Environmental & Social Consultants

GOULBURN RIVER SOLAR FARM

Water Resources Impact Assessment

FINAL

April 2023

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Water Resources Impact Assessment

FINAL

Prepared by

Umwelt (Australia) Pty Limited

on behalf of

Lightsource bp

Project Director: Malinda Facey
Project Manager: Jessica Henderson Wilson
Technical Director: Darren Lyons
Technical Manager: Matilda Mathieu

Report No. 21507/R11
Date: April 2023

Environmental & Social Consultants

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

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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 chance 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 Sulfate Soils / Potential Acid Sulfate 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 approximately 799.5 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.
Involved Dwelling	Dwelling located on land owned by landholders involved in the Project.
Involved 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.
MNES	Matter of National Environmental Significance.
MW	Megawatt.

Term/Abbreviation	Definition
Non-involved dwelling	Dwelling located on land owned by landholders not involved in the Project.
Non-involved 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-involved landholders are investigated in the EIS.
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 2,000 ha.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual, it is the likelihood of consequences arising from the interaction of floods, communities, and the environment.
Runoff	The amount of rainfall which ends up as a streamflow, also known as rainfall excess.
Scour	Erosion by mechanical action of water, typically of soil.
Sensitive receiver	Non-involved dwellings in proximity to the Project Area that may be sensitive to noise, visual, traffic and other impacts. Potential impacts to sensitive receivers are investigated in the EIS.
Solar farm site	The parcels of land where the solar farm would be located, covering an area of approximately 1,370 ha.
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 Licence.
WSP	Water Sharing Plan.

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Appendices

1.0 Introduction

1.1 Project Overview

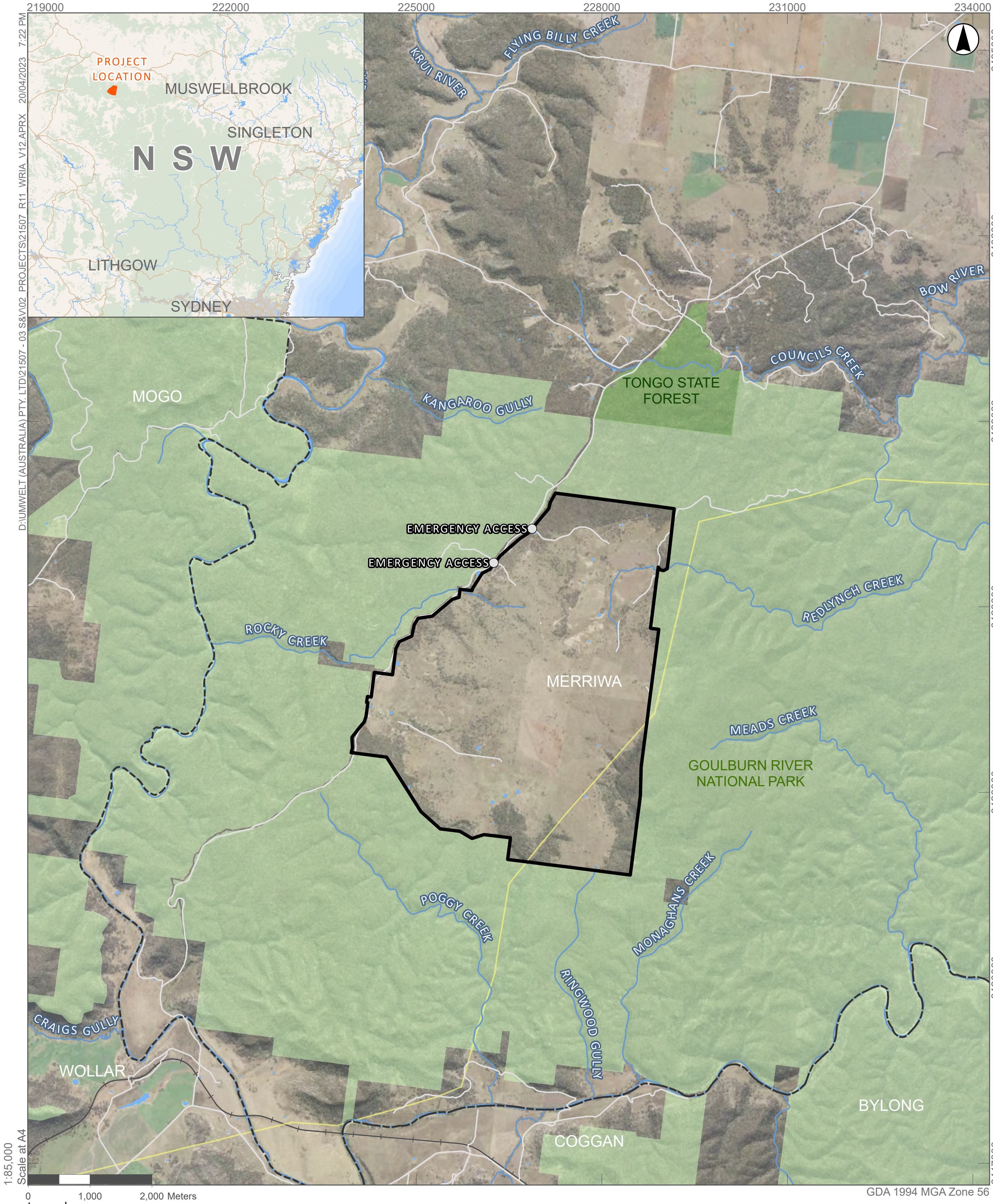
Lightsource Development Services Australia Pty Ltd (Lightsource bp) is seeking to develop the proposed Goulburn River Solar Farm in New South Wales (NSW), approximately 28 kilometres (km) southwest of Merriwa within the Upper Hunter Shire Local Government Area (LGA) (refer to **Figure 1.1**). The Goulburn River Solar Farm includes up to 550 megawatt peak (MWp) of solar electricity generation with a Battery Energy Storage System (BESS) of up to 280 MWp and 570 megawatt hours (MWh) capacity (the Project).

The Project will also include a substation and connection to an existing 500 kilovolt (kV) transmission line. The Project will include various associated infrastructure, including road repairs and upgrades to Ringwood Road, temporary construction facilities, operation and maintenance buildings, internal access roads, civil works and electrical infrastructure to connect the Project to the existing transmission line which passes through the Project Area. The conceptual layout for the Project is shown in **Figure 2.1**.

The Project Area is situated on two freehold properties and sections of Crown Land, covering an area of approximately 2,000 hectares (ha), currently primarily used for grazing and cropping activities. The Development Footprint for the Project is approximately 799.5 ha.

The Project is expected to operate for 40 years following an approximately 27-month construction period. After the initial 40-year operating period, the solar farm would either be decommissioned, removing all infrastructure and returning the site to its existing land capability, or repurposed with new equipment subject to technical feasibility and planning consents.

The Project is a State Significant Development (SSD) under the *State Environmental Planning Policy (Planning Systems) 2021* (Planning Systems SEPP) 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 NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).



Legend

- Access Points
- Electricity Transmission Line
- Watercourse
- Roads and Tracks
- Railway
- Local Goverment Boundary
- Project Area
- NSW National Parks
- NSW State Forests
- Waterbodies

FIGURE 1.1

Location and Regional Context

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

1.2 Purpose and Scope of this Report

This Water Resources Impact Assessment (WRIA) has been prepared by Umwelt in accordance with the Secretary's Environmental Assessment Requirements (SEARs) (amended on 1 February 2022) issued by the Department of Planning and Environment (DPE) and as presented in **Section 1.4**.

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

- assessments on the following:
  - flooding (including modelling for 10%, 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.

1.3 Statutory Context, Policy and Guidelines

This report has been prepared in accordance with the following guidelines and legislative requirements:

- NSW *Water Management Act 2000* (WM Act).
- NSW *Water Act 1912* (Water Act).
- Relevant Water Sharing Plans within the Project Area.
- Groundwater:
  - NSW State Groundwater Policy Framework Document and component policies (DPIE).
  - NSW Aquifer Interference Policy 2012 (DPIE).
  - National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC).
- Flooding:
  - Floodplain Development Manual (OEH).
  - Floodplain Risk Management Guideline (OEH).
  - Australian Rainfall and Runoff Guidelines 2019.

- Surface Water:
    - NSW State Rivers and Estuary Policy (DPIE Water).
    - NSW Government Water Quality and River Flow Objectives at [http://www.environment.nsw.gov.au/ieo/].
    - Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC, 2006).
    - National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ).
    - Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DECC, 2008).
    - Managing Urban Stormwater: Soils and construction (Landcom).
    - Technical Guidelines: Bunding and Spill Management (EPA).
    - NSW Guidelines for Controlled Activities (Various) (DPIE).
    - NSW Water Quality Objectives (DECCW, 2006).
    - ANZECC (2000) Guidelines for Fresh and Marine Water Quality.
    - Approved Methods for the Sampling and Analysis of Water Pollutant in NSW (DECC, 2004).
- Guidelines for Controlled Activities on Waterfront Land: There a number of guidelines for Controlled Activities under the WM Act, developed by the former NSW Office of Water (now DPE – Water).
    - *Guidelines for riparian corridors on waterfront land*.
    - *Guidelines for instream works on waterfront land*.
    - *Guidelines for vegetation management plans on waterfront land*.
    - *Guidelines for watercourse crossings on waterfront land*.
    - *Controlled Activities on Waterfront Land*: *Controlled activity exemptions on waterfront land.*

Note that there has been no specific engagement with the community or government stakeholders as part of this assessment due to the minor impacts. Broader engagement has been undertaken with the community and government stakeholders as part of the EIS.

1.4 Summary of SEARs

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 and measures proposed to monitor, reduce and mitigate these impacts;	**Section 7.0** and **Section 8.0**
details of water requirements and supply arrangements for construction and operation; and	**Section 3.5, Section 4.1, Section 7.4** and **Section 8.0**
where the project involves works within 40 metres of any river, lake or wetlands (collectively waterfront land), identify likely impacts to the waterfront land, and how the activities are to be designed and implemented in accordance with the DPI *Guidelines for Controlled Activities on Waterfront Land* (2018) and (if necessary) *Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (DPI 2003), and *Policy & Guidelines for Fish Habitat Conservation & Management* (DPE, 2013); and	**Section 3.1, Section 7.1, Section 7.2** and **Section 8.0**
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 8.0**

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

2.0 Project Description

The Project includes the construction, operation and decommissioning of a photovoltaic (PV) solar farm with a capacity of approximately 550 MWp, which will supply electricity to the national electricity grid. The Project will also include a BESS with a proposed capacity of about 570 MWh and an electrical substation to connect the solar farm to the existing 500 kV transmission line that runs through the Project Area. Road upgrades are proposed to the north of the Project Area on Ringwood Road.

Subject to the final design process, the key components of the Project include:

- Approximately 1 million bifacial solar PV modules in an east-west single-axis tracking arrangement with an average height of approximately 3.1 m at full tilt, with a maximum of 4 m in some areas due to undulating site topography.
- A BESS with an approximate 570 MWh capacity.
- Onsite 500 kV switchyard and substation, with underground electrical conduits and cabling leading into the yard and overhead lines reaching above to the existing transmission line.
- A 30 m Communications tower, providing communications, radio and cellular services to the site and the wider region.
- Perimeter and internal gravel access roads allowing for site maintenance.
- Temporary construction facilities and a site office and operations and maintenance building with parking for the operations team.
- Primary access point from existing driveway off Wollara Road, and two access points strictly for emergency access along the north-western boundary of the Project Area (**Figure 2.1**).
- Drainage line crossings, if and where required, to manage existing surface water flows.
- Perimeter security fencing around the solar modules, crossing gates, water tanks and/ or dams, and internal access points around the Project boundary.
- Ringwood Road would include a 1.8 km section to be widened and resealed between Bow River and Killoe Creek. These repairs will include 8 m bitumen-sealed formation with a minimum of 500 mm unsealed shoulders. The horizontal and vertical alignment of the proposed road will ensure safe sight distance, safe movement of longer vehicles, and an improved road network for the users.
- Culvert Upgrades: Two locations on Ringwood Road have been identified for upgrade to the water crossings at Bow River and Killoe Creek. The culvert upgrades will include:
  - installing culverts designed to accommodate B doubles and various farm machinery
  - culvert width 7 m (3.5 m lane width) sealed carriageway with suitable guardrail and signage
  - associated drainage works
  - stockpile site to be located on disturbed land within the road reserve in consultation with Upper Hunter Council
  - temporary side track at both locations to facilitate access during construction.

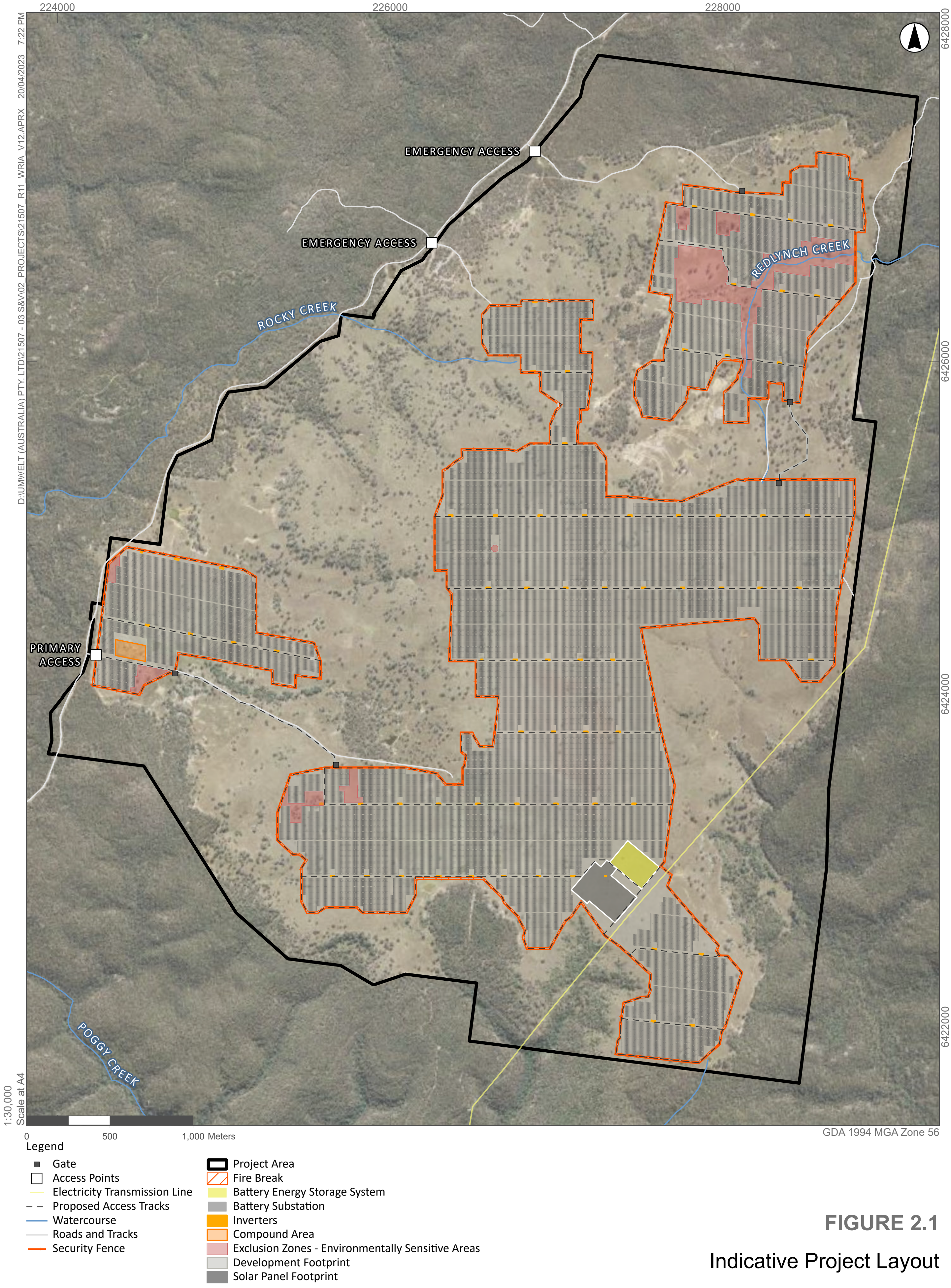


FIGURE 2.1

Indicative Project Layout

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

3.0 Existing Environment

3.1 Hydrology

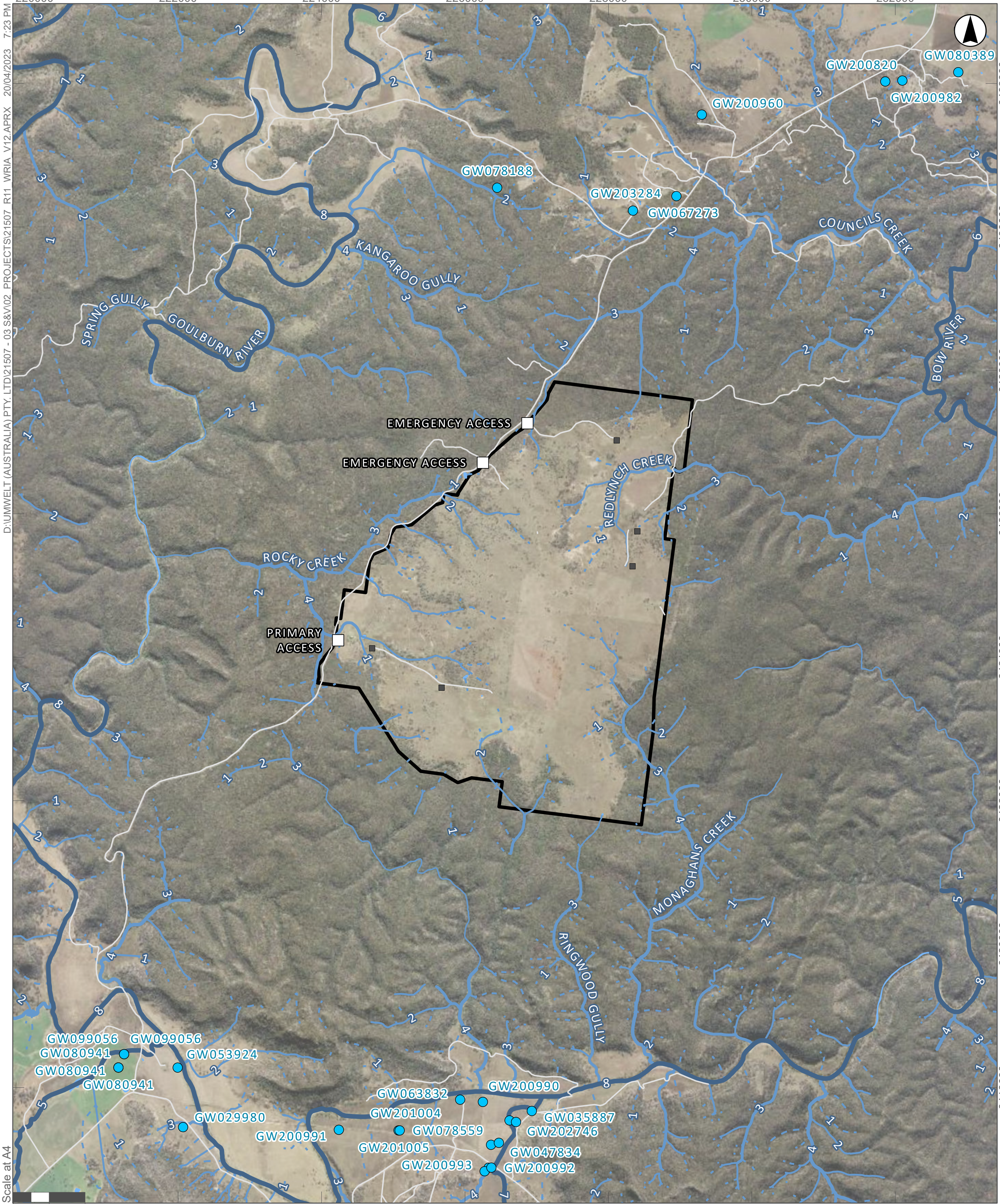
The Project Area is located within the Hunter River catchment, within the Goulburn River sub-catchment. In the surrounding area of the Project, Redlynch Creek is located to the northeast, Rocky Creek to the northwest, Poggy Creek to the southwest and Ringwood Gully to the south. Goulburn River is located approximately 3 km to the south and to the west of the Project Area (refer to **Figure 3.1**).

The topography of the Project Area varies, with the majority of the Project Area between 400 mAHD and 440 mAHD, with elevation between 350 mAHD and 390 mAHD in the north and southwest of the Project Area (refer to **Figure 5.1**). The identified watercourse alignments with their corresponding Strahler stream order are shown in **Figure 3.1**. As the Project Area is located on top of a ridge, watercourses and unnamed flow paths within the Project Area are located towards the boundary.

The majority of the watercourses in the Project Area are only 1st and 2nd order watercourses with sections of Redlynch Creek, Rocky Creek and Monaghans Creek also becoming 3rd order watercourses within the Project Area. All watercourses within the Project Area eventually flow into the Goulburn River.

There are approximately 20 to 30 small man-made farm dams present within the Project Area where water pooling occurs for extended periods, as shown in **Figure 3.1**.

The Road Upgrade Area includes two watercourses, Bow River a 6th order watercourse and Killoe Creek a 4th order watercourse. The identified watercourse alignments with their corresponding Strahler stream order are shown in **Figure 3.1a**.



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1:75,000 Scale at A4

GDA 1994 MGA Zone 56

Legend

- Gate
- Access Points
- Groundwater Bores
- Roads and Tracks
- Project Area

Strahler Stream Order

- 1
- 2
- 3
- 4
- > 5

FIGURE 3.1

Hydrological Context

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

Legend

- Groundwater Bores
- Roads and Tracks
- Watercourse
- Development Footprint
- Project Area

Strahler Stream Order

- 1
- 2
- 3
- 4
- > 5

FIGURE 3.1A

Hydrological Context in Road Repairs and Upgrades Area

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022)

3.2 Rainfall and Evaporation

The closest active Bureau of Meteorology (BoM) daily rainfall gauge to the Project Area is Barrigan St, Wollar (Gauge 062032), approximately 16 km to the southwest. The gauge is considered representative of the local region rainfall patterns.

Records from the Barrigan St, Wollar gauge cover a continuous period of over 121 years from 1901 to 2022. The recorded annual average rainfall over this period is 590 mm, with 1950 providing for the highest annual total of 1,205 mm.

The average monthly rainfall data from the Barrigan St, Wollar gauge is presented in **Figure 3.2**. The mean and median rainfalls are highest during spring/summer, with the highest monthly mean reaching 61.5 mm in January, and are lowest in May at 26.5 mm. The highest daily rainfall values indicate storm events are most likely to occur during February with peak daily totals exceeding 180 mm.

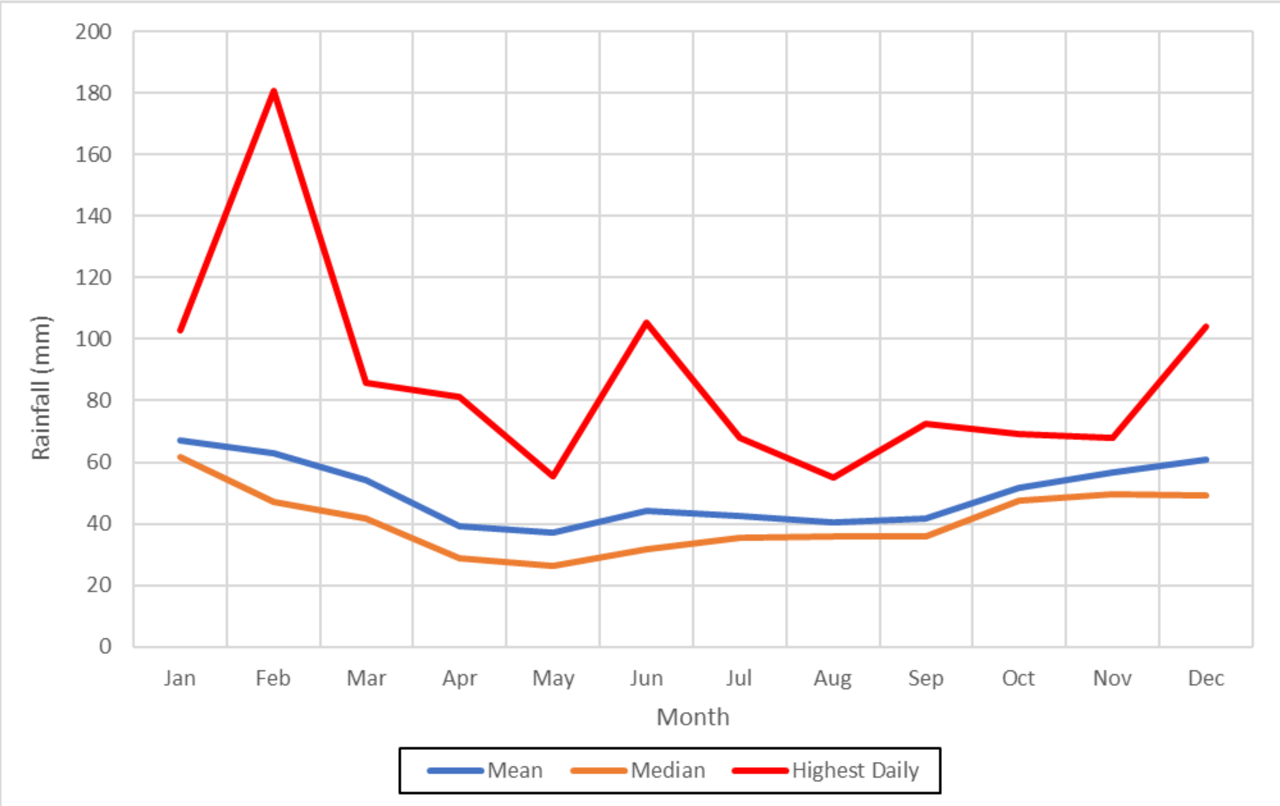


Figure 3.2 Monthly Rainfall at Barrigan St, Wollar Gauge (Gauge ID 062032)

The average annual evaporation across the Project Area is estimated to be between 1,200 and 1,600 mm/year (BoM, 2006), as shown in **Figure 3.3**.

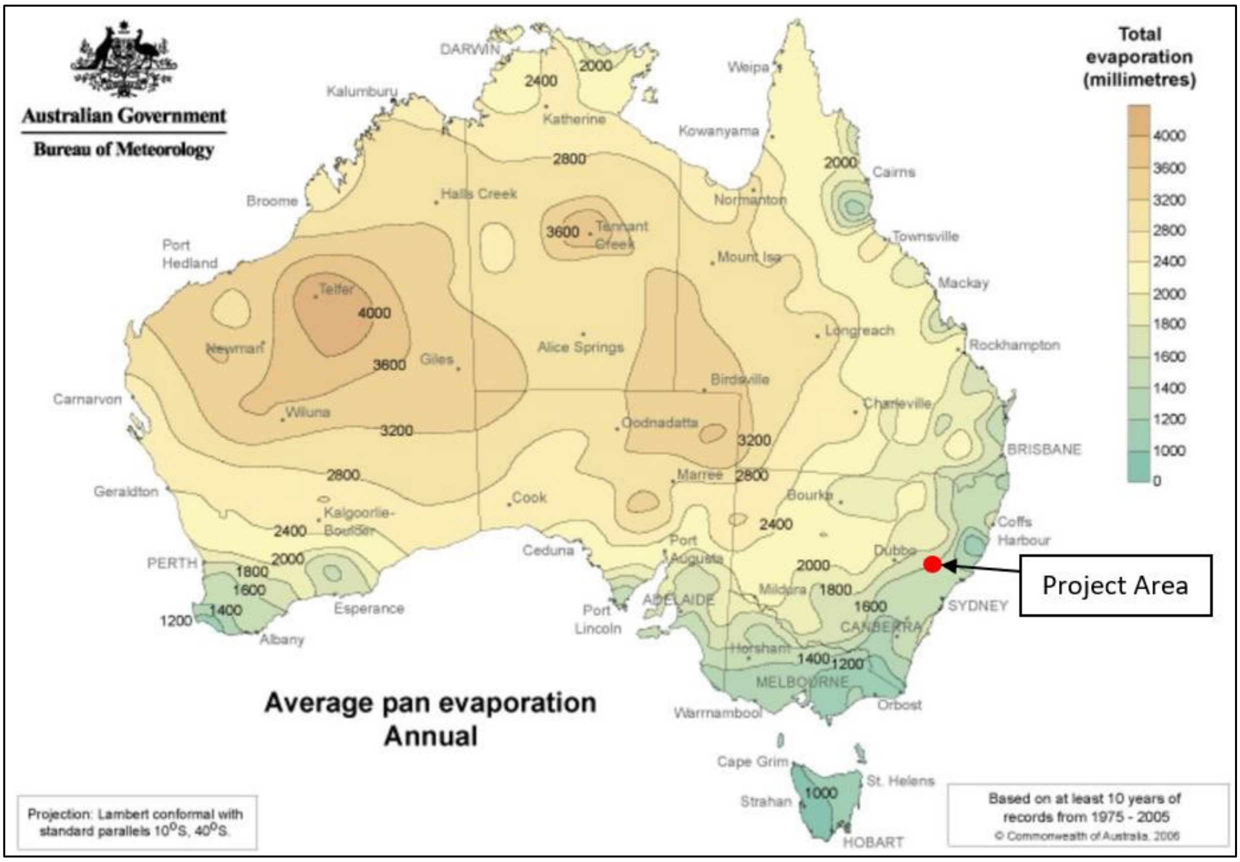


Figure 3.3 Average Annual Evaporation

3.3 Geology and Soils

The Project Area geology is generally comprised of Carboniferous granites and Cainozoic units with smaller sections 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 sulfate soils (ASS) within the Project Area (OEH, 2010).

A review of NSW DPE soil profile and soil map information website, 'eSPADE', indicated the majority of the Project Area is located within the 'Bald Hill' soil landscape described as covering low hillocks and basalt or dolerite caps and flows to the south of Merriwa. The main soils are Euchrozem – Chocolate Soil intergrades with shallow stony loams on crests (DPE, 2022). The soil landscapes across the Project Area are shown in **Figure 3.4**. Refer to the Soil, Land and Agriculture Assessment report (Umwelt, 2023) for more information on the soils, issues identified and recommended management measures.

3.4 Groundwater

Groundwater at the Project Area is managed under the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources (DPE, 2022).

Groundwater to the southwest and northwest of the Project Area, surrounding the Goulburn River is mapped in the *Upper Hunter Local Environmental Plan 2013* as 'Groundwater Vulnerability'. There is no identified groundwater vulnerability within the Project Area.

There are no WaterNSW registered groundwater bores within the Project Area. The closest groundwater bore (GW203284) is approximately 3 km northwest of the Project Area and is described as being drilled to 82 m in depth and for stock and domestic water supply purposes. The last recorded groundwater depth was 41 m below ground on 7 June 2014 (WaterNSW, 2021a). Bores approximately 4 km south of the Project Area (GW063832, GW200990, GW035887) located along the Goulburn River are either for monitoring or water supply purposes.

3.5 Water Extraction and Users

The *Water Management Act 2000* is the key piece of legislation for water resource management in NSW. Under the Act, Water Sharing Plans (WSPs) have been developed to protect the environmental health of water sources, whilst securing sustainable access to water for all users. The WSPs specify maximum water abstractions and allocations and provide licenced and unlicensed water users with a clear picture of when and how water will be available.

All water extraction in NSW, apart from some exemptions for basic landholder rights extractions and pollution control, must be authorised by a water access licence (WAL).

The Project Site is subject to the WSP for the *Hunter Unregulated and Alluvial Water Sources 2022* and the Project Site is located within the Upper Goulburn River Water Source.

Licensed surface water use in the Upper Goulburn River Water Source is primarily for agricultural (irrigation) use. The number of WALs and total share entitlement in the water source as well as the number and type of shares for the 2022/2023 year are presented in **Table 3.1**.

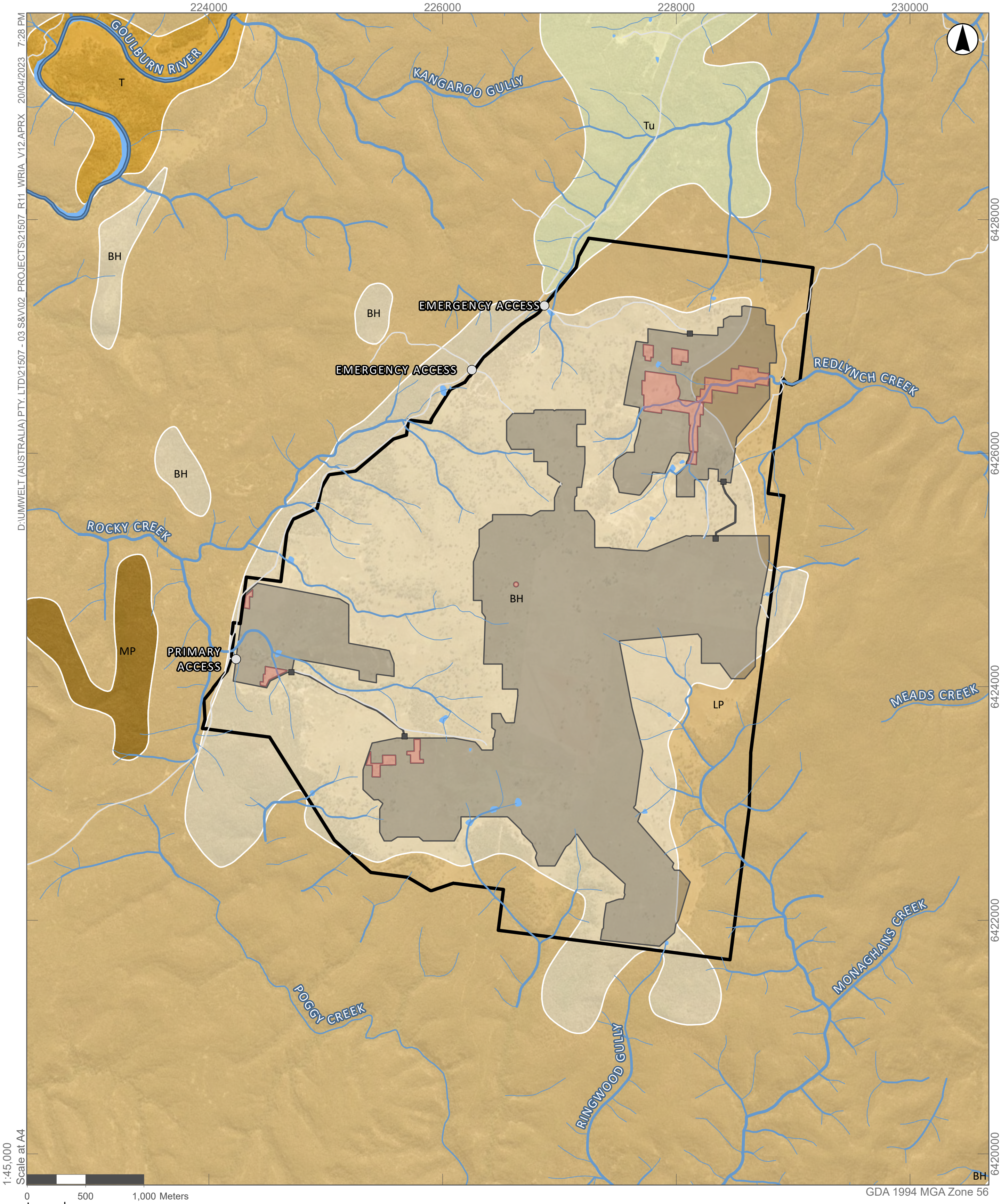
Table 3.1 Surface Water Access Licences

Number of WALs 2022/2023	Number of Shares			Total
	Aquifer	Domestic and Stock	Unregulated River	
20	102	8	1780	1890

3.6 Groundwater Dependent Ecosystems (GDEs)

The Goulburn River supports a number of identified moderate and low priority groundwater dependent ecosystems (GDEs) within the area surrounding the Project Area (DPIE, 2019), as shown on **Figure 3.5**.

Moderate potential aquatic GDEs were identified along significant reach lengths of the Goulburn River, west and south of the Project Area. Low potential terrestrial GDEs were identified within the Project Area, with some isolated small areas of medium and high potential terrestrial GDEs located well downstream of the Project Area along the natural surface water drainage paths (BoM, 2017).



Legend

- Gate
- Access Points
- Roads and Tracks
- Watercourse
- Waterbodies
- Study Area
- Exclusion Zones - Environmentally Sensitive Areas
- Disturbance Footprint

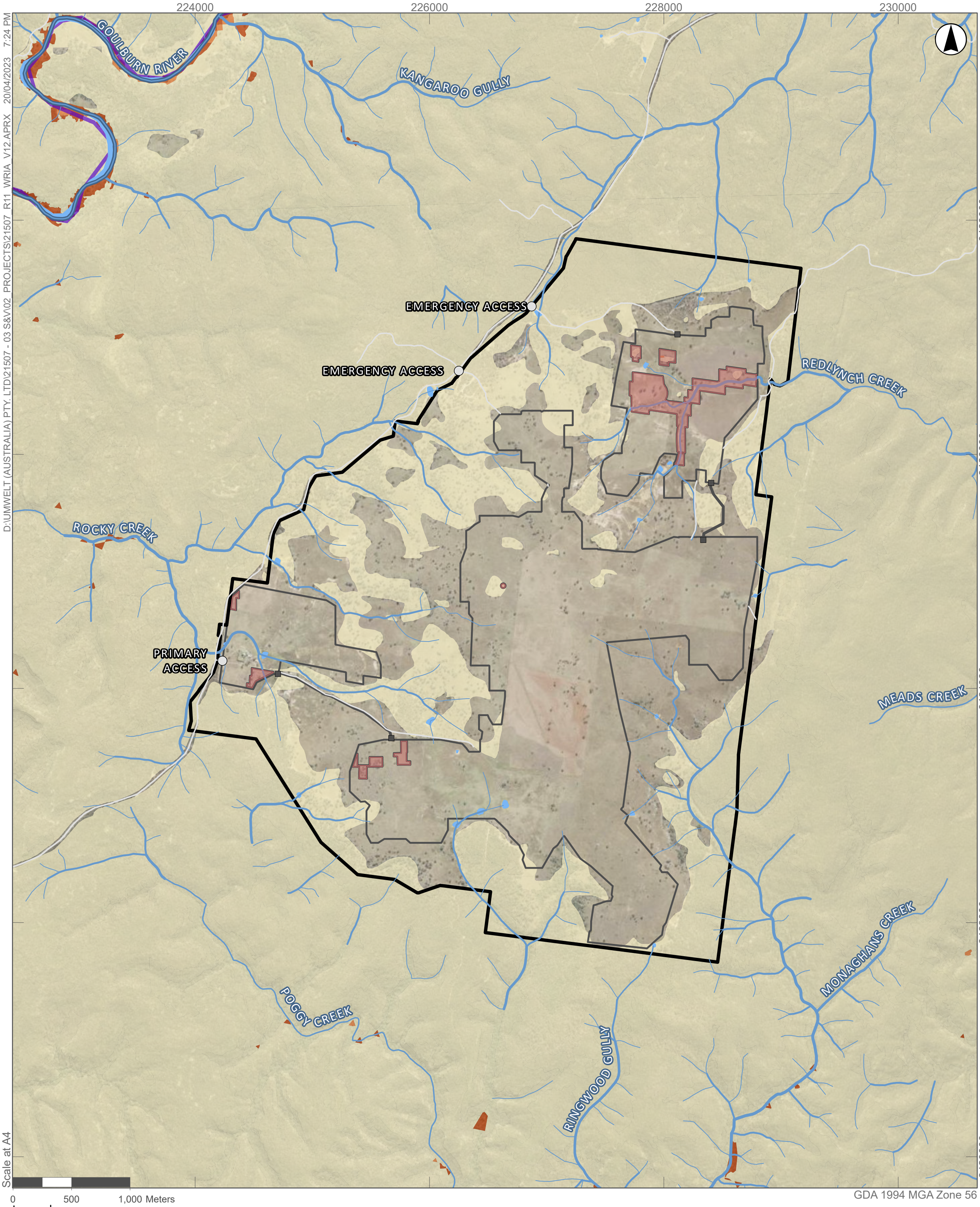
Soil Landscapes

- Bald Hill (BH)
- Lees Pinch (LP)
- Munghorn Plateau (MP)
- Talbragar (T)
- Turill (Tu)

FIGURE 3.4

Soil Landscape Mapping

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



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Legend

- Gate
- Access Points
- Roads and Tracks
- Watercourse
- Waterbodies
- Study Area
- Disturbance Footprint
- Exclusion Zones - Environmentally Sensitive Areas

Aquatic GDEs

- Moderate potential GDE - from national assessment

Terrestrial GDEs

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

FIGURE 3.5

Groundwater Dependent Ecosystems

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

3.7 Surface Water Quality, 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 Hunter River catchment have been developed to achieve suitable water quality for the protection of:

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

The River Flow Objectives for the Hunter River catchment have been developed to:

- protect pools in dry times
- protect natural low flows
- protect important rises in water levels
- maintain wetland and floodplain inundation
- maintain natural flow variability
- manage groundwater for ecosystems
- minimise effects of weirs and other structures.

Based on the likely construction activities and operations for the Project and the environmental values listed above, the water quality objectives presented in **Table 3.2** are considered relevant to the Project.

There is no relevant available water quality information for the existing environment. Often in modified environments, there is the potential for the current water quality to not meet the existing guidelines and trigger values for protecting environmental values. Irrespective of the current condition of waterways, the Project should not further degrade water quality. As such, the key objective of the Project is to minimise the potential impacts on downstream receiving waters, so that the Project changes the existing water regime by the smallest amount practicable.

Table 3.2 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.

4.0 Water Demand, Supply and Discharge

4.1 Proposed Water Supply and Use

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

During construction, non-potable water would primarily be used for plant establishment, dust suppression and site ablutions. The associated water demand for the 27-month construction period is estimated to peak at 11.26 ML/month.

During operations, non-potable water would be required for occasional maintenance activities such as washing of the PV solar panels, amenities and potable water would be required by operational staff as well as for stock. Washing of the panels would not require any detergent or cleaning agents. It is expected that this water demand would be minimal.

Potable water demands for both the construction and operational phases of the Project will be primarily sourced from rainfall stored in on-site water tanks at the O&M facility and augmented by water trucks if required. Potable water storages will be routinely tested to ensure water quality meets the requirements of the Australian Drinking Water Guidelines (ADWG) (National Health and Medical Research Council, 2011) and an appropriate maintenance regime will be implemented to ensure ADWG water quality standards are maintained.

Non-potable water demands to meet construction water demands will be sourced by purchasing and transporting water or treated wastewater to site by tanker from commercial suppliers in the nearby region. Other sources of non-potable water may include:

- Harvested runoff from farm dams under agreement with host or local landholders. These existing dams are unlikely to be licensed 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 which has been calculated for the Project Area as 130 megalitres (based on a Project Area of 2,000 ha) (WaterNSW, 2022b). No change in licensing is expected to be required, however this should be confirmed prior to construction.

- Harvested runoff from disturbed areas captured in excavations or sediment basins/traps constructed to prevent sediment transport off-site.

- Groundwater from licensed bores in the region under agreement with host or local landholders.

Water sources would be determined in consultation with suppliers and landholders and will be subject to availability. Where further licenses are needed to access water from these sources or licence amendments are required, these will be secured by Lightsource bp prior to the water being used.

All other water sourced from either surface water or groundwater sources to meet Project construction demands will be licenced and managed, as required, in accordance with the requirements of the *Water Management Act 2000*, the Water Management (General) Regulation 2018 and relevant WSPs (i.e. the *Hunter Unregulated and Alluvial Water Sources 2022*.

4.2 Discharge

No change to the natural surface waterway outlets from the Project Area is being proposed and no water discharge is proposed as part of the Project.

5.0 Flood Assessment Methodology

5.1 Modelling Approach

The hydrological assessment was undertaken in accordance with ARR2019 and with consideration of the relevant provisions of the NSW Floodplain Development Manual (2005). The mapping within 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 Upper Hunter Shire Council that cover the Project Area. The most recent floodplain risk management plan prepared within Upper Hunter Shire LGA is the Aberdeen Floodplain Risk Management Study and Draft Plan (2015). This document uses the NSW Government's Floodplain Development Manual (2005) to characterise and map flood hazard.

There are no Rural Floodplain Management Plans covering the Project Area, but the analysis and reporting is consistent with the expectations of a Rural Floodplain Management Plan.

A flood investigation was undertaken for 10%, 1%, 0.5% and 0.2% AEP events and the PMF. AEP is a measure of the likelihood a flood level or flow will be equalled or exceeded 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 finer resolution 2D TUFLOW model covering the Project Area catchment was used to determine the critical storm durations and temporal patterns. The TUFLOW model was run for the critical storms and temporal patterns determined using this resolution model.

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.

5.1.1 Design Rainfall Inputs

5.1.1.1 Event Duration

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

5.1.1.2 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 BoM as shown in **Table 5.1**. A consistent design rainfall was adopted (i.e., no spatial variation) given the size of the local catchment.

The PMP was estimated using the Generalised Short Duration Method (GSDM) (BoM, 2003).

Table 5.1 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	18.0	25.3	27.4	30.7	37.6	42.7	46.8	53.2	58.1
5	23.8	33.3	36.0	40.3	49.6	56.7	62.5	71.9	79.3
10	27.9	38.8	42.0	46.9	57.9	66.4	73.5	85.3	94.7
20	32.1	44.5	48.0	53.6	66.2	76.1	84.7	98.9	111.0
50	37.9	51.9	55.9	62.4	77.7	90.1	101.0	119.0	134.0
100	42.6	57.6	62.0	69.3	86.8	101.0	114.0	136.0	154.0
200	49.2	66.6	71.6	79.9	99.8	117.0	131.0	157.0	178.0
500	58.6	79.4	85.3	95.0	118.0	138.0	156.0	186.0	212.0

5.1.1.3 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 ARR2019 Data Hub and used to simulate the temporal distribution of burst rainfall depths during each storm duration modelled. The suite of temporal patterns has been applied to estimate the critical design event for flood estimation in accordance with ARR2019 procedures.

The GSDM temporal pattern was used for the PMP event.

5.1.2 Model Domain and Topography

The Project Area catchment was delineated using LiDAR data and is shown in **Figure 5.1**. The total modelled area is approximately 33 km^2, covering all of the Project Area catchment, and extending downstream of the Project Area boundary along the relevant watercourse alignments.

The model topography was developed from the LiDAR data available for the site. The Project Area is covered by 2 m resolution LiDAR data flown in 2017 (GA, 2017). A 4 m model grid resolution was adopted covering the Project Area. The modelled topography is shown in **Figure 5.1**.

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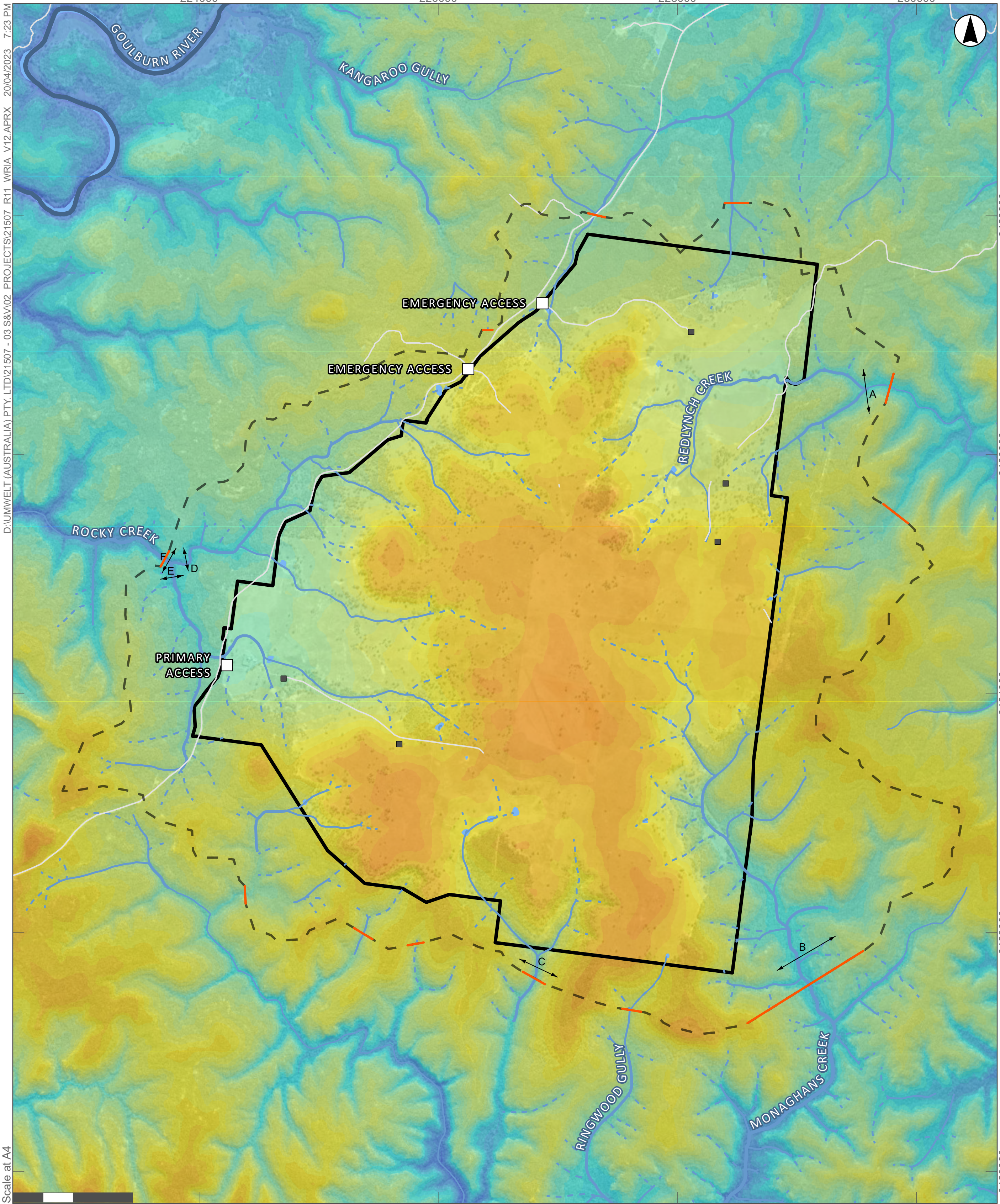

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- Gate
- Access Points
- Roads and Tracks
- Watercourse
- Model Boundaries
- RFFE Comparison Locations
- Model Extent
- Project Area

Elevation m(AHD)

- 240 - 250
- 250 - 260
- 260 - 270
- 270 - 280
- 280 - 290
- 290 - 300
- 300 - 310
- 310 - 320
- 320 - 330
- 330 - 340
- 340 - 350
- 350 - 360
- 360 - 370
- 370 - 380
- 380 - 390
- 390 - 400
- 400 - 410
- 410 - 420
- 420 - 430
- 430 - 440
- 440 - 450

FIGURE 5.1

Model Domain and Topography

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

5.1.3 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 5.2**. Most of the Project Area is minimally to moderately vegetated based on aerial photography. Initial and continuing losses were also applied as per land use and the adopted values are shown in **Table 5.3**. The values used are typical and have been used in similar studies.

Losses were initially extracted from the ARR online Data Hub. The suggested losses were a 47.0 mm initial loss (IL) and a 3.8 mm/hr continuing loss (CL). As the site is in NSW, the CL was multiplied by a factor of 0.4, reducing it to a CL value of 1.52 mm/hr.

Table 5.2 Manning's Roughness used in the Developed Hydraulic Model

Manning's 'n'	Land Use
0.15	Residential – Rural (lower density)
0.3	Industrial/Commercial or large buildings on site
0.03	Minimal vegetation
0.06	Moderate vegetation
0.09	Heavy vegetation
0.06	Open water (with reedy vegetation)
0.02	Open water (with submerged vegetation)
0.02	Car park/pavement/wide driveways/roads

Table 5.3 Losses Used in the Developed Hydraulic Model

Event	Initial Loss (mm)	Continuing Loss (mm/h)
10% AEP	8.1	1.5
1% AEP	7.8	1.5
0.5% AEP	7.8	1.5
0.2% AEP	7.8	1.5
PMF	0	1

5.2 Model Scenarios

A range of storm duration and temporal patterns (as discussed in **Section 5.1.1**) were simulated (using ARR2019 inputs) to identify the rainfall profiles providing for the critical flood conditions (design peak water levels) across the Project Area. A coarse grid (10 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 results providing the design peak water levels across the Project Area are presented in **Table 5.4**. The 1% AEP critical storms and temporal patterns were also adopted for the 10%, 0.5% and 0.2% AEP. These scenarios were modelled in the finer 4 m grid hydraulic model.

Table 5.4 Critical Storm and Temporal Patterns

Event	Critical Duration (hours)	Temporal Pattern[1]
10% AEP	0.5 hours	8
1% AEP	0.5 hours	5
0.5% AEP	0.5 hours	5
0.2% AEP	0.5 hours	5
PMF	0.25 hours	GSDM

*Note: [1] Refer to **Section 5.1.1.3**.*

5.3 Model Verification

There are no river flow gauges in the vicinity of the Project Area and therefore, in the absence of calibrated data, the modelled TUFLOW design flows were verified by comparison with those produced by the ARR Regional Flood Frequency Estimation (RFFE) method (**Table 5.5**). The RFFE Method is a replacement for the Probabilistic Rational Method described in the previous version of ARR. The RFFE flows were compared to the TUFLOW flows at a selection of sub-catchments, and all TUFLOW flows were within the RFFE Lower and Upper Confidence Limits. 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 **Section 5.1.3**) are within ranges typically applied in studies of this nature.

Table 5.5 ARR Regional Flood Frequency Estimation Model Results

Location (Refer to Figure 5.1)	AEP (%)	TUFLOW Discharge (m^3/s)	RFFE Discharge (m^3/s)	RFFE Lower Confidence Limit (5%) (m^3/s)	RFFE Upper Confidence Limit (95%) (m^3/s)
A	10% AEP	35.5	19	8.2	43.7
	1% AEP	73.0	57.1	24	137
B	10% AEP	52	23.3	10.1	53.6
	1% AEP	98.2	70.3	29.6	168
C	10% AEP	23.6	16.2	7.1	37.3
	1% AEP	43.2	49	20.6	117
D	10% AEP	49.3	21.5	9.3	49.4
	1% AEP	99.6	64.8	27.2	155
E	10% AEP	30.9	18.3	8.0	42.2
	1% AEP	72.2	55.3	23.3	132
F	10% AEP	79.8	36.1	15.7	83.1
	1% AEP	168.4	109	45.8	260

6.0 Flood Modelling Results and Discussion

6.1.1 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 50 mm have been filtered from the results.

A comparison of the 1% AEP and PMF flood inundation extents is shown on **Figure 6.1** and a suite of detailed flood mapping of the simulated depth, velocity and flood hazard distributions for all modelled events is provided in **Appendix C**. Discussion of the flood conditions for each design event is provided in the following sections as outlined below:

- 10% AEP event (refer **Section 6.1.2**)
- 1% AEP event (refer **Section 6.1.3**) – representative of the principal flood planning event
- 0.5% and 0.2% AEP events (refer **Section 6.1.4**) – representative of indicative climate change impacts
- PMF event (refer **Section 6.1.5**).

The Project Area is typically located over the upper catchments of the minor watercourses that flow through the site. This provides for the 1% AEP flood inundation to be largely confined to narrow corridors along the watercourse alignments. The PMF inundation extents provide a significantly greater land area coverage of the Project Area, however much of this is shallow overland sheet flow with low flood hazard (Hazard Category H1). The PMF event represents the largest flood conceivable that could occur at a location.

The flood hazard of the site was assessed in accordance with ARR 2019, which defines six hazard categories as presented in **Table 6.1**. The combined flood hazard curves are presented in **Figure 6.2**. The flood hazard mapping is provided in **Appendix C**.

Table 6.1 Hazard Classification (ARR, 2019)

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.

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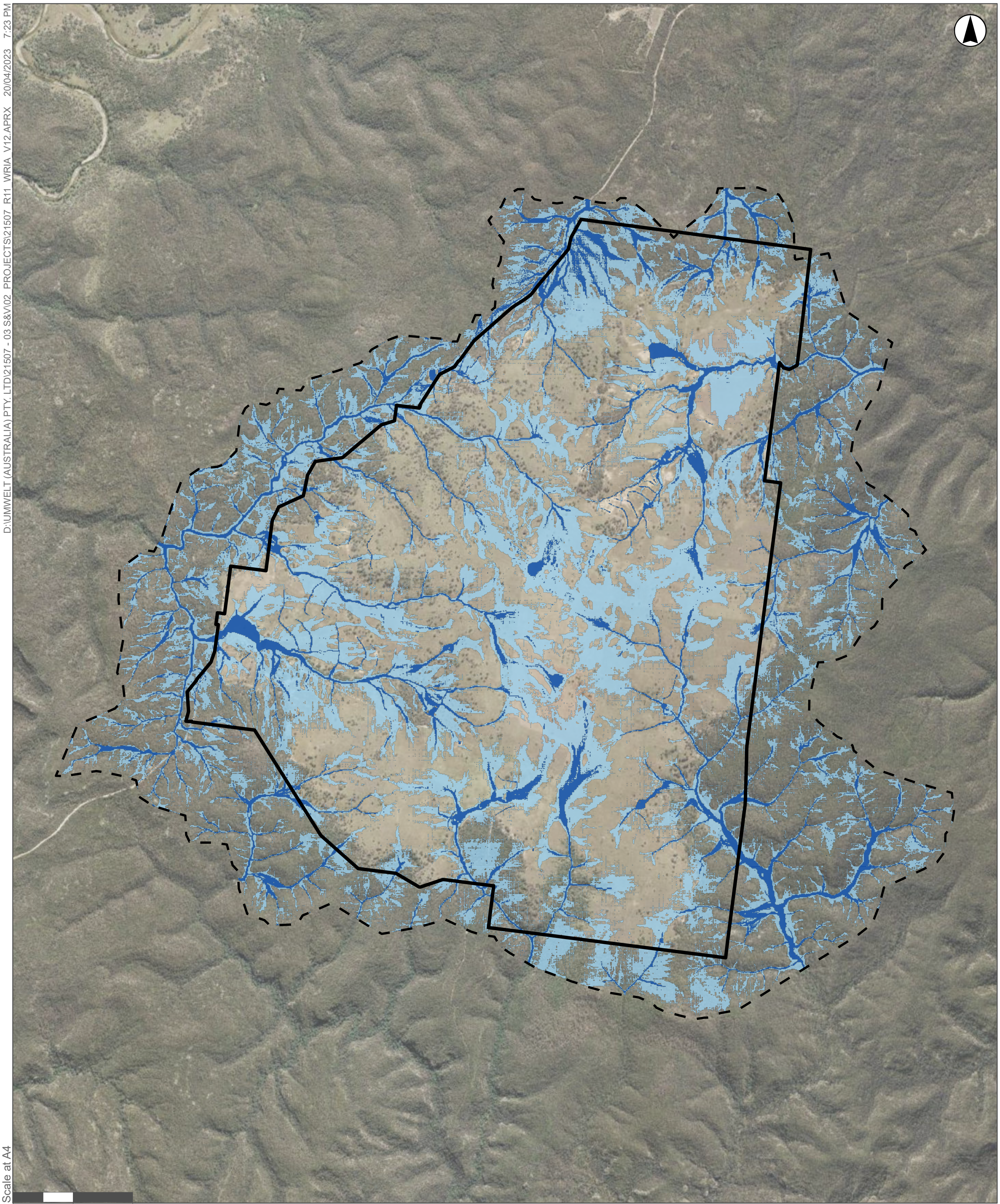

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Legend

Model Extent

Project Area

<VALUE>

PMF Flood Extent

<VALUE>

1% AEP Flood Extent

FIGURE 6.1

Flood Extents

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

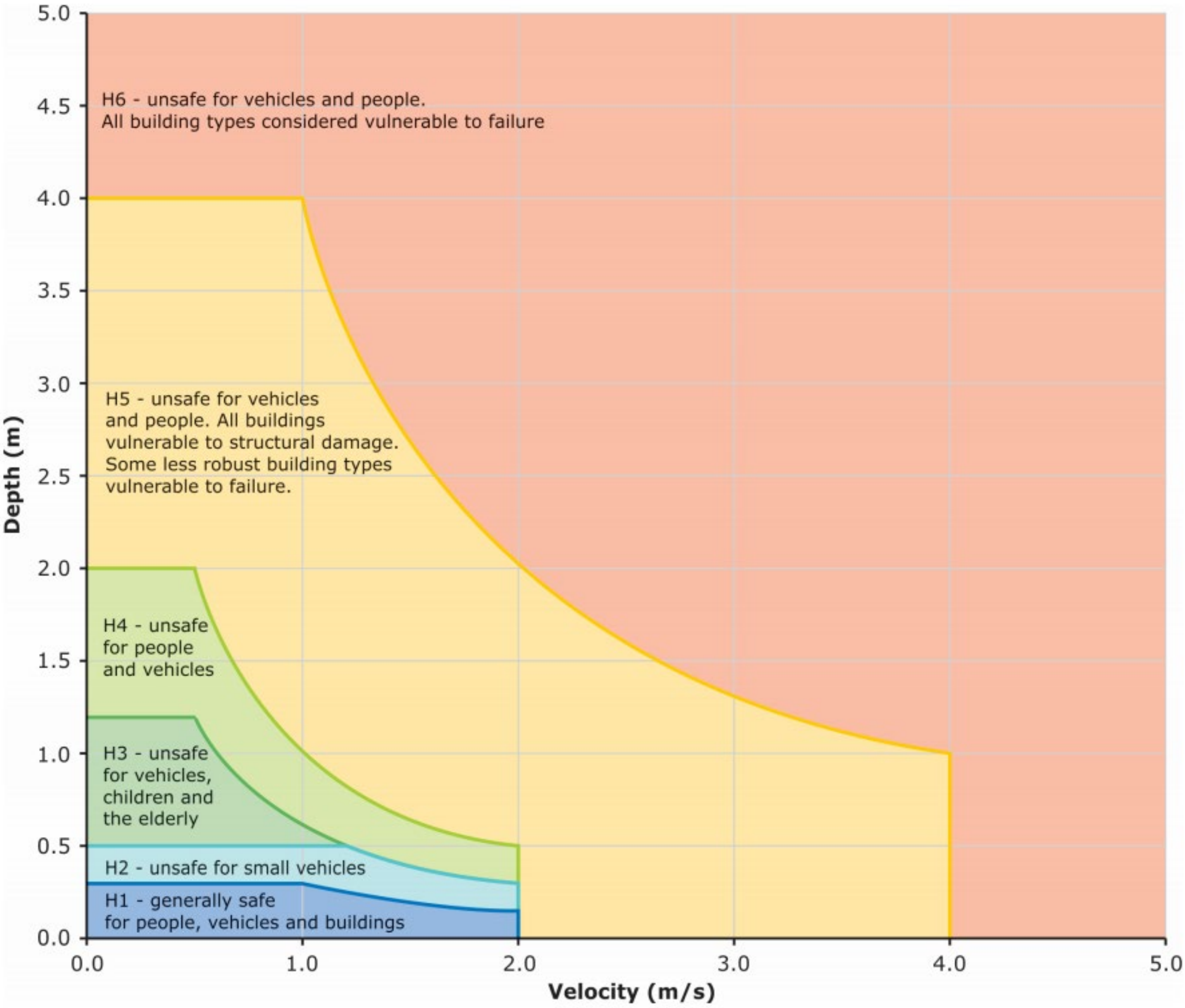

Figure 6.2 Combined Flood Hazard Curves (Smith et al. 2014)

6.1.2 10% AEP Results

Modelled 10% AEP depths, velocities and flood hazards are presented in **Appendix C**. Results show 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 1 m with some higher depths observed at farm dam locations. Higher flood depths exceeding 1 m are observed along the main channel alignment.

High velocities up to approximately 4.5 m/s are predicted within the northeast and western channels. Review of aerial imagery shows evidence of erosion and sedimentation (due to higher flow velocities and steeper areas).

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 northeastern and southern areas of the site, however these areas are well confined to the waterways and defined drainage lines (which will be avoided due to slope limitations on the PV trackers).

6.1.3 1% AEP Results

Modelled 1% AEP depths, velocities and flood hazard are in **Appendix C**. The general flood inundation patterns and extents are similar to the 10% 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 of flow along the minor watercourses within the Project Area typically up to 1 m with some localised higher depths along the reaches. A similar flood depth range is observed for farm dams. The mainstream flooding of the creek adjacent to the Project Area is still relatively confined.

High velocities up to approximately 4.5 m/s are predicted within the northeast and western channels. Review of aerial imagery shows evidence of erosion and sedimentation (due to higher flow velocities and steeper areas).

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.

6.1.4 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% and 0.2% AEP depths, velocities and flood hazards are presented in **Appendix C**.

The flood inundation patterns and extents are again generally similar to the 1% AEP design results (as discussed in **Section 6.1.3**). 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 increase in floodplain area which could hold water at high depths for extended periods of time.

6.1.5 PMF Results

Modelled PMF depths, velocities and flood hazards are presented in **Appendix C**. 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 with broader areas of overland sheet flow (up to 0.5 m depth) as a result of extreme rainfall intensity, 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 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 5.0 and 6.0 m/s. Review of aerial imagery shows evidence of erosion and sedimentation (due to higher flow velocities and steeper areas).

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 C-15** in **Appendix C**.

7.0 Assessment of Potential Impacts

Based on the outcomes of the flood modelling (**Section 6.0**) 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 stream stability, riparian health and fish passage
- impacts to flooding, including flow rates, velocities and depths
- impact on water supply
- impacts to groundwater, including impacts to downstream users and GDEs.

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).

7.1 Surface Water Quality

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

7.1.1 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 3.7**), damage to private property for involved 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 Goulburn River and the tributaries which discharge to the Hunter River. The key factor influencing the extent of sediment runoff and stormwater 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 runoff. With the implementation of erosion and sediment control measures (outlined in **Section 8.0**) 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 8.0**, potential construction-related soil contamination would be appropriately managed and is 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 would be undertaken in line with relevant guidelines prior to any works commencing.

Road upgrades are proposed to the north of the Project Area on Ringwood Road and detailed design would be undertaken in line with relevant guidelines prior to any works commencing. With the implementation of erosion and sediment control measures (outlined in **Section 8.0**), and the design of appropriate erosion and scour protection, potential construction-related erosion and sedimentation impacts would be appropriately managed and are expected to be minor.

With the implementation of measures outlined in **Section 8.0**, the potential water quality impacts would be adequately managed during the Project's construction and decommissioning phases.

7.1.2 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 (it is noted that herbicides are currently used on the site for agricultural applications).

With the implementation of operational management measures outlined in **Section 8.0**, water quality impacts during the operational phase are expected to be negligible.

7.2 Impacts on Stream Stability, Riparian Health and Fish Passage

There are a number of non-perennial and perennial streams traversing the Project Site (refer to **Figure 3.1**). While the Project design has aimed to avoid works close to or within waterways, several waterway crossings will be required for site access, internal access roads and the electrical cabling layout. Project waterway crossings will be designed to minimise impacts on stream stability and fish passage and will be designed with reference to:

- Guidelines for Controlled Activities on Waterfront Land (the CAA Guidelines) (Department of Planning, Industry and Environment (DPIE) Water, 2018).
- Why Do Fish Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Department of Primary Industries (DPI) Fisheries, 2003).
- Fisheries NSW Policy and guidelines for fish habitat conservation and management, (NSW DPI, 2013).

For works on waterfront land (within 40 m of top of bank of a defined 3rd order stream, i.e. the lower reaches of Redlynch Creek, Rocky Creek and Monaghans Creek and road upgrade works at Bow River and Killoe Creek as described in **Section 3.1**) the following measures will be incorporated into the design of the works and controls included in the Soil and Water Management Plan:

- a site specific erosion and sediment control plan will be prepared for all works on waterfront land
- where practicable, infrastructure will be maintained outside of the vegetated riparian zone

- utilisation of stream crossings for co-location of services to avoid the need to trench through stream beds wherever practicable
- rehabilitate disturbed areas and provide scour protection to bed and banks as required to mitigate any areas with increased potential for erosion due to changes in flow regimes associated with Project infrastructure
- where practicable, undertake works on waterfront land from April to mid-October when fish passage is unlikely to occur.

During detailed design, consultation will be undertaken with DPI Fisheries to determine if any of the proposed waterway crossings require consideration of fish passage. For any crossings that do require consideration of fish passage, the relevant DPI Fisheries guidelines will be considered during the detailed design process.

7.3 Flooding

The 10%, 1%, 0.5% and 0.2% AEP and PMF were assessed using flood depth, velocity, and hazard levels. Modelling has shown the Project Area to be of low flood risk (**Section 6.0**) 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 access points 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.

Minimal changes to the land topography, impervious fraction and therefore runoff and groundwater infiltration are expected due to the nature and extent of proposed infrastructure. If the recommendations outlined in **Section 8.0** 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 residual impacts on surface or groundwater.

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 6.0**), and filling them (if required) would likely have negligible 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.

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

Security fencing around the perimeter of the development footprint 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 the risk of any potential blockages is low and any inundation outside of the mapped flood extents would be minor. Fence maintenance and clearing of debris after each flood event will further minimise any potential impacts.

The proposed road repairs and culvert upgrades at Ringwood Road will be designed to accommodate B--double trucks and the safe passing of vehicles in both directions with 3.5 m lanes. Detailed design would be undertaken in line with relevant guidelines prior to any works commencing. If the upgrades are designed to minimise impacts/afflux to acceptable levels and the design of appropriate erosion and scour protection is undertaken, it is expected that any impacts as a result of the upgrades works will be negligible.

7.4 Impact on Water Supply

7.4.1 Construction and Decommissioning

The Project would require a water supply during the construction and decommissioning phases, as discussed in **Section 4.0**.

The associated water demand is estimated as 11.26 ML/month for the 27-month construction period.

Water supply for the Project is proposed to be trucked in through a commercial supplier. Farm dams may also be utilised. 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 would 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 and licensed water use would not be exceeded. Water requirements beyond existing water rights would be sourced from commercial suppliers and delivered to site by water tanker.

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

7.4.2 Operation

During operations, a minimal water demand would be required for ongoing maintenance activities such as washing of the PV solar panels, amenities, and potable purposes by operational staff as well as for stock. Potable water demands for both the construction and operational phases of the Project will be primarily sourced from rainfall stored in on-site water tanks at the O&M facility and augmented by water trucks if required.

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

7.5 Groundwater Impacts

7.5.1 Construction and Decommissioning

Impacts to groundwater resources, including GDEs, 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 **Section 3.4**, **Section 3.5** and **Section 3.6**). This 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.

7.5.2 Operation

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

7.6 Cumulative Impacts

Cumulative impacts are considered to be negligible as the Project is located in the upper reaches of the catchment (mainly 1st and 2nd order streams) and other projects do not occur in these areas.

Potential water quality impacts and erosion and sedimentation will be controlled with the implementation of measures outlined in **Section 8.0**.

8.0 Management and Mitigation Measures

Table 8.1 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 8.1 Management and Mitigation Measures relating to Water Resources

ID	Management and Mitigation Measure	Timing	Relevant Impacts
WR1	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	Flooding, Refer to **Section 7.2**.
WR2	The solar panel piles will be designed to withstand the 1% AEP flood velocities expected in the Project Area.	Detailed design	Flooding, Refer to **Section 7.2**.
WR3	No sensitive infrastructure (e.g., substation, BESS, etc.) will be placed within 20 m of any Strahler 3 or above order streams.	Detailed design	Flooding, Refer to **Section 7.2**.
WR4	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	Flooding, Refer to **Section 7.2**.
WR5	Further investigations 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	Flooding, Refer to **Section 7.2**.
WR6	A Construction Soil and Water Management Plan (CSWMP) will be prepared to outline measures to manage soil and water impacts associated with the construction and decommissioning works. 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 designation of 'no go' zones for construction plant and equipment.	Prior to construction	Surface Water Quality and Groundwater, Refer to **Section 7.1** and **Section 7.5**.

ID	Management and Mitigation Measure	Timing	Relevant Impacts
	• 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 sites 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".		
WR7	Debris will be cleared from fencing following flood events.	Operation	Flooding, Refer to **Section 7.2**.
WR8	An Operational Environmental Management Plan (OEMP) 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 minimise the potential for erosion and export of sediment. Additional measures for the treatment of stormwater quality are not considered necessary.	Operation	Surface Water Quality and Groundwater, Refer to **Section 7.1** and **Section 7.5**.
WR9	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.	Detailed Design	Water Supply, Refer to **Section 7.4**.
WR10	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.	Operation	Surface Water Quality, Refer to **Section 7.1**.
WR11	Proposed road repairs at Ringwood Road and culvert upgrades at Ringwood Road: • Appropriate scour protection will be designed for the road repairs and culvert upgrades. • The road and culvert upgrades will be designed to minimise afflux to an acceptable level. • The culverts will be designed to accommodate a 5% AEP event. • Culverts to be constructed at existing invert levels or similar to maintain existing low flow conveyance in channel.	Detailed Design / Construction.	Surface Water Quality and Flooding, Refer **Section 7.1 and Section 7.2**.

9.0 Conclusion

This WRIA 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) can be adequately 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 OEMP. This will include the development and appropriate maintenance of a suitable ground cover underneath and 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 10%, 1%, 0.5% and 0.2% AEP and PMF were assessed using flood depth, velocity, and hazard levels. The Project Area was found to present 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.
- High velocities were predicted within the northeast and western channels. Review of aerial imagery shows evidence of erosion and sedimentation (due to higher flow velocities and steeper areas). It is recommended the erosion on site is further investigated (including site investigation) and remediation undertaken if deemed necessary prior to construction. These areas will be avoided.
- 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 recommendations outlined in **Section 8.0** 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 likely to have nil to minor 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 will be mitigated through design and will be operated to comply with relevant Australian Standards and local planning requirements.

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		
5	The EIS must map the following features relevant to water and soils including:	
a.	Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map).	**Section 3.3**. 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).	**Section 3.1**, **Section 5.0** and **Section 7.0**. Mapping of the rivers and wetlands has been undertaken using hydraulic modelling.
c.	Wetlands as described in s4.2 of the Biodiversity Assessment Method.	**Section 3.1**, **Section 5.0** and **Section 7.0**. Mapping of the rivers and wetlands has been undertaken using hydraulic modelling.
d.	Groundwater.	**Section 3.4** and **Section 7.0.**
e.	Groundwater dependent ecosystems.	**Section 3.6** and **Section 7.0.**
f.	Proposed intake and discharge locations.	**Section 4.1** and **Section 7.0.**
6	The EIS must describe background conditions for any water resource likely to be affected by the development, including:	
a.	Existing surface and groundwater.	**Section 2.0**, **Section 5.0** and **Section 7.0**.
b.	Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations.	**Section 2.0** and **Section 7.0**.
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.	**Section 3.7** and **Section 7.0**.
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.	**Section 3.7** and **Section 7.0**.
7	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 Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction.	**Section 5.0** and **Section 7.0**.
b.	Identification of proposed monitoring of water quality.	**Section 7.0**.

Agency Advice and Where it has Been Addressed in the WRIA		
8	The EIS must assess the impact of the development on hydrology, including:	
a.	Water balance including quantity, quality and source.	Proposed water supply is discussed in **Section 4.0**. Detailed water balance modelling was not undertaken as water demands are expected to be minimal during construction, operation and decommissioning. Assessment of flows from the Project Area using TUFLOW models, see **Section 5.0** and **Section 7.0**.
b.	Effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas.	Assessment flows from the Project Area using TUFLOW models, see **Section 5.0** and **Section 7.0**.
c.	Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems.	**Section 3.6**. 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 7.0**.
e.	Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water.	**Section 4.0** and **Section 7.0**.
f.	Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and reuse options.	No major stormwater and wastewater infrastructure proposed for the Project Area. See **Section 7.0** for surface water impacts.
g.	Identification of proposed monitoring of hydrological attributes.	See **Section 7.0**.
Flooding		
9	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.	**Section 5.0** and **Section 7.0**.
b.	Flood planning area, the area below the flood planning level.	**Section 5.0** and **Section 7.0**.
c.	Hydraulic categorisation (floodways and flood storage areas).	**Section 5.0** and **Section 7.0**.
10	The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event.	**Section 5.0** and **Section 7.0**.
11	The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios:	**Section 5.0** and **Section 7.0**.

Agency Advice and Where it has Been Addressed in the WRIA		
a.	Current flood behaviour for a range of design events as identified in 11 above. This includes the 1 in 200 and 1 in 500 year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.	**Section 5.0** and **Section 7.0**.
12	Modelling in the EIS must consider and document:	
a.	The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood.	**Section 5.0** and **Section 7.0**.
b.	Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazards and hydraulic categories.	**Section 5.0** and **Section 7.0**.
c.	Relevant provisions of the NSW Floodplain Development Manual 2005.	**Section 5.0** and **Section 7.0**.
13	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.	**Section 5.0** and **Section 7.0**.
b.	Consistency with Council floodplain risk management plans.	**Section 5.0** and **Section 7.0**.
c.	Compatibility with the flood hazard of the land.	**Section 5.0** and **Section 7.0**.
d.	Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land.	**Section 5.0** and **Section 7.0**.
e.	Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site.	**Section 5.0** and **Section 7.0**.
f.	Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	**Section 5.0** and **Section 7.0**.
g.	Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the SES and Council.	**Section 5.0** and **Section 7.0**.
h.	Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and Council.	**Section 5.0** and **Section 7.0**.
i.	Emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the SES.	**Section 5.0** and **Section 7.0**.
j.	Any impacts the development may have on the social and economic costs to the community as consequence of flooding.	**Section 5.0** and **Section 7.0**.

APPENDIX B

Risk Assessment and Mitigation Measures

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:

- **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.
- **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.
- **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.
- **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.
- **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 Soil and Water Management Plan (CSWMP) will be prepared to outline measures to manage soil and water impacts associated with the construction works and decommissioning. 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 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 sites 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".	Low	Low
Soil disturbance	• Aquatic ecosystems • Primary Recreation • Secondary Recreation • Visual Recreation • Cultural & Spiritual Values.	**Low**	**Moderate**	**Low**	• The area of vegetation to be cleared will be kept to a minimum and 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 CSWMP 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.	Low	Negligible

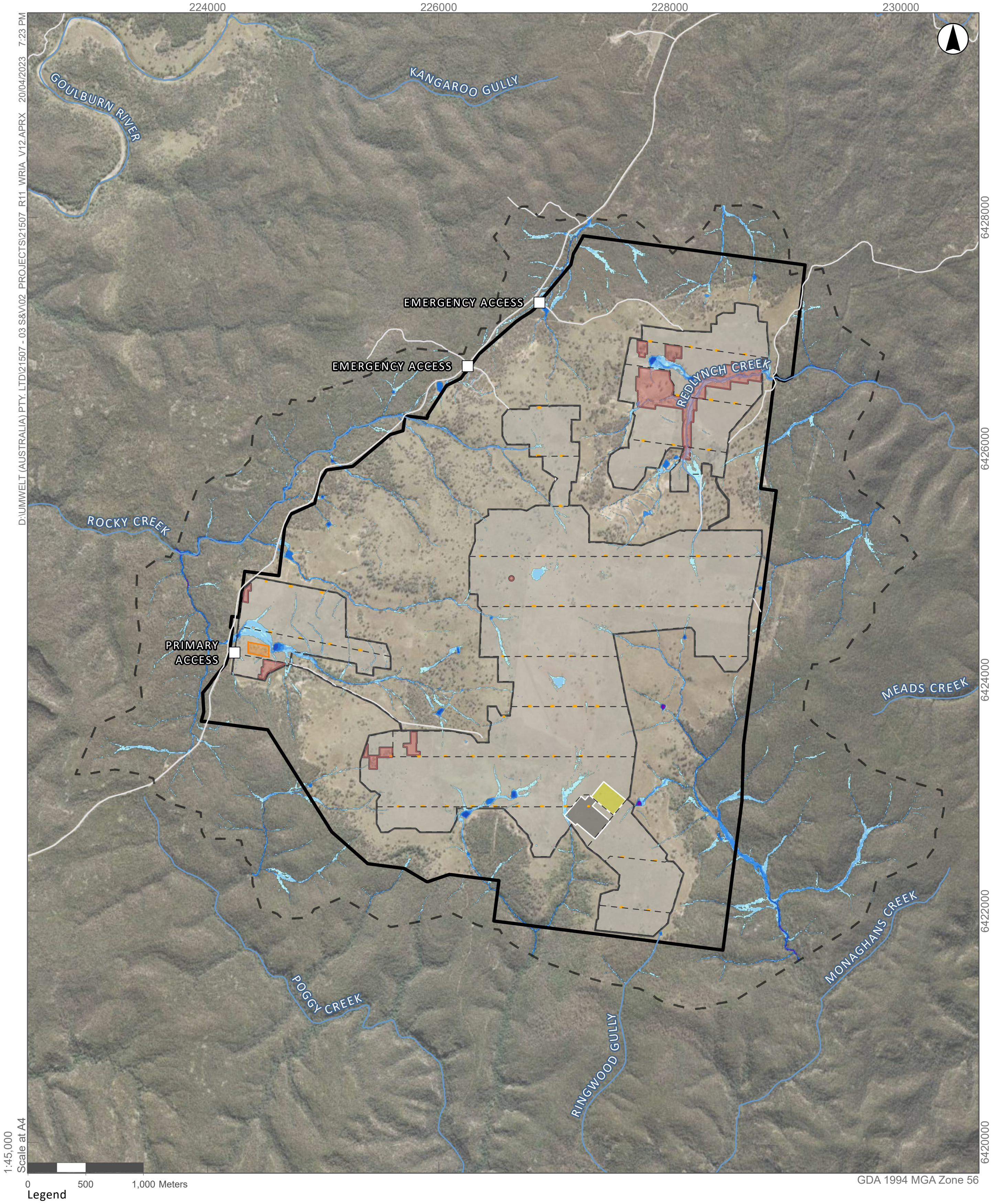
Potential Impacts to Surface Water	Relevant Environmental Value/s	Pre-Mitigated Impact			Mitigation Measure	Residual (Mitigated) Impact	
		Sensitivity	Magnitude	Significance		Magnitude	Significance
					• Post-construction, disturbed areas will be stabilised by the establishment and maintenance of a 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. 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.		

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.
					• Debris will be cleared from fencing following flood events.
					• Erosion controls (e.g., rip rap, i.e. rock protection) 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.
					• The proposed road repairs and culvert upgrades at Ringwood Road will be designed to minimise afflux and appropriate scour protection will be designed to minimise erosion and scour.
						Low	Negligible

Potential Impacts to Surface Water	Relevant Environmental Value/s	Pre-Mitigated Impact			Mitigation Measure	Residual (Mitigated) Impact	
		Sensitivity	Magnitude	Significance		Magnitude	Significance
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**	• Effluent will be removed from the Project Area and disposed in a suitable facility by a licensed 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 project infrastructure and returning the development footprint to its pre-existing land use, as far as practicable. Mitigation measures are therefore not considered necessary post decommissioning.	Low	Negligible
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. • The proposed road repairs and culvert upgrades at Ringwood Road will be designed to minimise afflux. • 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

APPENDIX C

Flood Mapping



Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Compound Area
- Solar Panel Footprint

Water Depth (m)

- 0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

APPENDIX C.1

10% AEP Flood Depth for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

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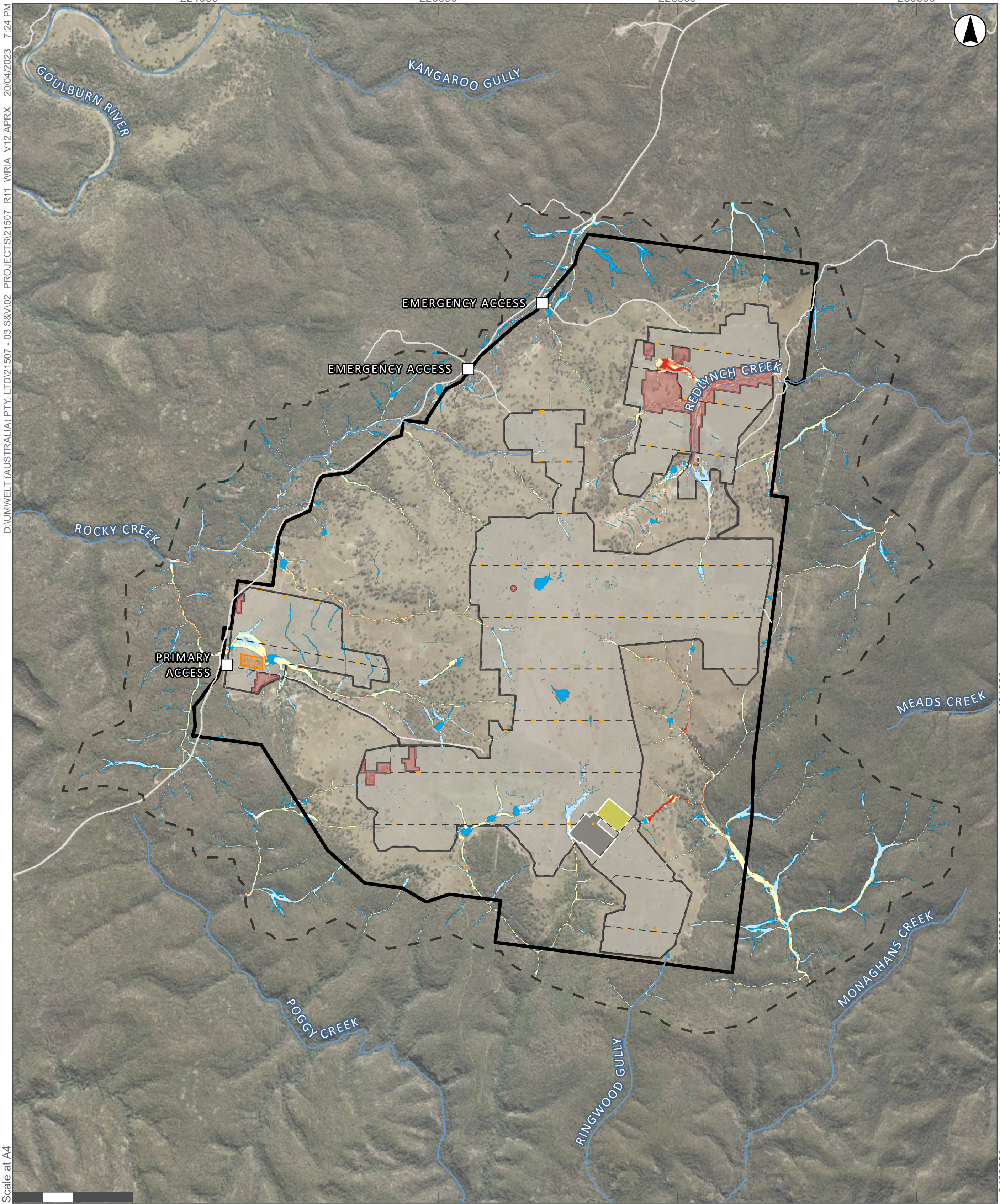

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Scale at A4
1:45,000

GDA 1994 MGA Zone 56

Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Compound Area
- Solar Panel Footprint

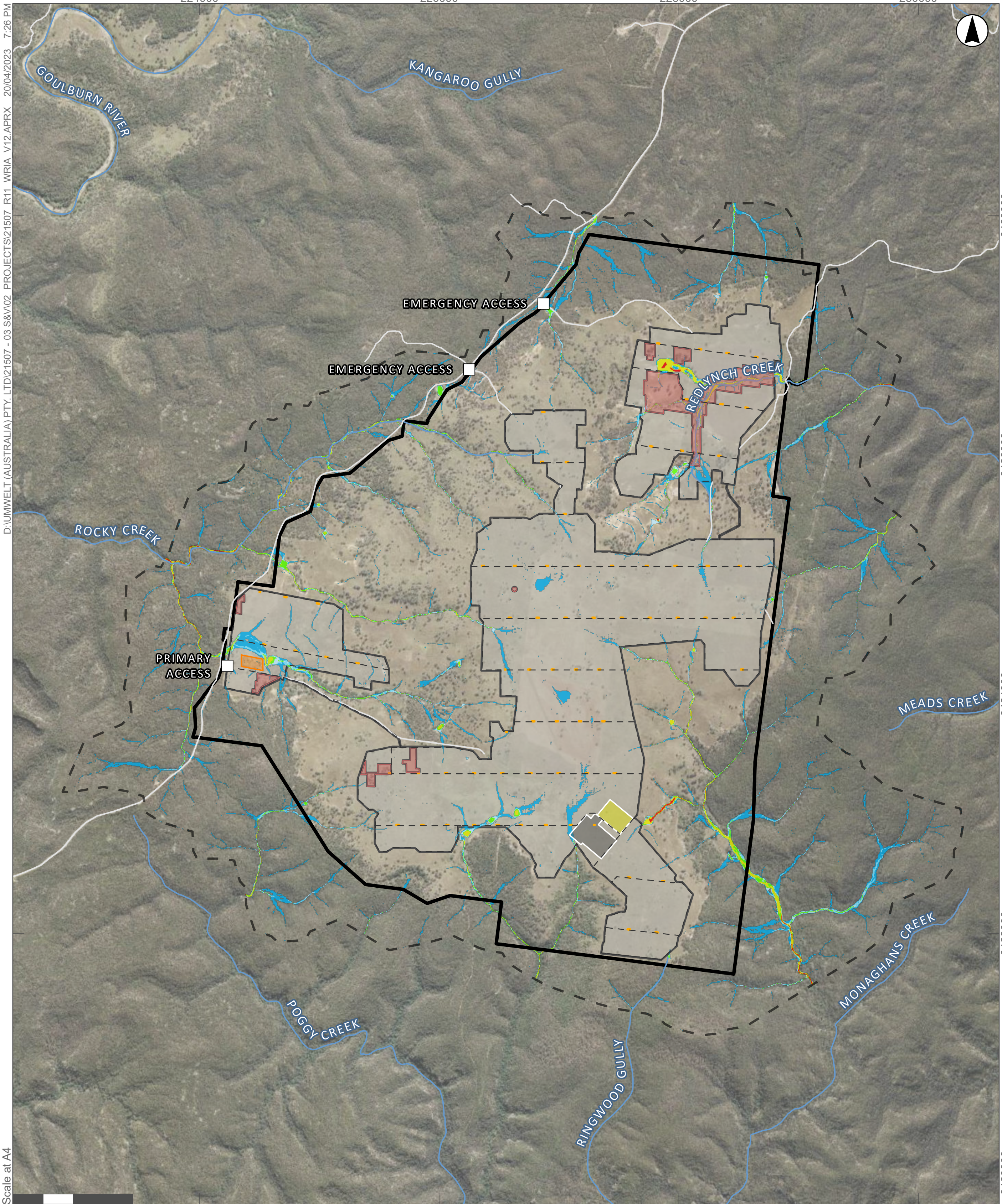
Water Velocity (m/s)

- < 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- > 3.0

APPENDIX C.2

10 % AEP Flood Velocity for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



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1:45,000 Scale at A4

Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint
- Compound Area

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Solar Panel Footprint

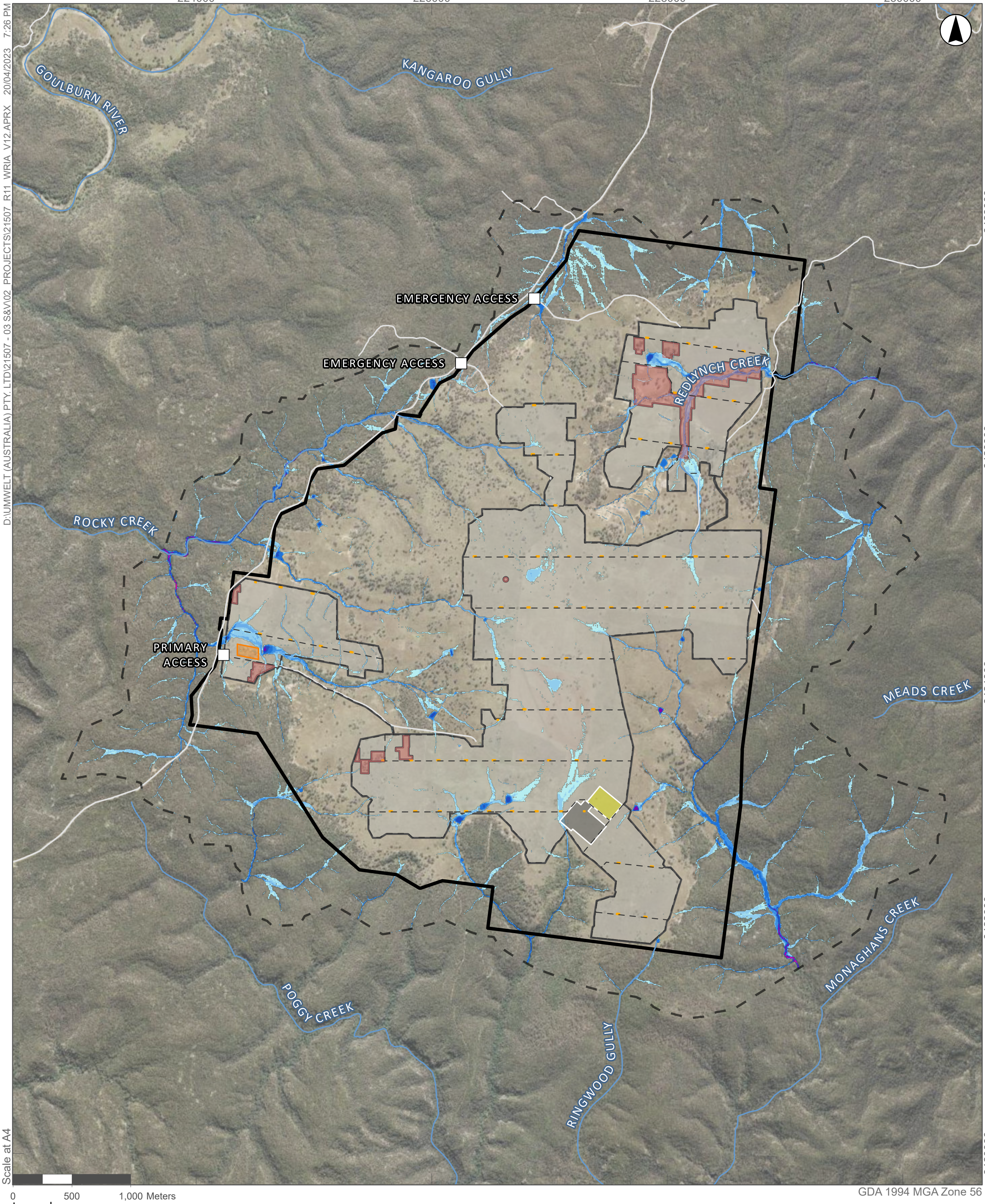
Hazard Category

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

APPENDIX C.3

10% AEP Flood Hazard for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint
- Compound Area

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Solar Panel Footprint

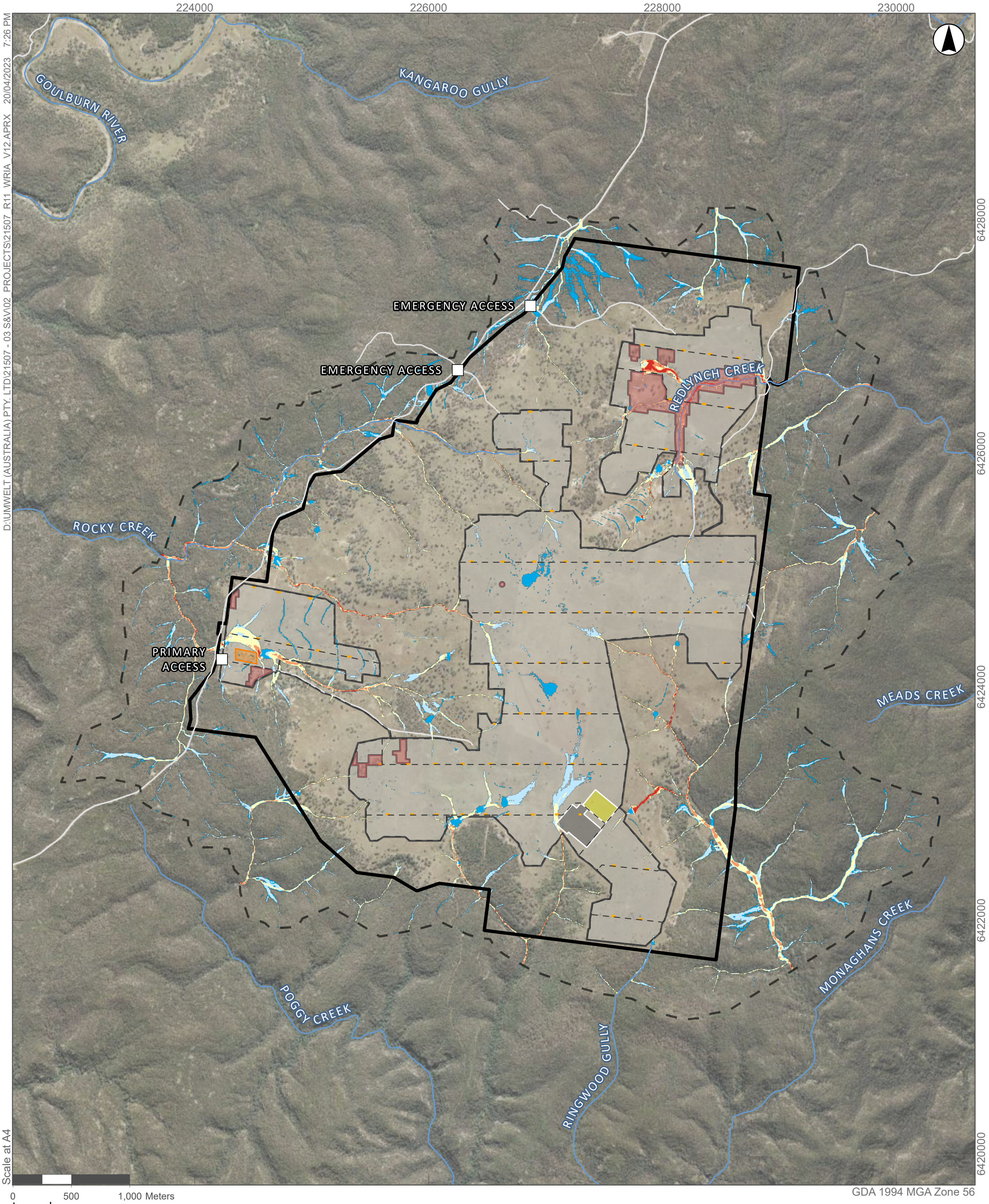
Water Depth (m)

- < 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4.0

APPENDIX C.4

1% AEP Flood Depth for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



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1:45,000 Scale at A4

Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint
- Compound Area

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Solar Panel Footprint

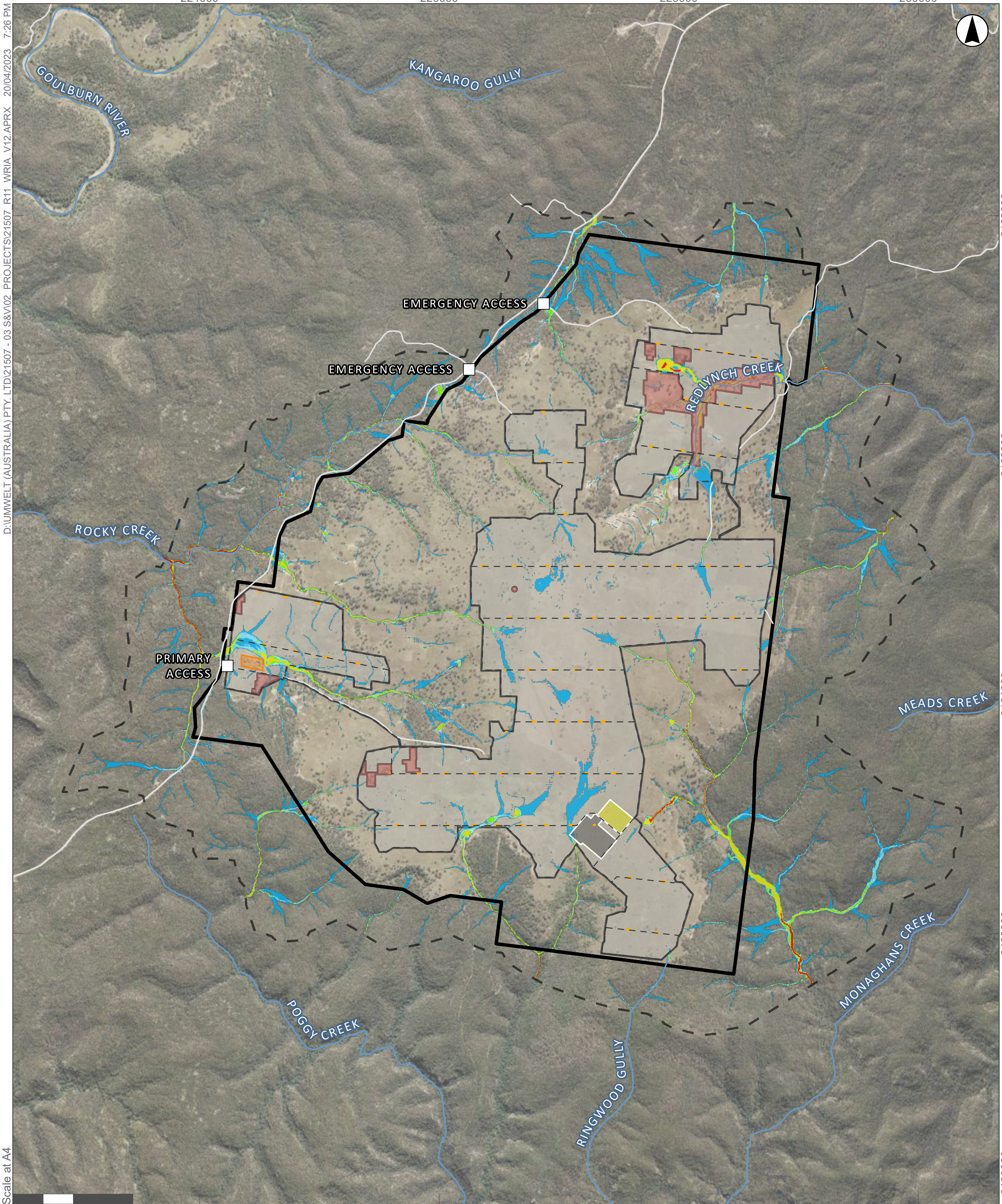
Water Velocity (m/s)

- < 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- > 3.0

APPENDIX C.5

1% AEP Flood Velocity for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint
- Compound Area

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Solar Panel Footprint

Hazard Category

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

APPENDIX C.6

1% AEP Flood Hazard for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

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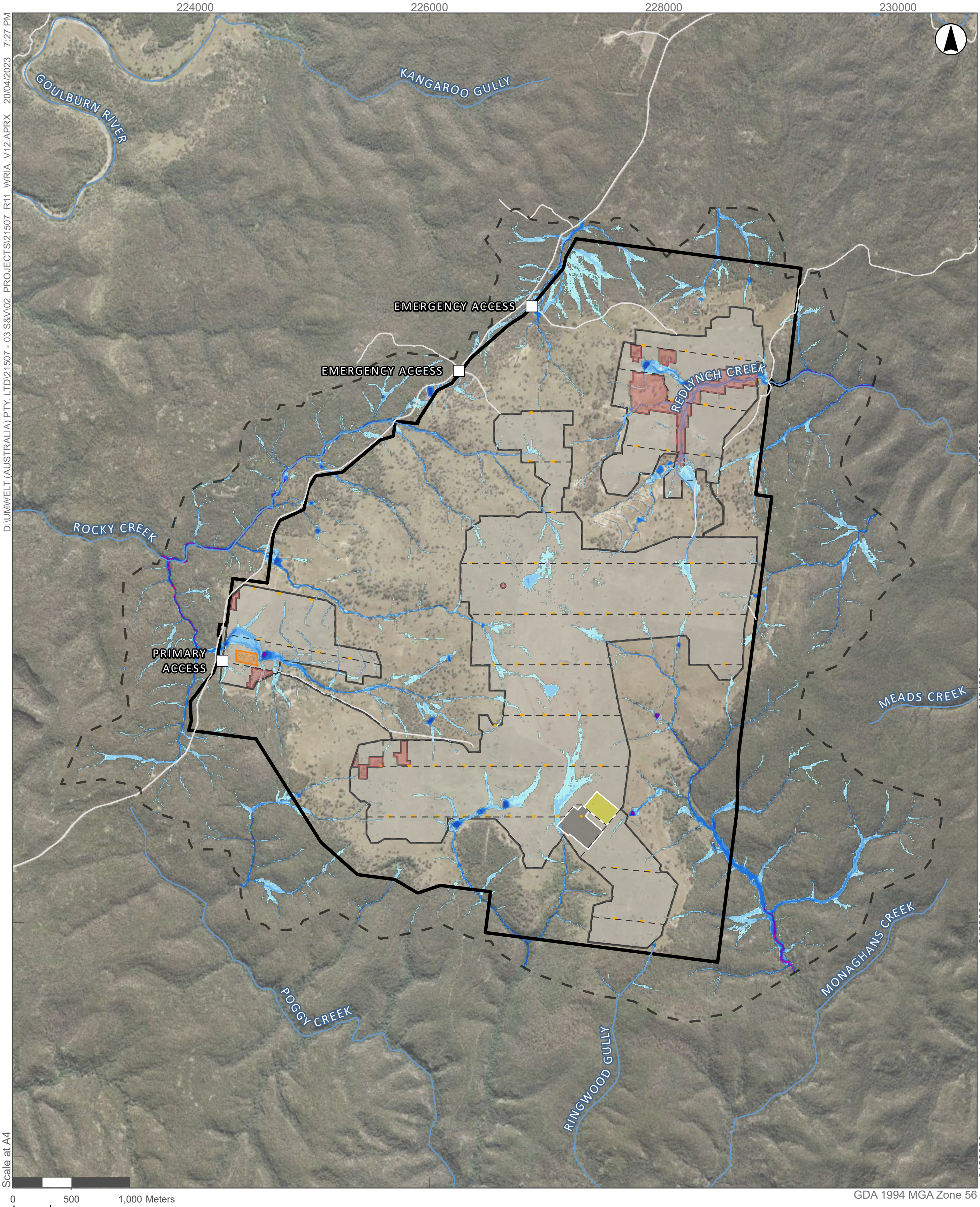


Scale at A4 1:45,000

GDA 1994 MGA Zone 56

Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint
- Compound Area

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Solar Panel Footprint

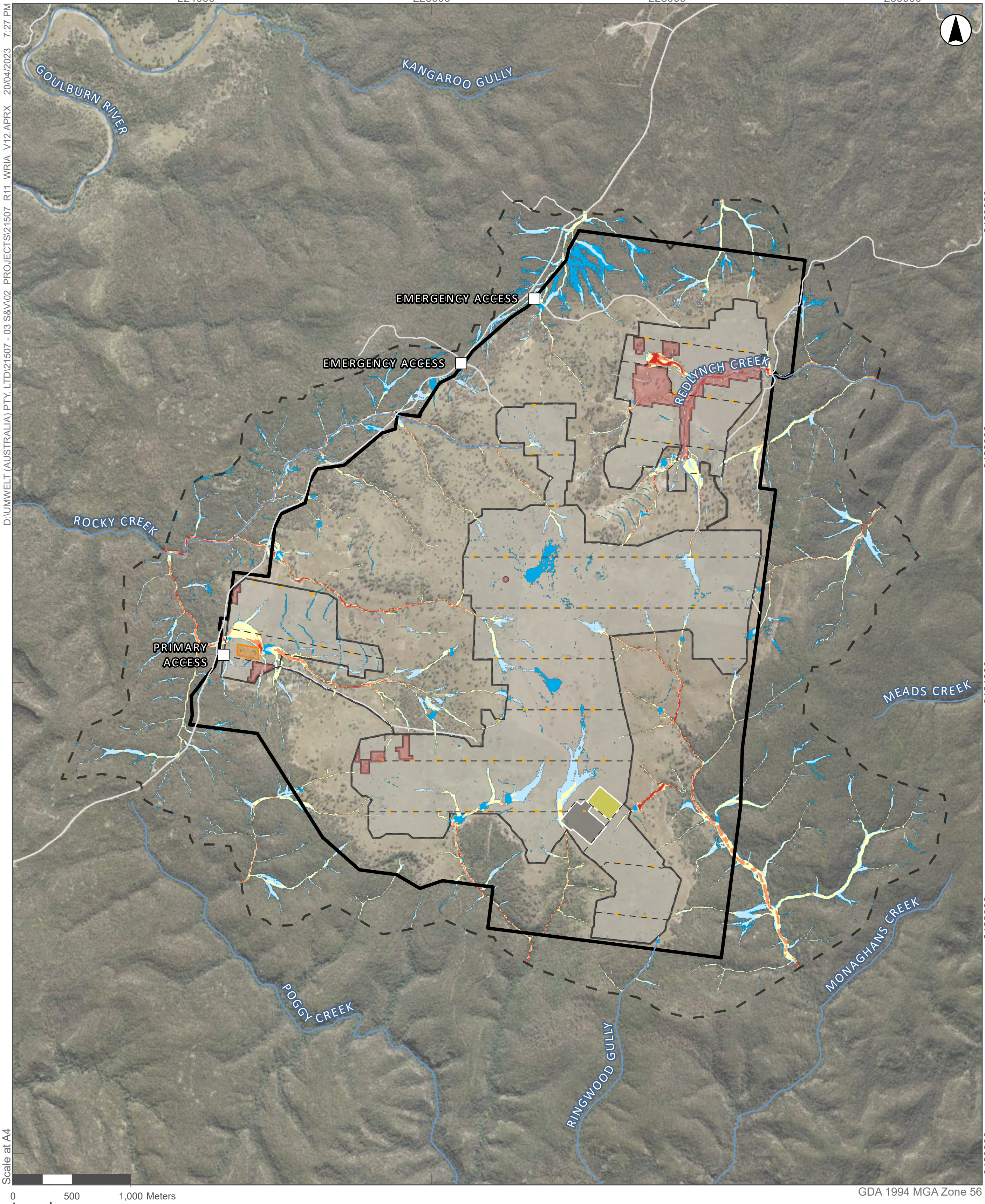
Water Depth (m)

- < 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4.0

APPENDIX C.7

0.5% AEP Flood Depth for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



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Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint
- Compound Area

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Solar Panel Footprint

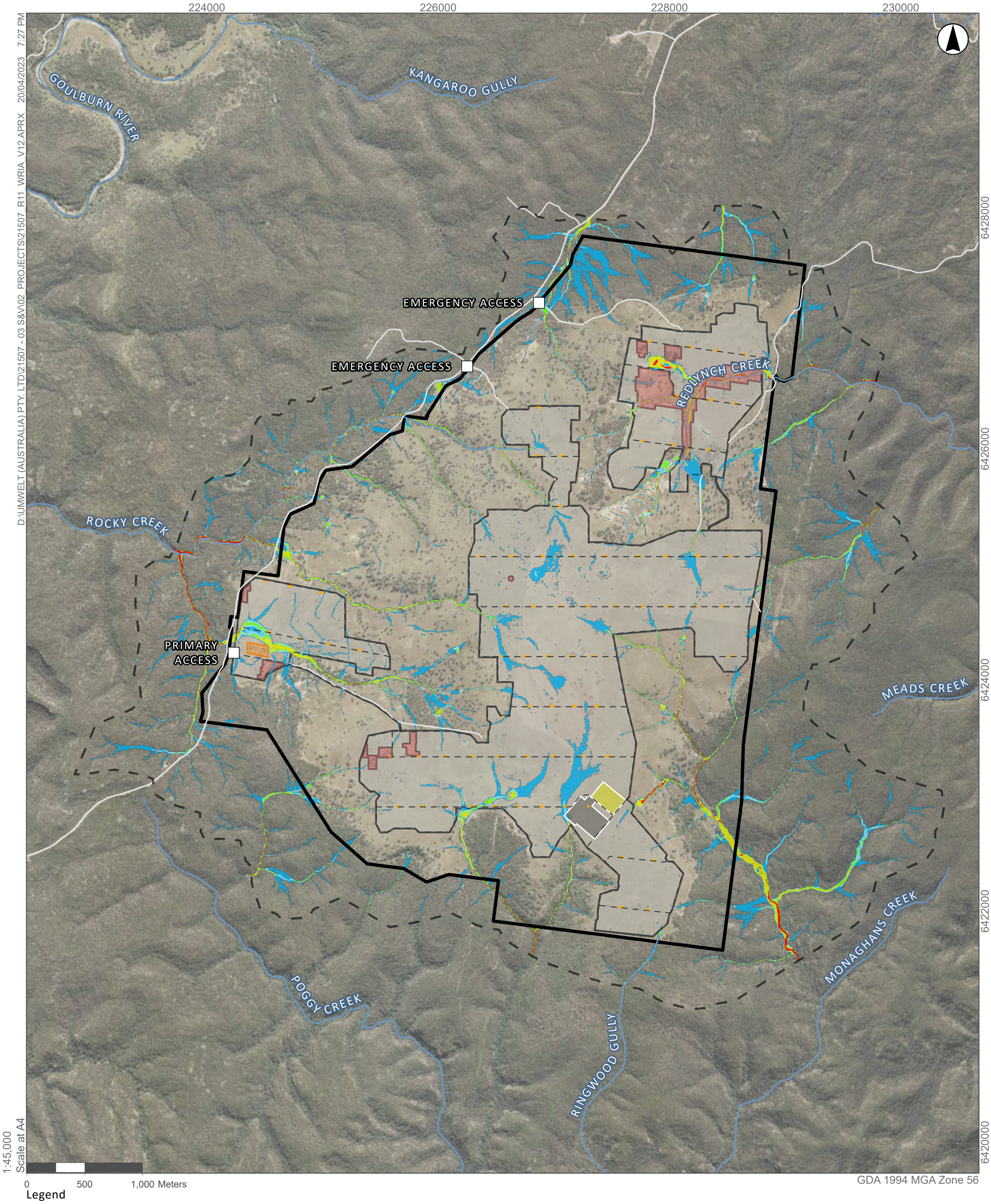
Water Velocity (m/s)

- < 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- > 3.0

APPENDIX C.8

0.5% AEP Flood Velocity for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



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Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint
- Compound Area

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Solar Panel Footprint

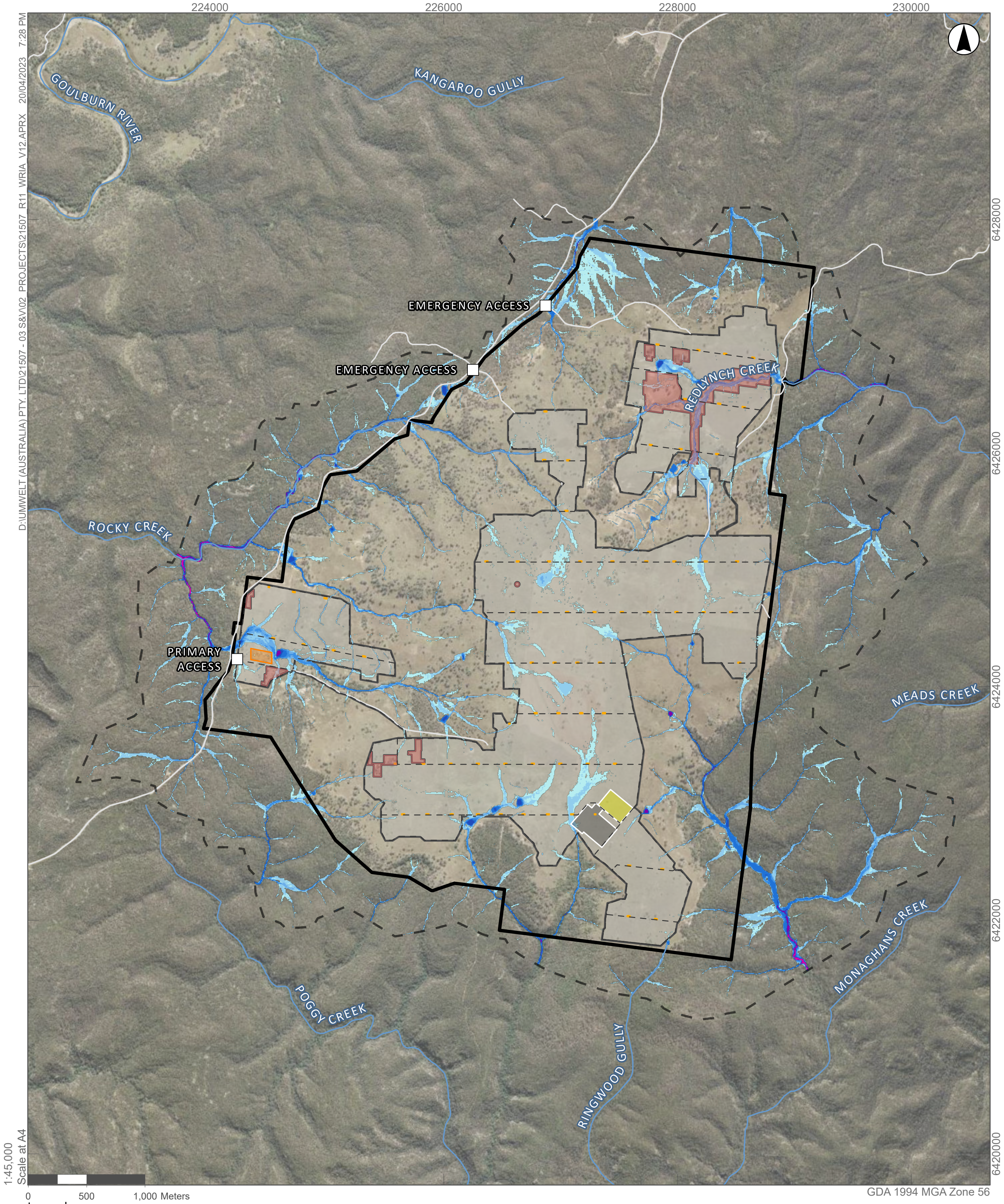
Hazard Category

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

APPENDIX C.9

0.5% AEP Flood Hazard for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint
- Compound Area

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Solar Panel Footprint

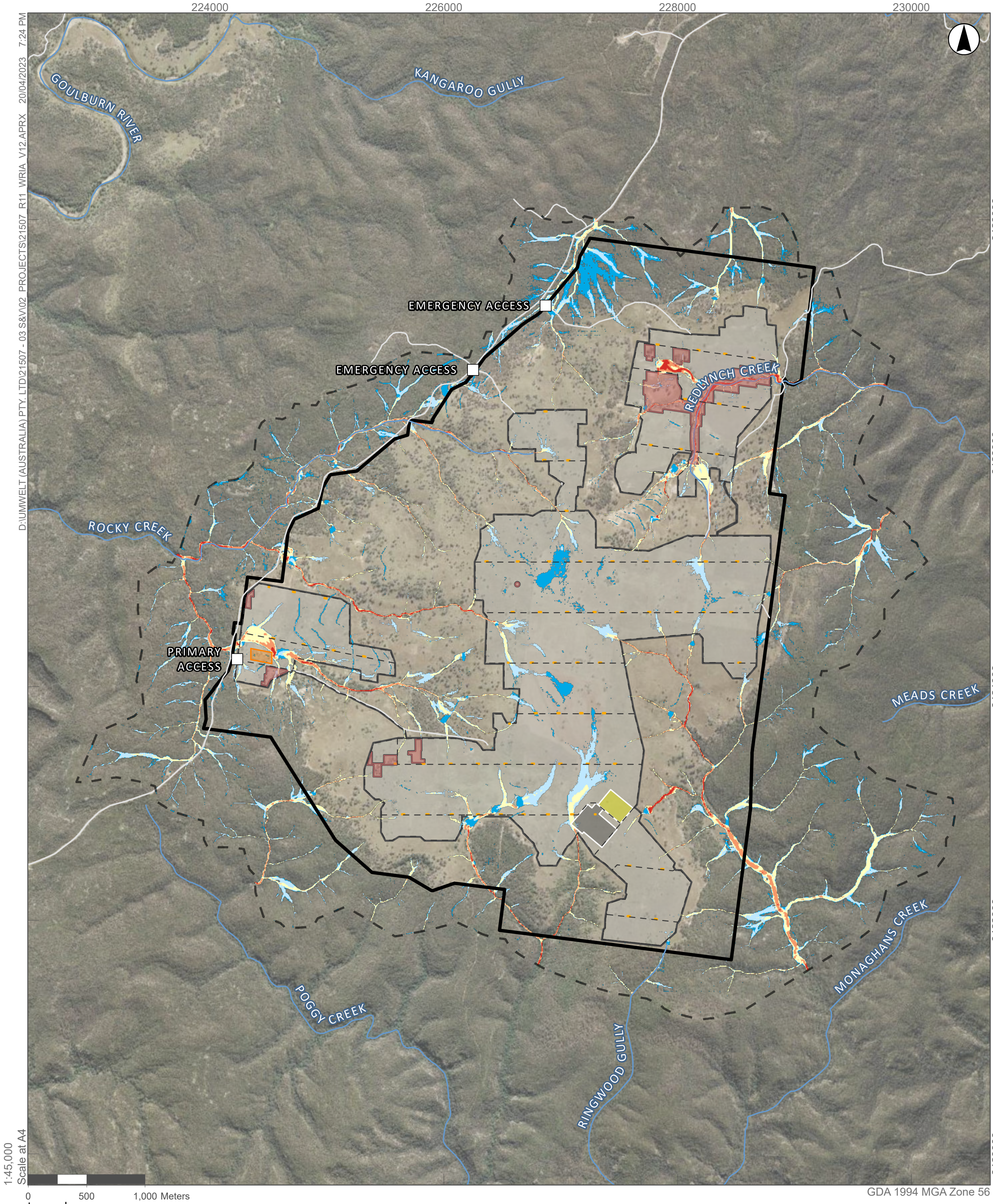
Water Depth (m)

- < 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4.0

APPENDIX C.10

0.2% AEP Flood Depth for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint
- Compound Area

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Solar Panel Footprint

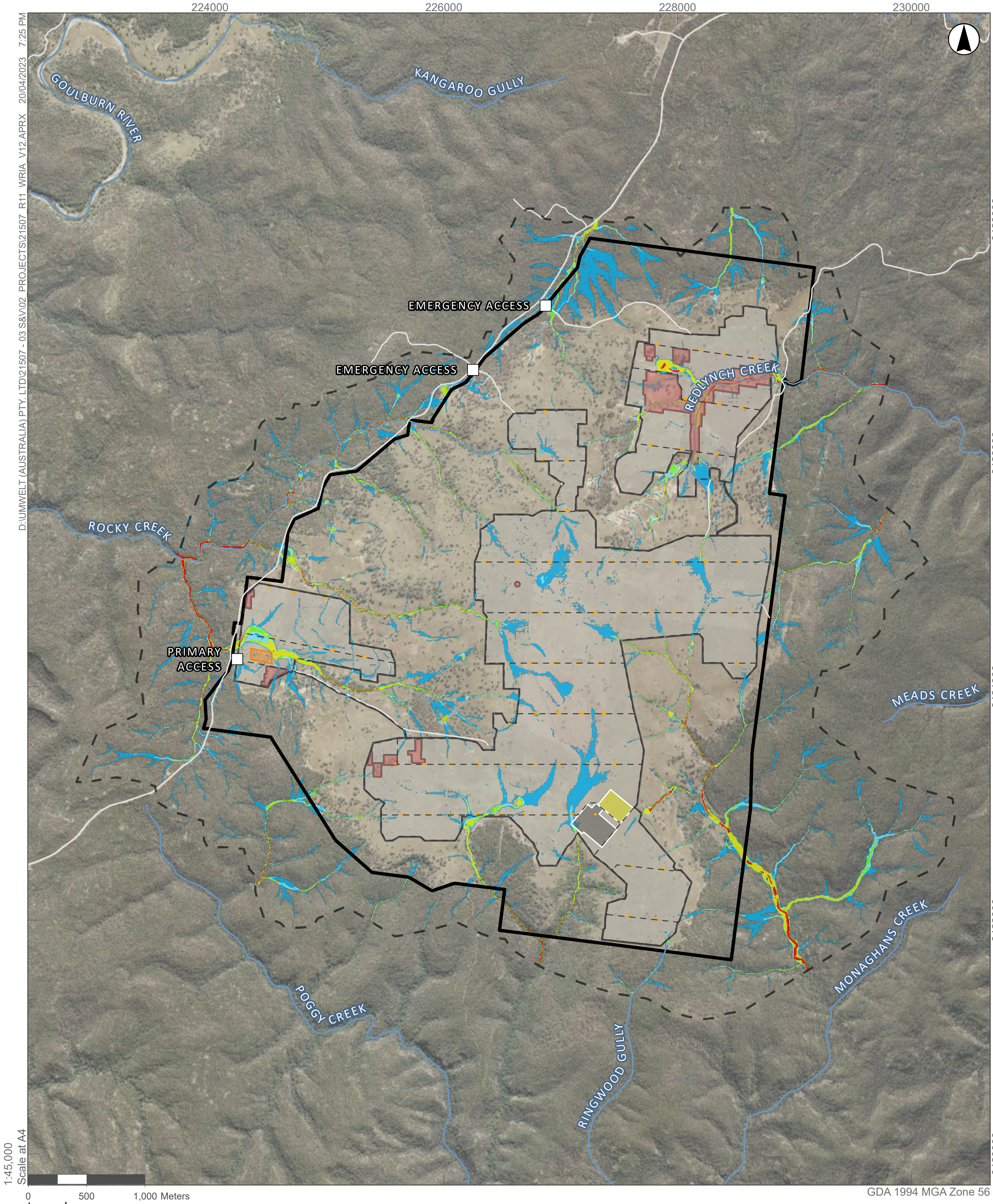
Water Velocity (m/s)

- < 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- > 3.0

APPENDIX C.11

0.2% AEP Flood Velocity for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint
- Compound Area

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Solar Panel Footprint

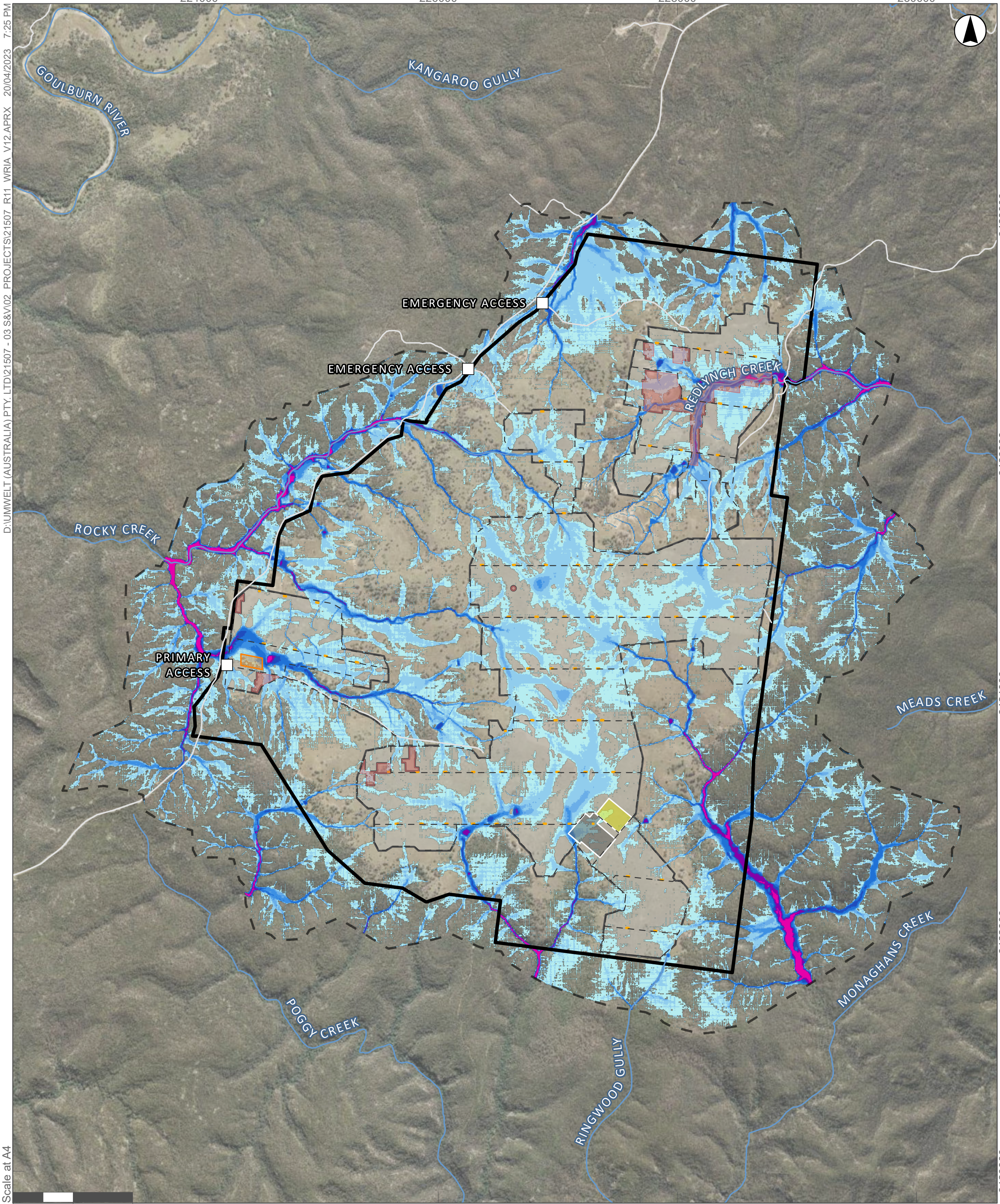
Hazard Category

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

APPENDIX C.12

0.2% AEP Flood Hazard for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint
- Compound Area

Proposed Infrastructure

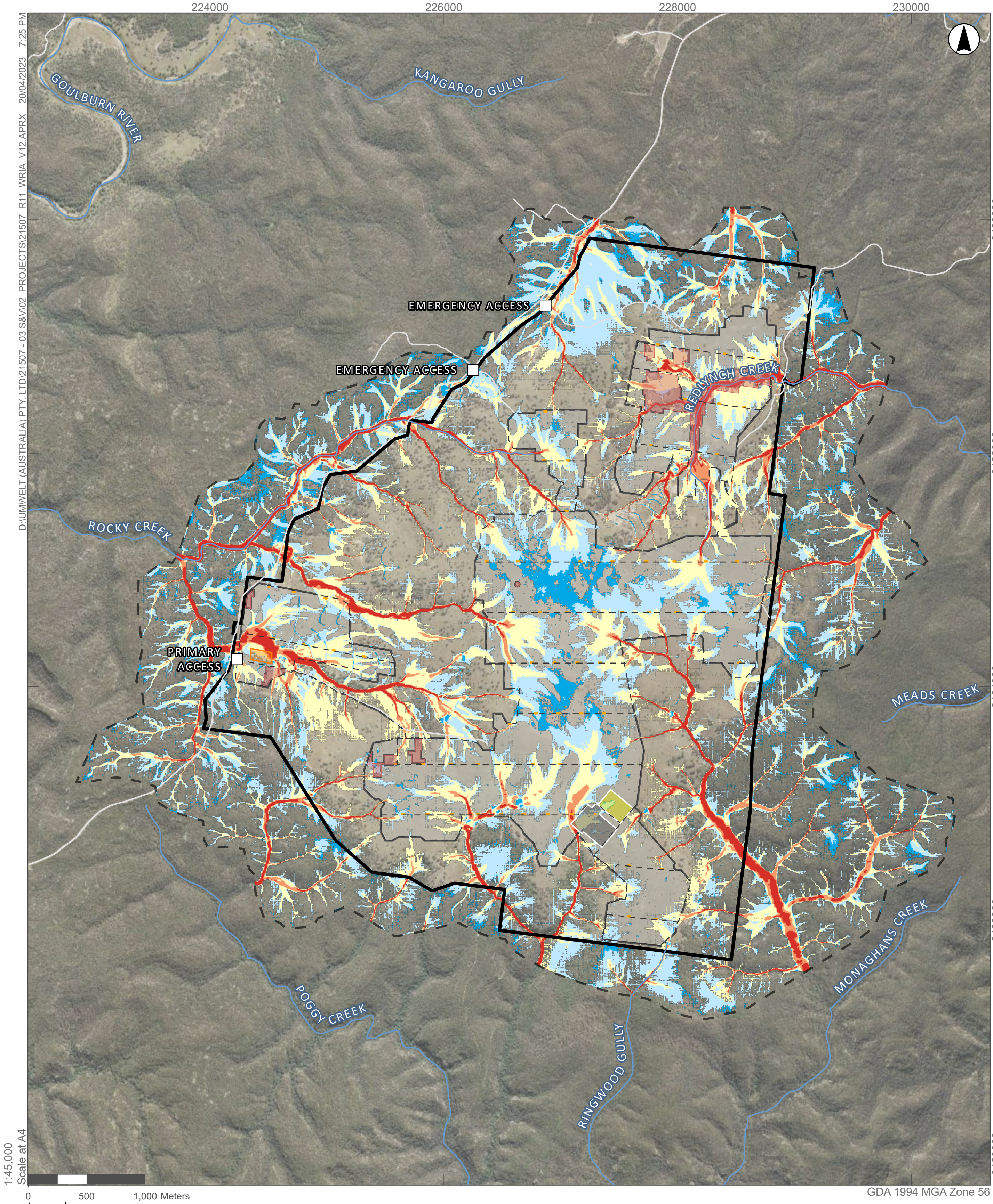
- Battery Energy Storage System
- Battery Substation
- Inverters
- Solar Panel Footprint

Water Depth (m)

- < 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4.0

APPENDIX C.13

PMF Flood Depth for Existing Conditions



Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint
- Compound Area

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Solar Panel Footprint

Water Velocity (m/s)

- < 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- > 3.0

APPENDIX C.14

PMF Flood Velocity for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

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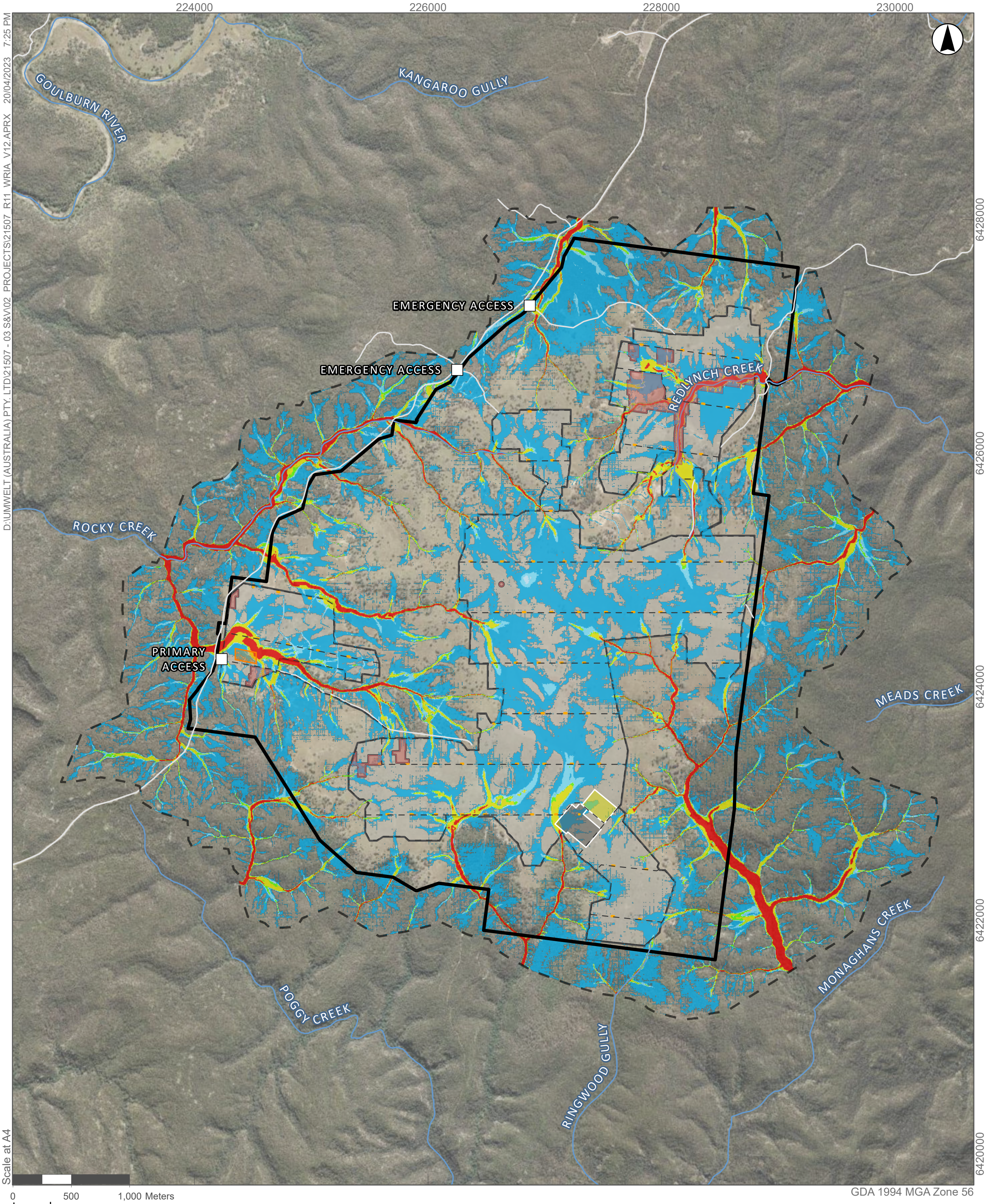

Legend

- Access Points
- Proposed Access Tracks
- Roads and Tracks
- Watercourse
- Model Extent
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint

Proposed Infrastructure

- Battery Energy Storage System
- Battery Substation
- Inverters
- Compound Area
- Solar Panel Footprint

Hazard Category

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

APPENDIX C.15

PMF Flood Hazard for Existing Conditions

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

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Environmental & Social Consultants

Umwelt (Australia) Pty Limited

T| 1300 793 267 E| info@umwelt.com.au www.umwelt.com.au