 1 – Soil Profile

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	**0.00 – 0.15**	Dark reddish brown (Munsell 2.5YR 2.5/4) Light Clay with weak pedality, sandy fabric and weak consistence. Very strongly pH, non-saline and non-sodic. No coarse fragments. Few roots and well drained. Gradual boundary.
B21	**0.15 – 0.50**	Reddish brown (Munsell 5YR 4/4) Clay Loam with weak pedality, rough fabric and weak consistence. Very strongly alkaline pH, slightly saline and sodic. No coarse fragments. Trace roots and well drained. Gradual boundary.
B22	**0.50 +**	Yellowish red (Munsell 5YR 4/6) Light Medium Clay with weak pedality, rough fabric and moderate consistence. Very strongly alkaline pH, moderately saline and sodic. No coarse fragments. No roots and well drained. 15% calcium carbonate.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	1.4	Non-saline	9.1	Very Strongly Alkaline	5.0	Non sodic
0.30 – 0.40	3.3	Slightly saline	9.5	Very Strongly Alkaline	12.6	Sodic
0.60 – 0.70	6.3	Moderately saline	9.5	Very Strongly Alkaline	19.3	Strongly Sodic

Site Description – Site 13				
Site Reference	13	**ASC Name**	Calcareous Lutic Rudosol	
Average Slope	1%	**Land Use**	Cropping	**Coordinates**
Landform Pattern	Broad Dunefield	**Soil Fertility**	Moderately Low	MGA 54
Landform Element	Lower Slope	**Drainage**	Rapid	X: 637303
Surface Condition	Loose	**Permeability**	High	Y: 6239361

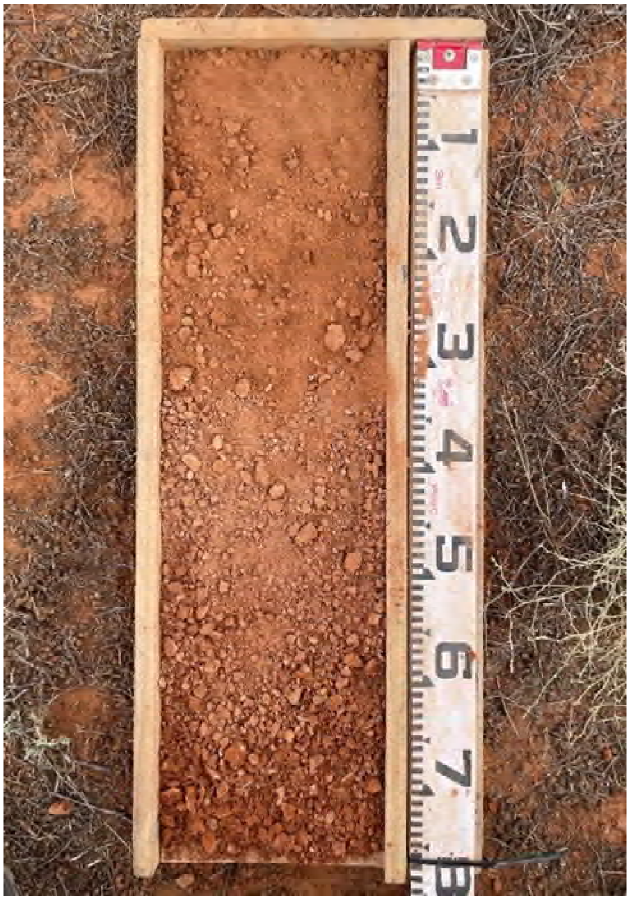

Plate 1 – Soil Profile

Plate 2 – Landscape

Plate 3 – Surface

Horizon	Depth (m)	Description
A1	0.00 – 0.35	Dark reddish brown (Munsell 2.5YR 3/4) apedal Sand with sandy fabric. No coarse fragments. Few roots and well drained. Gradual boundary.
A2	0.30 – 0.60	Yellowish red (Munsell 5YR 4/6) apedal Loamy Sand with sandy fabric. 15% coarse fragments 10 – 20mm. Trace roots and well drained. Gradual boundary. 5% calcium carbonate in base of horizon.
B2	0.60 +	Dark red (Munsell 2.5YR 3/6) Sandy Loam with very weak pedality, sandy fabric and weak consistence. 15% coarse fragments 10 – 20mm. No roots and well drained. 20% calcium carbonate.

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