Environmental & Social Consultants

TALLAWANG SOLAR FARM

Water Resources Impact Assessment

FINAL

August 2022

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Water Resources Impact Assessment

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Prepared by
Umwelt (Australia) Pty Limited
on behalf of
RES Australia Pty Limited

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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
Final	Darren Lyons	04/08/2022	Malinda Facey	10/08/2022

Glossary and Abbreviations

<table>
<tr><th>Term/Abbreviation</th><th>Definition</th></tr>
<tr><td>AEP (Annual Exceedance Probability)</td><td>Annual Exceedance Probability. The change of a flood of a given or large size occurring in any one year, usually expressed as a percentage. In this study AEP has been used consistently to define the probability of occurrence of flooding. The following relationships between AEP and ARI applies to this study (ARR, 2019).
<table>
<tr><th>Frequency Descriptor</th><th>EY</th><th>AEP (%)</th><th>AEP (1 in x)</th><th>ARI</th></tr>
<tr><td rowspan="6">Very frequent</td><td>12</td><td></td><td></td><td></td></tr>
<tr><td>6</td><td>99.75</td><td>1.002</td><td>0.17</td></tr>
<tr><td>4</td><td>98.17</td><td>1.02</td><td>0.25</td></tr>
<tr><td>3</td><td>95.02</td><td>1.05</td><td>0.33</td></tr>
<tr><td>2</td><td>86.47</td><td>1.16</td><td>0.50</td></tr>
<tr><td>1</td><td>63.2</td><td>1.58</td><td>1.00</td></tr>
<tr><td rowspan="4">Frequent</td><td>0.69</td><td>50.00</td><td>2</td><td>1.44</td></tr>
<tr><td>0.5</td><td>39.35</td><td>2.54</td><td>2.00</td></tr>
<tr><td>0.22</td><td>20.00</td><td>5</td><td>4.48</td></tr>
<tr><td>0.2</td><td>18.13</td><td>5.52</td><td>5.00</td></tr>
<tr><td rowspan="4">Infrequent</td><td>0.11</td><td>10.00</td><td>10.00</td><td>9.49</td></tr>
<tr><td>0.05</td><td>5.00</td><td>20</td><td>20.0</td></tr>
<tr><td>0.02</td><td>2.00</td><td>50</td><td>50.0</td></tr>
<tr><td>0.01</td><td>1.00</td><td>100</td><td>100</td></tr>
<tr><td rowspan="4">Rare</td><td>0.005</td><td>0.50</td><td>200</td><td>200</td></tr>
<tr><td>0.002</td><td>0.20</td><td>500</td><td>500</td></tr>
<tr><td>0.001</td><td>0.10</td><td>1000</td><td>1000</td></tr>
<tr><td>0.0005</td><td>0.05</td><td>2000</td><td>2000</td></tr>
<tr><td rowspan="5">Extremely Rare</td><td>0.0002</td><td>0.02</td><td>5000</td><td>5000</td></tr>
<tr><td></td><td></td><td rowspan="4">↓</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Extreme</td><td></td><td></td><td>PMP</td><td></td></tr>
</table>
</td></tr>
<tr><td>AHD</td><td>Australian Height Datum. A common national surface level datum approximately corresponding to mean sea level.</td></tr>
<tr><td>ARR</td><td>Australian Rainfall and Runoff. Guidelines prepared by the Institute of Engineers Australia for the estimation of design floods.</td></tr>
<tr><td>ASS / PASS</td><td>Acid Sulphate Soils or Potential Acid Sulphate Soils</td></tr>
<tr><td>BESS</td><td>Battery Energy Storage System</td></tr>
<tr><td>CEMP</td><td>Construction Environmental Management Plan</td></tr>
<tr><td>Development footprint</td><td>The maximum extent of ground disturbance associated with the construction and operation of the Project. The development footprint would cover an area of up to 866 ha within the Project Area.</td></tr>
<tr><td>Discharge</td><td>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).</td></tr>
<tr><td>Flood</td><td>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.</td></tr>
</table>

Term/Abbreviation	Definition
Flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future, and continuing risks. They are described below: • Existing flood risk: the risk a community is exposed to as a result of its location on the floodplain. • Future flood risk: the risk a community may be exposed to as a result of new development on the floodplain. • Continuing flood risk: the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
Flood storage areas	Those parts of the floodplain that are important for the temporary storage of floodwaters during passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is flood prone land.
GW	Gigawatt
GWh	Gigawatt-hour
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.
ICNIRP	International Commission on Non-Ionizing Radiation Protection
Associated Dwelling	Dwelling located on land owned by landholders associated with the Project
Associated landholder	A landholder whose property would have Project infrastructure located on it.
kL	Kilolitre, one thousand litres
km	Kilometres
kV	Kilovolt
m AHD	Metres Australian Height Datum (AHD)
m/s	Metres per second. Unit used to describe the velocity of floodwaters.
m^3/s	Cubic metres per second or “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.
MDBA	Murray-Darling Basin Authority
MHRDC	Maximum Harvestable Right Dam Capacity
ML	Megalitre, one million litres
MW	Megawatt
Non-associated dwelling	Dwelling located on land owned by landholders not associated in the Project
Non-associated landholder	A landholder whose property is located in proximity to the Project Area but would not have Project infrastructure located on it. Potential impacts to non-associated landholders are investigated in the EIS.

Term/Abbreviation	Definition
NVR Map	Native Vegetation Regulatory Map
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.
Project Area	The total area in which the Project would be developed. The Project Area covers approximately 1,370 ha and includes the solar farm site, and the transmission line corridor.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual, it is the likelihood of consequences arising from the interaction of floods, communities, and the environment.
Runoff	The amount of rainfall which ends up as a streamflow, also known as rainfall excess.
Scour	Erosion by mechanical action of water, typically of soil.
Sensitive receiver	Non-associated dwellings in proximity to the Project Area that may be sensitive to noise, visual, traffic and other impacts. Potential impacts to sensitive receivers are investigated in the EIS.
Solar farm site	The parcels of land where the solar farm would be located.
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.
WAL	Water Access License
WSP	Water Sharing Plan

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Appendices

1.0 Introduction

RES Australia Pty Ltd (RES) is seeking to develop the proposed Tallawang Solar Farm (the Project) in the Central West region of New South Wales (NSW), approximately 8 kilometres (km) northwest of Gulgong within the Mid-Western Local Government Area (LGA) (refer to **Figure 1.1**).

The Project lies within the Central West Orana Renewable Energy Zone (CWO REZ), established under the NSW Government's Electricity Strategy (2021).

The Project will involve the construction, operation, and decommissioning of a 500 megawatt (MW) solar farm with a Battery Energy Storage System (BESS) of approximately 200 MW/400 MW-hours, a 330 kilovolt (kV) overhead transmission line of approximately 13 km long and associated infrastructure which will connect the Project to the national electricity grid. The Project's conceptual layout is included in **Figure 1.2**. One onsite switchyard and a 330 kV substation is proposed, at two possible locations within the solar farm and BESS development area (refer to **Figure 1.2**). The final location of the onsite switchyard and substation will be determined during detailed design.

The Project will have access from the Castlereagh Highway at a newly proposed access point via a local unserviced road directly south of the Project area (refer to **Figure 1.1**). After investigation of possible accesses, the final location of the access was determined in consultation with the road authority and Mid-Western Regional Council. Intersection works on the Castlereagh Highway are proposed as part of the Project to establish the Project access.

The Project will connect to the grid via the proposed CWO-REZ Transmission Project (including new 500 kV and 330 kV transmission lines, substations, and related infrastructure) currently being developed by the NSW Government to support the growth of the CWO-REZ. The CWO-REZ Transmission Project is subject to a separate development application process.

The final arrangement and design of the CWO-REZ Transmission Project has not yet been confirmed, however based on consultation between the proponent and NSW Government, it is anticipated that the grid connection point for the Project will be via a proposed switching station near to the proposed Barneys Reef Wind Farm project area, directly north of the Tallawang Solar Farm. The proposed Barneys Reef Wind Farm is also being developed by RES and subject to a separate development application process. The proposed switching station will support independent connections from both the Tallawang Solar Farm and Barneys Reef Wind Farm projects.

The final alignment of the Project's overhead transmission line is subject to the final placement of the switching station and the grid connection point, however a 60 m wide corridor of approximately 13 km long has been identified by RES to support access to the anticipated connection point.

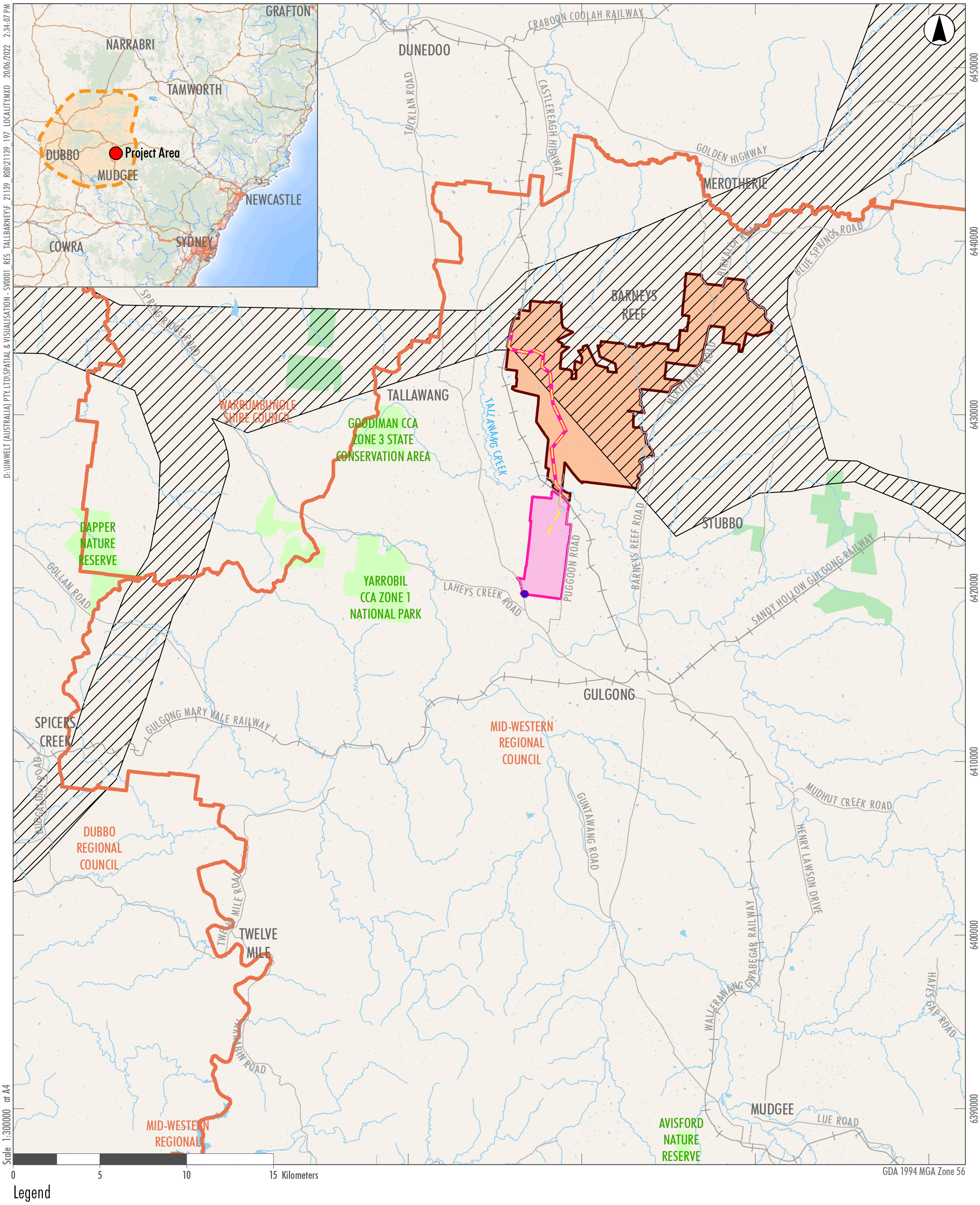
For the purposes of this assessment, the Project Area is defined as the area inclusive of:

- the solar farm and BESS development area
- a transmission line corridor of approximately 13 km long and 60 m wide for an overhead transmission line connecting the Project to the proposed new to build grid infrastructure.

The Project encompasses eight freehold properties and some parcels of Crown Land ('paper roads'), covering an area of approximately 1,370 ha. These properties are primarily utilised for cropping and grazing activities. The development footprint for the Project is approximately 866 ha.

The Project is expected to generate up to 270 direct Full Time Equivalent (FTE) jobs over the 34-month construction period and 7 direct FTE jobs during operation.

The Project is a State Significant Development (SSD) under the *State Environmental Planning Policy (Planning Systems) 2021* as the capital value of the Project is over $30 million. A development application (DA) for the Project is required to be submitted under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).



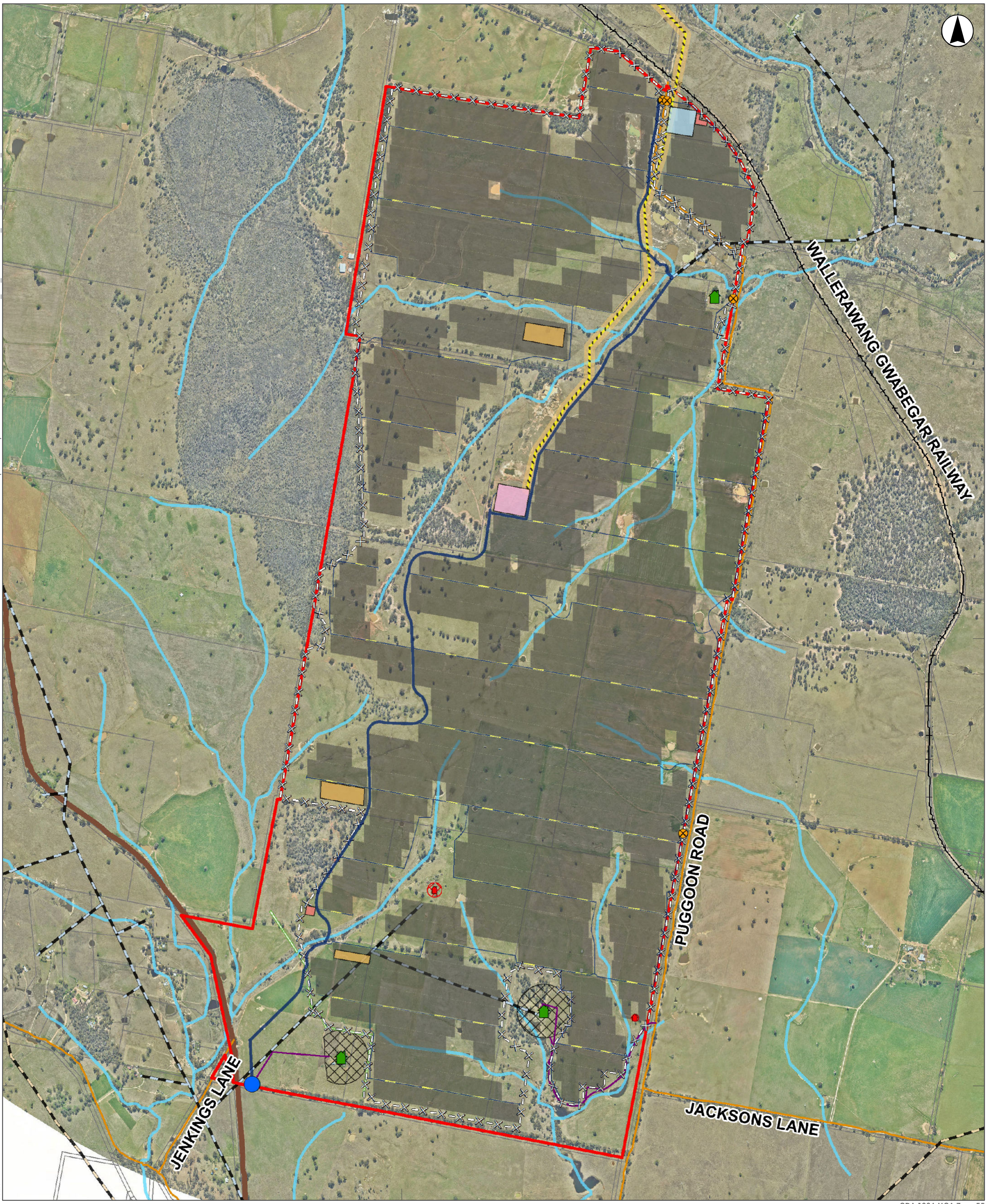
Legend

- Tallawang Solar Farm Project Area
- Barneys Reef Wind Farm Project Area
- Proposed HV Powerline
- Indicative Proposed Central West Orana REZ Transmission Corridor
- Indicative Central-West Orana Renewable Energy Zone
- Access Point
- National Parks (NPWS Estate)
- State Forest
- Road
- Drainage Line
- Railway Line

FIGURE 1.1

Location and Local Context

Image Source: Data source: Geoscience Australia; Forestry Corporation of NSW (2019); DSFI (2017); NPWS Estate (2019)



GDA 1994 MGA Zone 55

D:\UMWELT (AUSTRALIA) PTY LTD\SPATIAL & VISUALISATION - SV0001 RES_TALLBARNEY\F 21139 R07\21139 176 PROJECTLAYOUT.MXD 9/06/2022 12:57:42 PM

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Legend

- Primary Project Access
- Secondary Access
- Proposed Single Axis Tracker
- Bess and DC-DC Coupled PCs with Hardstanding
- Proposed Access Track
- Proposed O&M Facility
- Proposed Substation Central
- Proposed Substation North
- Temporary Construction Compound & Laydown
- Proposed Landowner Access Track
- Proposed Transmission Line
- Proposed Transmission Line Buffer, 30m
- Proposed Landscaping Area
- Involved Dwelling
- Dwelling Exclusion Zone
- Cultural Heritage Huts
- Cultural Heritage Huts Exclusion Zone
- Water Course
- State Road
- Local Road
- 22kV Distribution Line (To Be Rerouted Where Necessary)
- Security Fence
- Project Area Boundary
- NSW Cadastre (2021-11-02)

FIGURE 1.2

Project Layout

Image Source: RES (2021)

1.1 Purpose and Scope of this Report

This Water Resources Impact Assessment (WRIA) has been prepared by Umwelt Australia Pty Ltd (Umwelt) in accordance with the Secretary's Environmental Assessment Requirements (SEARs) (amended on 26 November 2021) issued by the Department of Planning, Industry and Environment (DPIE) (now Department of Planning and Environment (DPE)) and as presented in **Section 1.3**.

This report considers the potential impacts of the Project on water resources in the vicinity of the Project Area, as required in the SEAR's and the scope of this report includes:

- assessments on the following:
  - flooding (including modelling for 5%, 1%, 0.5%, 0.2% Annual Exceedance Probability (AEP) and the Probable Maximum Flood (PMF))
  - groundwater levels
  - potential impacts and mitigation measures for erosion and sedimentation
  - surface and groundwater quality
  - water users
  - water sourcing and licensing.
- identification of any mitigation and management measures to minimise potential impacts of the Project on water and soil resources.

1.2 Statutory Context, Policy and Guidelines

The hydrological assessment was undertaken in accordance with the ARR2019 and with consideration of the relevant provisions of the NSW *Floodplain Development Manual* (2005). The mapping within the ARR2019 is consistent with the NSW *Floodplain Development Manual* (2005) but provides additional detail and updated recommendations on hazard category thresholds.

There are no specific floodplain risk management plans prepared by Mid-Western Regional Council which cover the Project Area. The most recent floodplain risk management plan prepared within Mid-Western Regional Council is the *Floodplain Risk Management Study and Floodplain Risk Management Plan for Kandos and Rylstone* (2017). This document uses the NSW Government's *Floodplain Development Manual* (2005) to characterise and map flood hazard. The hydrological assessment has used updated guidance from ARR2019 to characterise and map Flood Hazard which Mid-Western Regional Council is expected to use in their future floodplain risk management plans.

There are no Rural Floodplain Management Plans covering the Project Area, but the analysis and reporting carried out in the hydrological assessment is in line with guidance from ARR2019 and is consistent with the expectations of a Rural Floodplain Management Plan.

1.3 Summary of Secretary's Environmental Assessment Requirements

The SEARs identify matters that must be addressed in the Environmental Impact Statement (EIS). **Table 1.1** references the relevant requirements for Water and where the SEARs have been addressed in this report.

Table 1.1 SEARs Items and Responses

Requirement	Section where addressed
Water – including: • an assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources traversing the site and surrounding watercourses, 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;	**Section 6.1, 6.2,** and **6.4**
• details of water requirements and supply arrangements for construction and operation; and	**Section 3.1** and **6.3**
• a description of the erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with *Managing Urban Stormwater: Soils & Construction (Landcom 2004)*;	**Section 7.0**

The Agency Advice and where in the WRIA it has been addressed is included in **Appendix A**.

1.4 Existing Flood Related Studies

The flood studies found in the nearby area, are the following:

- Gulgong Stormwater Drainage Study 2009 Lyall & Associates Consulting Water Engineers, (2009), https://flooddata.ses.nsw.gov.au/flood-projects/gulgong-stormwater-drainage-study. The Gulgong study area was confined to the urban area of Gulgong and accordingly has no overlap with the Project Area. Being an urban drainage study, there is limited relevance to the rural flood assessment for the Project.

- Stubbo Solar Farm Flood Study 2020 (Water Technology, 2020). The Stubbo Solar Farm Flood area does not overlap with the Tallawang Solar Farm area so comparison in flood estimation was not possible. However, the model parameters adopted (as discussed in **Section 4.0**) are similar to those reported in the Stubbo Solar Farm Flood Study report.

2.0 Existing Environment

2.1 Hydrology

The Project Area is located within the Macquarie-Bogan Rivers System, in the lower catchment of Tallawang Creek, with Slapdash Creek to the east and Wialdra Creek to the south. Tallawang Creek is located to the north of the Project Area (refer to **Figure 2.1**). These waterways discharge to Cudgegong River, around 8 km southwest of the Project Area.

The topography (refer to **Figure 4.2**) of the Project Area is gently undulating with higher ground to the west, reaching to above 520 m AHD and lower ground to the east to around 430 m AHD. The identified watercourse alignments with their corresponding Strahler stream order are shown in **Figure 2.1**. Flow paths within the Project Area are unnamed with intermittent flows following rain events and generally without a well-defined drainage channel. An example overland flow path is shown in **Figure 2.2**.

The majority of the watercourses in the Project Area are only 1st and 2nd order watercourses. These minor watercourses in northern portion of the Project discharge to Tallawang Creek, the southern watercourses discharging to Wialdra Creek.

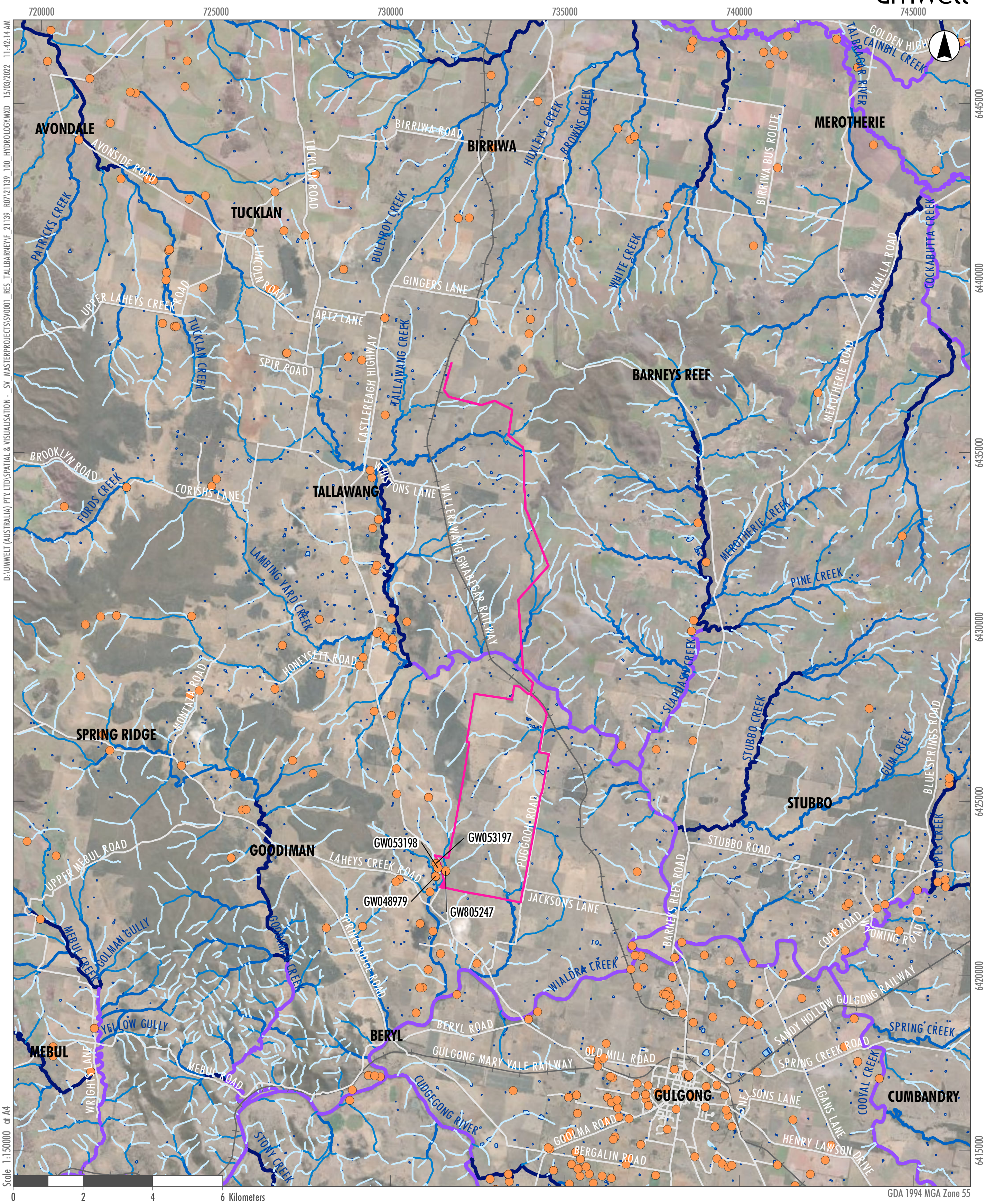
There are around 35 small farm dams present within the Project Area where water pooling occurs for extended periods, as shown in **Figure 2.1**.

2.2 Rainfall

The closest active Bureau of Meteorology (BoM) daily rainfall gauge to the Project Area is Gulgong Post Office (Gauge 062013), approximately 8 km to the south-east as shown in **Figure 2.3**. Whilst not located in the same catchment as the Project Area, given the proximity of the gauge the recorded data may be considered representative of the local region rainfall patterns. It is noted that the Gulgong (Tallawang (Talinga)) (Gauge 062105) located north-west of the Project Area has a limited period of discontinuous record between 2003 and 2014.

The period of record for the Gulgong Post Office gauge covers a continuous record of over 140 years from 1881 to 2021. The recorded annual average rainfall over this period is 650 mm, with 1950 providing for the highest annual total of some 1412mm.

The average monthly rainfall data from the Gulgong Post Office is presented in **Figure 2.3**. The mean and median rainfalls are highest during Spring/Summer, with the highest monthly mean reaching 70.2 mm in January and is lowest in April at 43.9 mm. The highest daily rainfall values indicate storm events are most likely to occur during February and March with peak daily totals exceeding 120 mm.



Legend

- Tallawang Solar Farm Project Area
- Dam/Waterbody
- Road
- Railway
- Groundwater Monitoring Bores

Strahler Stream Ordering

- 1
- 2
- 3
- 4
- ≥ 5

FIGURE 2.1

Hydrological Context

Image Source: ESR Basemap Data source: RES Australia (2021), NSW DFSI (2020)

Figure 2.2 Overland Flow Path within the Project Area

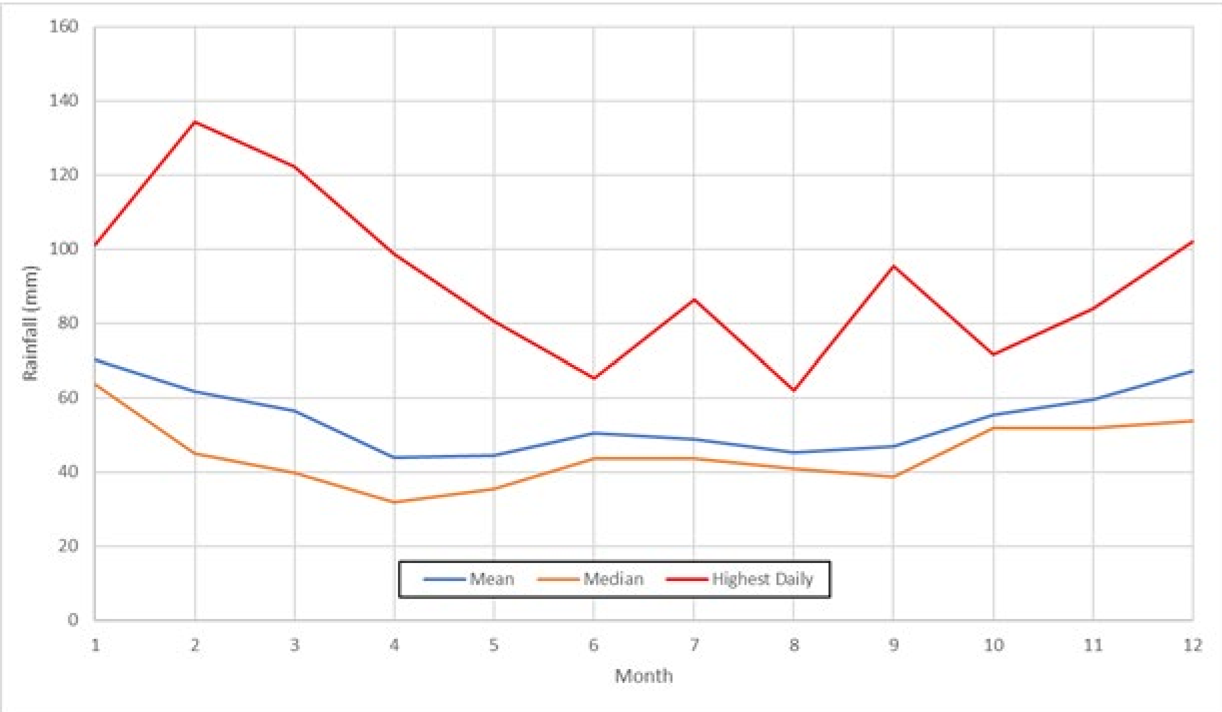
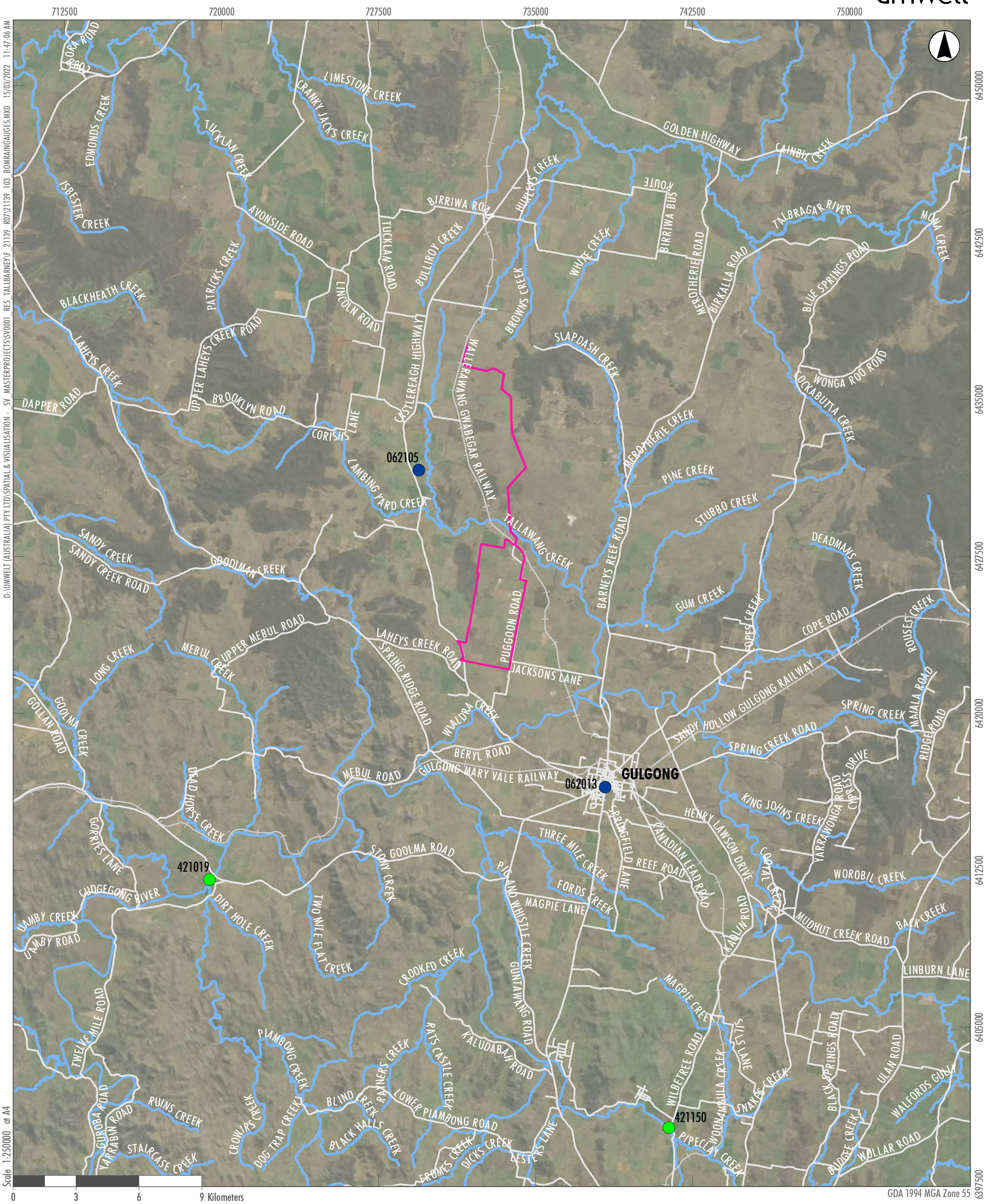


Figure 2.3 Monthly Rainfall at the Gulgong Post Office Station (BOM Gauge 062013)

umwelt



Scale 1:250000 at A4

Legend
- Tallawang Solar Farm Project Area
- BOM Daily Rainfall Gauge
- River Gauge
- Road
- Railway
- Watercourse

FIGURE 2.4

BOM Daily Rainfall Gauges

Image Source: ESR Basemap Data source: Umwelt (2021)

2.3 Evaporation

The average annual evaporation across the Project Area is estimated to be between 1,700 and 1,800 mm/year (BOM, 2006), as shown in **Figure 2.5**.

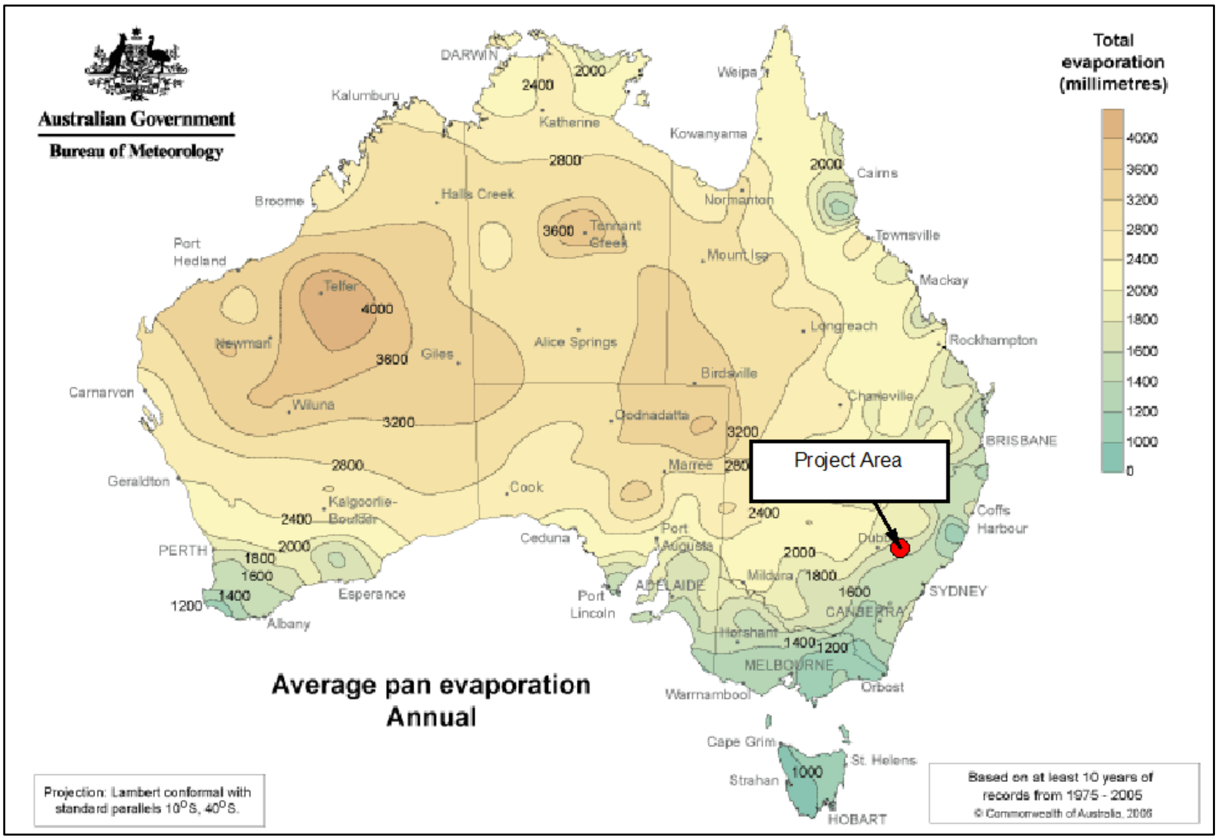


Figure 2.5 Average Annual Evaporation

2.4 Geology and Soils

The Project Area geology is generally comprised of Carboniferous granites and Cainozoic units with smaller section of the Project Area comprised of Dungeree Volcanics and Tucklan Formation (Meakin et al, 2000). Common minerals are quartz, and biotite.

There are no known occurrences of acid sulphate soils (ASS) within the Project Area (OEH, 2010).

A review of NSW DPIE soil profile and soil map information website, 'eSPADE', indicated the majority of the Project Area is located within the 'Home Rule' soil landscape described as 409 square kilometres of undulating low hills with sediment derived from the Gulgong and Rouse Granites, located east and north of Gulgong (Murphy B.W. and Lawrie J.M., 2010). The soil landscapes at the site are shown in **Figure 2.6**. Refer to the Soil, Land and Agriculture Assessment report (Umwelt, 2021) for more information.

2.5 Groundwater

Groundwater at the Project Area is managed under the *Water Sharing Plan NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011* (Lachlan Fold Belt Murray Darling Basin (Lachlan Fold Belt MDB) Groundwater Source) (DPIE, 2012).

Groundwater in the northern half of the Project Area and surrounding the Project Area creek systems are noted in the Mid-Western Regional LEP as 'Groundwater Vulnerability'.

The Lachlan Fold Belt MDB is described as a fractured rock aquifer system where groundwater occurs mainly within the fractures and joints. Aquifer usage is relatively limited however there are some areas of intense groundwater utilisation due to locally favourable groundwater availability and water quality. 73,599 entitlement shares are managed under the water sharing plan for the Lachlan Fold Belt with the majority used for irrigation purpose (DPIE, 2012).

Groundwater monitoring bores are discussed in **Section 2.6** and are shown on **Figure 2.1**.

2.6 Water Users

Locations of WaterNSW registered groundwater monitoring bores are shown on **Figure 2.1**. One groundwater bore (GW0805247) is located within the Project Area adjacent to and east of Castlereagh Highway. The bore is described as being drilled to 42 m in depth and for stock and domestic water supply purposes. The last recorded groundwater depth was recorded as 12 m below ground on 15/02/2013 (WaterNSW, 2021a).

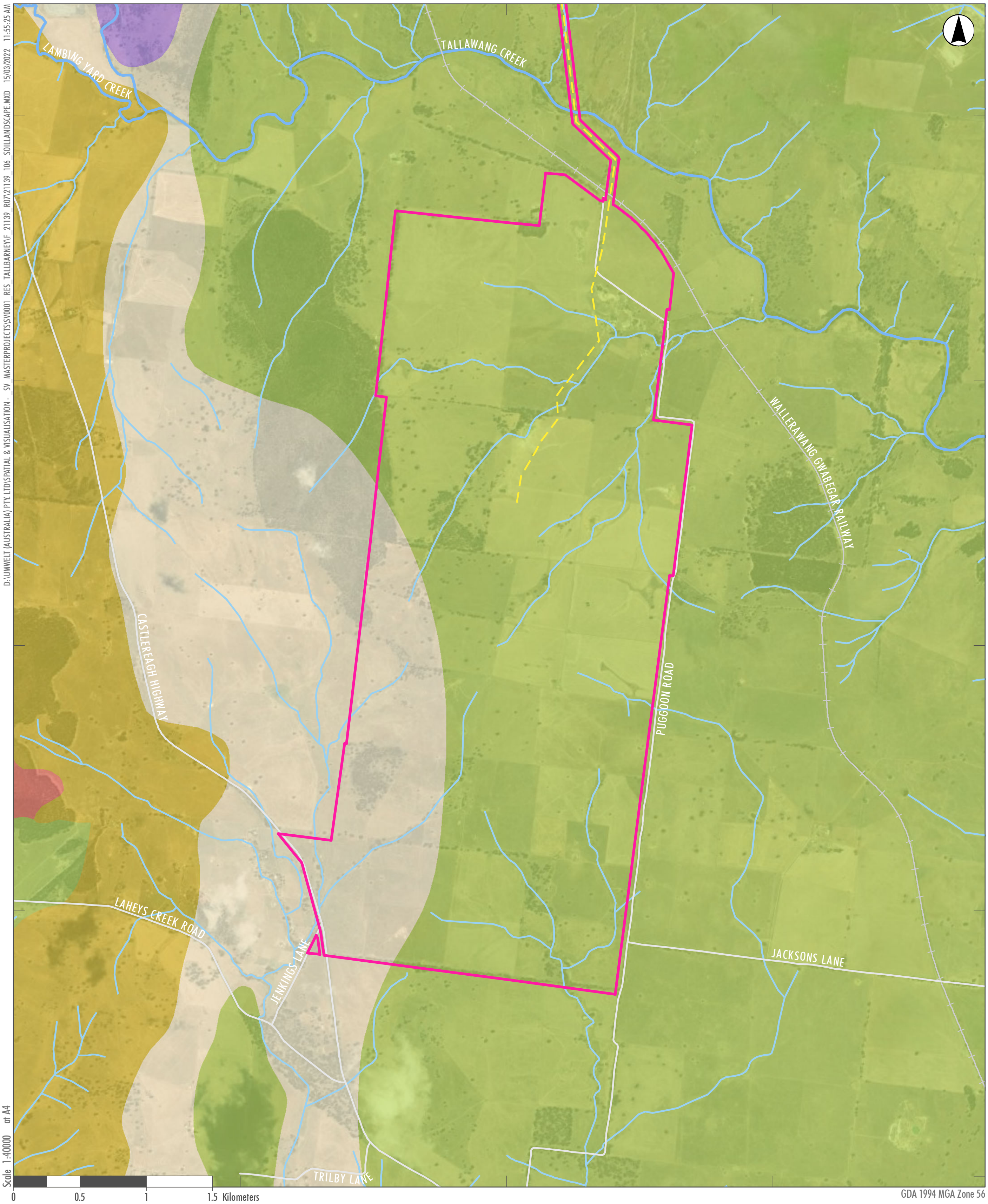
There are also three bores (GW048979, GW053198, GW053197) located immediately outside of the Project Area (adjacent to and west of Castlereagh Highway) and are either for irrigation or water supply purposes.

2.7 Groundwater dependent ecosystems (GDEs)

The Lachlan Belt MDB aquifer supports a number of identified high priority groundwater dependent ecosystems (GDEs) and springs are noted within Project Area (DPIE, 2019), as shown on **Figure 2.7**.

High potential groundwater dependent ecosystems (GDEs) were identified approximately 400 m north of the Project Area (at the Tallawang Creek watercourse) and moderate-low potential GDEs were identified within the Project Area (BOM, 2017).

The presence of shallow groundwater or springs may occur in association with rock fractures identified by valleys. Groundwater is expected to occur at greater depths from the surface and it is expected that the development proposed excavation depths will be shallow.



Legend

- Tallawang Solar Farm Project Area
- Proposed HV Powerline
- Road
- Railway
- Watercourse

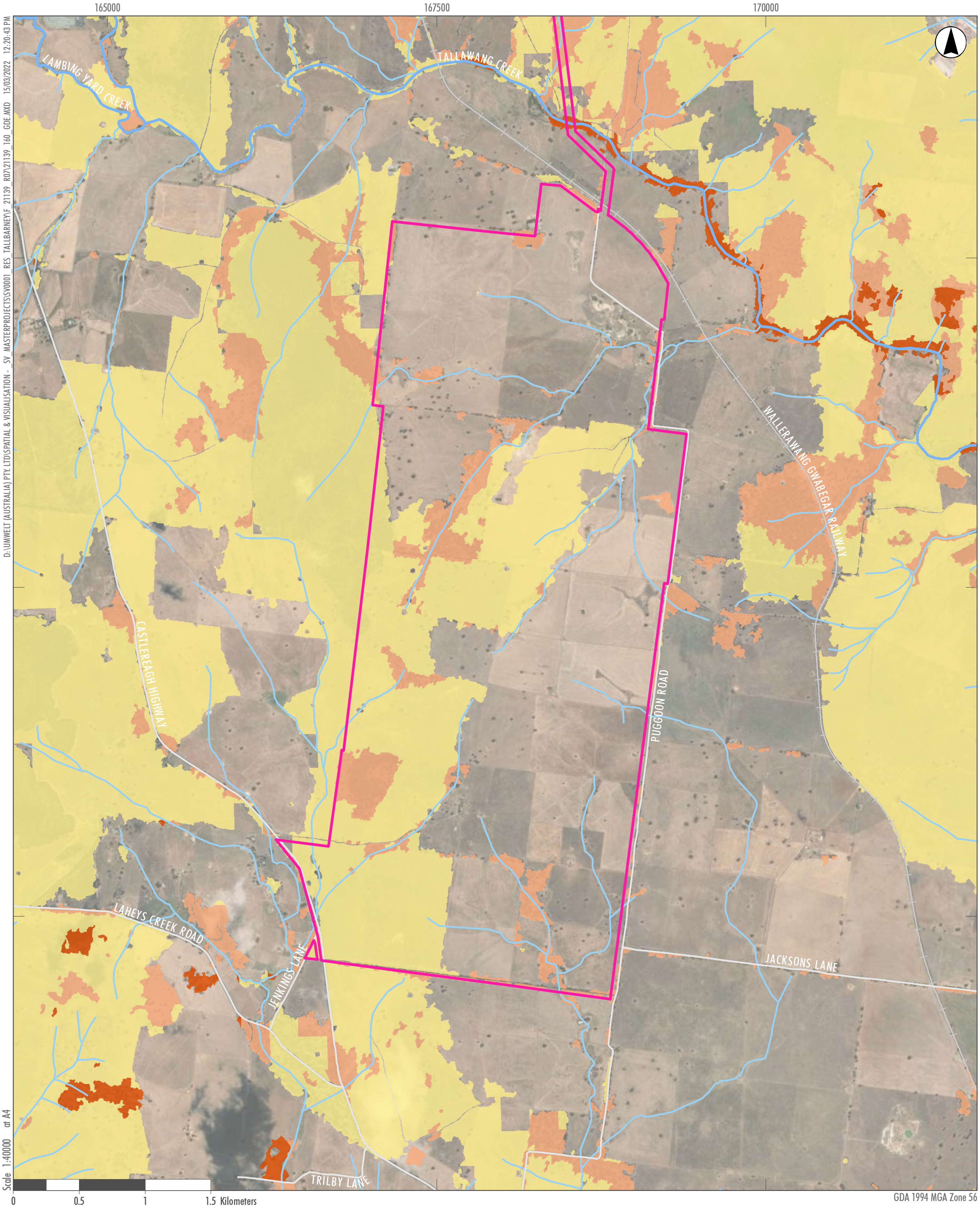
Dominant Australian Soil Classification (ASC) - Order

- Chromosols
- Ferrosols
- Kurosols, Natric
- Rudosols
- Sodosols

FIGURE 2.6

Soil Landscape

Image Source: Data source: Australian Soil Clasification (2013), Umwelt (2021)



Legend

- Tallawang Solar Farm Project Area
- Road
- Railway
- Watercourse

Terrestrial GDEs

- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies

FIGURE 2.7

Groundwater Dependent Ecosystems (GDE)

2.8 Environmental Values and 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, visual amenity, drinking water and agricultural water. The WQOs for the Macquarie-Bogan basin have been developed to achieve suitable water quality for the protection of:

- aquatic ecosystems
- livestock water supply
- irrigation water supply
- homestead water supply
- drinking water
- primary and secondary contact recreation
- visual amenity
- aquatic foods.

The River Flow Objectives for the Macquarie-Bogan basin have been developed to:

- protect pools in dry times
- protect natural low flows
- manage groundwater for ecosystems
- minimise effects of weirs and other structures.

Based on the likely construction activities and operations at the Project and the environmental values listed above, the water quality objectives presented in **Table 2.1** are considered relevant to the Project.

Table 2.1 Project Relevant Water Quality Objectives

Parameter	Units	Value/Range
pH	-	6.5 to 8.0
Salinity (Electrical conductivity)	µS/cm	30 to 350
Turbidity	NTU	2 to 25
Total Phosphorus	µg/L	20
Total Nitrogen	µg/L	250
Visual clarity and colour	-	Natural visual clarity should not be reduced by more than 20%. Natural hue of the water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.
Surface films and debris	-	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter.

3.0 The Project

3.1 Proposed Water Supply and Use

The Project would require a water supply during the construction, operational and decommissioning phases.

During construction, water would primarily be used for plant establishment and dust suppression. The associated water demand would likely be in the order of 206 megalitres (ML) for the 34-month construction period.

During operations, approximately 3.4 ML per year would be required for ongoing maintenance activities such as washing of the PV solar panels, amenities, and potable purposes by operational staff. Washing of the panels would not require any detergent or cleaning agents.

Water for the Project would be sourced from a local commercial supplier who has confirmed availability for the Project. Water will be transported from Gulgong via 14,000 or 18,000L water trucks. Water for the Project may also be sourced from farm dams or licensed groundwater bores located within the development footprint, where appropriate and available.

3.2 Water Licensing Requirements

Two water sharing plans apply to the Project Area:

- Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012
- *NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011* (Lachlan Fold Belt Murray Darling Basin Groundwater Source).

There are approximately 35 farm dams within the Project Area used for livestock water points. Most of the dams are relatively small ranging in capacity between roughly 20 kL and 0.5 ML, with the largest dam in the Project Area estimated at between 3 and 5 ML and the next two largest estimated around 1 ML. An example farm dam in the Project Area is shown in **Figure 3.1**.

These existing dams are unlikely to be licenced as the dams are likely to capture water under a harvestable right. The total capacity of all dams on a property allowed under the harvestable right is called the Maximum Harvestable Right Dam Capacity and the Maximum Harvestable Right Dam Capacity for the Project Area has been calculated as 95 ML (based on a Project Area of 1370 ha) (WaterNSW, 2021b). Therefore, it is expected that the existing dams do not require a licence as their total capacity is assumed to be less than 95 ML. No change in licencing would be required since the existing dams are expected to be unlicenced, however this should be confirmed prior to construction.

A desktop review of water access licenses on the NSW Water Register undertaken during June 2022 indicated that there are no existing groundwater access licenses for the Project Area (WaterNSW, 2022). Should the Project use water from groundwater bores, approval for Water Access Licences (WAL) would be required under the NSW Water Management Act 2000, and groundwater use will need to be within licensing requirements.

No change to the natural surface waterway outlets from the Project Area is being proposed. The Project's layout has considered the larger farm dams and have an exclusion zone of up to 40 m around these, as illustrated in **Figure 1.2**.

No water discharge is proposed as part of the Project.

Figure 3.1 A farm dam within the Project Area

4.0 Flood Assessment Methodology

4.1 Modelling Approach

A flood investigation was undertaken for 5%, 1%, 0.5% and 0.2% Annual Exceedance Probability (AEP) events and the Probable Maximum Flood (PMF). AEP is a measure of the likelihood a flood level or flow will be equalled or exceed in any given year. The PMF is the largest flood that could be conceivably expected to occur at a particular location, usually estimated from Probable Maximum Precipitation (PMP).

Hydraulic modelling of the Project Area was completed using a two-dimensional (2D) TUFLOW flood model. TUFLOW software is one of the most widely used hydraulic modelling software packages in Australia. The software is considered an appropriate modelling tool for modelling riverine and local overland flooding. TUFLOW allows the simulation of runoff generated from local rainfall on a grid that is representative of the site topography, known as “direct rainfall”, modelling. A coarse resolution 2D TUFLOW model covering the Tallawang Creek catchment upstream of the site was used to determine the critical storm durations and temporal patterns. A finer resolution TUFLOW model covering the complete local catchment area draining to the Project Area was run for the critical storms and temporal patterns determined using the coarse resolution model (refer to **Figure 4.1**).

The model provides estimates of flood levels, depth, velocities, and flood hazard for each of the modelled design events. The hydraulic model was run for both existing and climate change conditions. Climate change modelling was undertaken using 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.

The flood hazard was assessed in accordance with *Australian Rainfall and Runoff: A Guide to Flood Estimation* (ARR2019). In accordance with the ARR2019, the assessment considered:

- velocity of floodwaters
- depth of floodwaters
- combination of velocity and depth of floodwaters
- isolation during flood
- effective warning time
- rate of rise of floodwater.

4.1.1 Design Rainfall Inputs

4.1.1.1 Event Duration

Design rainfall was derived for burst duration between 30 min and 24 hours, based on the expectation that the critical storm duration for the Project Area catchment would be relatively short, given its size.

4.1.1.2 Intensity-Frequency-Duration (IFD)

Rainfall burst depths for the modelled AEP events were estimated for the centroid of the catchment using the 2016 ARR IFD analysis available from the Bureau of Meteorology as shown in **Table 4.1**. A consistent design rainfall was adopted (i.e., no spatial variation) given the size of the local catchment.

The Probable Maximum Precipitation (PMP) was estimated using the Generalised Short Duration Method (GSDM Method) (BOM, 2003).

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

AEP (1: Y)	30 min	1.5 hr	2.0 hr	3.0 hr	6.0 hr	9.0 hr	12.0 hr	18.0 hr	24.0 hr
2	13.4	16	18	20.9	23.2	26.8	31	34.3	39.7
5	14.9	17.9	20	23.3	25.8	29.8	34.4	38.2	44.2
10	19.6	23.4	26.2	30.4	33.6	38.7	45	50.1	58.5
20	22.8	27.2	30.5	35.2	38.9	44.7	52	58.3	68.1
50	26.1	31.1	34.7	40	44	50.4	58.7	66.1	77.7
100	30.4	36.2	40.2	46.2	50.7	57.8	67.6	76.7	90.8
200	33.9	40.1	44.5	50.9	55.6	63.4	74.2	84.8	100.4
500	38.2	45.3	50.2	57.2	62.5	71.1	83.6	95.9	114.9

4.1.1.3 Temporal Patterns

Temporal patterns are the distribution of the total rainfall in different periods within a given duration.

The 10 available temporal patterns were downloaded from ARR 2019 Data Hub and used to simulate the temporal distribution of burst rainfall depths during each storm duration modelled. The suite of temporal has been applied to estimate the critical design event for flood estimation in accordance with ARR 2019 procedures.

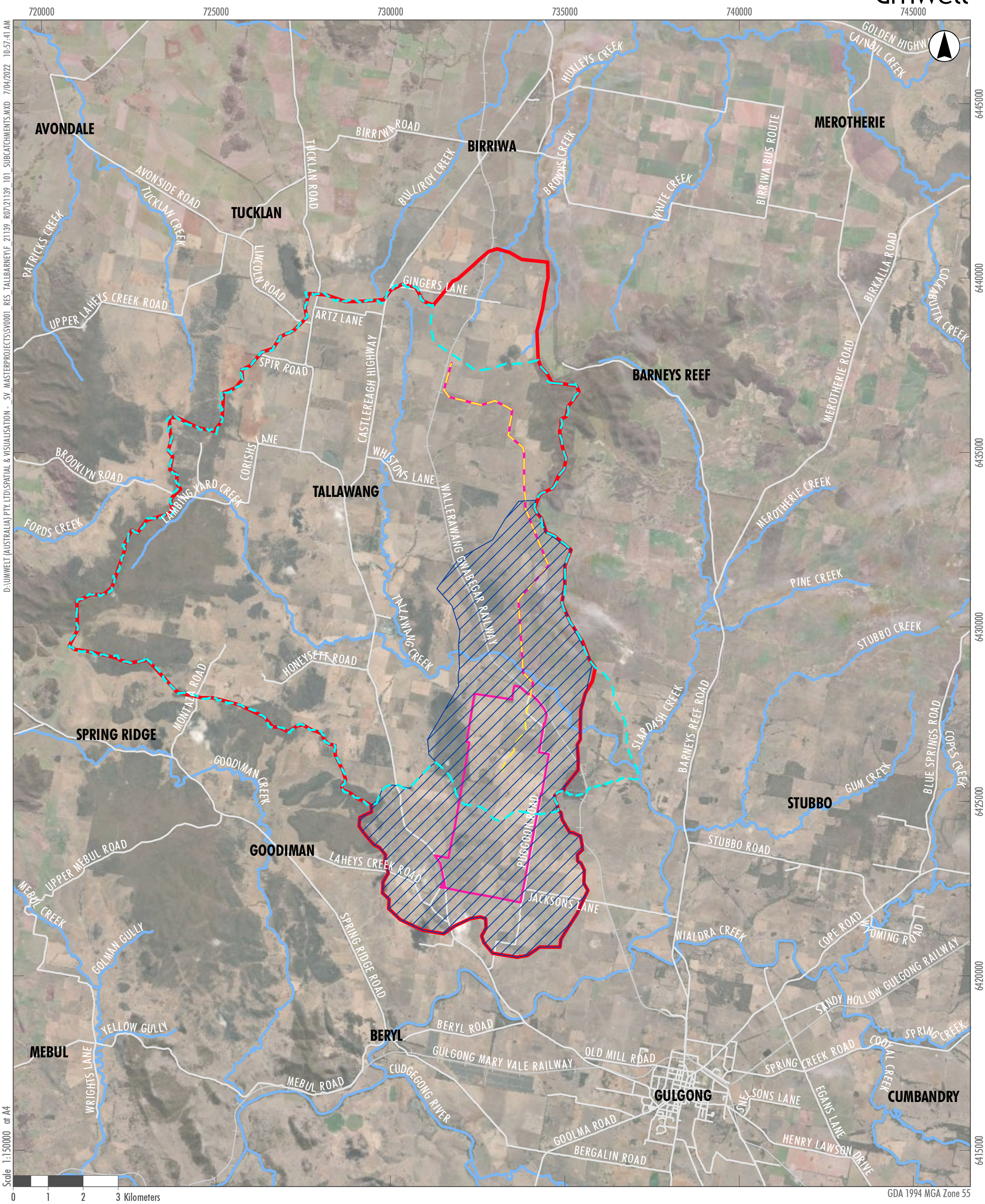
The GSDM temporal pattern was used for the PMP event.

4.1.2 Model Domain and Topography

The Tallawang Creek catchment was delineated using LiDAR data and is shown in **Figure 4.1**. The total catchment area of the Tallawang Creek upstream of the site was calculated as 148 km^2.

The model topography was developed from the LiDAR data available for the site. The Project Area and west catchment is covered by 5 m resolution LiDAR data flown in 2012 (GA, 2012) and the area to the east of the Project Area is covered by 2 m resolution LiDAR data flow in 2015 (GA, 2015). The modelled topography is shown in **Figure 4.2**. LiDAR data flown in 2021 (RES, 2021) was also provided by RES at a 50 cm contour resolution after the modelling had been completed. The 2021 LiDAR was compared to the 2012/2015 LIDAR data showing that there was less than 0.3 m difference in elevations for the majority of the Project Area, with an increase between 0.5 and 1 m in some areas. To test the impact of the 2021 LiDAR on the flood modelling results, the 1% AEP flood event was rerun with the 2021 LiDAR data and the results showed a minimal change in flood extents (a slight reduction) using the 2021 LIDAR. Given these results, the model was not rerun with 2021 LiDAR data and was deemed sufficient for the purposes of this assessment.

A coarse resolution model (20m grid resolution) was developed covering the entire Tallawang Creek catchment. This model was used to determine critical storm durations and temporal patterns for use in the finer resolution model. The finer resolution model (5m grid resolution) was developed to cover the Project Area and was used to estimate flood depths and flood hazard within the Project Area. The model domains are shown in **Figure 4.1**.



Legend
- Tallawang Solar Farm Project Area
- Tallawang Creek Catchment
- Tuflow Model Domain
- Coarse Resolution Tuflow Model Domain
- Proposed HV Powerline
- Road
- Railway
- Watercourse

FIGURE 4.1

Tuflow Model Domain

Image Source: ESR Basemap Data source: RES Australia (2021), NSW DFSI (2020)

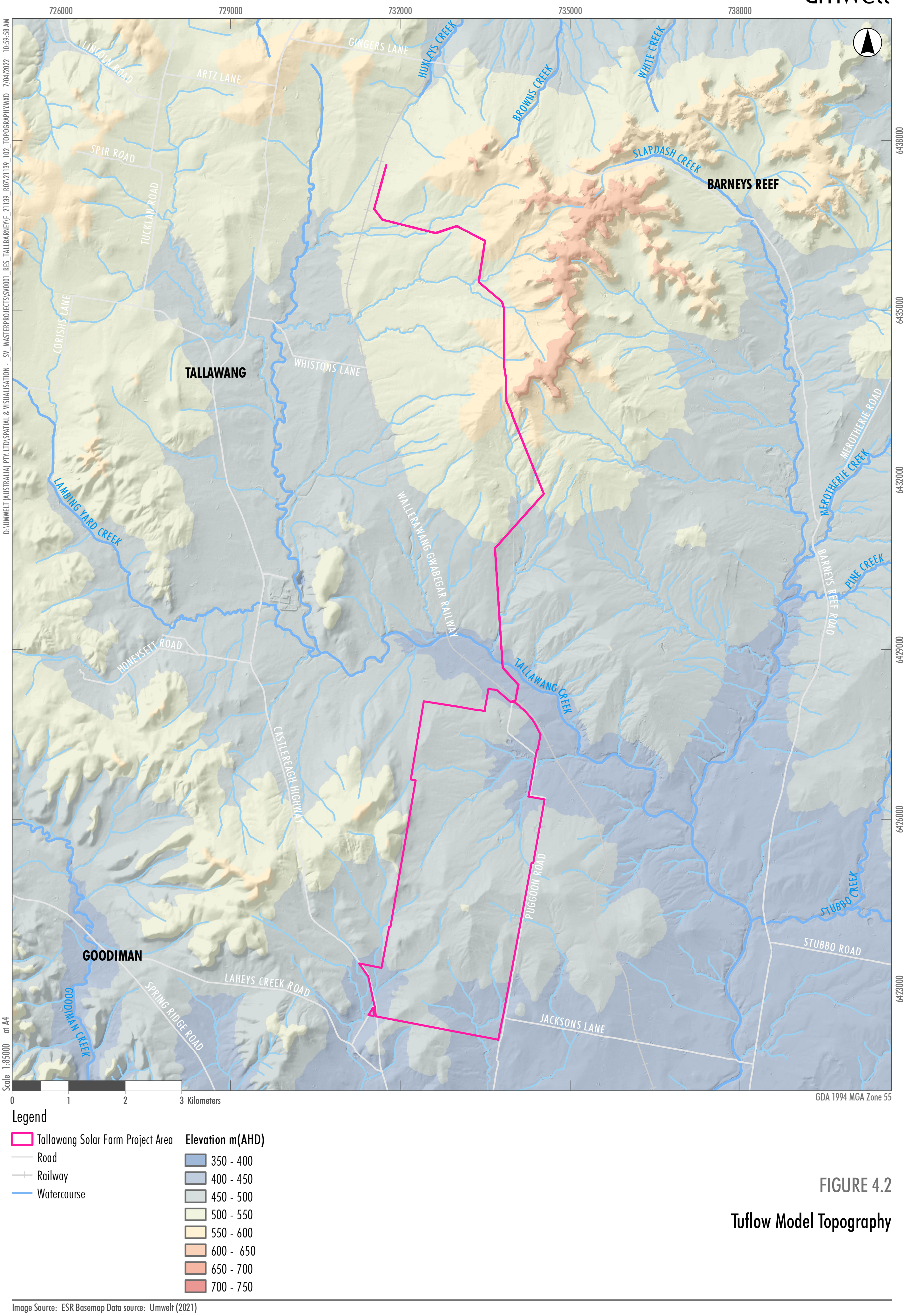


FIGURE 4.2

Tuflow Model Topography

Image Source: ESR Basemap Data source: Umwelt (2021)

4.1.3 Hydraulic Roughness and Losses

The hydraulic model used Manning's 'n' to represent the hydraulic roughness to determine the restriction caused by the range of land uses within the model area. Aerial photography was used to assign a specific Manning's 'n' roughness coefficient based on the recommendations in ARR2019, as shown in **Table 4.2**. Most of the Project Area was modelled with a roughness of 0.03. Initial and continuing losses were also applied as per land use and the adopted values are shown in **Table 4.2**. The values used are typical and have been used in similar studies.

Losses were initially extracted from the ARR online datahub. The suggested losses were a 19 mm initial loss (IL) and a 1.9 mm/hr continuing loss (CL). As the site is in NSW, the continuing loss was multiplied by a factor of 0.4, reducing it to a CL value of 0.76 mm/hr.

Table 4.2 Manning's Roughness and Losses used in the Developed Hydraulic Model

Manning's 'n'	IL (mm)	CL (mm/hr)	Land Use
0.15	10	2.0	Residential – Rural (lower density)
0.3	5	1.0	Industrial/Commercial or large buildings on site
0.03	15	1.0	Open Space or Waterway – minimal vegetation
0.06	15	1.0	Open Space or Waterway – moderate vegetation
0.09	15	1.0	Open Space or Waterway – heavy vegetation
0.06	0	0.0	Open water (with reedy vegetation)
0.02	0	0.0	Open water (with submerged vegetation)
0.02	2.5	0.5	Car park/pavement/wide driveways/roads

4.2 Model Scenarios

Hydraulic modelling was undertaken for each AEP or PMF using the runs as per the critical storm durations and temporal patterns in **Table 4.3**.

4.2.1 Critical Storm Duration and Temporal Patterns

A range of storm duration and temporal patterns(as discussed in **Sections 4.1.1.1** and **4.1.1.3**) were simulated (using ARR2019 inputs) to identify the rainfall profiles providing for the critical flood conditions (design peak water levels) across the Project Area and along Tallawang Creek. A coarse grid (20 m resolution) TUFLOW model was used to determine the critical storm duration for the 1% AEP and PMF events.

The critical storm duration and temporal pattern providing the design peak water levels across the Project Area results are presented in **Table 4.3**. The 1% AEP critical storms and temporal patterns were also adopted for the 5%, 0.5% and 0.2% AEP. These scenarios were modelled in the finer 5m grid hydraulic model.

Table 4.3 Critical Storm with Selected Temporal Patterns

Event	Critical Storm (min)	Temporal Pattern[1]	Location
1% AEP	45	5	Project Area (Upper reaches)
	90	7	Project Area (Middle reaches)
	120	4	Project Area (Lower reaches)
PMF	30	GSDM	Project Area (Upper reaches)
	60	GSDM	Project Area (Middle reaches)
	180	GSDM	Project Area (Lower reaches)

[1] Refer to **Section 4.1.1.3**.

4.3 Model Verification

There are no river flow gauges in the vicinity of the Project Area (the nearest river gauges are shown in **Figure 2.4**), and therefore, in the absence of calibrated data, the adopted roughness and rainfall losses was verified by comparing the modelled peak flows with those produced by the ARR Regional Flood Frequency Estimation (RFFE) method (**Table 4.4**). The RFFE Method is a replacement for the Probabilistic Rational Method described in the previous version of ARR.

For the 1% AEP event, the TUFLOW model produced a peak flow of 567 m^3/s matching the flow produced by the RFFE model at the outlet position for 1% AEP. For the 5% AEP event, TUFLOW produced a peak flow of 260 m^3/s, comparing to 273 m^3/s for the RFFE tool.

Given the general agreement between the TUFLOW and RFFE flows, the adopted model parameters values were considered fit for purpose. Additionally, the roughness values and losses adopted for this assessment (refer to **Section 4.1.3**) are within ranges typically applied in studies of this nature and correspond well to the adopted parameters of flood studies undertaken in the vicinity (i.e., Stubbo Solar Farm Flood Study (Water Technology, 2020)).

Table 4.4 ARR Regional Flood Frequency Model Results

AEP (%)	RFFE(m^3/s)	Lower Confidence Limit (5%)	Upper Confidence Limit (95%)	TUFLOW (m^3/s)
5	273	119	629	260
1	567	241	1340	567

5.0 Flood Modelling Results and Discussion

5.1.1 Overview and Flood Hazard Classifications

The flood model results provide the distribution of peak flood level, depth, velocity, and hazard across the Project Area for each modelled design magnitude flood event. Note that areas where the modelled flood depths are less than 5 cm have been filtered from the results.

The flood mapping and discussion of the flood conditions for each design event are discussed in the following sections as outlined below:

- 5% AEP event (refer to **Section 5.1.2**)
- 1% AEP event (refer to **Section 5.1.3**) - represents the principal flood planning event
- 0.5% and 0.2% AEP events (refer to **Section 5.1.4**) – representative of indicative climate change impacts
- PMF event (refer to **Section 5.1.5**).

The flood hazard of the site was assessed in accordance with ARR 2019, which defines six hazard categories as presented in **Table 5.1**. The combined flood hazard curves are presented in **Figure 5.1**.

Table 5.1 Hazard Classification (ARR, 2016)

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.

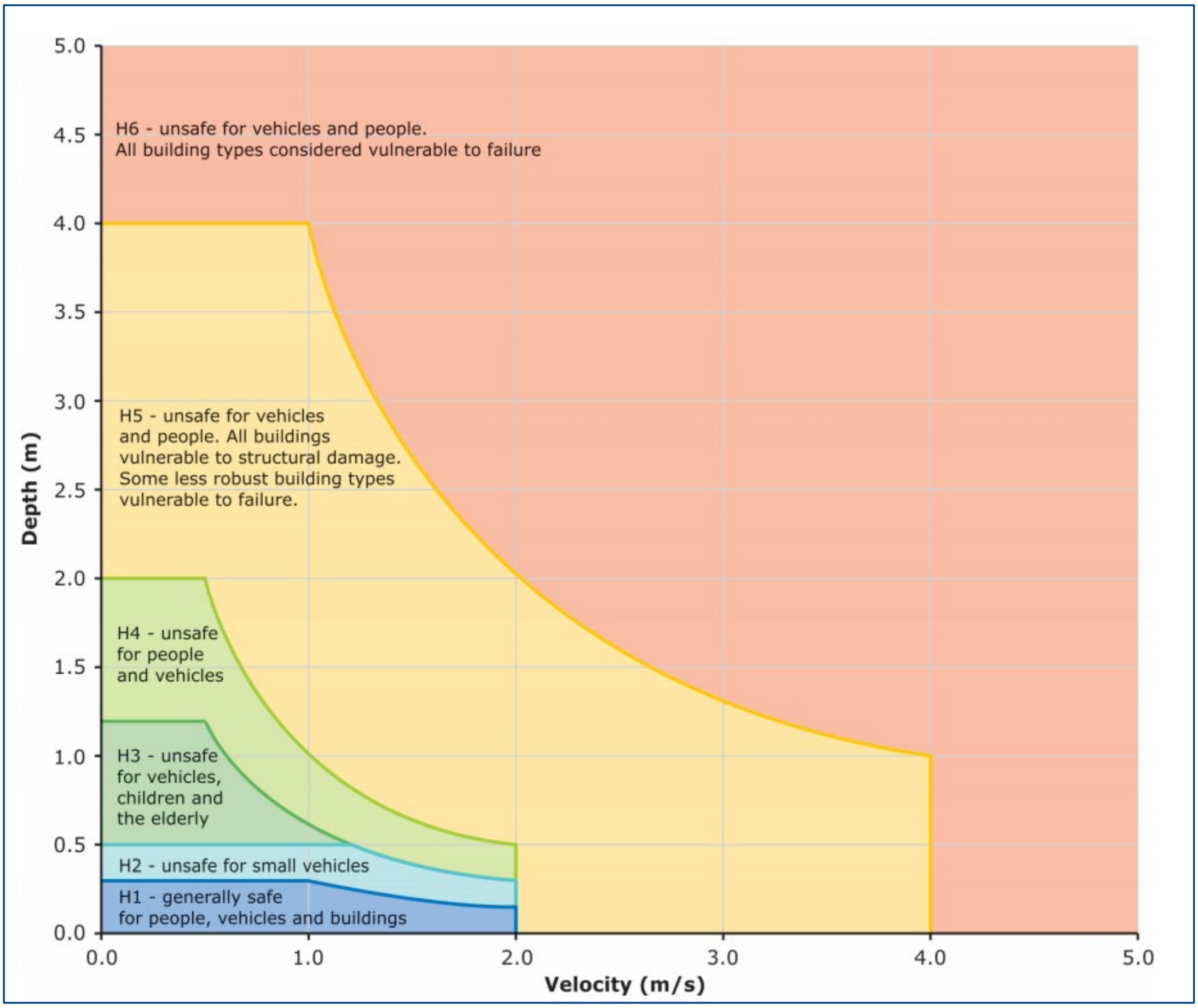


Figure 5.1 Combined Flood Hazard Curves (Smith et al. 2014)

5.1.2 5% AEP Results

Modelled 5% AEP depths, velocities and flood hazard are presented in **Figure 5.2, Figure 5.3** and **Figure 5.4** respectively. There is generally no widespread flooding within the Project Area with active flowpaths typically confined within the watercourses and local depressions.

General overland flood flow depths outside of the main waterway alignments are typically shallow at less than 0.3 m. The minor watercourses within the Project Area have flood depths generally less than a 1 m with some higher depths observed at farm dam locations. Higher flood depths exceeding 1 m are observed along the main Tallawang Creek channel alignment, including the location of the proposed transmission line crossing.

Velocities within the Project Area along overland flow alignments are typically less than 1 m/s. Within the better-defined drainage lines or waterways, peak velocities may be typically 1-2 m/s depending on the local channel slopes and overall flow accumulation concentrating in the lower reaches of the channels.

The flood hazard within the site for this flood event is mostly characterised as H1: '*Generally safe for vehicles, people and buildings*', with isolated areas of higher flood hazard (H5 and higher) predicted in the north eastern and southern areas of the site, however these areas are well confined to the waterways and defined drainage lines.

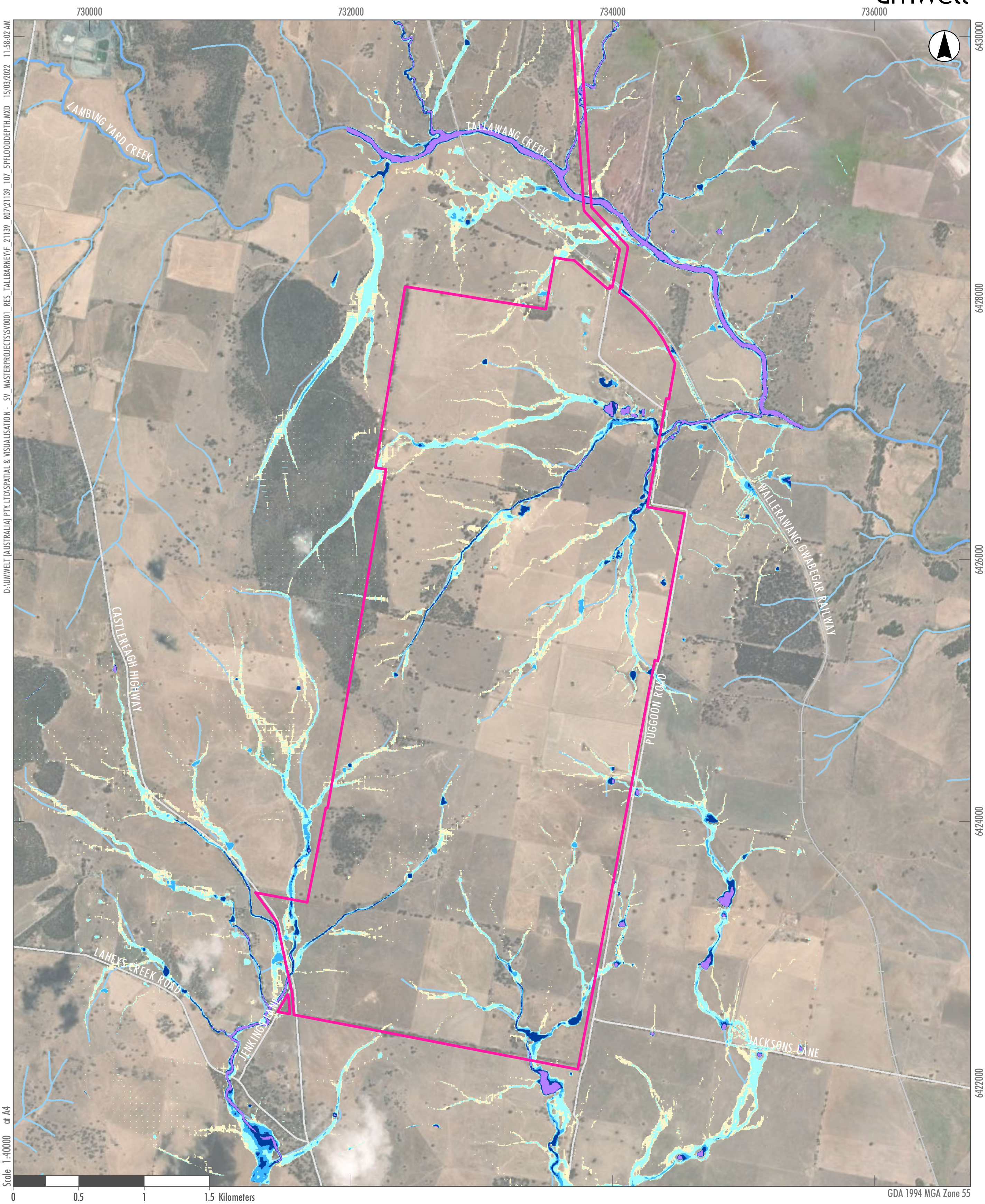
5.1.3 1% AEP Results

Modelled 1% AEP depths, velocities and flood hazard are presented in **Figure 5.5**, **Figure 5.6** and **Figure 5.7** respectively. The general flood inundation patterns and extents are similar to the 5% AEP event, albeit with increasing depths and velocities associated with the higher flows.

Flood depths remain generally less than 0.3 m along overland flow paths and local depressions, with depths flow along the minor watercourses within the Project Area typically up to a 1.0 m with some localised higher depths along the reaches. A similar flood depth range is observed for farm dams. The mainstream flooding of Tallawang Creek adjacent to the Project Area is still relatively confined.

The overland flow velocities within the Project Area remain generally less than 0.3 m/s. Velocities only exceed 0.6 m/s within the waterways. Within the defined drainage lines, velocities reach between 2.0 and 2.5 m/s in the lower reaches.

The flood hazard within the site for this flood event is mostly characterised as H1: '*Generally safe for vehicles, people and buildings*', and only reaches above this in the waterways and defined drainage lines. Within some of the watercourse alignments, flood hazard classes H5 and H6 are attained and accordingly would represent areas where infrastructure should be avoided

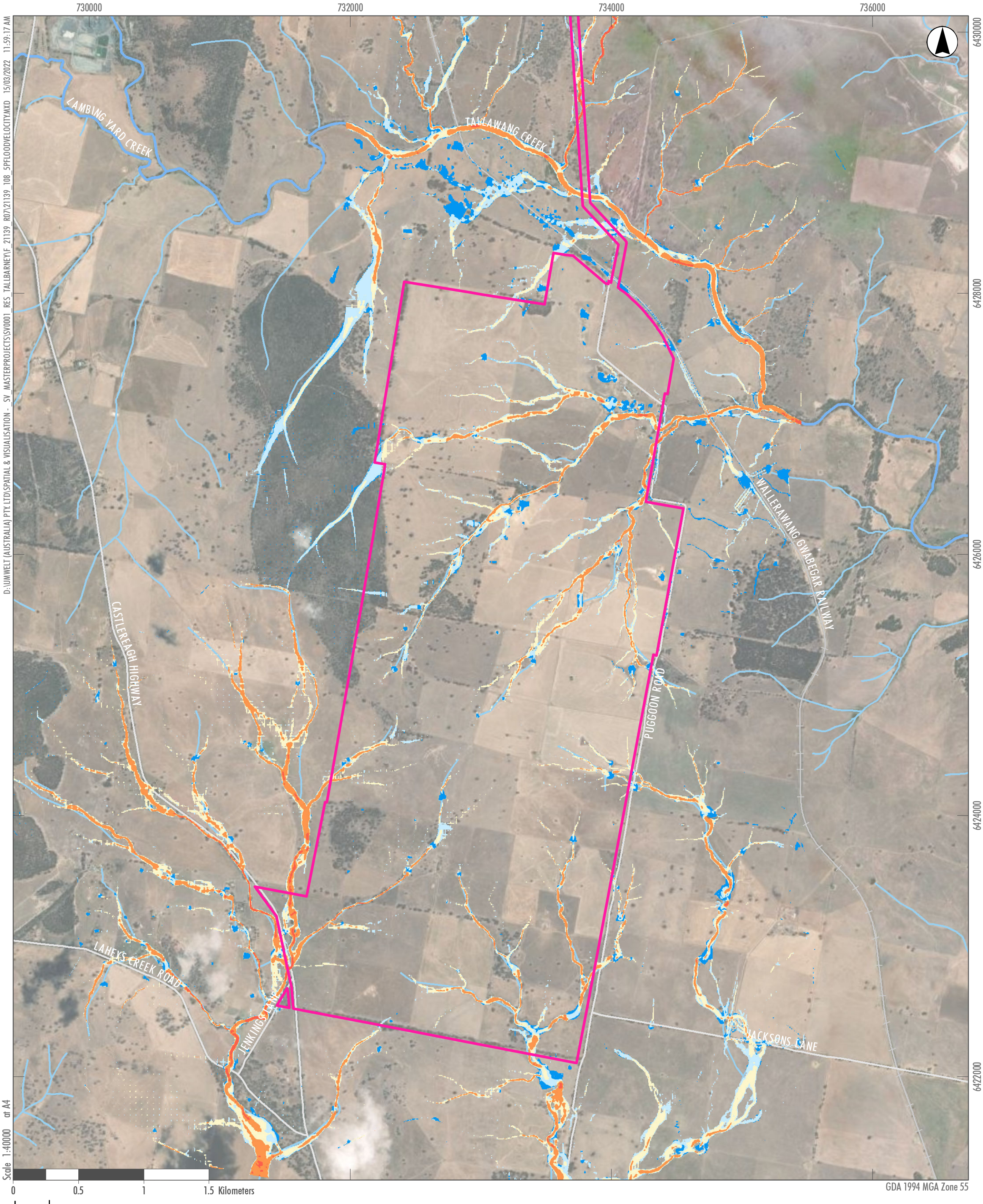


Legend

Tallawang Solar Farm Project Area		Water Depth (m)	
Road			< 0.1
Railway			0.1 - 0.3
Watercourse			0.3 - 0.5
			0.5 - 1.0
			> 1.0

FIGURE 5.2

5% AEP Flood Depth for Existing Conditions



Legend

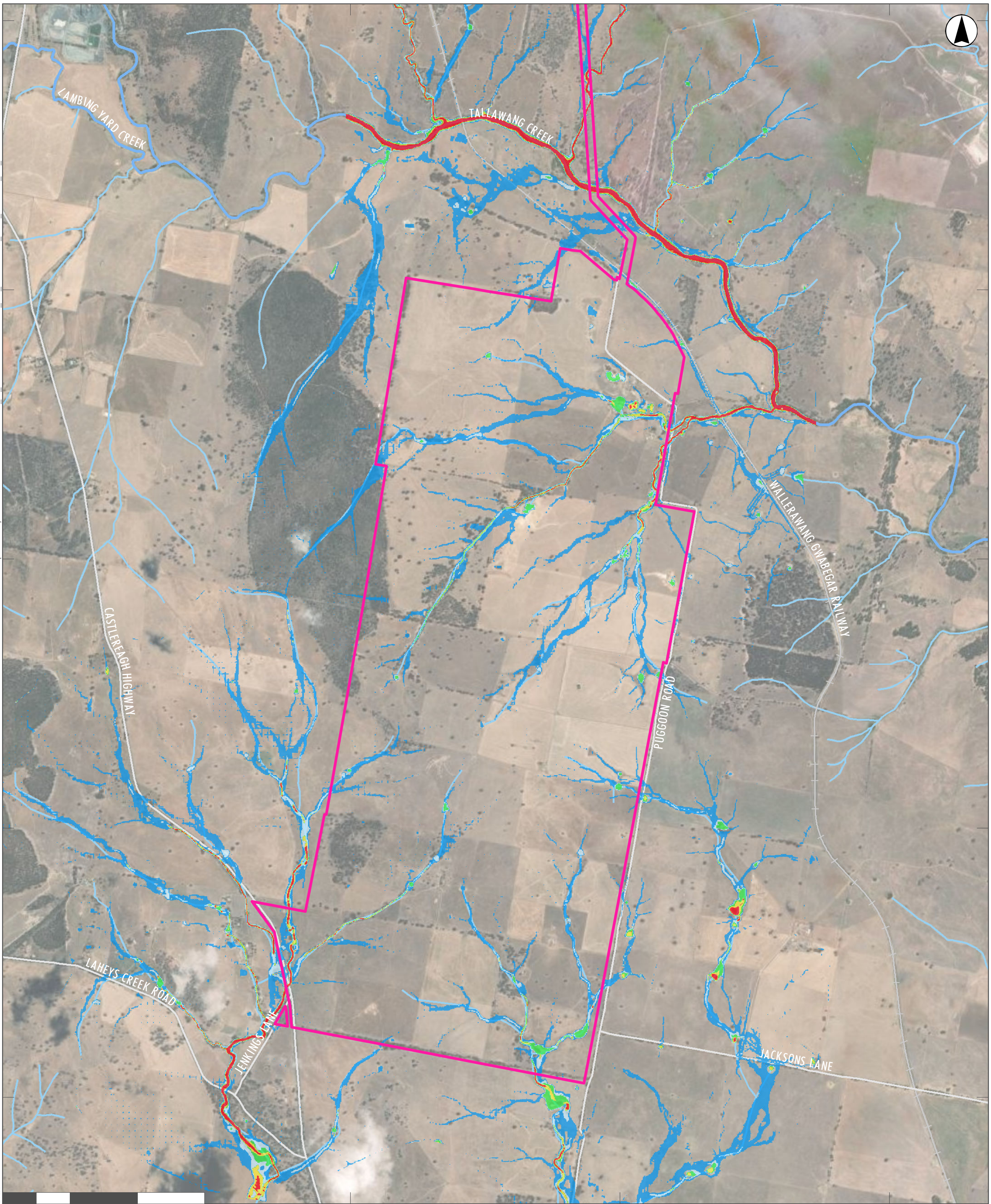
- Tallawang Solar Farm Project Area
- Road
- Railway
- Watercourse

Water Velocity (m/s)

- 0 - 0.3
- 0.3 - 0.6
- 0.6 - 1.0
- 1.0 - 2.0
- > 2.0

FIGURE 5.3

5% AEP Flood Velocity for Existing Conditions



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Legend

- Tallawang Solar Farm Project Area
- Road
- Railway
- Watercourse

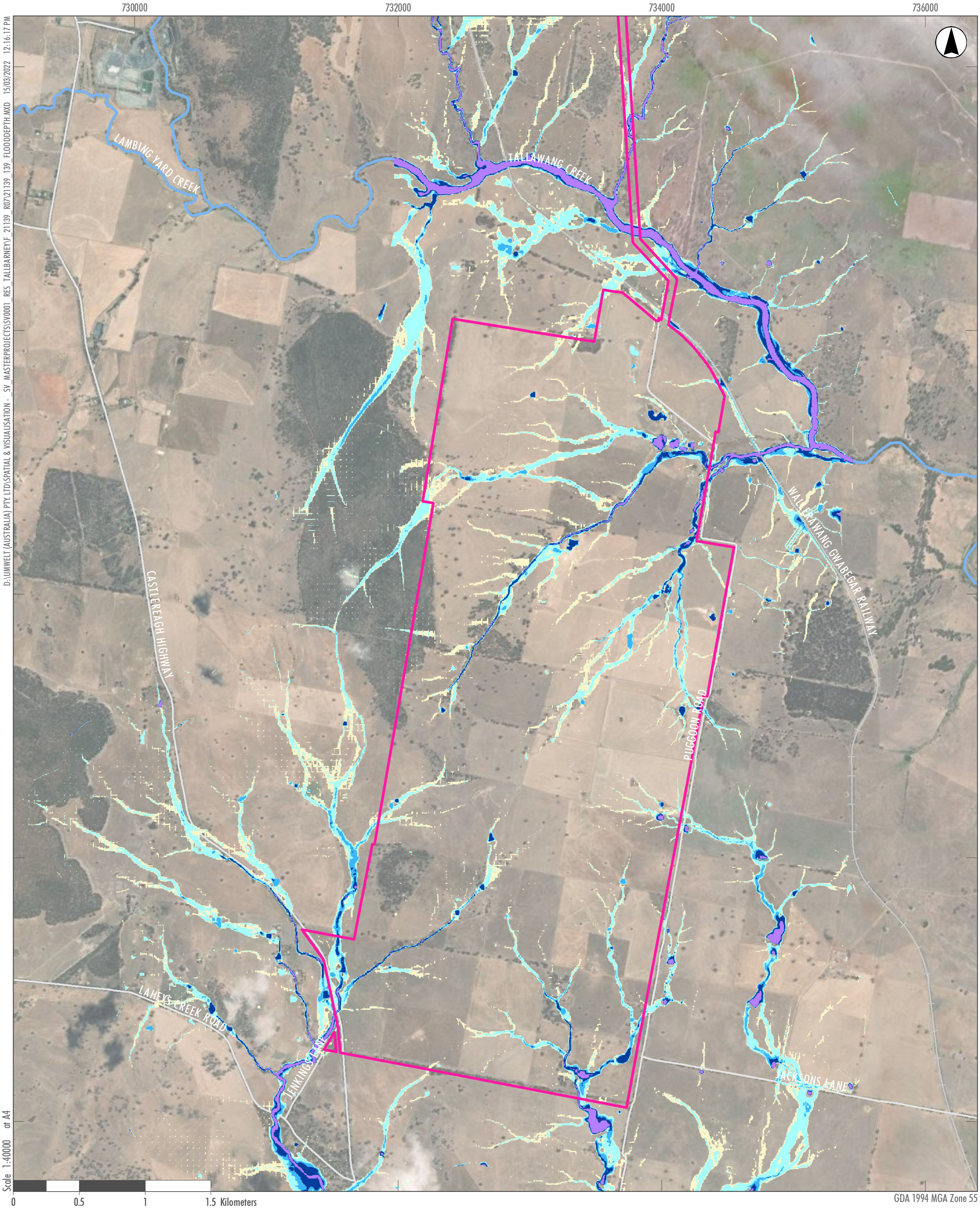
Hazard Category

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

FIGURE 5.4

5% AEP Flood Hazard for Existing Conditions

Image Source: ESR Basemap Data source: RES Australia (2021), NSW DFSI (2020)



Legend

- Tallawang Solar Farm Project Area
- Road
- Railway
- Watercourse

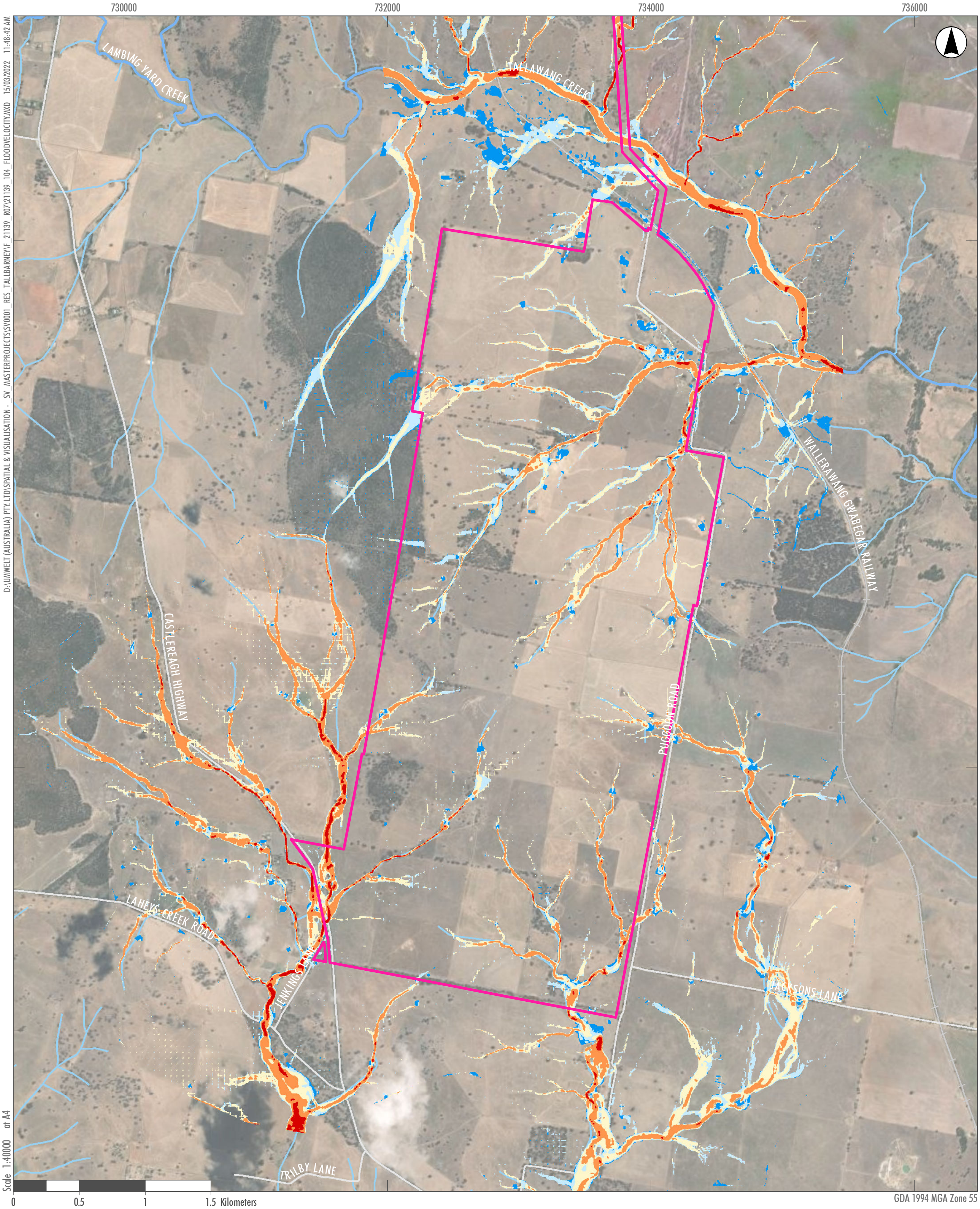
Water Depth (m)

- < 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- > 1.0

FIGURE 5.5

1% AEP Flood Depth for Existing Conditions

Image Source: ESR Basemap Data source: RES Australia (2021), NSW DFSI (2020)



Legend

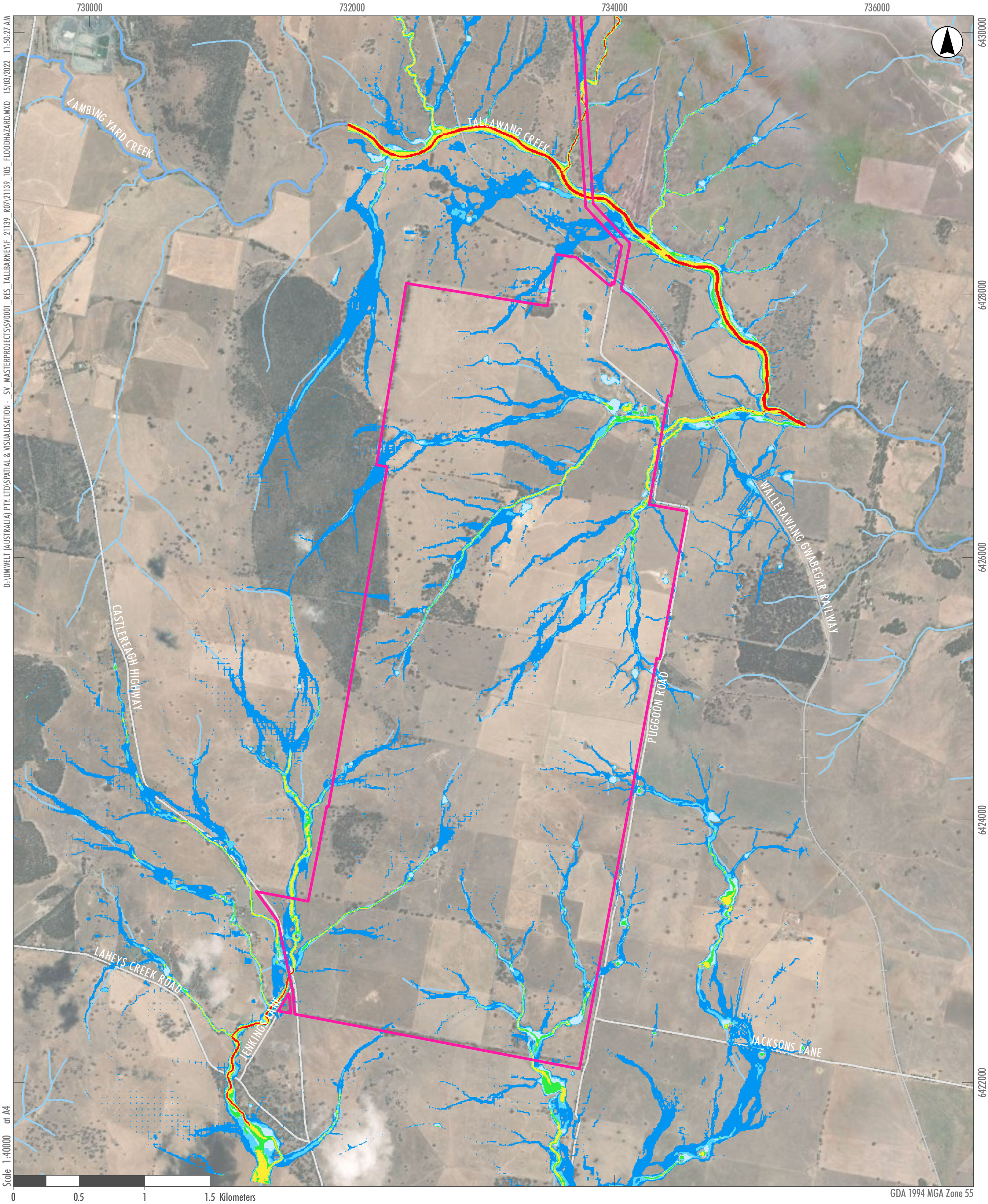
- Tallawang Solar Farm Project Area
- Road
- Railway
- Watercourse

Water Velocity (m/s)

- < 0.3
- 0.3 - 0.6
- 0.6 - 1.0
- 1.0 - 2.0
- > 2.0

FIGURE 5.6

1% AEP Flood Velocity for Existing Conditions



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Legend

- Tallawang Solar Farm Project Area
- Road
- Railway
- Watercourse

Hazard Category

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

FIGURE 5.7

1% AEP Flood Hazard for Existing Conditions

Image Source: ESR Basemap Data source: RES Australia (2021), NSW DFSI (2020)

5.1.4 Climate Change Modelling

The 0.5% and 0.2% AEP year flood events were used as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change. The 0.5% and 0.2% AEP design rainfalls for the Project Area represent general increases of 10% and 25% in rainfall respectively above the 1% AEP design rainfall. Accordingly, these are within the 10-30% range typically adopted for climate change allowance on design rainfall.

Modelled 0.5% AEP depths, velocities and Flood Hazard are presented in **Figure 5.8**, **Figure 5.9** and **Figure 5.10** respectively, with the modelled 0.2% AEP depths, velocities and Flood Hazard presented in **Figure 5.11, Figure 5.12** and **Figure 5.13** respectively.

The flood inundation patterns and extents are again generally similar to the 1% AEP design results (as discussed in **Section 5.1.3**). The modelling shows no activation of additional flow paths or extended inundation areas that materially impact on the development.

Flood depth remains generally less than 0.3 m for overland flow areas with flood depths up to 2 m along the well-defined mapping extents of the larger watercourses.

The 0.5% and 0.2% AEP climate change flood depths are only marginally larger than that of 1% AEP existing conditions. Higher AEP events show similar results indicating the inundation impact of climate change is not anticipated to be a significant issue for the Project. The results suggest the Project Area is able to drain effectively without a significant floodplain area which could hold water at high depths for extended periods of time.

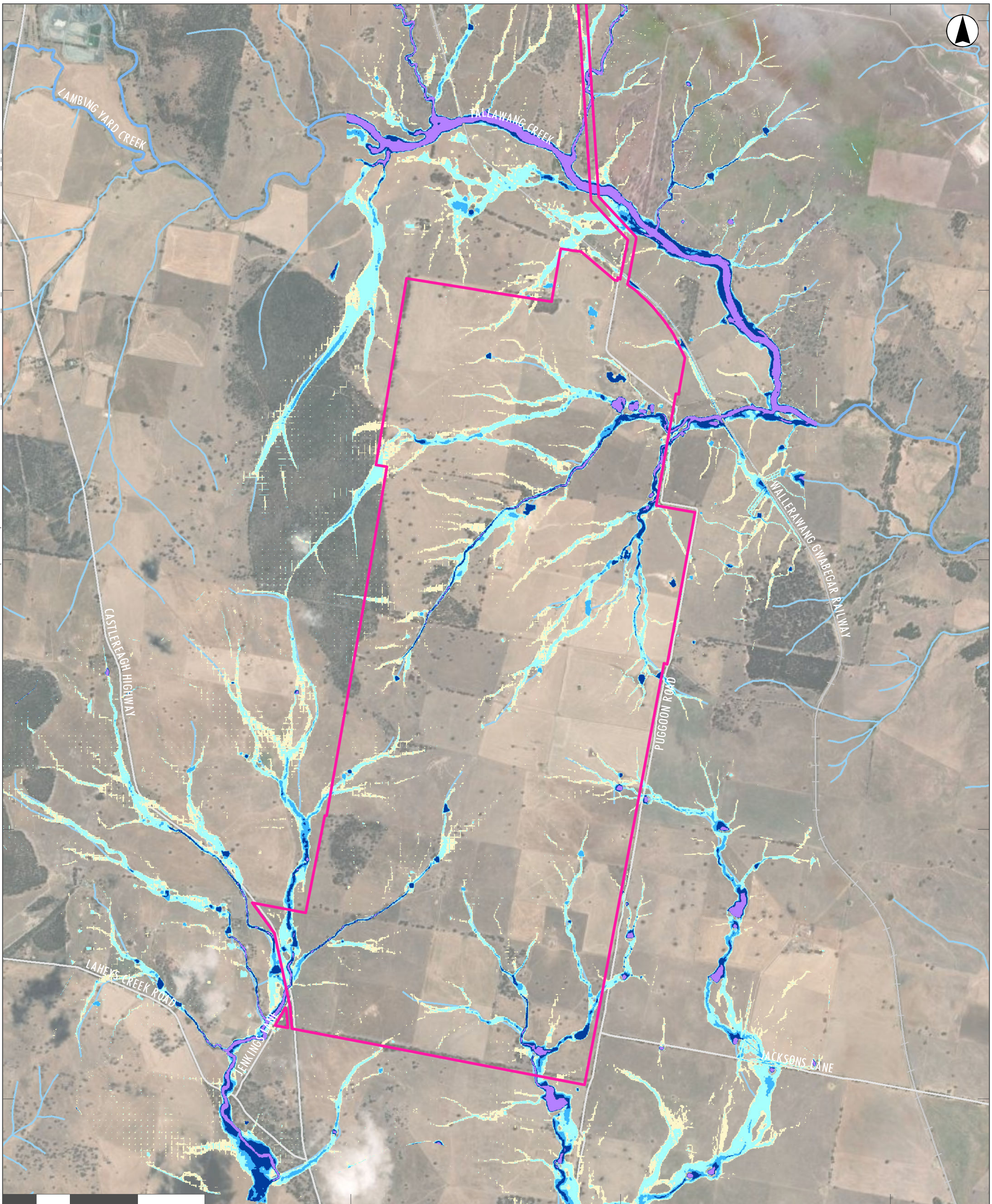
5.1.5 PMF Results

Modelled PMF depths, velocities and Flood Hazard are presented in **Figure 5.14, Figure 5.15** and **Figure 5.16** respectively. There is an overall increase in mapped flood extent, although a significant proportion of this area is in overland flow areas with flow depth less than 0.3 m.

Flood extents along the defined watercourses and overland flow paths have generally increased, but still typically confined to the general alignments albeit with increasing flood depth. The watercourses within the Project Area have flood depths up to 4 m in the lower reaches with a similar flood depth range is observed within the Project Area’s dams.

Corresponding to the increase in the flood depth distribution across the Project Area, flow velocities are increased for the PMF event. Within defined watercourses, velocities reach between 2.0 and 3.0 m/s in the lower reaches.

The flood hazard within the site is mostly characterised as H1: ‘*Generally safe for vehicles, people and buildings*’ and only reaches above this in the waterways and defined drainage lines. Within some of the watercourse alignments, flood hazard classes H5 and H6 are attained and accordingly would represent areas where infrastructure should be avoided as shown in **Figure 5.16**.



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Scale 1:40000 at A4

0 0.5 1 1.5 Kilometers

GDA 1994 MGA Zone 55

Legend

- Tallawang Solar Farm Project Area
- Road
- Railway
- Watercourse

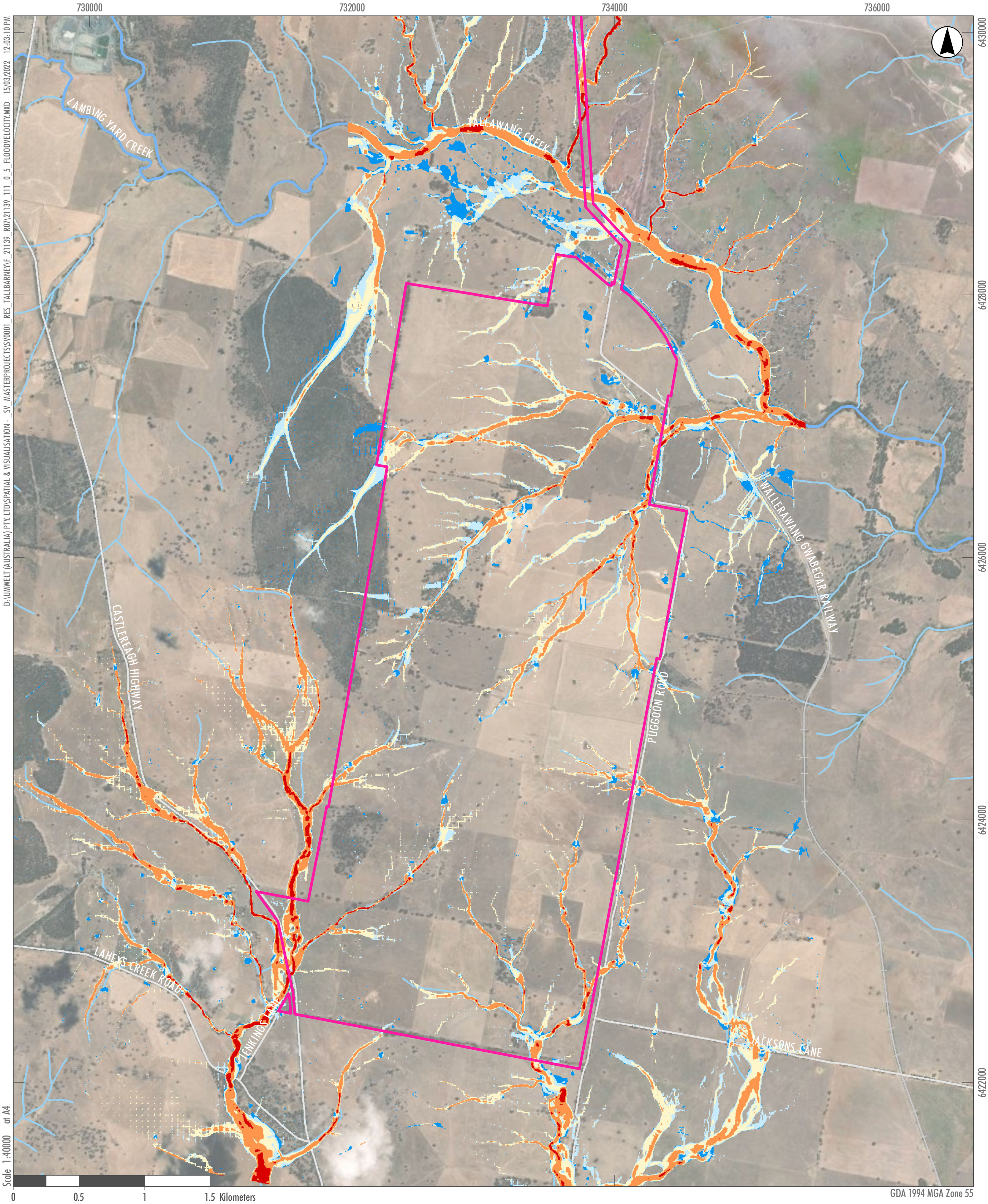
Water Depth (m)

- < 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- > 1.0

FIGURE 5.8

0.5% AEP Flood Depth for Existing Conditions

Image Source: ESR Basemap Data source: RES Australia (2021), NSW DFSI (2020)



Legend

- Tallawang Solar Farm Project Area
- Road
- Railway
- Watercourse

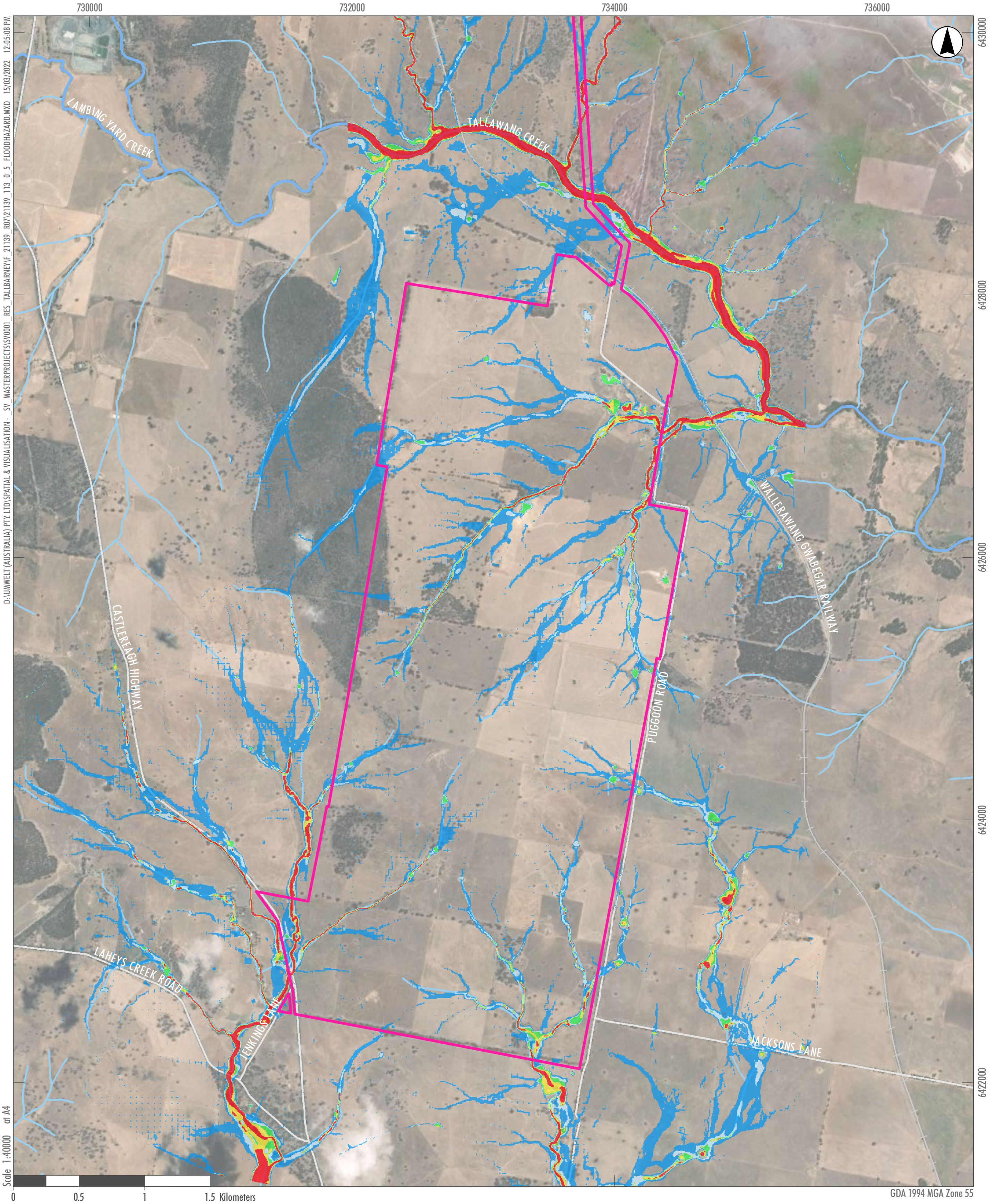
Water Velocity (m/s)

- < 0.3
- 0.3 - 0.6
- 0.6 - 1.0
- 1.0 - 2.0
- > 2.0

FIGURE 5.9

0.5% AEP Flood Velocity for Existing Conditions

Image Source: ESR Basemap Data source: RES Australia (2021), NSW DFSI (2020)



Legend

- Tallawang Solar Farm Project Area
- Road
- Railway
- Watercourse

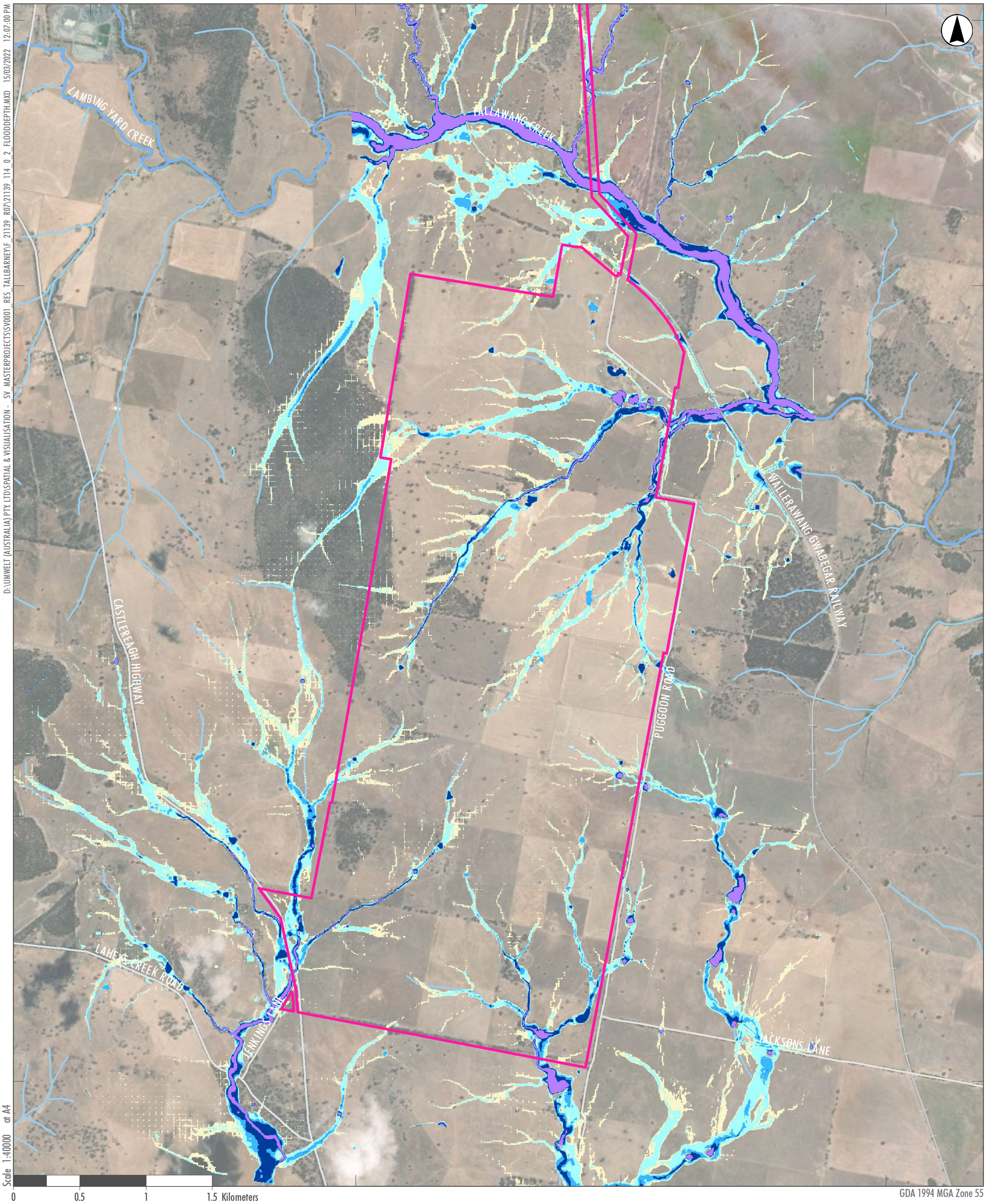
Hazard Category

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

FIGURE 5.10

0.5% AEP Flood Hazard for Existing Conditions

Image Source: ESR Basemap Data source: RES Australia (2021), NSW DFSI (2020)



Legend

Tallawang Solar Farm Project Area
Road
Railway
Watercourse

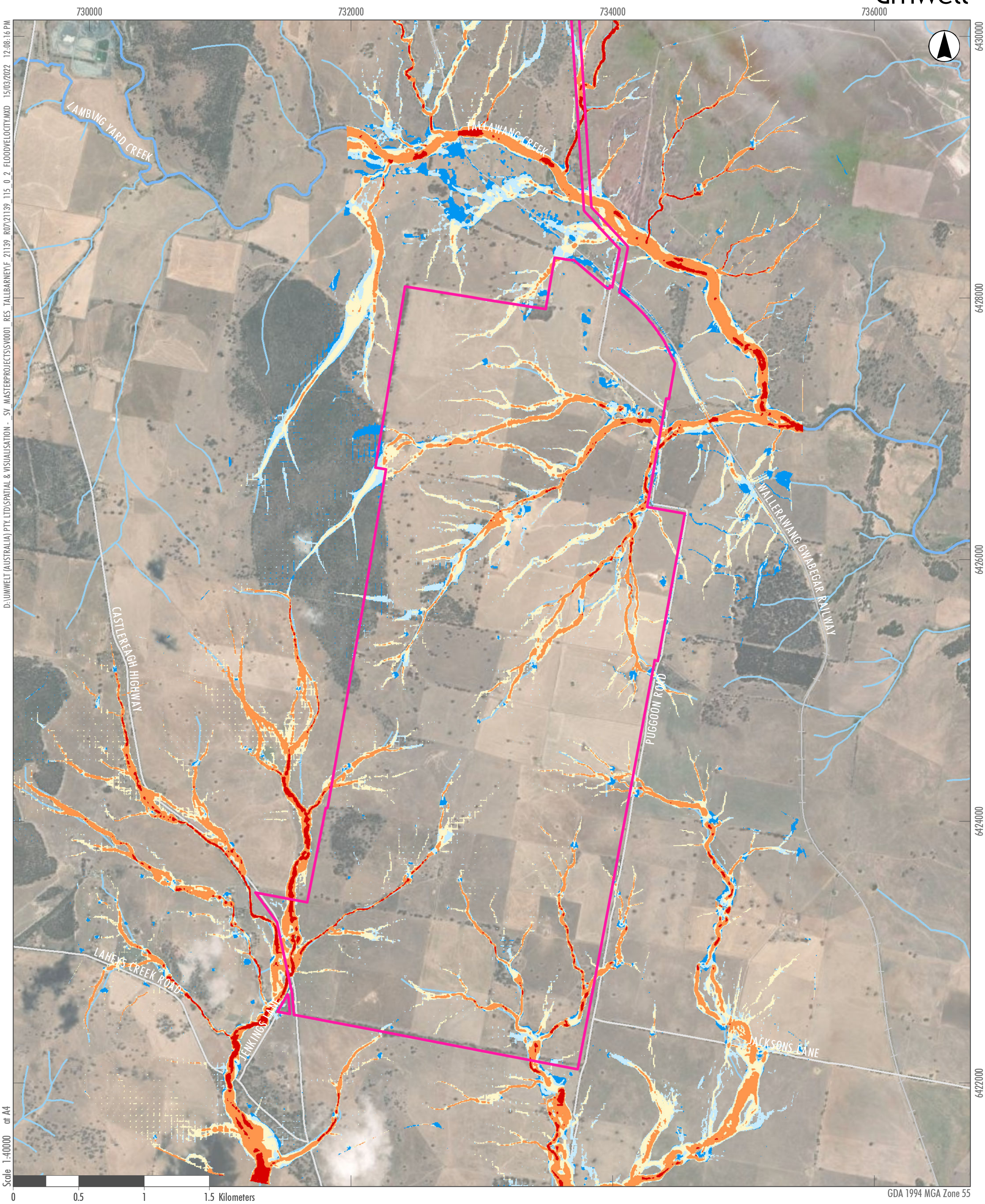
Water Depth (m)

< 0.1
0.1 - 0.3
0.3 - 0.5
0.5 - 1.0
> 1.0

FIGURE 5.11

0.2% AEP Flood Depth for Existing Conditions

Image Source: ESR Basemap Data source: RES Australia (2021), NSW DFSI (2020)



Legend

- Tallawang Solar Farm Project Area
- Road
- Railway
- Watercourse

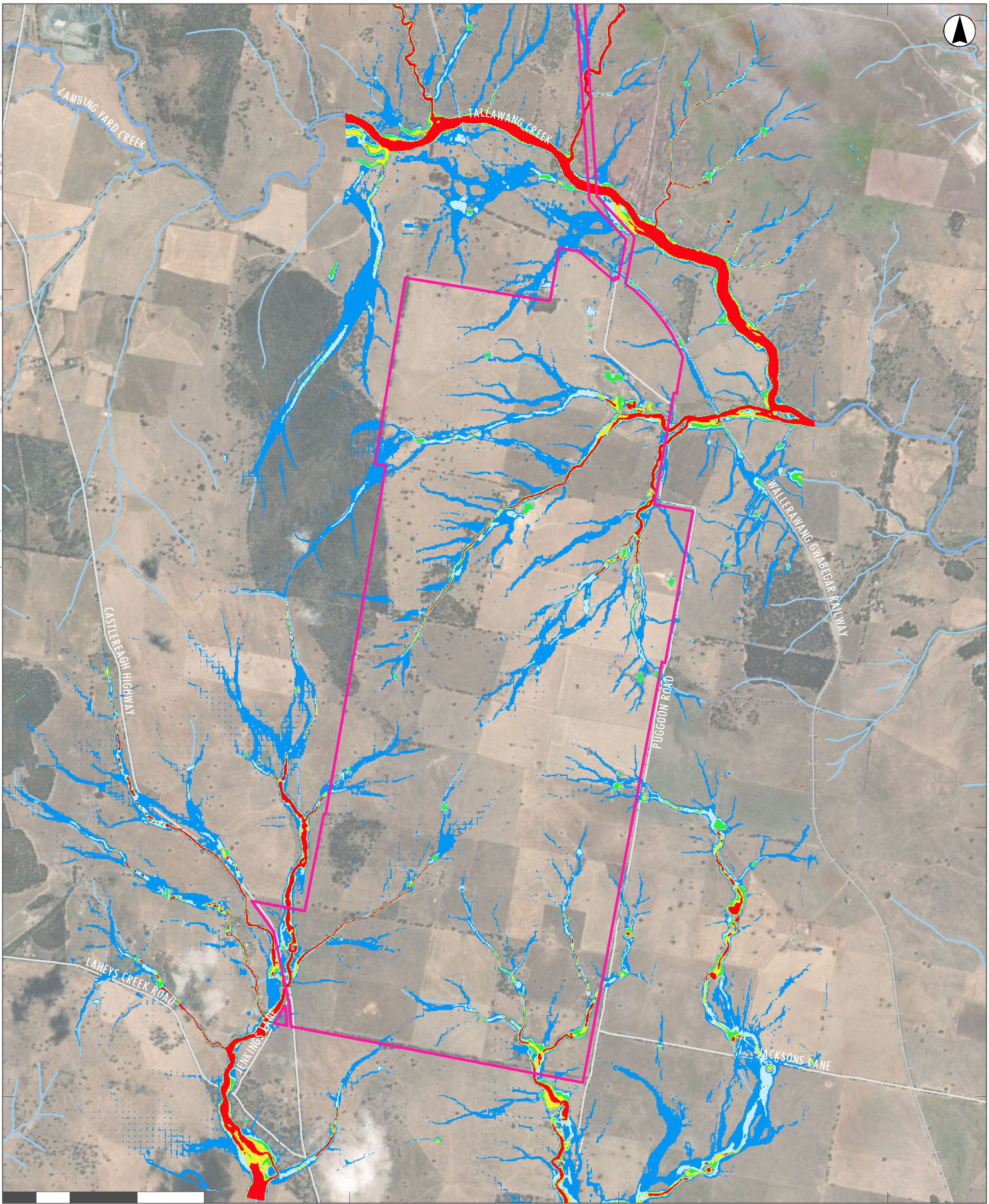
Water Velocity (m/s)

- < 0.3
- 0.3 - 0.6
- 0.6 - 1.0
- 1.0 - 2.0
- > 2.0

FIGURE 5.12

0.2% AEP Flood Velocity for Existing Conditions

Image Source: ESR Basemap Data source: RES Australia (2021), NSW DFSI (2020)



Legend

- Tallawang Solar Farm Project Area
- Road
- Railway
- Watercourse

Hazard Category

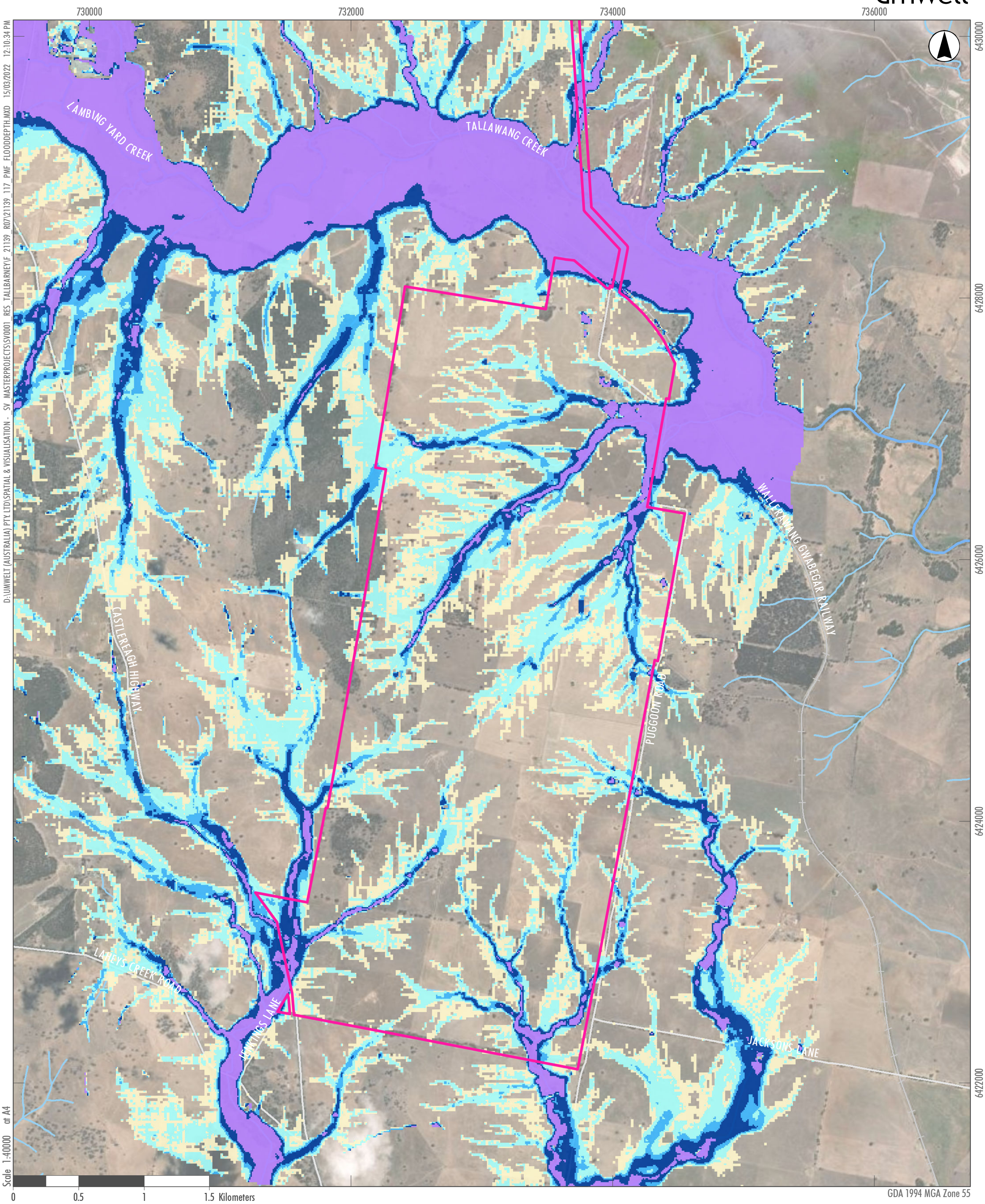
- H1
- H2
- H3
- H4
- H5
- H6

FIGURE 5.13

0.2% AEP Flood Hazard for Existing Conditions

Image Source: ESR Basemap Data source: RES Australia (2021), NSW DFSI (2020)

umwelt



Scale 1:40000 at A4

GDA 1994 MGA Zone 55

Legend

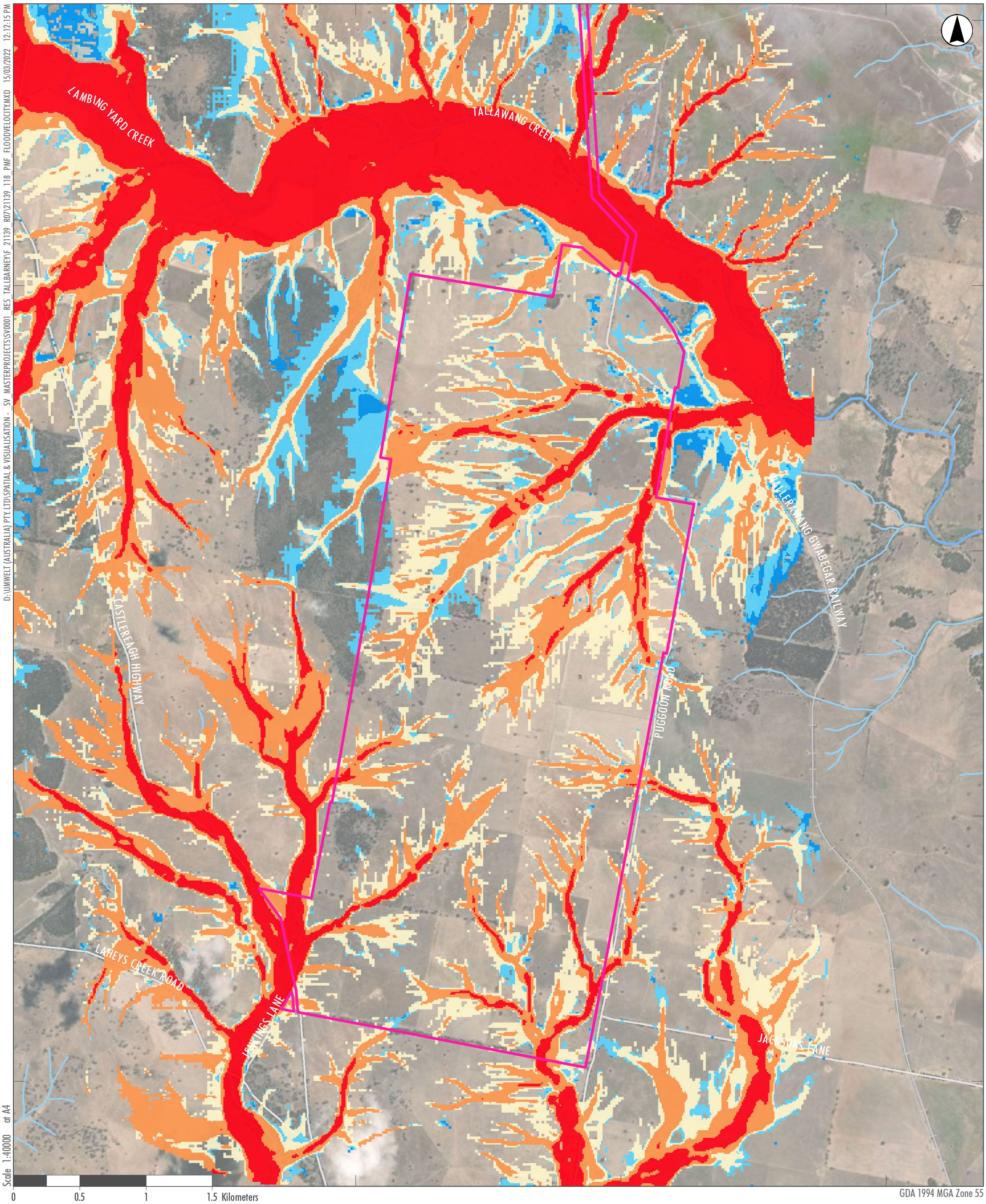
Tallawang Solar Farm Project Area
Road
Railway
Watercourse

Water Depth (m)

- < 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- > 1.0

FIGURE 5.14

PMF Flood Depth for Existing Conditions



Legend

Tallawang Solar Farm Project Area
Road
Railway
Watercourse

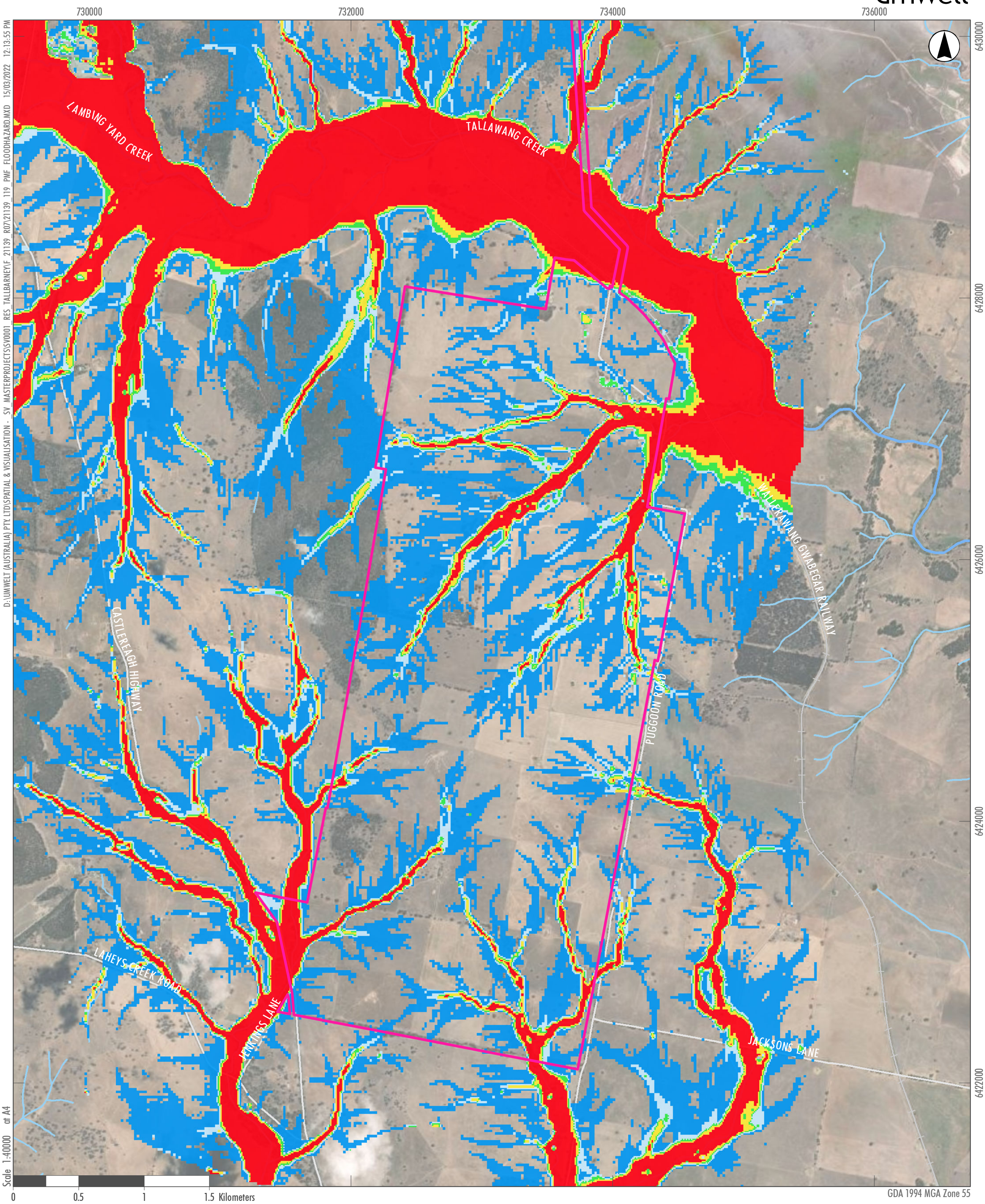
Water Velocity (m/s)

- < 0.3
- 0.3 - 0.6
- 0.6 - 1.0
- 1.0 - 2.0
- > 2.0

FIGURE 5.15

PMF Flood Velocity for Existing Conditions

Image Source: ESR Basemap Data source: RES Australia (2021), NSW DFSI (2020)



D:\UMWELT (AUSTRALIA) PTY. LTD\SPATIAL & VISUALISATION - SV_MASTERPROJECTS\SV0001_RES_TALLBARNEY\F_21139_R07\21139_119_PMF_FLOODHAZARD.MXD 15/03/2022 12:13:55 PM

Scale 1:40000 at A4

GDA 1994 MGA Zone 55

Legend

- Tallawang Solar Farm Project Area
- Road
- Railway
- Watercourse

Hazard Category

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

FIGURE 5.16

PMF Flood Hazard for Existing Conditions

5.1.6 Transmission Line

The transmission line passes through several watercourses as shown in **Figure 2.2**. The estimated 1% AEP flood depth where the transmission line crosses Tallawang Creek is approximately 4 m. The 1% AEP flood depth at the other locations along the alignment range between 0.2 and 2 m.

Should the central location for the onsite substation be adopted, the overhead transmission line will extend onto the solar farm site and will cross an additional two flow paths.

5.1.7 Substations

The flood modelling results show that both options for the location of the onsite substation (northern and central) within the Project Area are predicted to be free from flooding up to and including the 0.2% AEP flood event.

5.1.8 Site Access

The Project Area will have primary access from the Castlereagh Highway (via a local unserviced road directly south of the Project Area) and four alternate (secondary) access locations on the eastern side of the Project Area via Puggoon Road. These alternate access locations would only be utilised for stock movements and in case of emergencies.

The modelling shows that the access via Castlereagh Highway is relatively flood free making the Project compatible with the Flood Hazard of the land. Castlereagh Highway to the north of the Jenkings Lane may experience flooding during a 1% AEP event with a flooding depth of up to 0.3 m. The alternate access points off Puggoon Road are generally not inundated up to a 1% AEP event with up to 0.3m flood depths predicted at the waterway crossings.

6.0 Assessment of Potential Impacts

A risk assessment was undertaken for the Project to identify and assess the potential water resources related risks associated with the Project. The risk assessment is provided in **Appendix B** and has adopted the Risk Assessment Framework set out in *Australian Standard/New Zealand Standard (AS/NZS) ISO 31000:2018 Risk Management – Principles and Guidelines* (2018).

Based on the outcomes of the flood modelling (**Section 5.0**) and the risk assessment (**Appendix B**), the Project has the potential to impact on water resources in the following manner:

- Impacts to surface water quality on receiving and downstream waterways
- Impacts to flooding, including flow rates, velocities, and depths
- Impact on water supply
- Impacts to groundwater, including impacts to downstream users and GDEs.

6.1 Surface Water Quality

Water quality impacts are most likely to be experienced during construction (and decommissioning) with limited operational impact.

6.1.1 Construction and Decommissioning

During construction and decommissioning of the Project soils would be subject to disturbance, involving minor vegetation removal, excavation works and stockpiling of materials, which can potentially lead to sediments and/or pollutants mobilising in runoff and entering local waterways. Furthermore, this could result in the deterioration of EVs and WQOs (as outlined in **Section 2.8**), damage to private property for associated landholders as well as increased turbidity and decrease in water quality to downstream waterways. Sediments and pollutants present in runoff may enter the downstream waterways and have the potential to flow into Tallawang Creek and the tributaries which discharge to Wialdra Creek. The key factor influencing the extent of sediment runoff and storm water pollution is likely to be weather events. The occurrence of a major storm event at a critical phase of the construction period could potentially result in higher levels of turbid run-off. With the implementation of erosion and sediment control measures outlined in **Section 7.0**, potential construction related erosion and sedimentation impacts would be appropriately managed and are expected to be minor.

In addition, the potential exists for spills (such as hydraulic oil and fuels from equipment or vehicles as well as concrete spills, building materials and chemicals) to be washed into waterways. With the implementation of the control measures outlined in **Section 7.0**, potential construction related soil contamination would be appropriately managed and are expected to be minor.

During the construction phase, there may be a requirement to construct waterway crossings within the Project Area to allow for access tracks to be constructed. Detailed design will be undertaken prior to any works commencing.

With the implementation of measures outlined in **Section 7.0**, the potential water quality impacts would be adequately managed during the Project's construction and decommissioning phases.

6.1.2 Operation

Potential water quality impacts during the operational phase would be minimal, as the day-to-day activities during this phase would be limited to routine maintenance and monitoring. There is the potential for:

- Stormwater runoff from impervious surfaces such as the base of PV panels resulting in localised erosion.
- Accidental spills or discharge through use and storage of chemicals such as fuel.
- Use of herbicides for vegetation control.
- Discharges from on-site wastewater facility within the operations and maintenance facility.

With the implementation of operational management measures outlined in **Section 7.0**, water quality impacts during the operational phase are expected to be negligible.

6.2 Flooding

The 5%, 1%, 0.5% and 0.2% Annual Exceedance Probability, and Probable Maximum Flood were assessed using flood depth, velocity, and hazard levels. Modelling has shown the Project Area to be of low flood risk (**Section 5.0**) with minimal risk to changes in internal or external waterway flows (discussed in **Appendix B**). Access points to the Project Area were also predicted to be of low flood risk. Design of waterway crossings for this access point and crossings within the Project Area will be undertaken at the detailed design phase.

The results of the flood impact assessment have shown that the Project Area is located outside areas of major flood hazard. Peak stormwater discharges from the Project Area for impervious areas may increase slightly through the creation of compacted gravel roads and some small operational buildings. However, potential impacts to drainage features and downstream watercourses are considered likely to be minimal due to the relative size of the Project Area in relation to the size of the receiving catchments, and the distributed nature of minor impacts.

Minimum changes to the land topography, impervious fraction and therefore runoff and groundwater infiltration are expected due to the nature and extent of proposed infrastructure. If the above recommendations outlined in **Section 7.0** are met and a relevant set of construction and operation Management Plans (to be approved prior to construction/operation commencement) are developed, the Project is unlikely to have any major residual impacts on surface or ground water.

If there is an intent to fill or level areas of flood inundation for the construction of PV arrays and/or ancillary infrastructure, individual or collective assessments would be required. These assessments would form part of a Soil and Water Management Plan to be developed as part of the Construction Environmental Management Plan (CEMP) to be developed prior to the commencement of construction.

Farm dams covering the Project Area do not appear to hold significant volumes of water as per the 1% AEP flood depths (discussed further in **Section 4.0**), and filling them is unlikely to cause any significant adverse impacts to flood behaviour within receiving watercourses but may increase general day to day flows within receiving waterways due to a decrease in catchment storage. This would need to be considered further in the Soil and Water Management Plan to define the degree of potential impact.

Tracks and cable reticulation are the only works proposed within the watercourses and no other artificial structures are planned to be installed in the creeks within the Project Area. Where waterway crossings (i.e., culvert crossings or causeways) are required, these would be designed and constructed in compliance with the Department of Primary Industries (Office of Water) *Guidelines for riparian corridors on waterfront land* (2012) and *Guidelines for watercourse crossings on waterfront land* (2012). For the unnamed creeks in the Project Area, a setback of 40 metres to the PV panels has been adopted in the design layout to minimise potential impacts.

A chain wire fence around the perimeter of the Project area has the potential to trap and accumulate flood debris and impede flows. This may result in minor increases in water level upstream of the blockage and potential redistribution of flow at the boundary. Given the local topography and minor nature of the identified watercourses in the Project Area, any redistribution of flow though fence blockage would be localised and not provide for any significant inundation outside of the mapped flood extents. Fence maintenance and clearing of debris after each flood event will further minimise any potential impacts.

6.3 Impact on Water Supply

6.3.1 Construction and Decommissioning

The Project would require a water supply during the construction and decommissioning phases, as discussed in **Section 3.0**.

The associated water demand would likely be in the order of 206 megalitres (ML) for the 34-month construction period.

Water supply for the Project through a commercial supplier (via water trucks) has been confirmed. Water may also be sourced from farm dams or licensed groundwater bores located within the development footprint, where appropriate and available. A water sourcing strategy will be developed so that water used during the construction phase does not cause issues to adjacent landowners or other stakeholders.

The use of any farm dams during construction and decommissioning would be agreed with the landholder. The estimated maximum harvestable right dam capacity would not be exceeded.

The use of any bore water during construction and decommissioning would be agreed with the landholder and Water Access Licences (WAL) would need to be confirmed and/or obtained as discussed in **Section 3.2**. The licensed water use (if available) would not be exceeded.

Based on the above, it is anticipated that the Project's proposed water use during construction and decommission would not have a negative impact on water supply to the Project area and the region.

6.3.2 Operation

During operations, approximately 3.4 ML per year would be required for ongoing maintenance activities such as washing of the PV solar panels, amenities, and potable purposes by operational staff. The same construction water supply options will apply for the operational phase of the Project.

6.4 Groundwater Impacts

6.4.1 Construction and Decommissioning

Impacts to groundwater resources including Groundwater Dependent Ecosystems (GDEs) and bore users are not expected given the groundwater table is unlikely to be intercepted during Project construction and the relatively deep depth to groundwater at the Project Area based on available information (refer to **Sections 2.5** and **2.6**) means that any hydrocarbon/chemical spills are unlikely to infiltrate to the groundwater table.

Should the final Project design identify that construction activities will result in the interception of the groundwater table, an assessment of impacts will be undertaken, and appropriate management measures be developed to mitigate any potential impacts.

6.4.2 Operation

There will be no impacts to groundwater resources including Groundwater Dependent Ecosystems (GDEs) and bore users during operation given that the groundwater table will not be intercepted during operation.

7.0 Management and Mitigation Measures

Table 7.1 presents the proposed measures to be implemented as part of the Project to manage and minimise impacts on water resources. Refer to **Appendix B** for risk assessment.

Table 7.1 Management and Mitigation Measures relating to Water Resources

No	Management and mitigation measure	Timing
1	Solar panels will be designed to provide a minimum of 300 mm freeboard for the lowest edge above the maximum 1% AEP flood level.	Detailed design
2	The solar panel piles will be designed to withstand the 1% AEP flood velocities expected in the Project Area.	Detailed design
3	No sensitive infrastructure (e.g., substation, PCS, and BESS, etc) will be placed within 20 m of any Strahler 3 or above order streams.	Detailed design
4	All waterway crossings will be designed and constructed in compliance with the Department of Primary Industries, Office of Water, Guidelines for riparian corridors on waterfront land and Guidelines for watercourse crossings on waterfront land.	Detailed design
5	Further flood investigations and hydrological and hydraulic modelling will be carried out where required during detailed design to confirm the flood immunity objectives and design criteria for the project are met. The modelling will be used to define the nature of both mainstream flooding and major overland flow across the development footprint under pre- and post-project conditions and to define the full extent of any impact that the project will have on patterns of both mainstream flooding and major overland flow.	Detailed design
6	Water sources would be confirmed during detailed design phase and in consultation with suppliers and landholders and be subject to availability. A water sourcing strategy will be developed so that water used during the construction phase does not cause issues to adjacent landowners or other stakeholders. The use of any bore water during construction and decommissioning would be agreed with the landholder and Water Access Licences (WAL) would need to be confirmed and/or obtained.	Detail design

No	Management and mitigation measure	Timing
7	A Construction Soil and Water Management Plan (CSWMP) will be prepared to outline measures to manage soil and water impacts associated with the construction works, including contaminated land. The CSWMP will provide: • Measures to minimise/manage erosion and sediment transport both within the construction footprint and offsite including requirements for the preparation of erosion and sediment control plans (ESCP) for all progressive stages of construction, Measures to manage waste including the classification and handling of spoil. • Procedures to manage unexpected, contaminated finds. • Measures to manage stockpiles including locations, separation of waste types, sediment controls and stabilisation. • Measures to manage accidental spills including the requirement to maintain materials such as spill kits. • Controls for receiving waterways which may include: o Designation of 'no go' zones for construction plant and equipment • Creation of catch/diversion drains and sediment fences at the downstream boundary of construction activities where practicable to support containment of sediment-laden runoff Erosion and sediment control measures will be implemented and maintained at all work site in accordance with the principles and requirements in Managing Urban Stormwater - Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (NSW Department of Environment, Climate Change and Water 2008b), commonly referred to as the "Blue Book".	Prior to construction
8	Debris will be cleared from fencing following flood events.	Operation
9	An OEM will be developed for the Project to address potentially adverse impacts on the receiving environment surface water quality during the operational phase. This will include the development and appropriate maintenance of suitable ground cover around solar panels, and grassed table drains near access tracks to minimize the potential for erosion and export of sediment. Additional measures for the treatment of stormwater quality are not considered necessary.	Operation

8.0 Conclusion

This Water Resources Impact Assessment has reviewed information and data to understand the potential impacts of the Project on water resources within the Project Area. The potential impacts associated with the construction, operation and decommissioning phases can be appropriately managed through implementation of a range of conventional mitigation measures. In summary:

- The potential for discharge of sediments and the resulting impact on the receiving environment surface water quality during ground disturbance activities (construction and decommissioning) will be managed through appropriate construction management planning including best practice erosion and sediment control measures.
- Potentially adverse impacts on the receiving environment surface water quality during the operational phase will be addressed through development of an operational management plan. This will include the development and appropriate maintenance of a suitable ground cover around solar panels, and grassed table drains near access tracks to minimise the potential for erosion and export of sediment. Additional measures for the treatment of stormwater quality are not considered necessary.
- The flood risk assessment conducted in this study assessed the flood behaviour for both the existing and Climate Change conditions. The 5%, 1%, 0.5% and 0.2% Annual Exceedance Probability, and Probable Maximum Flood were assessed using flood depth, velocity, and hazard levels. The Project Area is found to be a low risk of flooding for both the existing and Climate Change conditions.
- The results of the flood impact assessment have shown that the Project Area is located outside areas of major flood hazard. Peak stormwater discharges from the Project Area for impervious areas may increase slightly. However, potential impacts to drainage features and downstream watercourses are considered likely to be minimal due to the relative size of the Project Area in relation to the size of the receiving catchments, and the distributed nature of minor impacts.
- Minimum changes to the land topography, impervious fraction and therefore runoff and groundwater infiltration are expected due to the nature and extent of proposed infrastructure. If the above recommendations outlined in **Section 7.0** are met and a relevant set of construction and operation Management Plans (to be approved prior to construction/operation commencement) are developed, the Project is not likely to have any major residual impacts on surface or ground water.
- The potential for adverse impacts on the receiving environment surface water quality from point sources such as chemical storage and on-Project Area wastewater treatment (septic tanks to service the operations and maintenance buildings) will be mitigated through design and will be operated to comply with relevant Australian Standards and local planning requirements.
- Water sources would be confirmed during detailed design phase and in consultation with suppliers and landholders and be subject to availability. A water sourcing strategy will be developed so that water used during the construction phase does not cause issues to adjacent landowners or other stakeholders. The use of any bore water during construction and decommissioning would be agreed with the landholder and Water Access Licences (WAL) would need to be confirmed and/or obtained.

No constraints were identified within the Project Area that would prevent the Project from meeting the requirements of the local and state planning requirements.

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APPENDIX A

Responses to Agency Advice

Agency Advice and where it has been addressed in the WRIA		
Water and soils		
6	The EIS must map the following features relevant to water and soils including:	
a.	Acid sulphate soils (Class 1, 2, 3 or 4 on the Acid Sulphate Soil Planning Map).	**Section 2.4.** The land is not identified as a risk area for acid sulphate soils, and it is highly unlikely they would exist at the site or be impacted by the Project.
b.	Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method).	**Sections 2.1, 4.0 and 6.0.** Mapping of the rivers and wetlands has been undertaken using hydraulic modelling.
c.	Wetlands as described in 4.2 of the Biodiversity Assessment Method.	**Sections 2.1, 4.0 and 6.0.** Mapping of the rivers and wetlands has been undertaken using hydraulic modelling.
d.	Groundwater.	**Sections 2.4 and 6.0.**
e.	Groundwater dependent ecosystems.	**Sections 2.4 and 6.4.**
f.	Proposed intake and discharge locations.	**Sections 3.2 and 6.0**
7	The EIS must describe background conditions for any water resource likely to be affected by the development, including:	
a.	Existing surface and groundwater.	**Sections 2.4, 4.0 and 6.0.**
b.	Hydrology, including volume, frequency, and quality of discharges at proposed intake and discharge locations.	**Sections 2.1 and 6.0.**
c.	Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters.	**Sections 2.4 and 6.0.**
d.	Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government.	**Sections 2.4 and 6.0.**
e.	Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions	**Sections 6.0.**
8	The EIS must assess the impacts of the development on water quality, including:	
a.	The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water proposed stormwater and wastewater management during and after construction being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction.	**Sections 4.0 and 6.0.**
b.	Identification of proposed monitoring of water quality.	**Sections 6.0.**

Agency Advice and where it has been addressed in the WRIA		
9	The EIS must assess the impact of the development on hydrology, including:	
a.	Water balance including quantity, quality, and source.	Assessment of flows from the Project Area using TUFLOW models, see **Sections 4.0 and 6.0.**
b.	Effects to downstream rivers, wetlands, estuaries, marine waters, and floodplain areas.	Assessment flows from the Project Area using TUFLOW models, see **Sections 4.0 and 6.0.**
c.	Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems.	**Section 2.7.** Please refer to Biodiversity Development Assessment Report for impacts to fauna and flora.
d.	Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g., river benches).	**Section 6.0.**
e.	Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water/	**Sections 3.0 and 6.0.**
f.	Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options.	No major stormwater and wastewater infrastructure proposed for the Project Area. See **Section 6.0** for surface water impacts.
g.	Identification of proposed monitoring of hydrological attributes.	See **Section 6.0.**
Flooding		
10	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.	**Sections 4.0 and 6.0**
b.	Flood planning area, the area below the flood planning level.	**Sections 4.0 and 6.0**
c.	Hydraulic categorization (floodways and flood storage areas).	**Sections 4.0 and 6.0**
d.	Flood hazard	**Sections 4.0 and 6.0**
11	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.	**Sections 4.0 and 6.0**
12	The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios:	**Section 6.0**
a.	Current flood behaviour for a range of design events as identified in 14 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.	**Sections 4.0 and 6.0.**

Agency Advice and where it has been addressed in the WRIA		
13	Modelling in the EIS must consider and document:	
a.	Existing council flood studies in the area and examine consistency to the flood haviour documented in these studies.	**Sections 1.4 and 6.0.**
b.	The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood, or an equivalent extreme flood.	**Sections 4.0 and 6.0.**
c.	Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of the developments or land. This may include redirection of flow, flow velocities, flood levels, hazard categories and hydraulic categories.	**Section 6.0.**
d.	Relevant provisions of the NSW Floodplain Development Manual 2005.	**Sections 4.0 and 6.0.**
14	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.	**Sections 4.0 and 6.0.**
b.	Consistency with Council floodplain risk management plans	**Sections 4.0 and 6.0.**
c.	Consistency with any Rural Floodplain Management Plans.	**Sections 4.0 and 6.0.**
d.	Compatibility with the flood hazard of the land.	**Sections 4.0 and 6.0.**
e.	Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land.	**Sections 4.0 and 6.0.**
f.	Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site.	**Sections 4.0 and 6.0.**
g.	Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses.	**Sections 4.0 and 6.0.**
h.	Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the NSW SES and Council.	**Section 6.0.**
i.	Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the NSW SES and Council.	**Section 6.0.**
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 NSW SES.	**Section 6.0.**

APPENDIX B

Risk Assessment and Mitigation Measures

B.1 Risk Assessment and Mitigation Measures

The Risk Assessment Framework set out in *Australian Standard/New Zealand Standard (AS/NZS) ISO 31000:2018 Risk Management – Principles and Guidelines (2018)* was adopted for this assessment. Criteria used to rank the likelihood and consequences of potential impacts and how they are combined to determine the level of impact are set out in **Table B1** through to **Table B3** below. Specifically, the degree of sensitivity for Environmental Values (EV) (High, Moderate or Low) is outlined in **Table B1**, while the magnitude of impacts (High, Moderate or Low is described in **Table B2**). Finally, the sensitivity and impact magnitude are combined to give five categories for the significance of impacts in **Table B3** (Major, High, Moderate, Low or Negligible). The five categories for the significance of an impact are explained below:

1. **Major** significance of impact - arises when an impact will potentially cause irreversible or widespread harm to an EV that is irreplaceable because of its uniqueness or rarity. Avoidance through appropriate design responses is the only effective mitigation.

2. **High** significance of impact - occurs when the proposed activities are likely to exacerbate threatening processes affecting the intrinsic characteristics and structural elements of the EV. While replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred to preserve its intactness or conservation status.

3. **Moderate** significance of impact - although reasonably resilient to change, the EV would be further degraded due to the scale of the impact or its susceptibility to further change. The abundance of the EV ensures it is adequately represented in the region, and that replacement, if required, is achievable.

4. **Low** significance of impact - occurs where an EV is of local importance and temporary and transient changes will not adversely affect its viability provided standard environmental management controls are implemented.

5. **Negligible** significance of impact - impact on the EV will not result in any noticeable change in its intrinsic value and hence the proposed activities will have negligible effect on its viability. This typically occurs where the activities occur in industrial or highly disturbed areas.

Mitigation measures were applied to the potential (unmitigated) impacts to identify the residual (mitigated) impacts as shown in **Table B4**.

Table B1 Description of Sensitivity Criteria

Sensitivity	Description
High	The EV is listed on a recognised or statutory state, national or international register as being of conservation significance. The EV is intact and retains its intrinsic value. The EV is unique to the environment in which it occurs. It is isolated to the affected system/area which is poorly represented in the region, territory, country, or the world. It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the EV. Project activities would have an adverse effect on the value.
Moderate	The EV is recorded as being important at a regional level and may have been nominated for listing on recognised or statutory registers. The EV is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural elements. It is relatively well represented in the systems/areas in which it occurs, but its abundance and distribution are limited by threatening processes. Threatening processes have reduced its resilience to change. Consequently, changes resulting from project activities may lead to degradation of the prescribed value. Replacement of unavoidable losses is possible due to its abundance and distribution.
Low	The EV is not listed on any recognised or statutory register. It might be recognised locally by relevant suitably qualified experts or organisations e.g., historical societies. It is in a poor to moderate condition as a result of threatening processes which have degraded its intrinsic value. It is not unique or rare and numerous representative examples exist throughout the system/area. It is abundant and widely distributed throughout the host systems/areas. There is no detectable response to change, or change does not result in further degradation of the EV. The abundance and wide distribution of the EV ensures replacement of unavoidable losses is achievable.

Table B2 Description of Magnitude Criteria

Magnitude	Description
High	An impact that is widespread, long lasting and results in substantial and possibly irreversible change to the EV. Avoidance through appropriate design responses or the implementation of Project Area-specific environmental management controls are required to address the impact.
Moderate	An impact that extends beyond the area of disturbance to the surrounding area but is contained within the region where the Project is being developed. The impacts are short term and result in changes that can be ameliorated with specific environmental management controls.
Low	A localised impact that is temporary or short term and either unlikely to be detectable or could be effectively mitigated through standard environmental management controls.

Table B3 Significance Assessment Matrix

Magnitude of Impact	Sensitivity of Environmental Value		
	High	Moderate	Low
High	Major	High	Moderate
Moderate	High	Moderate	Low
Low	Moderate	Low	Negligible

Table B4 Risk Assessment and Mitigation Measures

Potential Impacts to Surface Water	Relevant Environmental Value/s	Pre-Mitigated Impact			Mitigation Measure	Residual (Mitigated) Impact	
		Sensitivity	Magnitude	Significance		Magnitude	Significance
Discharge of sediments (both air and water-borne) from exposed ground during construction and decommissioning phases resulting in impacts on receiving environment surface water quality.	• Aquatic ecosystems • Irrigation • Farm supply • Stock watering • Visual Recreation • Cultural & Spiritual Values	**Moderate**	**Moderate**	**Moderate**	• A Construction Environmental Management Plan (CEMP) will be developed for the Project which will incorporate an Erosion and Sediment Control Plan and detail methods for minimising sediment-laden runoff and rehabilitation of disturbed areas in accordance with the International Erosion Control Association's (IECA) Best Practice Erosion and Sediment (BPESC) guidelines (IECA, 2008).	**Low**	**Low**
Soil disturbance	• Aquatic ecosystems • Primary Recreation • Secondary Recreation • Visual Recreation • Cultural & Spiritual Values	**Low**	**Moderate**	**Low**	• The Project would require minimal vegetation clearing. The area of vegetation to be cleared will be kept to a minimum determined during detailed design of the Project. • Placement of infrastructure in vegetated areas will be avoided where possible. Where clearance of vegetation is required, clearance activities would be undertaken in accordance with the Project Area-specific CEMP prior to the commencement of construction.	**Low**	**Negligible**
Discharge of stormwater from the Project Area during operational phase resulting in impacts on receiving environment surface water quality.	• Aquatic ecosystems • Irrigation • Farm supply • Stock watering • Visual Recreation • Cultural & Spiritual Values	**Low**	**Moderate**	**Low**	• Infrastructure such as inverters and battery storage will be located with a minimum 300 mm freeboard above the maximum 1% AEP flood level. It is common for this type of infrastructure to be housed within containers or small sheds with relatively small footprints. Given the shallow depths across the site, raising these small fill pads is highly unlikely to result in any adverse impacts offsite. • Operation phase mitigation measures will be guided by an operational management plan developed for the Project, which will detail methods for minimising sediment loss from the Project Area in accordance with best practice guidelines. • Stormwater runoff from the Project Area during the operational phase will be discharged diffusely across the Project Area via vegetated surfaces wherever practical. • Post-construction, disturbed areas will be stabilised by the establishment and maintenance of a vegetated groundcover consisting of low-growing grasses. A weed control program will be implemented for the Project Area to manage noxious weeds and reduce weed invasion. In order to reduce the potential impact of pesticide use, glyphosate-based products, or similar non-residual and non-persistent herbicides, will be used to manage vegetation and grazing on-the Project Area. This groundcover is expected to both significantly reduce the incidence of impact erosion as well as provide for the additional filtering of suspended solids and biological uptake of nutrients. Consequently, the likelihood that stormwater generated from the Project Area will contain levels of suspended solids significantly greater than baseline existing conditions is low. • Stormwater discharging from the Project Area post-development is anticipated to be of a quality that will not impact the surface water receiving environment, which is currently considered to be 'Moderately Disturbed' (DEHP, 2013). Specific treatment and/or detention of stormwater for the removal of sediments and gross pollutants prior to the release to the environment are not considered necessary.	**Low**	**Negligible**

Potential Impacts to Surface Water	Relevant Environmental Value/s	Pre-Mitigated Impact			Mitigation Measure	Residual (Mitigated) Impact	
		Sensitivity	Magnitude	Significance		Magnitude	Significance
Discharge of stormwater from the Project Area during operational phase resulting in adverse impacts on receiving environment surface water geomorphology (e.g., stream bank erosion and scouring) or hydroecology	• Aquatic ecosystems • Irrigation • Farm supply • Stock watering • Visual Recreation • Industrial use • Cultural & Spiritual Values	**Low**	**Moderate**	**Low**	• Project Area drainage works will aim to minimise potential impacts on the existing overland flow paths and stormwater will be discharged diffusely across the Project Area via vegetated surfaces wherever practical. Project Area drainage works will aim to minimise potential impacts on the existing overland flow paths. Waterway crossings will be built in accordance with the code for self-assessable development for waterway barrier works. • Erosion controls (e.g., rip rap) will be installed where considered necessary in accordance with BPESC Guidelines (IECA, 2008). • Although peak flows of stormwater runoff from the Project are expected to increase slightly post-development at locations where surfaces are made impervious or less pervious, these increases are not expected to impact the downstream environment for the following reasons: • A very small proportion of the catchment will be subject to development and this runoff is expected to form a very small percentage of peak flow in each receiving watercourse. • The areas to be developed are spread across the Project Area, and any increases in runoff will be dissipated across the Project Area. • Mitigation measures such as grassy buffer strips and vegetated table drains will attenuate peak flows. • Additional specific mitigation measures to control stormwater discharge from the Project Area are not considered necessary given the small volume discharged in the context of each receiving catchment. The proposed mitigation measures are considered sufficient to reduce any impacts to stream water quality and geomorphology.	**Low**	**Negligible**
Spills/leaks from chemical (e.g., fuel and oil) storage areas into surface water bodies during construction and decommissioning phases resulting in adverse impacts on receiving environment surface water quality.	• Aquatic ecosystems • Irrigation • Farm supply • Stock watering • Primary Recreation • Secondary Recreation • Visual Recreation • Cultural & Spiritual Values	**Low**	**Moderate**	**Low**	• Chemicals such as hydrocarbon materials will be stored in accordance with relevant Australian Standards to ensure that any spillages are contained.	**Low**	**Negligible**
Untreated discharges from on-Project Area wastewater during operational phase into surface water environment.	• Aquatic ecosystems • Irrigation • Farm supply • Stock watering • Primary Recreation • Secondary Recreation • Visual Recreation • Cultural & Spiritual Values	**Low**	**Moderate**	**Low**	• The operations and maintenance facility will have an on-Project Area effluent disposal system in accordance with the Mid-Western Regional Planning Scheme and relevant Australian Standards and statutory requirements. • Effluent will be removed from the Project Area and disposed in a suitable facility by a licenced operator.	**Low**	**Negligible**
Discharge of stormwater from the Project Area following the decommissioning phase resulting in impacts on receiving environment surface water quality and/or quantity	• Aquatic ecosystems • Irrigation • Farm supply • Stock watering • Visual Recreation • Cultural & Spiritual Values	**Low**	**Moderate**	**Low**	• After the Project reaches the end of its operational life, the project would either be upgraded (pending any additional approval requirements) or decommissioned. Decommissioning would involve removing all above ground project infrastructure and returning the development footprint to its pre-existing land use, or another land use in consultation with the landholders, as far as practicable. Mitigation measures are therefore not considered necessary post decommissioning.	**Low**	**Negligible**

Potential Impacts to Surface Water	Relevant Environmental Value/s	Pre-Mitigated Impact			Mitigation Measure	Residual (Mitigated) Impact	
		Sensitivity	Magnitude	Significance		Magnitude	Significance
Changes to the quantity of downstream water flows (e.g. from Diversion of surface water bodies during construction) as a result of construction of the project.	• Aquatic ecosystems • Irrigation • Farm supply • Stock watering • Primary Recreation • Secondary Recreation • Visual Recreation • Industrial use • Cultural & Spiritual Values	**Moderate**	**Moderate**	**Moderate**	• Project Area drainage works will aim to minimise potential impacts on the existing overland flow paths. Waterway crossings will be built in accordance with the code for self-assessable development for waterway barrier works. • Detailed design of project will be undertaken to minimise the need for waterway diversions as far as practical and to ensure minimal changes to downstream flows through the use of water attenuation devices (tanks/dams etc.) where increases to Area discharges are anticipated due to increases in impervious areas. • A construction management plan will be developed for the Project which will incorporate an Erosion and Sediment Control Plan and detail methods for minimising sediment-laden runoff in accordance with the International Erosion Control Association's (IECA) Best Practice Erosion and Sediment (BPESC) guidelines (IECA, 2008). • Debris will be cleared from fencing following flood events.	**Low**	**Low**

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