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TALLAWANG SOLAR FARM

Soil, Land and Agriculture Assessment

FINAL

June 2022

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Soil, Land and Agriculture Assessment

FINAL

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

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Project Manager: Marion O'Neil
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Report No. 21139/R10
Date: June 2022

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

Acknowledgement of Country

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

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
Final	Marion O'Neil	13 April 2022	Malinda Facey	13 April 2022

Abbreviations

Acronyms	
AHD	Australian Height Datum
BoM	Bureau of Meteorology
BSAL	Biophysical Strategic Agriculture Land
DPIE	Department of Planning, Industry and Environment.
EC	Electrical Conductivity
ECEC	Effective Cation Exchange Capacity
EIS	Environmental Impact Assessment
ESP	Exchangeable Sodium Percentage
FTE	Full Time Equivalent
km	Kilometres
SEARs	Secretary's Environmental Assessment Requirements
LUCRA	Land Use Conflict Risk Assessment
LVIA	Landscape and Visual Impact Assessment
LEP	Local Environmental Plan
LGA	Local Government Area
m	metres
mm	millimetres
OEMP	Operational Environmental Management Plan

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1.0 Introduction

Umwelt (Australia) Pty Limited (Umwelt) has been engaged by RES Australia Pty Ltd (RES) to complete a soil, land, and agricultural assessment in accordance with the Planning Secretary's Environmental Assessment Requirements (SEARs) to support the Environmental Impact Statement (EIS) that has been prepared for the proposed Tallawang Solar Farm located approximately 8 km north of Gulgong, New South Wales (NSW) (the Project).

The Project is located within the Mid-Western Regional Local Government Area (LGA), as shown in **Figure 1.1**. The Project lies within the Central West Orana Renewable Energy Zone (CWO REZ).

1.1 Project Overview

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

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

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

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

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

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

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

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

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

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

The Project will have an operational lifespan of 35 years. It is proposed that during the Project's operational life, the land will also be utilised sheep grazing. Refer to **Photo 1.1** for an example of co-habitation of a solar farm development and sheep grazing.

Photo 1.1 Example of co-habitation of solar farm development and sheep grazing (Bomen Solar Farm, Wagga Wagga, NSW)

Source: RES, 2021

1.2 Purpose and Objectives of the Report

The purpose of this report is to identify and assess the potential impact of the Project on agricultural land, and to identify measures to manage and mitigate any potential impacts.

The objectives of this assessment include:

- Assess the Project Area to verify BSAL or non-BSAL in accordance with the Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land (Office of Environment & Heritage (OEH) and Department of Primary Industries - Office of Agricultural Sustainability and Food Security (DPI-OAS&FS), 2013).
- Undertake a site soil survey and classify the soil profiles within the Project Area using the *Australian Soil Classification* (ASC) system (Isbell, 2007), including a description and figure showing the distribution of each soil type.
- Complete a land and soil capability assessment including figures, showing the land capability within the Project Area using *The Land and Soil Capability Assessment Scheme: Second Approximation* (Office of Environment and Heritage (OEH), 2013).
- Undertake a Land use Conflict Risk Assessment (LUCRA), provided as a standalone report in **Appendix A.**
- Complete an assessment of impacts to agriculture.
- Identify suitable management and mitigation measures to mitigate any potential impacts in relation to soil, land capability or agriculture.

1.3 Secretary's Environmental Assessment Requirements (SEARs)

The SEARs (SSD-23700028) issued for the Project identify matters that must be addressed in the EIS. **Table 1.1** specifically lists the requirements relevant to this assessment and where they have been addressed in this report.

Table 1.1 SEARs relevant to the Soil Survey Report

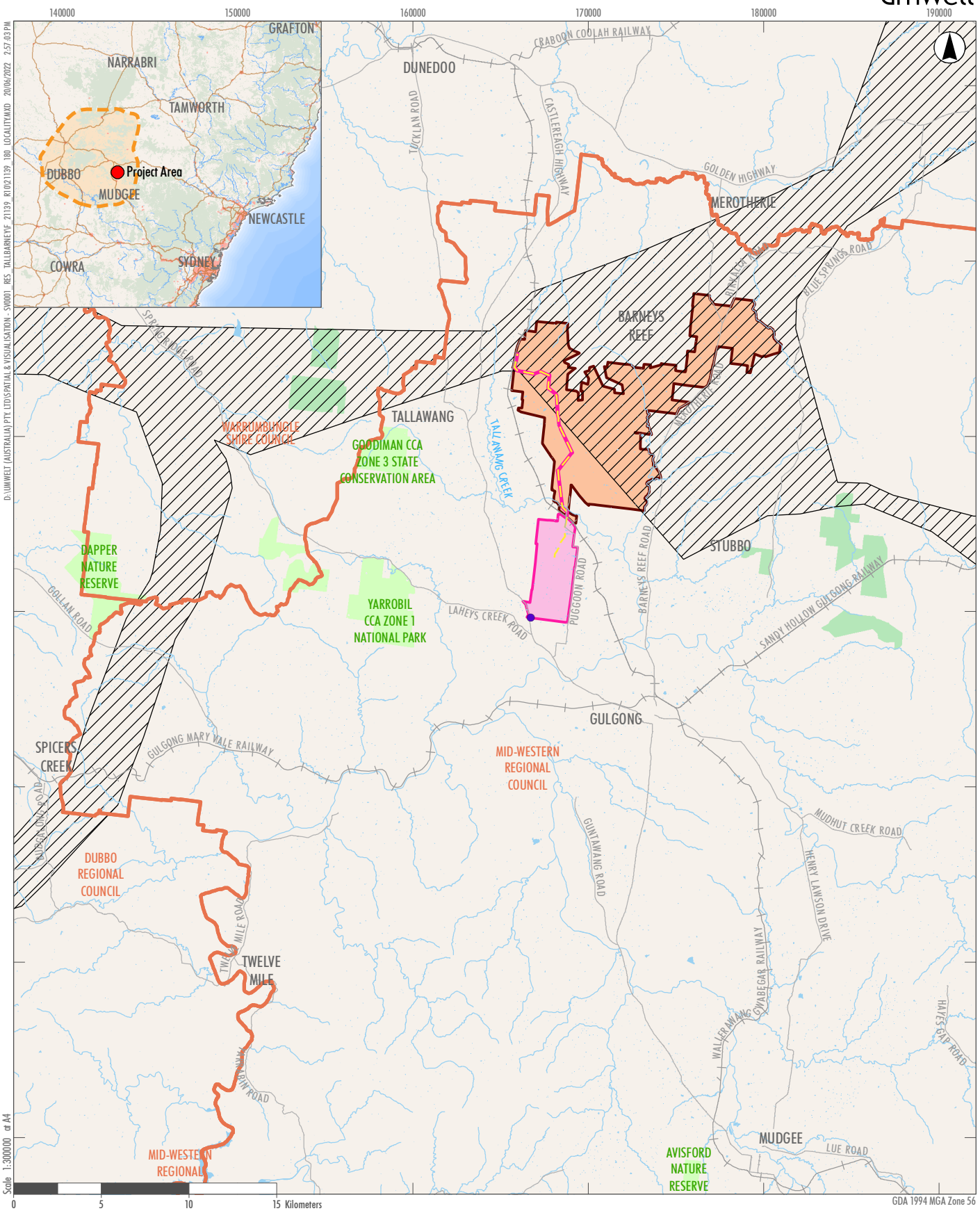
Requirement	Section addressed
Land – including: • a detailed justification of the suitability of the site and that the site can accommodate the proposed development having regard to its potential environmental impacts, permissibility, strategic context, and existing site constraints;	**This is addressed in the EIS Section 9.0.** **This report is a component of the justification of the suitability of the site.**
• an assessment of the potential impacts of the development on existing land uses on the site and adjacent land, including:	
○ consideration of agricultural land (including Biophysical Strategic Agricultural Land and land and soil capability class 1,2 or 3), flood prone land, Crown lands, mining, quarries, mineral or petroleum rights;	**Section 4.0**
○ a soil survey to determine the soil characteristics and confirm land capability class and consider the potential for erosion to occur; and	**Sections 3.2 and 4.0**
○ a cumulative impact assessment of nearby developments,	**This is addressed in the EIS in Section 7.0**

Requirement	Section addressed
• an assessment of the compatibility of the development with existing land uses, during construction, operation and after decommissioning including:	
○ consideration of the zoning provisions applying to the land, including subdivision;	**This is addressed in the EIS in Section 4.1.2.**
○ completion of a Land Use Conflict Risk Assessment in accordance with the Department of Industry's Land Use Conflict Risk Assessment Guide; and	**Refer to Appendix A.**
○ assessment of impact on agricultural resources and agricultural production on the site and region.	**Section 5.0**

1.4 Structure of this Report

The structure of this report includes:

- **Section 1.0** Introduction – includes a project overview, purpose, structure and objective of the report and the relevant SEARs.
- **Section 2.0** Existing Environment – outlines the main features of the Project Area's location.
- **Section 3.0** Assessment Methodology – describes the methodology of the field work undertaken to prepare the soil survey.
- **Section 4.0** Results – describes the results of the soil survey, laboratory analysis, and the land capability classification of the Project Area as well as results from the BSAL assessment.
- **Section 5.0** Impact Assessment – describes the potential agricultural impacts of the proposed Project based on the results observed.
- **Section 6.0** Management and Mitigation Measures – provides a summary of the soil characteristics and the environmental mitigation and management recommendations.
- **Section 7.0** Conclusion
- **Section 8.0** References.



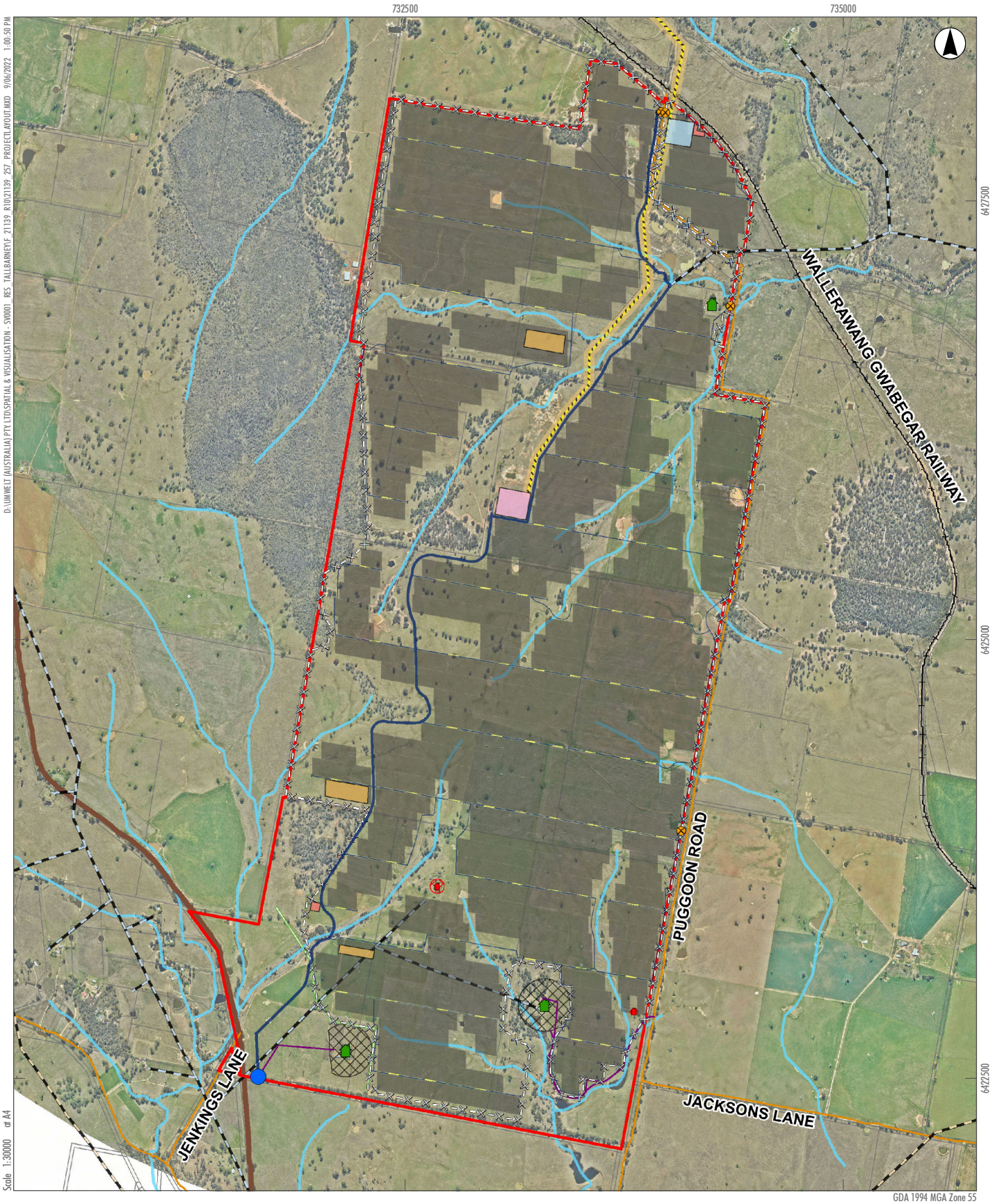
Legend

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

FIGURE 1.1

Location and Local Context

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



Legend

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

FIGURE 1.2

Project Layout

Image Source: RES (2021)

2.0 Existing Environment

2.1 Topography

The elevation of the Project Area ranges from 520 m AHD in the west to 430 m AHD in the east. The general topography of the Project Area is undulating low rises with gently inclined slopes (4 – 8 %).

2.2 Climate

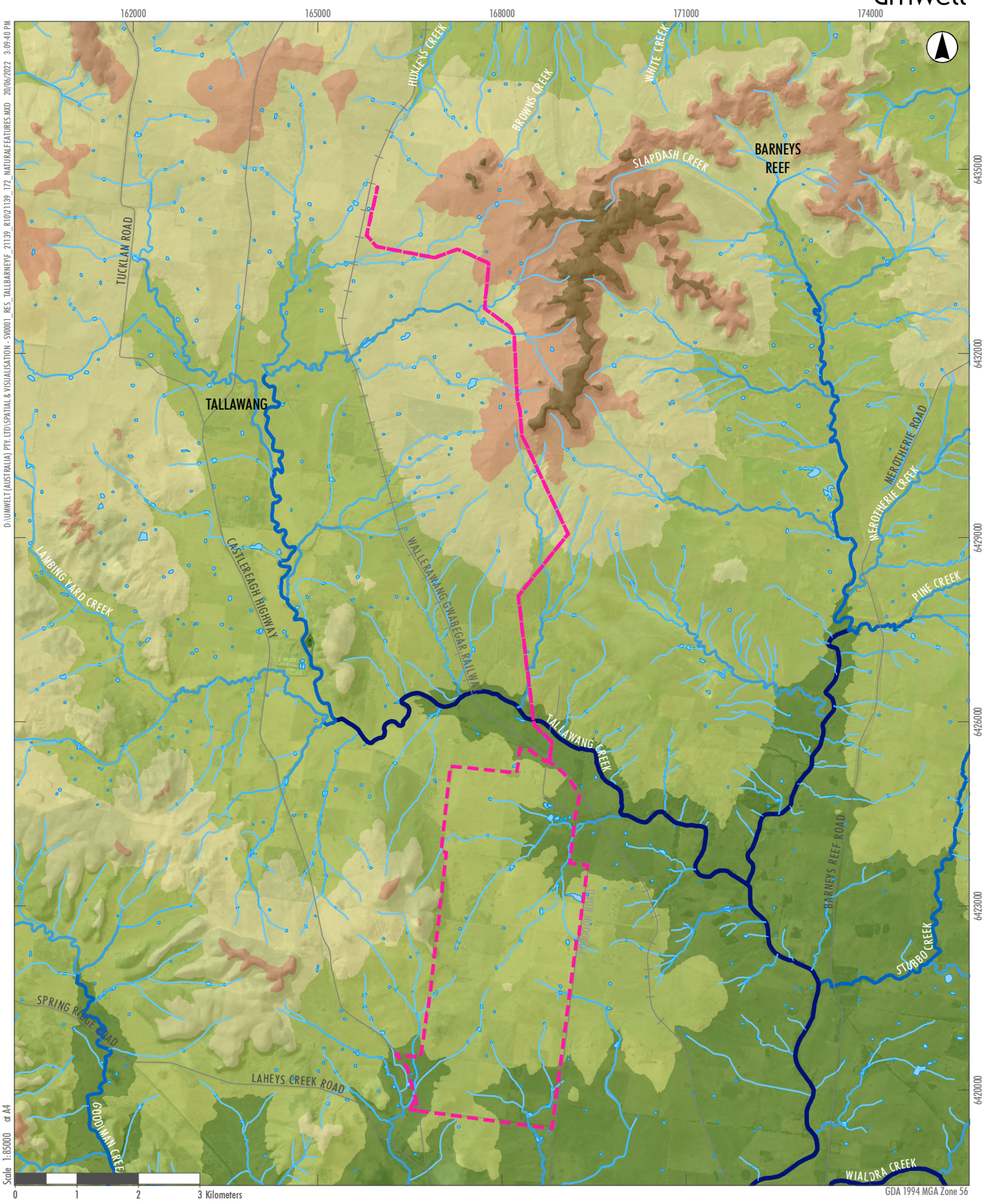
Temperatures are highest in January, with a mean maximum temperature of 31.4 ^{o}C, and lowest in July, with a mean minimum temperature of 2.6 ^{o}C (Bureau of Meteorology, 2021).

The average annual rainfall is 649.5 mm, with the highest mean monthly rainfall occurring in January (70.2 mm) and the lowest mean monthly rainfall occurring in April (43.9 mm) (Bureau of Meteorology, 2021).

2.3 Natural Features

The Project Area is described as predominately heavily disturbed due to historical land clearing, cropping and livestock grazing. Small areas of native vegetation remain within the Project Area boundary, with remnant trees (paddock trees) and introduced grass and weed species present (Umwelt, 2021). There is a small rocky outcrop along the western boundary of the Project Area.

The main natural feature of the Project Area includes natural drainage lines, or creeks located throughout the Project Area, as shown on **Figure 2.1**. In addition, a number of constructed farm dams are located within the Project Area. The layout incorporates exclusion zones around the remnant vegetation, small rocky outcrop, farm dams and creek lines present on the Project Area. A water resources assessment has been undertaken as part of the development of the EIS, and addresses the water related matters further.



Legend

- Tallawang Solar Farm Project Area
- Road
- Railway Line
- Dam/Waterbody

Elevation (mAHD)

- 350 - 400
- 400 - 450
- 450 - 500
- 500 - 550
- 550 - 600
- 600 - 650

Strahler Stream Ordering

- 1st Order
- 2nd Order
- 3rd Order
- 4th Order
- 5th Order or Greater

FIGURE 2.1

Natural Features

Image Source: ESRI Basemap (2021) Data source: NSW DFSI (2021); Umwelt (2021)

2.4 Geology

The *Dubbo 1:250,000 Geological Map* (Murphy, et al., 1998) indicates that the Project Area is predominantly underlain by alluvium and colluvium derived from the Gulgong and Rouse Granites. The south-west corner of the Project Area is underlain by in situ and colluvial materials derived from Andesite, tuff, arkose, and shale.

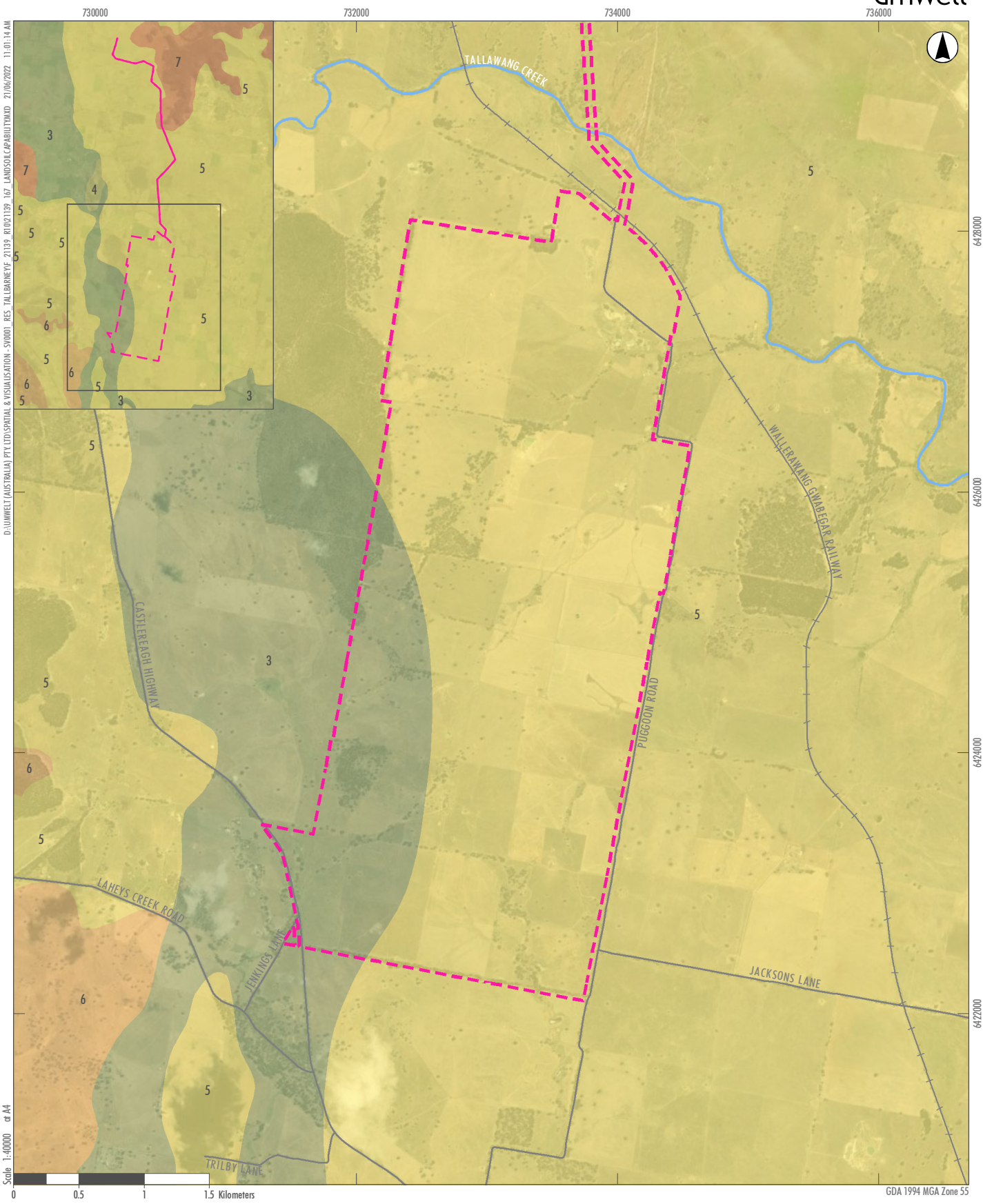
2.5 Agricultural Context

The Project Area is characterised by undulating plains, comprising of large paddocks which have been extensively cleared of vegetation for agricultural use (cropping and grazing for sheep and cattle). Fragmented sections of vegetation and isolated trees are also evident throughout the area.

The Mid-Western LGA has a long-standing association with agriculture. Since the surveying of the region between 1820 and 1821 by William Lawson the area has been known for its large expanses of good pastoral land. Historically the region is known to predominantly be used for grazing activities and cropping including but not limited to cereal crops, hay, and horticulture. Within the region, there is also strong history of viticulture, with winemaking dating back to the 1850s.

2.6 Surrounding Land Use

Surrounding the Project Area, adjacent lands have been subjected to extensive vegetation clearing associated with historic agricultural land uses, predominately being utilised for grazing activities including sheep with some cattle grazing. Agriculture (primarily sheep grazing with some cattle grazing) is the main land use in the Mid-Western Regional LGA.



Legend

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

Land and Soil Capability

- 3 - Moderate Limitations
- 4 - Moderate to Severe Limitations
- 5 - Severe Limitations
- 6 - Very Severe Limitations
- 7 - Extremely Severe Limitations

FIGURE 2.2

Mapped Land and Soil Capability

Image Source: ESRI Basemap (2021) Data source: NSW DPIE (2020), Umwelt (2021)

3.0 Assessment Methodology

This section details the desktop review and the assessment methodology for the soil survey, *land, and soil capability* (LSC) assessment, *Biophysical Strategic Agricultural Land* (BSAL) assessment, and *Land Use Conflict Risk Assessment* (LUCRA).

3.1 Desktop Review

The desktop assessment included a review mapping units provided by NSW DPIE (2021) accessed at espade.environment.nsw.gov.au, and seed.nsw.gov.au, these included:

- Australian Soil Classification (ASC) system soil type mapping of NSW,
- Great Soil Group mapping of NSW,
- Land and Soil Capability classes mapping,
- Inherent Soil Fertility,
- BSAL (seed.com.au), and
- Soil Landscapes.

These mapping units are predominately based on high level regional mapping and require ground truthing through site assessment and soil analysis to determine their accuracy.

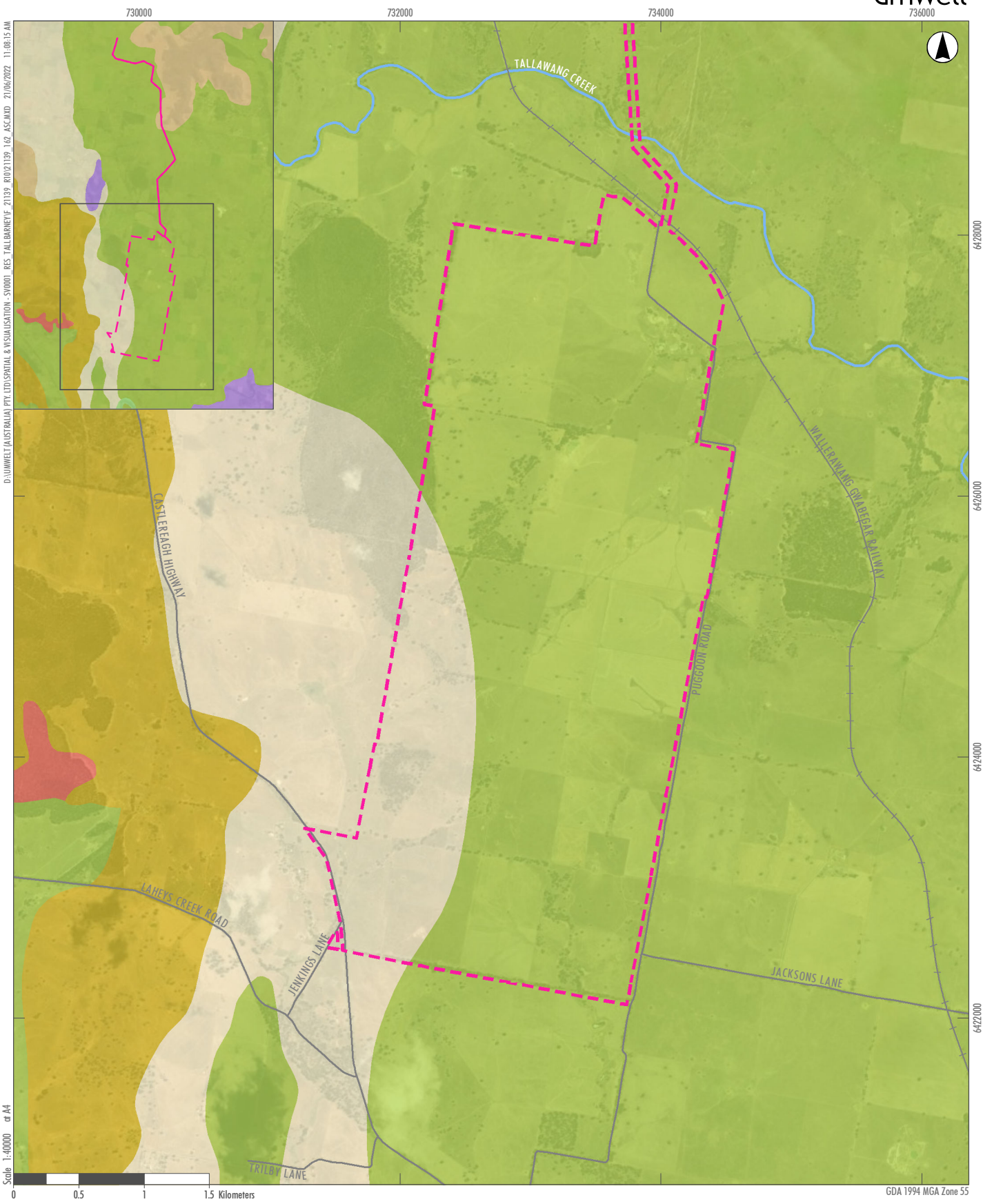
3.1.1 Mapped Soil Types, Land Capability, Soil Fertility, and BSAL

The following findings are based on the regional mapping available (as identified in **Section 3.1**):

- The soil types within the Project Area are classified as ferrosols and sodosols (refer to **Figure 3.1** under the *Australian Soil Classification Soil Type map of NSW* (DPIE 2020) and identified as Solodic Soils and Euchrozems (refer to **Figure 3.2**) under the *Great Soil Group mapping of NSW* (DPIE 2020).
- The Project Area is mapped as Land Class 3 and 5 under the NSW *Land and Soil Capability Assessment Scheme*.
- The areas of Land Class 3 are regionally mapped as BSAL and as an inherent 'moderately high' fertility land, indicating that it has high quality soil and water resources capable of sustaining high levels of productivity. The land mapped as Land Class 5 is mapped as having inherently "moderately low" fertility.

These regionally mapped soil and land features (LSC, BSAL, and inherent soil fertility) are shown in **Figure 3.3**.

The Land and Soil Capability assessment aims to ground truth the available mapping and is presented in **Section 4.0**.



Legend

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

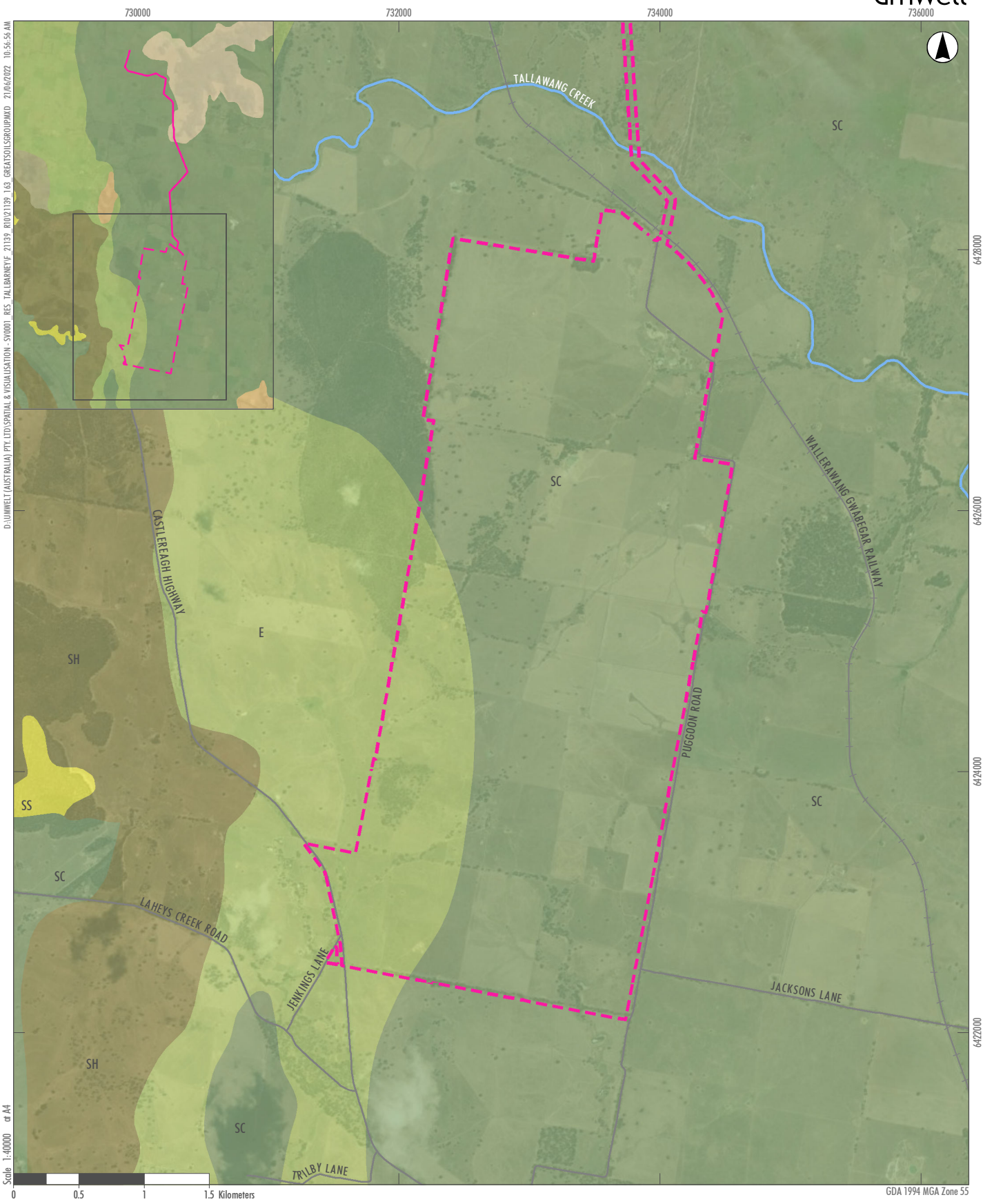
Dominant Australian Soil Classification (ASC) - Order

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

FIGURE 3.1

Australian Soil Classification

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



Legend

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

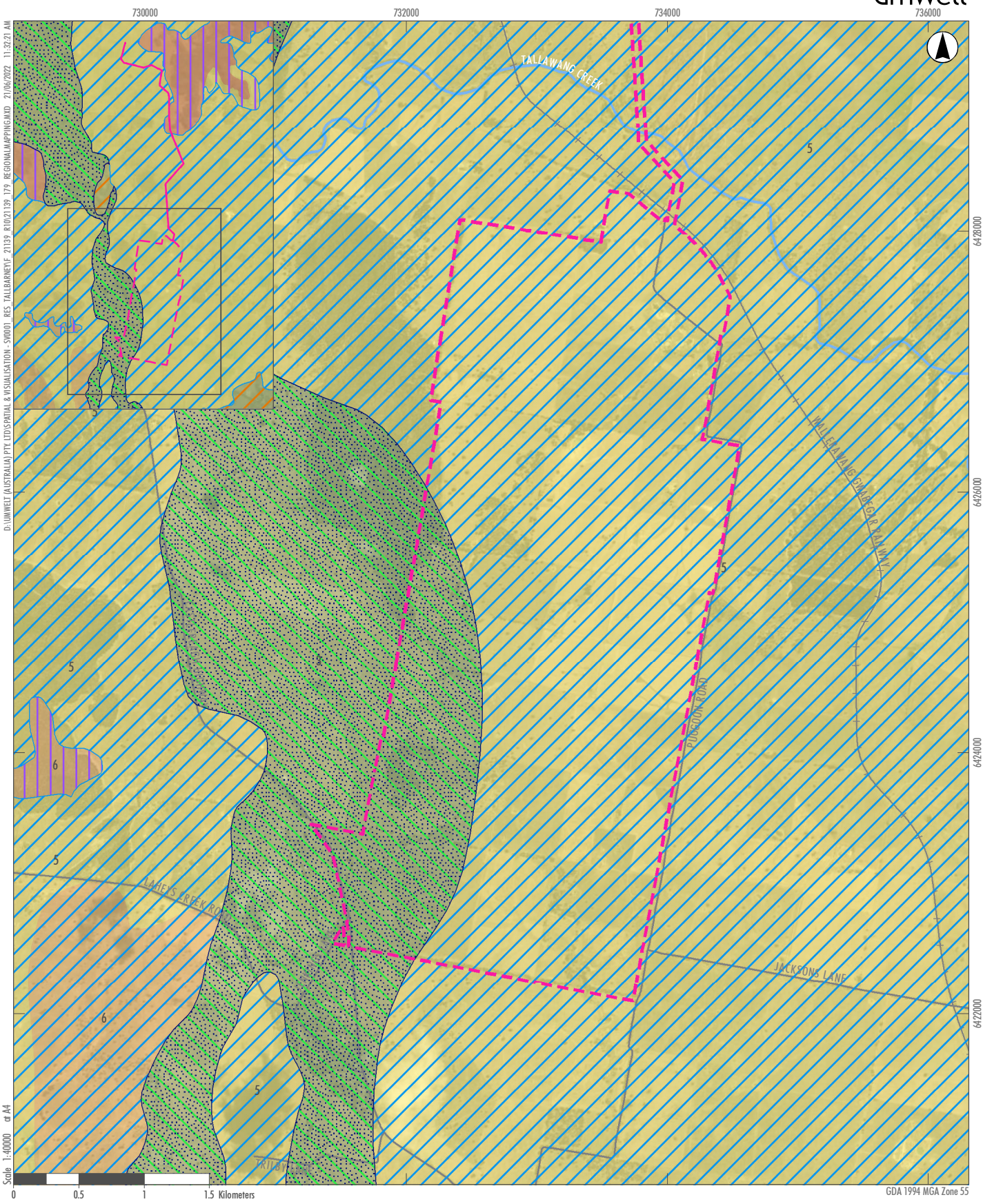
Dominant Great Soil Group (GSG)

- Earthy Sands (ES)
- Euchrozems (E)
- Lithosols (L)
- Non-calcic Brown Soils (NKB)
- Siliceous Sands (SS)
- Solodic Soils (SC)
- Soloths (SH)

FIGURE 3.2

Regionally Mapped Great Soils Group

Image Source: ESRI Basemap (2021) Data source: NSW DPIE (2021), Umwelt (2021)



Legend

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

Soil fertility

- Low
- Moderately low
- Moderate
- Moderately high

Land and Soil Capability

- 3 - Moderate Limitations
- 4 - Moderate to Severe Limitations
- 5 - Severe Limitations
- 6 - Very Severe Limitations
- 7 - Extremely Severe Limitations

FIGURE 3.3

Regionally Mapped Soil and Land Features

Image Source: ESRI Basemap (2021) Data source: NSW DPIE (2020), Umwelt (2021)

3.1.2 Mapped Soil Landscapes

Murphy and Lawrie (1998) described the Soil Landscape units of the Dubbo 1:250,000 Sheet through a classification of landscape assemblages and their associated soil characteristics. The Soil Landscapes within the Project Area are mapped by DPIE (2020) (refer to **Figure 3.4**), presented in **Table 3.1** and summarised in the following sections.

Table 3.1 Soil Landscapes within the Project Area

Soil Landscape	Abbreviation	Great Soil Group
Home Rule	hr	Sodosols
Tucklan	tk	Euchrozoems
Rouse	rs	Sodosols

Home Rule

Home Rule is characterised by undulating low hills, with sediment derived from the Gulgong and Rouse Granites. A local relief between 30-60 m; slopes 4-8%. Comprised of many Siliceous Sands (Uc1.42) and Earthy Sands (Uc4.21; Uc4.32) on upper and mid-slopes, bleached sands (Uc2.21; Uc2.22), Yellow Podzolic Soils (Dy2.41; Dy 2.21) and yellow Solodic Soils (Dy3.13; Dy 3.42) on lower slopes and flats and layered Siliceous Sands in some larger drainage lines.

Home Rule limitations include the following: very low fertility; low available water holding capacity; acidic surface soils; seasonal waterlogging; sodic subsoils in lower slopes; high permeability on mid to upper slopes; moderate to high erosion hazard under cultivation.

Tucklan

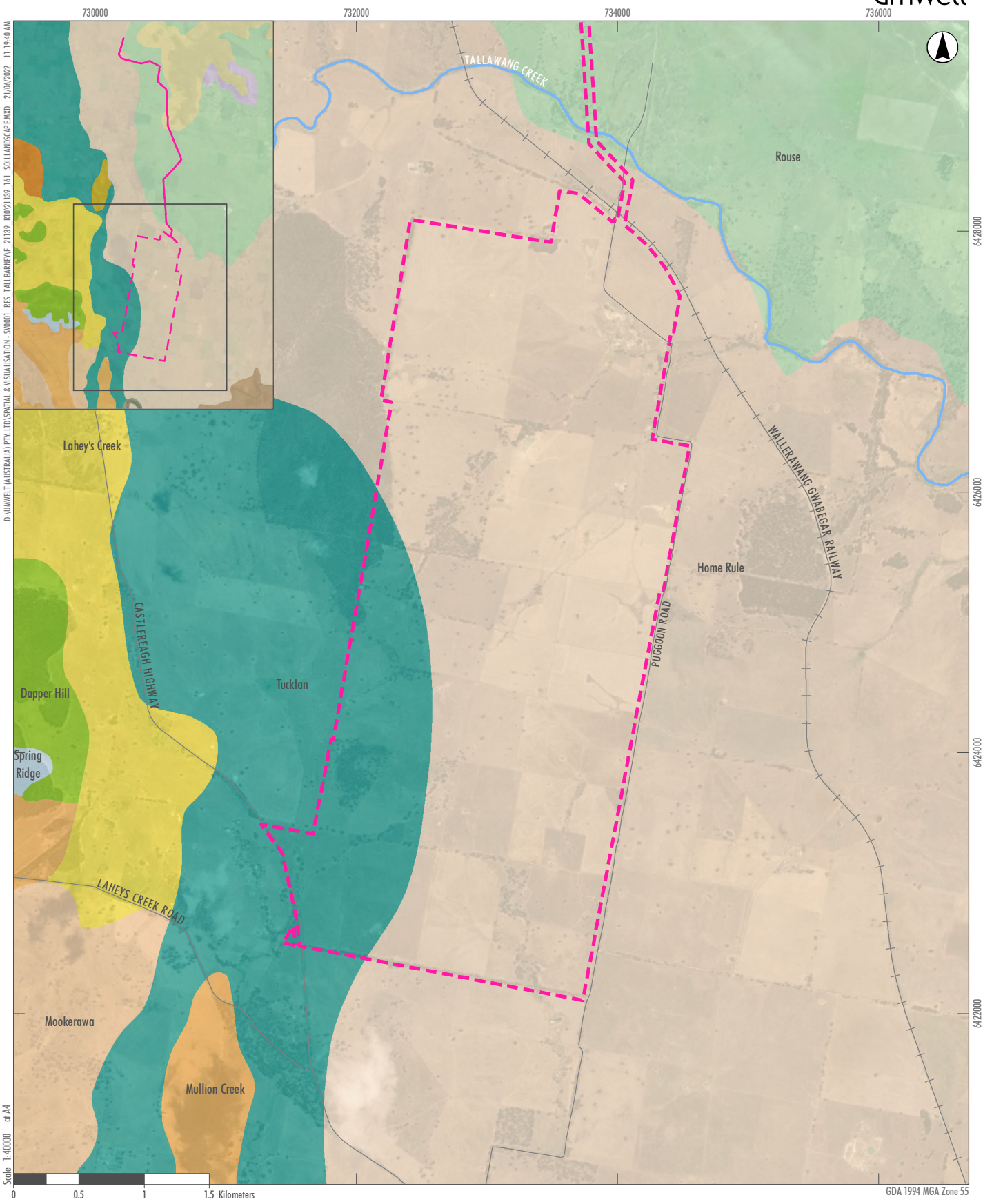
Tucklan is characterised by undulating low hills, andesite, basalt and associated shale, tuff, and siltstone. A relief to 40 -80 m; sloped 3 – 15%. Mainly Euchrozems (Gn3.13; Gn3.13) with rises of Red Podzolic Soils (Dr2.21) and Non-calcic Brown Soils (Dr2.22).

Limitations include: moderate to high erosion hazard under cultivation; moderate fertility; moderate to high water holding capacity; moderate to high shrink-swell potential.

Rouse

Rouse soil landscape is characterised by undulating hills and low hills with granite outcropping as tors and sloping pavements, with Gulgong granite, biotite granite, adamellite, granodiorite. A relief of 50-90 m; slopes 5-15% and 500-1000 m long. Mainly shallow Siliceous Sands (Uc1.42) and Earthy Sands (Uc4.21) on mid-slopes and upper slopes. Yellow Soloths (Dy3.41) and yellow Solodic Soils (Dy3.43, Dy3.32) on lower slopes and in depressions. Deeper A_2 horizons on lower slopes adjacent to main drainage lines. Other soils include bleached sands (Uc2.21), and Non-calcic Brown Soils and Red Earths on small areas of less siliceous rock.

Limitations include very low fertility; acidic surface soils; low available water holding capacity; seasonal waterlogging; sodic subsoils on lower slopes; high to very high erosion hazard under cultivation.



Legend

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

Soil Landscape

- Burrendong
- Craigmore
- Dapper Hill
- Home Rule
- Lahey's Creek
- Lees Pinch
- Mookerawa
- Mullion Creek
- Rouse
- Spring Ridge
- Surface Hill
- Tucklan
- Turill

FIGURE 3.4

Soil Landscape Mapping

Image Source: ESRI Basemap (2021) Data source: NSW DPIE (2020), Umwelt (2021)

3.2 Soil Survey

The soil survey, including field sampling and in-situ soils classification, was conducted in reference to the *Australian Soil and Land Survey Field Handbook* (2009) and *The Australian Soil Classification* (Isbell, 1996). During the assessment drainage was inferred from certain soil characteristics including effective root depth, and soil colour and mottling.

The soil survey was conducted on 3 and 4 August 2021, with the soils survey and sampling site locations shown in **Figure 3.5**.

Field survey included collection of GPS recordings and photographs of soil sampling sites and profiles, and slope and landforms of the sites, as shown in Table 8.2 in **Appendix B**.

Samples were submitted to the NATA accredited (N^{o}. 14960) Environmental Analysis Laboratory (EAL) for laboratory analysis of the parameters identified in **Appendix C**. Laboratory results are attached in **Appendix D**.

It is to be noted that access to some areas of the Project Area was restricted due to the recent high rainfall experienced throughout the Region and at the time of survey (inaccessible areas are identified on **Figure 3.5**).

Given the limitation in site access, soil test pits were required to be produced by hand-auger and/or shovel to depths ranging from 600mm to 800mm (depths at which refusal occurred).

The results of the assessment are discussed in **Section 4.0**.

3.3 Land and Soil Capability Assessment Methodology

The *Land and Soil Capability* (LSC) assessment was conducted in accordance with *The Land and Soil Capability Assessment Scheme; Second approximation* (DPIE, 2012), herein referred to as the LSC Guideline.

The LSC assessment scheme uses a range of data covering the biophysical characteristics of the landscape to establish the limitations to the land and the likelihood of degradation under 8 hazards. Included are land features such as slope, exposure to wind, drainage, groundwater recharge and discharge, cliffs, wetlands and rock outcrop, soil features such as texture, pH, structure and erodibility, and climate features such as average annual rainfall and wind erosive power.

These eight hazards are identified in the LSC guideline are as follow.

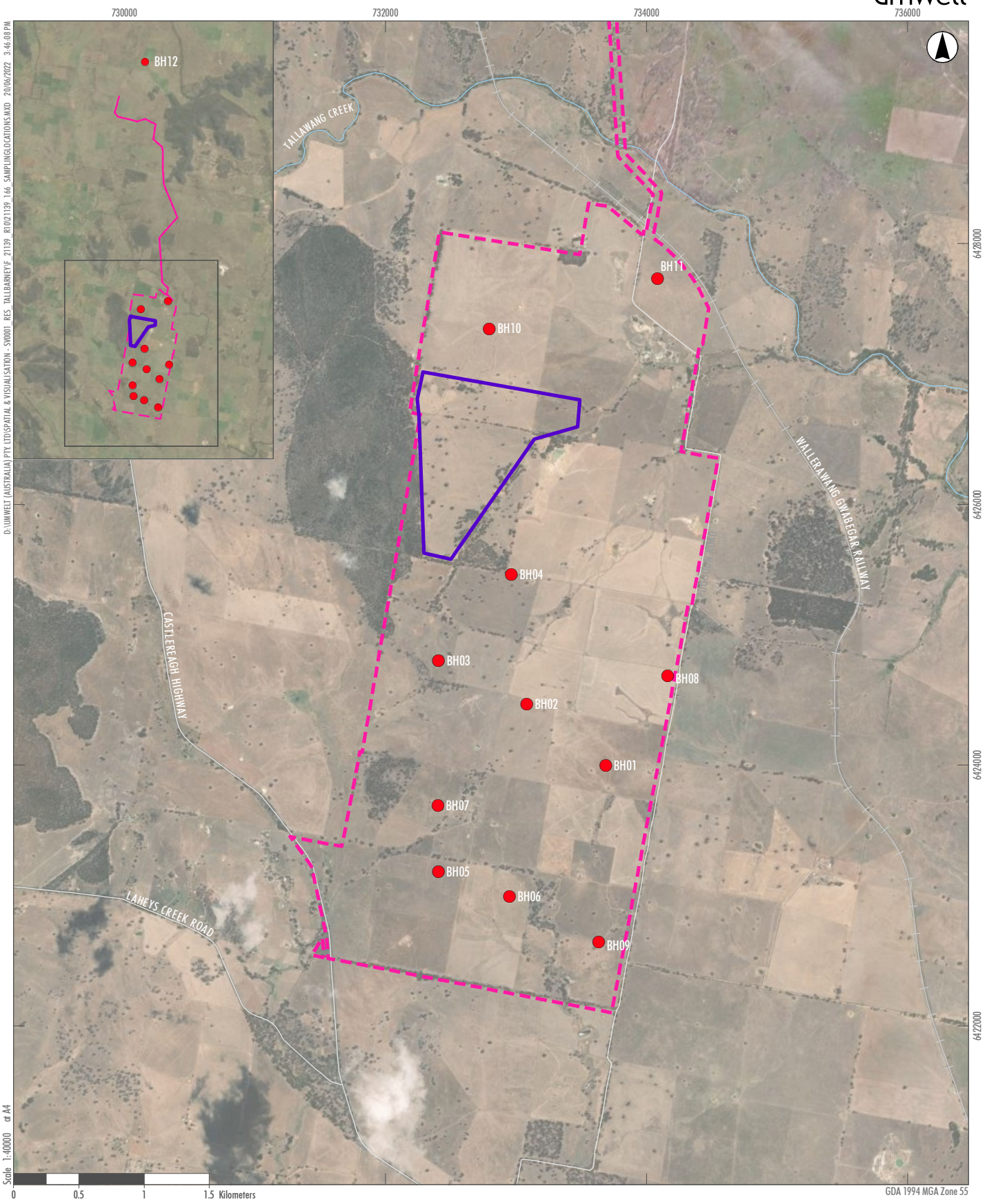
- Hazard 1 Wind erosion (including sheet, rill, and gully erosion)
- Hazard 2 Water erosion
- Hazard 3 Soil structure decline
- Hazard 4 Soil acidification
- Hazard 5 Salinity
- Hazard 6 Water logging
- Hazard 7 Shallow soils and rockiness
- Hazard 8 Mass movement

Following an assessment of each site and soil profile against the eight identified hazards, the results were used to establish the LSC of each site based on the 8 classes presented in **Table 3.2** and discussed in **Section 4.3**.

Table 3.2 Land and Soil Capability Classification

Class	Land and Soil Capability
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	**Extremely high capability land:** Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land:** Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	**High capability land:** Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available, and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4*	**Moderate capability land:** Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment, and technology.
5	**Moderate–low capability land:** Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)	
6*	**Low capability land:** Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	**Very low capability land:** Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	**Extremely low capability land:** Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

* LSC class located within the Study Area based on results of the assessment.



Legend

- Tallawang Solar Farm Project Area
- Inaccessible Area
- Sampling Location
- Road
- Railway
- Watercourse

FIGURE 3.5

Soil Sampling Sites

Image Source: ESRI Basemap (2021) Data source: NSW DPIE (2020), Umwelt (2021)

3.4 Biophysical Strategic Agricultural Land

Biophysical Strategic Agricultural Land (BSAL) are areas that consists of high-quality soil and water resources capable of sustaining high levels of agricultural productivity.

Approximately 228 ha in the south-western corner of the Project Area (refer to Figure 3.2) is regionally mapped as LSC 3 and BSAL (DPIE, 2021). To verify the regional mapping, a BSAL assessment was conducted in the identified BSAL area, which included sampling from three sites (Sites 3, 5 and 7 shown on **Figure 3.6**) within the BSAL area, and for the remainder of the Project Area. The assessment was conducted in reference to the flow chart from the *Interim protocol for site verification and mapping of biophysical strategic agricultural land* (BSAL Guidelines - DPIE 2013) as show in **Figure 3.7**.

The results of the BSAL verification assessment are discussed in **Section 4.0**.

3.5 Land-use Conflict Risk Assessment (LUCRA)

A LUCRA was conducted for the Project, with the report attached in **Appendix A**.

3.6 Consultation

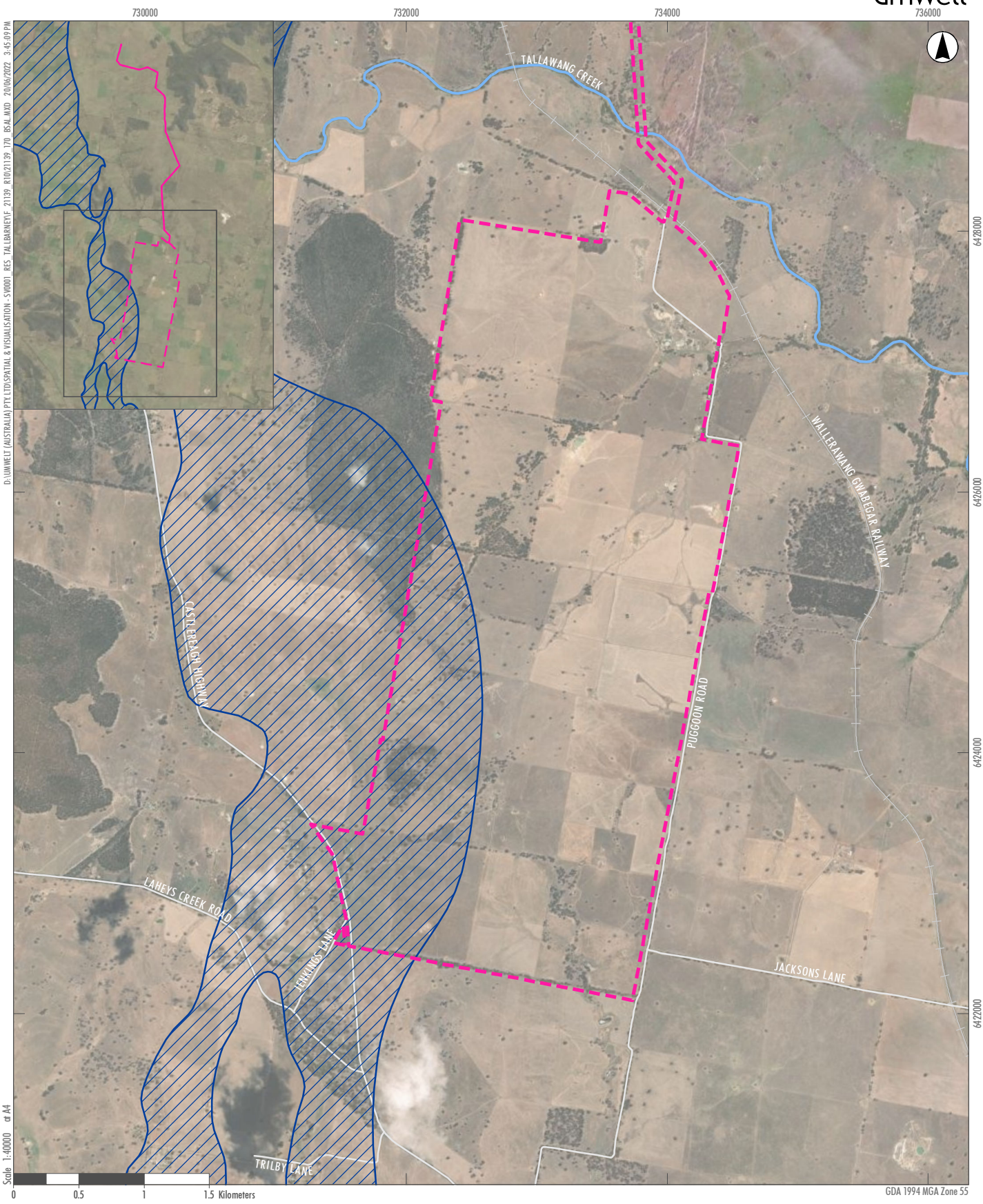
Consultation with affected landholders was undertaken as part of the LUCRA. This is discussed in further detail in Section 2.8 of the LUCRA (**Appendix A**).

In addition, a meeting was held with the Department of Primary Industry (DPI) – Agriculture on 30 November 2021 to introduce the Project and present the draft outcomes of the LUCRA. Feedback from the DPI – Agriculture included:

- Community consultation – effective consultation with affected landholders to be undertaken:
    - Refer to **Appendix A** for details on consultation with affected landholders as part of the LUCRA. In addition, a comprehensive stakeholder engagement program has been undertaken as part of the Social Impact Assessment (SIA) process. The SIA will detail the outcomes of the engagement program.
- Connecting to the grid – uncertainty for landholders when grid connection is still being designed and planned.
    - This has been further detailed in the EIS.
- Loss of Class 3 land – to rationalise the loss of the 73 ha of Class 3 that will be covered by solar arrays:
    - Refer to **Sections 4.3** and **5.1**.
    - Subsequent to the meeting with DPI Agriculture, the landholder of the area depicted as Class 3 land has provided the following input:
        - The property has been in his ownership since 2011. During this time, it has not been cropped or cultivated as the size, terrain and higher erosion occurring is not in favour of cropping. The property in its entirety is utilised for grazing, except for treed areas.

- The previous owners who owned it for 80 years (since approx. 1930) also did not crop the land, besides one crop of triticale, which failed.
- Based on the above, it was further ascertained that the 73 ha is not Class 3 land but Class 4, as further discussed in **Section 4.3**.

- Cumulative impacts – comprehensive assessment of cumulative impacts.
  - This has been addressed in detail in the EIS.
- Operational management of Project and farming enterprise – to provide measures on how the land will be managed.
  - Refer to **Section 6.0**.
- Erosion management – due to presence of sodic and dispersive soils on site, management of erosion need to be adequate to address this issue.
  - Refer to **Section 6.0**.
- Decommissioning – sound principles for rehabilitation and restoring land to same condition or better than before.
  - This has been addressed in the EIS in detail.



Legend

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

FIGURE 3.6

Mapped BSAL Area

Image Source: ESRI Basemap (2021) Data source: NSW DPIE (2020), Umwelt (2021)

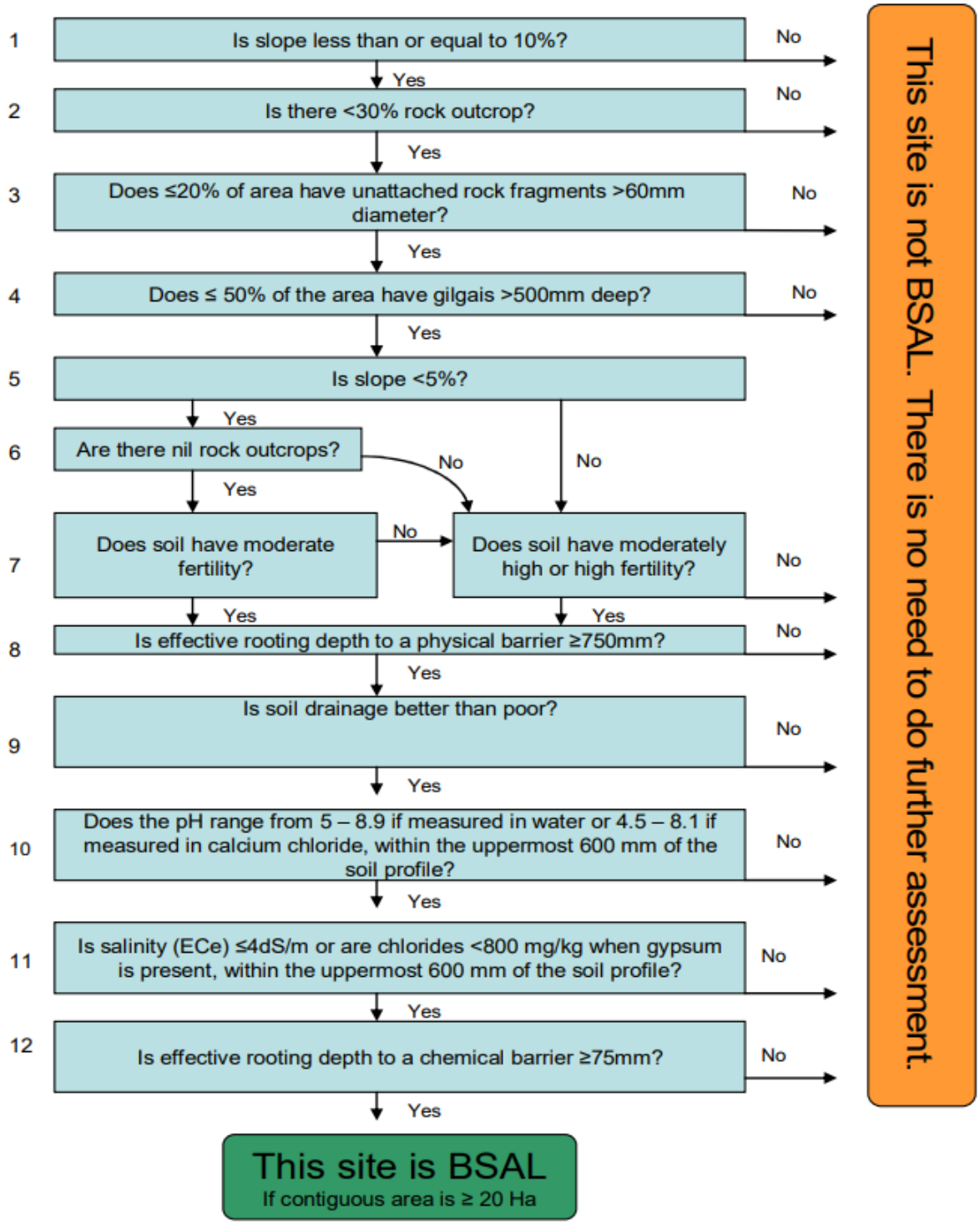


Figure 3.7 BSAL Site Verification Flow Chart Criteria (DPIE 2013)

4.0 Assessment Results

4.1 Results of Field Assessment

As shown in **Figure 3.1**, the desktop assessment identified the predominant soil types based on the *Australian Soil Classification* to be Sodosols and Ferrosols, with *Great Soil Groupings* identified as Euchrozoms and Solodic Soils (shown in **Figure 3.2**).

Following the field survey two predominant soil types (soil mapping units) were identified which included Sodosols and Chromosols, with the locations of the identified soil types shown in **Figure 4.1** and discussed below.

Physical soils descriptions and photographs of each sampling site and soil profile are attached in **Appendix B**.

4.1.1 Chromosols

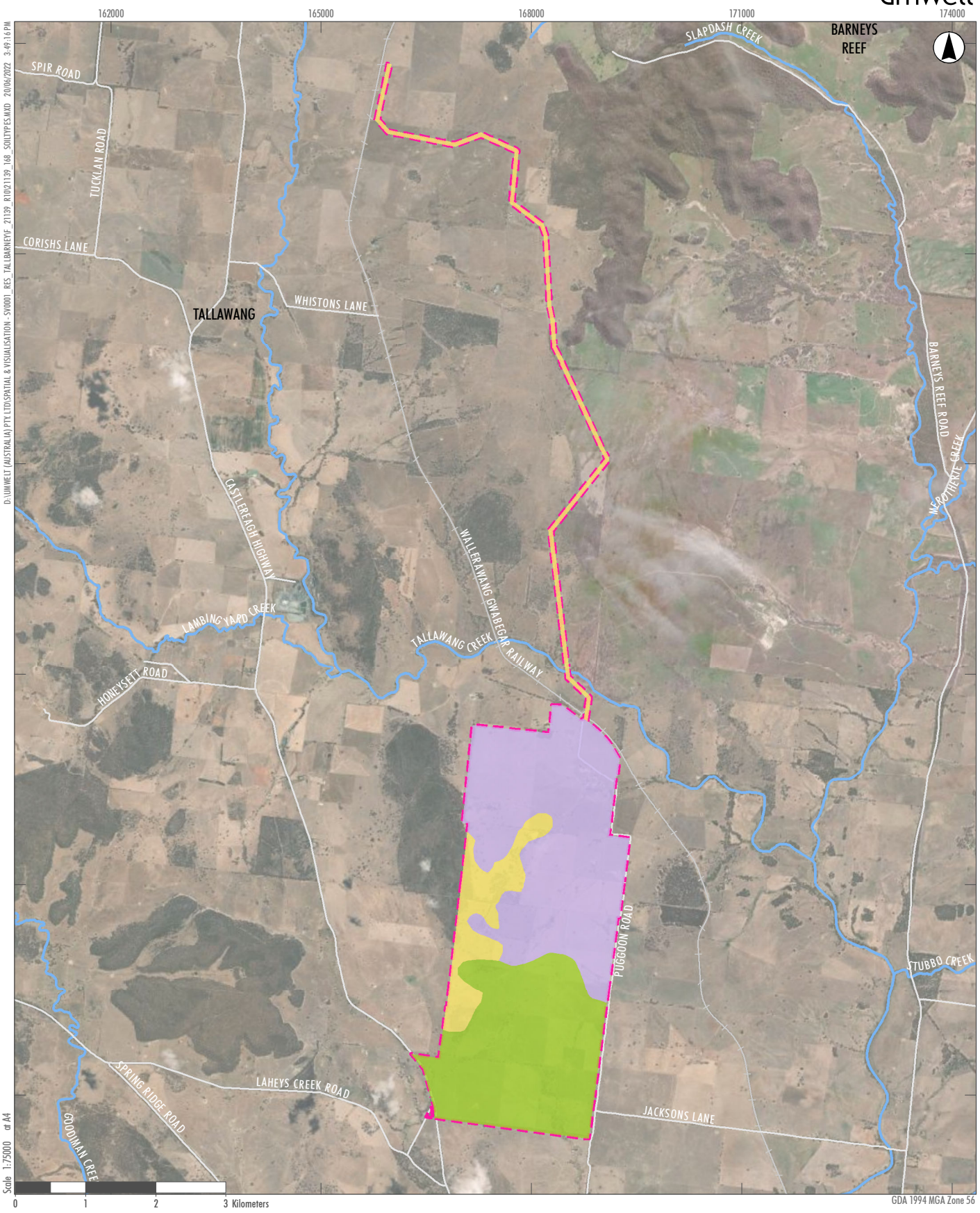
Chromosols have a strong texture contrast between A and B horizons. There is a clear or abrupt textural B horizon in which the upper portion of the horizon (0.2m) is not strongly acid or sodic and can include vertic properties. These soils are the most commonly encountered soils under agricultural use in Australia.

Chromosols identified during the field survey include Non-Sodic Mesotrophic Yellow Chromosol (Site 1), Non-Sodic Mesotrophic Red Chromosols (Site 2), Mesotrophic Yellow Chromosols (Site 5), Mesotrophic Brown Chromosols (Site 6), Dystrophic Yellow Chromosols (Site 7), Dystrophic Yellow Chromosols (Site 9), and Bleached-Sodic Dystrophic Red Chromosols (Site 12).

4.1.2 Sodosols

Sodosol are soils with strong texture contrast between A horizons and sodic B horizons which are not strongly acid and in which the major part of the upper 0.2 m of the B2 horizon (or the major part of the entire B2 horizon if it is less than 0.2m thick) is sodic, that being soils with an *Exchangeable Sodium Percentage* (ESP) >6 %).

Sodosols identified during the field survey included Mottled-Subnatric Sodic Eutrophic Yellow Sodosols (Site 3), Dystrophic Sodic Red Sodosols (Site 4), Dystrophic Sodic Yellow Sodosols (Site 8), Mottled-Subnatric Mesotrophic Sodic Yellow Sodosols (Site 10), and Mottled-Subnatric Mesotrophic Sodic Yellow Sodosols (Site 11). Soils at these sites were generally sandy loams being granite derived soils.



Legend

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

Soil Type

- Chromosol
- Sodosol
- Unknown - Not Assessed

FIGURE 4.1

Identified Soil Types

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

4.2 Results of Laboratory Analysis

Topsoil and subsoil analysis was conducted on the 38 samples taken from the 12 sampling locations. Topsoil samples were taken directly from the top 100-150mm, with subsoil samples taken from each soil profile / stratum identified below the topsoil.

The results of the soils survey are presented in **Appendix D**, with the analytical results shown in **Appendix C**.

The key analytical results of the assessment are summarised below.

4.2.1 pH and Electrical Conductivity (EC)

In soils, pH is a measure of alkalinity/acidity which is based on the amount of free hydrogen atoms in a soil solution, the greater the amount the more acidic the soil is. Values <7 are considered acidic, with values >7 considered alkaline.

EC is a measure of salinity and is measured in decisiemens per metre (dS/m). The EC value used is 'EC_E' which is the EC of saturated extracts and is calculated based on the estimated water holding capacities of the soil based on soil texture (approximate percentage of sand, silt, clays).

4.2.1.1 Topsoils

The pH values for the topsoil ranged from 5.27 to 6.45 which is classified as strongly acidic to slightly acidic. These ranges are generally not considered prohibitive to plant grow or likely to impact metal structures.

The EC (EC_E) in topsoil samples ranged from 0.15 to 0.69, which is classified as 'non-saline' (Hazelton and Murphy, 2016).

4.2.1.2 Subsoils

The pH values in the topsoil ranged from 5.65 to 8.47 which is classified as moderately acidic to moderately alkaline.

The ECe values range from 0.19 to 2.34, classified as 'non-saline' to 'slightly saline' (Hazelton and Murphy, 2016).

4.2.1.3 Summary

The results from both topsoil and subsoil analysis for pH and EC indicate that acidity/alkalinity and salinity do not present a constraint to plant growth or to the development of the Project Area. An exception to this was Site 2 and Site 10 topsoils samples which identified strongly acidic soils (below marginally acidic) which may present a constraint to plant growth as increased acidity increases exchangeable aluminium in soils that can be toxic to plants but is unlikely to impact construction materials.

It is noted that at the time of sampling significant rainfall had occurred, resulting in wet and in some instances saturated soils. This may 'dilute' soil salinity, therefore salinity results may be lower than under dryer conditions.

Additionally, no acid sulphate soils were identified.

4.2.2 Exchangeable Sodium Percentage (ESP) & Dispersion

4.2.2.1 Topsoils

ESP (a measure of Sodicity which occurs when exchangeable sodium on the cation exchange complex leads to clay dispersion in the soil) ranged from -0.2 to 7.6, classified as non-sodic (<3), slightly sodic (3-6), and sodic (6 – 14). The results identified the following.

- Site 3 topsoils is classified as sodic,
- Sites 4 and 11 topsoils are classified as slightly sodic, and
- The remaining topsoils Sites are classified as non-sodic.

The dispersibility (erosive potential) of the soils, based on the Emerson Aggregate Test (EAT), ranged between classes 2 and 4, classified as 'slightly dispersive' to 'negligible/aggregated' (non-dispersive). The results identified the following.

- Sites 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 are classified as slightly dispersive
- Site 1 is not dispersive.

4.2.2.2 Subsoils

The ESP ranged from -0.4 to 13, classified as non-sodic (<3) to sodic (6 – 14). The results identified the following.

- Sites 3, 4, 8, 10 and 11 subsoils are classified as sodic
- Sites 5, 7 and 12 subsoils are classified as slightly sodic, and
- The remaining subsoil sites are classified as non-sodic.

The dispersibility of the soils, based on the EAT, ranged between classes 2 and 4, classified as 'moderately dispersive' to 'negligible/aggregated' (non-dispersive). The results identified the following.

- Sites 3, 4, 9,10 and 11 contained 'moderately dispersive' soils
- Sites 5, 6, 7, 8, and 12 continued 'slightly dispersive' soils, and
- Site 1 contained 'non-dispersive' soils.

4.2.2.3 Summary

Sodic soils are identified at Site 3, 4, 8, 10 and 11, with slightly sodic soils identified at Sites 5, 7 and 12. All Sites (except Site 1) contained moderately or slightly dispersive soils.

4.2.3 Effective Cation Exchange Capacity (ECEC)

Cation Exchange Capacity (CEC) is an indication of the number of negative charges on soil particles and its ability to hold/adsorb and release the positively charged cations into the soil solution where plants can access these nutrients, and is used as a measure of soil fertility. Effective Cation Exchange Capacity (ECEC) refers to the sum of Calcium, Magnesium, Potassium, Sodium, Aluminium and Hydrogen giving a more accurate indication of soil CEC, which is what was measured in this assessment.

4.2.3.1 Topsoils

The ECEC for the topsoil ranged from 2.5 to 7.0 cmol(+)/kg, classified as low (<5) to moderate (5-15). Only Site 3 exceeded 5.0 cmol(+)/kg.

4.2.3.2 Subsoils

The ECEC for the subsoil ranged from 1.4 to 28.8 cmol(+)/kg, classified as low (<5) to high (>15). Only Site 3 exceeded 5.0 cmol(+)/kg. ECEC was generally higher in the subsoils, likely due to the higher percentage of clays with increasing depths.

4.2.3.3 Summary

The results from both topsoil and subsoil analysis identified soils with low ECEC, which indicates that the soils have a low resistance to changes in soil chemistry caused by land uses, particularly agriculture. As such, it is a major contributor to soil structure stability, and chemical changes (fertilizer inputs, ameliorants etc).

4.2.4 Colwell Phosphorus

4.2.4.1 Topsoils

Colwell P (plant available phosphorous) ranged from 19 to 122 mg/kg which is classified as extremely low to very high (Hazelton and Murphy, 2016).

The topsoil results are summarised as follows.

- Sites 8, 10 and 11 contained ‘very high’ levels of Colwell P
- Sites 1, 2, and 5 contained ‘high’ levels of Colwell P
- Site 9 contained ‘medium’ levels of Colwell P
- Site 4 and 6 contained ‘low’ levels of Colwell P
- Site 12 contained ‘very low’ levels of Colwell P
- Sites 3 and 7 contained ‘extremely low’ levels of Colwell P

4.2.4.2 Subsoils

Colwell P (plant available phosphorous) ranged from 8 to 71 mg/kg which is classified as extremely low to very high (Hazelton and Murphy, 2016).

The subsoil results are summaries as follows.

- All Sites at varying depths above 750mm bgl contained ‘extremely low’ levels of Colwell P.

4.2.4.3 Summary

The higher levels of Colwell P identified in topsoil samples is predominately due to the broad surface application of phosphorous fertilizers in the sown/cropped paddocks. Subsoil at all sites contained ‘extremely low’ levels of Colwell P, indicating the natural/background level of plant available P in the soils is ‘extremely low’ without ameliorants.

These results indicated that plant growth may be impacted by the identified levels of Plant available P.

4.2.5 Calcium: Magnesium Ratio (Ca: Mg Ratio)

4.2.5.1 Topsoils

The Ca:Mg ratio for the topsoils ranged between 0.7 to 4.9, classified as Low (<2) to 'moderate to balanced' (<5 – 2). Sites 3, 4, 10 and 11 had low results, indicating that magnesium is significantly higher than calcium, which may lead to an increase in erosion potential at these sites.

4.2.5.2 Subsoils

The Ca:Mg ratio for the subsoils ranged between 0.01 to 4.4, classified as Low (<2) to 'moderate to balanced' (<5 – 2). Sites 2, 3, 4, 5, 6, 7, 8, 10, 11 and 12 had low subsoil results, indicating that magnesium is significantly higher than calcium, which may lead to an increase in erosion potential at these sites.

4.2.5.3 Summary

The results indicate that the sites identified (Sites 2, 3, 4, 5, 6, 7, 8, 10, 11 and 12) have an imbalanced calcium: magnesium ratio that has the potential to lead to an increase in erosion potential. Additionally, this imbalance may result in impaired plant growth which may impact plant establishment following construction.

4.3 Results of Land and Soil Capability (LSC) Assessment

The 12 soil profile sites within the Project Area were assessed in reference to LSC Guideline as discussed in **Section 3.3** to determine the LSC classification. Regional mapping (DPIE 2021) identified the Project Areas as Class 3 and Class 5 LSC (refer to **Figure 2.2**). However, following field survey and review of the laboratory results, the LSC classes identified in the Project Area are classified as Classes 4 and 6.

The results of the assessment are identified in **Table 4.1** and shown in **Figure 4.2**.

Table 4.1 Land and Soil Capability Assessment Results

Site	Water Erosion Slope Class	Wind Erosion Class	Structural Decline Class	Soil Acidification Class	Salinity Class	Waterlogging Class	Shallow Soil Class	Mass Movement Class	LSC Class
1	3	3	4	3	2	3	2	1	4
2	3	4	4	3	2	3	2	1	4
3	5	2	6	3	2	3	4	6	6
4	3	3	4	3	2	3	2	1	4
5	3	3	4	2	2	3	2	1	4
6	3	3	4	3	2	3	2	1	4
7	3	2	3	2	2	4	2	1	4
8	3	3	4	3	2	3	2	1	4
9	3	3	4	3	2	3	2	1	4
10	3	3	4	3	2	3	2	1	4
11	3	3	4	3	2	3	2	1	4
12	3	3	4	3	2	3	2	1	4

The results of the assessment identified the following land classes, and their limitations.

Class 4 (Sites 1, 2, 4, 5, 6 & 7- 12)

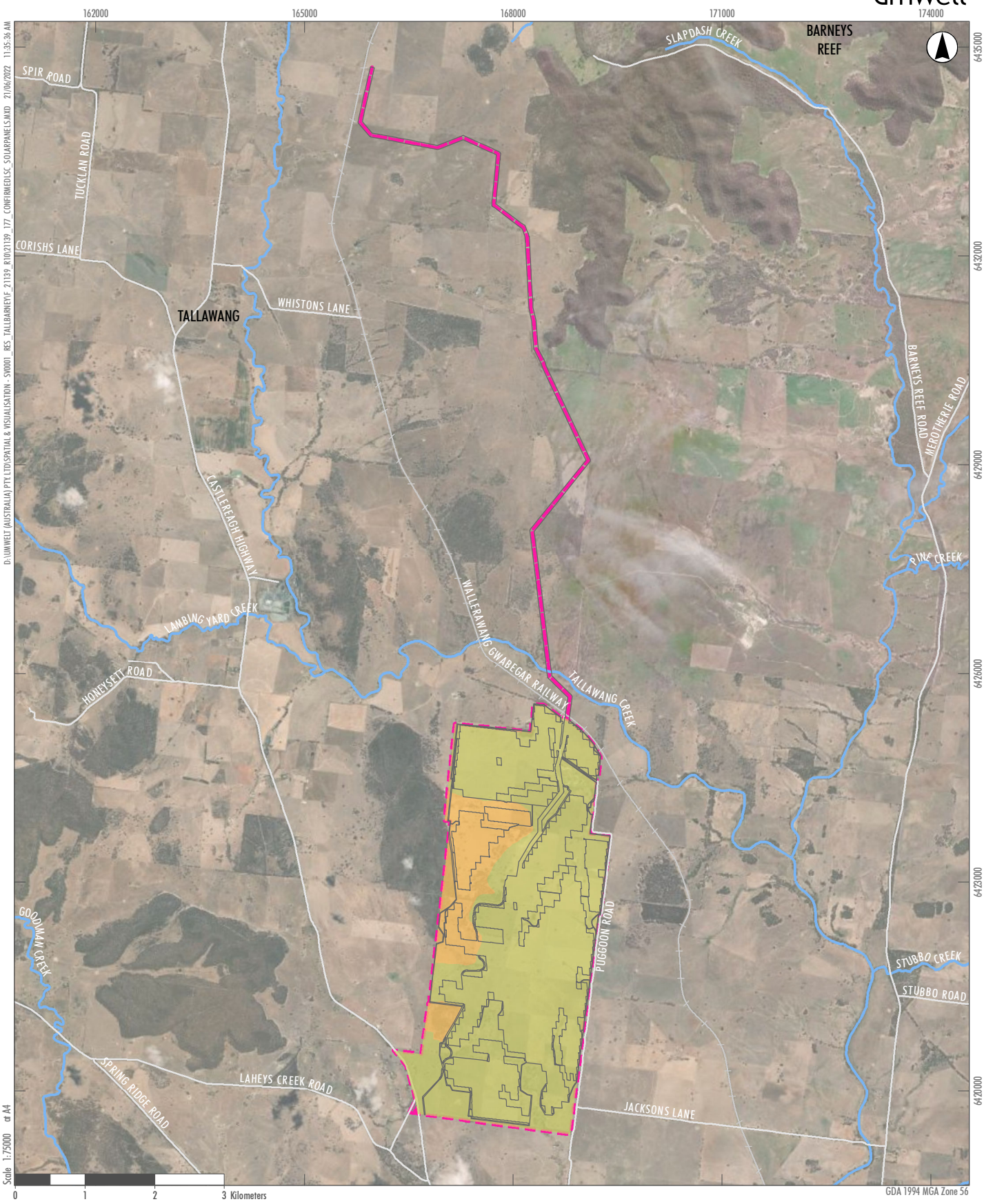
These 11 sites were classified as Class 4 land. This classification indicates the land is moderate capability land with moderate to high limitations for high-impact land uses. This land will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment, and technology.

Additionally, Sites 5 and 6 were considered as Class 4 as the chemical fertility status at these two sites is considered to be poor based on a low CEC and low Cowell P levels, and anecdotal evidence from the landholder of erosion and this area not being suitable for cropping (any attempt at cropping in the past has failed). Cowell P levels are high in topsoil at Site 5 due to recent phosphorous fertilizer application, but extremely low in subsoils >100mm depth, indicating naturally occurring levels are low or depleted.

Class 6 (Site 3)

This site is classified as Class 6 land. This classification indicates the land is low capability land with has very high limitations for high-impact land uses. Land use is restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.

Additionally, areas within the Project Site contained rock outcrops, and although they were not assessed in the field would meet the classification of Class 6 Land.



Legend

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

Land and Soil Capability

- 4 - Moderate to Severe Limitations
- 6 - Very Severe Limitations

FIGURE 4.2

Confirmed Land and Soil Capability

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

4.4 Identified Limitations

4.4.1 Erosion

Soil erosion is the loss of soil from the landscape predominately through the action of wind and water, with areas of erosion, predominately gully and rill erosion identified across the Project Area (refer to photographs in **Appendix B**). As discussed below, this erosion is due to the chemical properties of the soil, physical soil properties, and land management practices such as not maintaining ground cover, not maintaining riparian zone vegetation, overgrazing, or the use of farm machinery.

To establish the risk of soil erosion, the two primary laboratory tests were conducted (as discussed in **Section 4.2.2**) which included Exchangeable Sodium Percentage (ESP), to measure the soil sodicity, and the Emerson Aggregate Test (EAT), which measures dispersibility of soils. An increased risk of erosion is likely to occur where sodic or dispersive soils (high ESP, low EAT) are identified and are likely to be disturbed by the development.

The laboratory analysis identified both sodic and dispersive soils within the Project Area. In the instance where sodic/dispersive soils are identified, application of an ameliorate such as gypsum may assist in improving soil structure.

The proposed management practices which should ensure that any trenching through sodic soils during construction is to include soil amendment with gypsum at a rate to be determined prior to the excavation, but to ensure appropriate coverage of the soils.

Additionally, erosion risk is increased where there is an imbalance of Ca:Mg ratio is identified. Again, the application of gypsum, which contains Calcium is recommended to counter this imbalance.

Further management and mitigation measures are discussed in **Section 6.0**.

4.4.2 Fertility

Following analysis, low ECEC and low Cowell P levels (both indicators of soil fertility) were identified. Site soils were generally low in fertility which may affect the establishment and growth of vegetation in exposed surfaces.

The application of appropriate fertilisers and/or organic materials if growth of vegetation appears limited may be required. These soils should be carefully grazed to maintain vegetation cover.

4.4.3 Compaction

The field survey identified potential clay pans and compaction issues that are likely associated with the long-term use of the Project Area for agriculture production.

Soil compaction issues can potentially impact plant growth and will require ripping/tilling to remediate if inhibited vegetation growth is identified.

4.5 Results of BSAL Assessment

As shown in **Table 4.2**, the mapped BSAL areas and areas outside the mapped BSAL were verified as non-BSAL.

The verification assessment for the Sites sampled within the mapped BSAL area are summarised below.

Site 3 was verified non-BSAL due to the following:

- Presence of >30% rocky outcrops,
- Distinct mottling above 750mm bgl (indicator of water logging of subsoil when wet), and
- Low soil fertility and sodic soils

laboratory analysis confirmed (extremely low plant available Colwell P and sodicity)

Identified as a Mottled-Subnatric Sodic Eutrophic Yellow Sodosol which has an inherently moderately low fertility.

Sites 5 and 7 were verified as non-BSAL due to the following.

- Low soil fertility.

although being identified as a Mesotrophic Yellow Chromosol which has inherently a moderate to high soil fertility (BSAL Guidelines), laboratory analysis confirmed low soil fertility as shown by the low ECEC and Cowell P of soils at these Sites.

- A physical barrier to effective rooting depth was identified.

This included a high gravel content within the soil profile and refusal of the hand auger in the clay stratum at 500mm bgl (Site 5 only), with the likely encounter of a clay pan.

Both sites included mottling in the B2 horizon, evidence of water logging.

All remaining sites, those not mapped as BSAL, were verified as non-BSAL predominately due to poor soil fertility, waterlogging (evidenced by mottling/gleying), and some sites being sodic soils.

Table 4.2 BSAL Verification Assessment

SITE	SLOPE	ROCK	ROCK	GILGAI	SLOPE	ROCK	FERTILITY		DEPTH	DRAINAGE	pH	ECe	ERD	Verified BSAL
	1. Is slope < 10%?	2. Is there < 30% Rock Outcrop?	3. < 20% unattached Rock Fragments > 60mm?	4. Does < 50% have Gilgai >500mm deep?	5. Is Slope <5%?	6. Are there nil rock outcrops?	7a. Does Soil Have Moderate Fertility?	7b. Does soil have moderately high or high fertility?	8. Is Effective Rooting Depth to a physical barrier >750mm?	9. Is drainage better than poor?	10. Is pH between 5.0 and 8.9?	11. Is salinity (ECe) < 4 dS/m	12. Is Effective Rooting Depth to a chemical barrier >750mm?	
1	Yes	Yes	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	No
2	Yes	Yes	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	No
3	Yes	No	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	No
6	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	No
7	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	No
8	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	No
9	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	No
10	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	No
11	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	No
12	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes	Yes	Yes	No

5.0 Assessment of Impacts to Agriculture

5.1 Land to be temporarily removed from Agriculture

The Project intends to lease up to 1,370 ha land (mostly poor to moderate agricultural land) from the respective landowners for a maximum term of 38 years (allowing for a 34-month construction period and 35-year operational life). The land use will change from agricultural land to electricity generation.

During the 35-year operational life of the Project, the land will be able to be utilised for sheep grazing (as discussed in **Section 5.7**). This has the benefit of allowing the land holders to continue agricultural activities.

During the operation of the Project, RES will implement measures to manage the co-existence of farming activities and the operation of the Project. As detailed in **Section 6.0**, an Operational Environmental Management Plan (OEMP) will be developed in consultation with the host landholders and DPI Agriculture.

5.2 Land to be returned to Agriculture

Once the Project is decommissioned the Project Area will be remediated to enable agricultural production including cropping and grazing to resume.

As detailed in **Section 6.0**, a Rehabilitation Management Plan will be developed in consultation with the host landholders.

5.3 Soil erosion

Due to the presence of sodic and dispersive soils within the Project Area, the risk of erosion on site due to construction activities is considered high. Excavation of subsoils should be limited where possible, and excavated subsoils should be stockpiled and contained to avoid potential dispersion and sediment transfer. Disturbance to ground cover should be limited where possible. Maintenance of ground cover will also aid in the prevention of topsoil losses from wind erosion.

All construction and decommissioning activities for the Project will be undertaken in accordance with an erosion and sediment control plan (ESCP) as detailed in **Section 6.0**. Post approval, a Construction Environmental Management Plan (CEMP) will be prepared by RES that identifies erosion and sediment control mitigation measures prior to works commencing.

Similarly, the operation of the Project would be in accordance with an OEMP that will detail measures to limit erosion during the operation of the Project.

5.4 Weeds, Pests and Farm Biosecurity

With mitigation measures appropriately in place there is a low potential for weeds and invasive pests to spread or impact neighbouring land.

As detailed in **Section 6.0**, RES will prepare and implement an Operation Environmental Management Plan (OEMP) which would effectively outline the list of mitigation measures and detail any management programs e.g. weed spraying program to effectively manage invasive species.

Biosecurity is defined in the NSW Biosecurity Strategy 2013 – 2021 (NSW DPI, 2013) as 'protecting the economy, environment, and community from the negative impacts of pests, diseases and weeds'. The strategy provides measures to prevent pest, weeds, and disease from entering and establishing in Australia. Ensuring appropriate measures to this risk is important and will be addressed in the OEMP.

5.5 Spraying Impacts

Weed spaying would be undertaken throughout the Project Area to manage and control targeted weed species. Spray drift from weed spraying has the potential to impact neighbouring properties affecting nearby crops, livestock, and human health. In accordance with the *Pesticides Act 1999* alongside advice provided by the EPA NSW a variety of strategies would be implemented to minimise conflict and/or damage arising from spray drift. These strategies include:

- monitoring environmental conditions e.g. wind and rainfall before, during and after spraying
- only registered pesticides that carry an APVMA-approved label would be used
- adjacent areas containing susceptible crops and sensitive areas would be checked before spraying
- spray applicators would be fully trained and accredited
- neighbouring properties would be provided with notifications prior to spraying
- aerial spray would not be undertaken during a surface temperature inversion
- all pesticide labels would read and followed prior to use.

5.6 Socio-economic Impacts

Socio-economic impacts associated with the agriculture industry as a result of the Project are expected to be negligible. The Project Area intends to lease up to 1,370 ha of agricultural land accounting for only 0.00006% of the total amount of land associated with agricultural use within the Far West and Orana Region of NSW (according to the ABS 2019-2020) resulting in a negligible reduction in the overall productivity of the region.

As there will be negligible impact to agriculture activity (with grazing able to continue on the Project Area), impacts to supporting services, processing and value adding industries relevant to agricultural enterprises will be negligible. The leasing of the land for the purpose of solar generation provides additional benefits to the landholder, as it will provide a dual source of income, particularly during extreme drought conditions, such as those experienced in 2017 – 2020 drought where agricultural production and on farm income were severely limited.

Furthermore, no other industries have been identified to be negatively impacted by the Project.

5.7 Potential for Land Sharing

Once construction has been completed there would be an opportunity to maximise the Project Areas potential and offer a dual purpose for the Project Area allowing the area to be grazed by livestock, in particular sheep.

The *Australian Guide to Agrisolar for Large-Scale Solar, for proponents and farmers* (Agrisolar Guide 2021) was prepared by the Clean Energy Council (March 2021) to act as a guide for to co-sharing of agriculture and solar farming in Australian. The *Agrisolar Guide* 2021 identified that there were at least 13 large-scale solar farms successfully grazing sheep (identified as 'solar grazing') in Australia in 2020 and identified a number of successfully trialled positive benefits including.

- Sheep would help control vegetation growth within the Project Area, reducing the need for mowing or spraying, which will reduce grass fire risks in the area.
- Maintenance costs are also reduced as result of vegetation being controlled by sheep.
- Animal welfare conditions are improved, with
    - the solar panels providing shade and protection from strong winds for sheep resulting in higher quality wool
    - safety from predators is enhanced by the installation of secure boundary fencing
    - cover provided by the panels improves safety from wedge-tailed eagles.

The *Agrisolar Guide 2021* provides a number of recommendations to ensure land sharing success, these recommendations will be incorporated into the OEMP to be prepared for the Project. This will include measures for managing stock (sheep), including a requirement to keep the stock in good health, ensuring frequent shearing (to keep wool growth low), ensure mustering is conducted in an agreed safe manner, and that any fatalities are managed by the farmer.

5.7.1 Recent Trials

Commencing in February 2021, RES in partnership with a local livestock owner have conducted ongoing trials of sheep and solar farmland sharing at the Bomen Solar Farm, Wagga Wagga NSW. There have been positive results to date, with the sheep being used to manage ground cover within the solar farm. Following the success of this trial, plans to commence sheep grazing on RES' Emerald Solar Farm in Queensland are underway following the completion of weed control measures.

Results from this trial and any other trails will be incorporated in the Sheep Grazing Vegetation Management Plan (SGVMP) to be incorporated into the Operational Environmental Management Plan prepared for the Project Area.

6.0 Management and Mitigation Measures

The key issues identified during the assessment and their management and mitigation measures include:

- Management of farming enterprise and the Project.
    - Post approval, RES will develop an Operational Environmental Management Plan (OEMP) which will incorporate a Sheep Grazing Vegetation Management Plan (SGVMP) that will outline management measures for solar grazing in line with the Agrisolar Guide (2021) as well as other animal health and welfare standards and guidelines.
    - This will include measures to manage the stock appropriately, including a requirement to keep the stock in good health, ensuring frequent shearing (to keep wool growth low), ensure mustering is conducted in an agreed safe manner, and that any fatalities are managed by the farmer.
    - As per the SGVMP to be prepared, RES will enter into a *grazing agreement* (agistment contract) with the livestock owner (ideally a landowner/s).
    - The OEMP will be developed in consultation with the host landholders and DPI Agriculture and will be implemented post construction.
- Soil erosion, fertility, and compaction.
    - Post approval, a Construction Environmental Management Plan (CEMP) will be prepared by RES that identifies erosion and sediment control mitigation measures prior to works commencing, including mitigation measures discussed in **Section 4.4**. An erosion and sediment control plan (ESCP) will be developed as part of the CEMP for the Project, in accordance with the *Managing Urban Stormwater: Soils and Construction Volume 1* (NSW DPIE, 2004) "The Blue Book". The ESCP will be implemented.
    - The OEMP for the Project will detail requirements to manage erosion, soil fertility and compaction during the operation of the Project.
- Rehabilitation.
    - The rehabilitation of the Project Area will be conducted in accordance with the Rehabilitation Management Plan to be prepared as part of the OEMP for the Project.
- Weeds, pests, and biosecurity.
    - The OEMP will detail the management requirements, including:
        - Inspection of all vehicle and machinery entering the Project Area, cleaned if applicable to remove weeds including seeds.
        - Limit vehicle access to the established internal road network.

7.0 Conclusion

The key findings of the Soil, Land Capability and Agriculture assessment are:

- Sodic soils are identified at Site 3, 4, 8, 10 and 11, with slightly sodic soils identified at Sites 5, 7 and 12. All Sites (except Site 1) contained moderately or slightly dispersive soils.
- No *Biophysical Strategical Agricultural Land* was identified within the Project Area.
- Based on the Australian Soil Classification, soil types were identified as Chromosols and Sodosols.
- Following field survey and laboratory analysis, the Project Areas are mapped as Class 4 and Class 6 Land (prior to ground truthing, regional mapping indicated Class 3 and Class 5 Land).
    - Class 4 Land is moderate capability land with moderate to high limitations for high-impact land uses.
    - Class 6 Land is low capability land with has very high limitations for high-impact land uses.
- Agricultural activity within the Project Area will be limited to grazing activities during the operational phase and may return to the existing agricultural production (grazing and cropping) following decommissioning and rehabilitation.
- Based on the findings of this report, the long-term risks to soil, land capability and agriculture are low and can be managed by the recommendations provided in **Section 6.0**.

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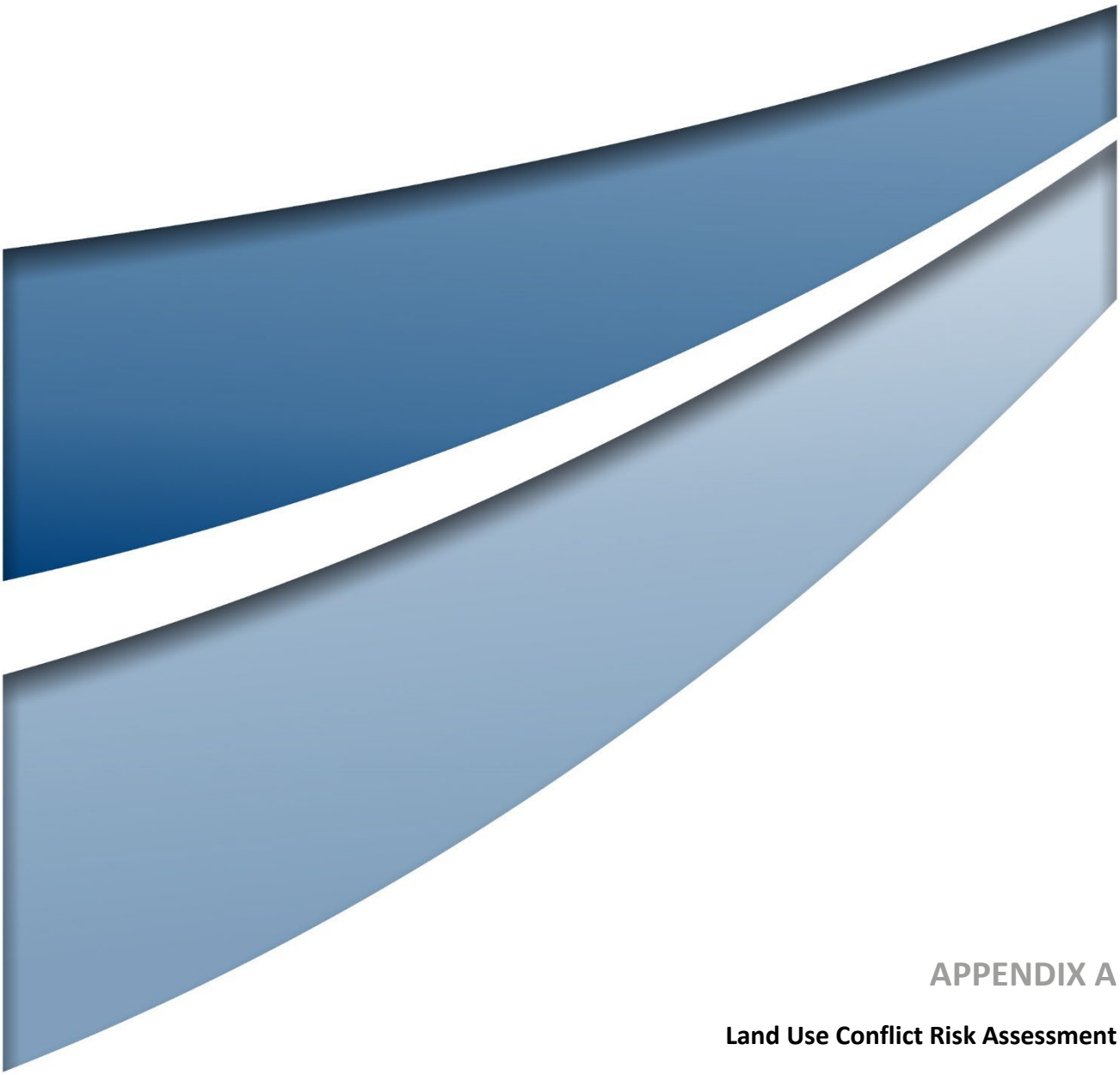

APPENDIX A

Land Use Conflict Risk Assessment

umwelt
Environmental & Social Consultants

res
power for good

TALLAWANG SOLAR FARM

Land Use Conflict Risk Analysis

FINAL

June 2022

TALLAWANG SOLAR FARM

Land Use Conflict Risk Analysis

FINAL

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

Project Director: Malinda Facey
Project Manager: Marion O'Neil
Technical Manager: David McQueeney
Report No. 21139/R10/Appendix A
Date: June 2022

Environmental & Social Consultants

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

Acknowledgement of Country

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

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
Final	Marion O'Neil	14 April 2022	Malinda Facey	14 April 2022

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Appendices

1.0 Introduction

Umwelt (Australia) Pty Limited (Umwelt) has been engaged by RES Australia Pty Ltd (RES) to conduct a Land Use Conflict Risk Assessment (LURCA) to support the Environmental Impact Statement (EIS) that has been prepared as part of the State Significant Development (SSD) Development Application for a proposed solar farm located at Tallawang, New South Wales (NSW).

1.1 Project Overview

The Project includes up to 500 megawatts (MW) of solar electricity generation with a Battery Energy Storage System (BESS) of approximately 200 MW/400 MW-hours (the Project).

The Project lies within the Central West Orana Renewable Energy Zone (CWO REZ), established under the NSW Government's Electricity Strategy, which has been identified as a suitable location for renewable energy projects.

The Project includes the construction, operation and decommissioning of the proposed solar farm, BESS, and associated infrastructure, such as operations and maintenance buildings, civil works, and electrical infrastructure (including a new onsite substation and a new 330kV overhead transmission line) required to connect to the electricity transmission network. The Project will have access from the Castlereagh Highway (**Figure 1.1**).

One new substation is proposed, with two possible locations currently included in the conceptual layout. Both locations will connect to the new 330 kilovolt (kV) transmission line proposed as part of the Project which traverses the proposed Barneys Reef Wind Farm project directly to the north (shown on **Figure 1.1**). The Barneys Reef Wind Farm project is proposed by RES and subject to a separate approvals process. The alignment of the proposed overhead transmission line will cross the Wallerawang Gwabegar Railway line north of the Project.

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

The Project will have an operational lifespan of 35 years. It is proposed that during the Project's operational life, the land will also be utilised sheep grazing.

1.2 Purpose and Scope of Works

1.2.1 Purpose

The purpose of a LUCRA is to identify land use and potential land use conflicts with neighbouring land uses and implement mitigation measures to minimise potential impacts. This is defined by the Department of Primary Industries (DPI) as to:

- Accurately identify and address potential land use conflict issues and risk of occurrence before a new land use proceeds or a dispute arises.

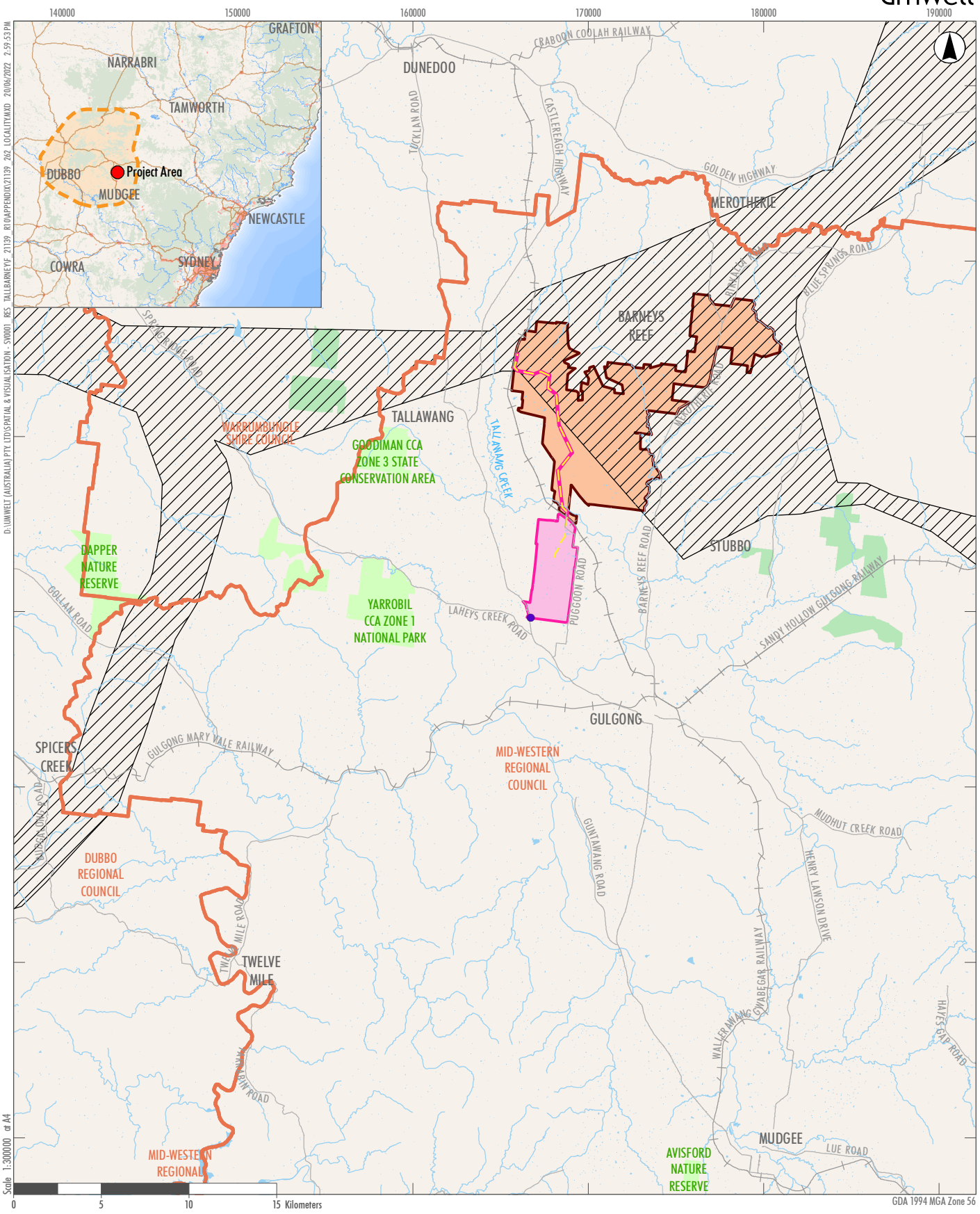
- Objectively assess the effect of a proposed land use on neighbouring land uses.
- Increase the understanding of potential land use conflict to inform and complement development control and buffer requirements.
- Highlight or recommend strategies to help minimise the potential for land use conflicts to occur and contribute to the negotiation, proposal, implementation, and evaluation of separation strategies.

1.2.2 Scope of Works

This LUCRA has been prepared in accordance with the *Land Use Conflict Risk Assessment Guide* (2011) fact sheet provided by the NSW DPI. This assessment has also been prepared to meet the DPIE Secretary's Environmental Assessment Requirements (SEARs) for the Project. The SEARs required the *'completion of a Land Use Conflict Risk Assessment in accordance with the Department of Industry's Land Use Conflict Risk Assessment Guide;'*

The guidelines set out four steps in undertaking the assessment. This includes:

- **Step 1: Gather information** – including describing the proposed land use change, development, and activities associated with it as well as understand the Site history and other land uses and environmental considerations.
- **Step 2: Evaluate the risk level of each activity** – Record each activity on the risk assessment matrix and identify the level of risk of a land use conflict arising from the activity.
- **Step 3: Identify risk management strategies and responses to mitigate potential disputes and conflicts** – including identifying management strategies for each activity, prioritising strategies and re-assess the risk base on these strategies and providing performance targets for each activity.
- **Step 4: Record the results of the LUCRA** – summarising the key issues, their risk level, and the recommended management strategies.



Legend

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

FIGURE 1.1

Location and Local Context

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

2.0 Information Gathering

2.1 Project Area Location and Zoning

The Project is approximately 8 km northwest of Gulgong within the Mid-Western Local Government Area (LGA) as shown on **Figure 1.1**. The Project Area is zoned RU1 Primary Production under the *Mid-Western Regional Local Environmental Plan 2012* (Mid-Western Regional LEP). Electricity generating works are permitted with consent in this zone. In addition, the proposed 330 kV overhead transmission line will cross the Wallerawang Gwabegar Railway line, which is zoned SP2 Infrastructure under the LEP.

The objectives of RU1 Primary Production zone are:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To encourage diversity in primary industry enterprises and systems appropriate for the area.
- To minimise the fragmentation and alienation of resource lands.
- To minimise conflict between land uses within this zone and land uses within adjoining zones.
- To maintain the visual amenity and landscape quality of Mid-Western Regional by preserving the area's open rural landscapes and environmental and cultural heritage values.
- To promote the unique rural character of Mid-Western Regional and facilitate a variety of tourist land uses.

The Project Area is located across 35 freehold cadastral lots, which are listed in **Appendix A**. RES has entered into landholder agreements with the associated owners (hereafter referred to as host landholders) allowing RES to lease the land over approximately 38 years.

Approximately 1,145 ha of the Project Area is subject to mineral exploration licences (EL8160 and EL8405), see **Figure 2.1**. No part of the Project Area is subject to a mining/production lease.

RES will lease up to the total of 1,370 ha of land from the respective landowners for a maximum term of 38 years (allowing for a 34 month construction period and 35 year operational life).

After the Project reaches the end of its operational life, the Project would either be upgraded (pending any additional approval requirements) or decommissioned. Decommissioning would involve removing all above and below ground project infrastructure and returning the development footprint to its pre-existing land use, or another land use in consultation with the landholders, as far as practicable.

2.2 Proposed Land Use

The Project will change the current land use from agricultural land to electricity generation. Following the construction period, grazing activities (sheep) will be reinstated once pasture is re-established. The land uses within the transmission line easement would not change. The Project is permissible with consent on

prescribed rural zoned land under the Mid-Western Regional LEP as well as the *State Environmental Planning Policy (Transport and Infrastructure) 2021*.

2.3 Nature of the Precinct Where the Land Use Change and Development is Proposed

Land within and surrounding the Project Area has been subject to extensive vegetation clearing associated with historic agricultural land uses and is predominately utilised for grazing activities. Agriculture (primarily sheep grazing with some cattle grazing) is the main land use in the LGA.

Other key land uses and features in the area surrounding the Project include:

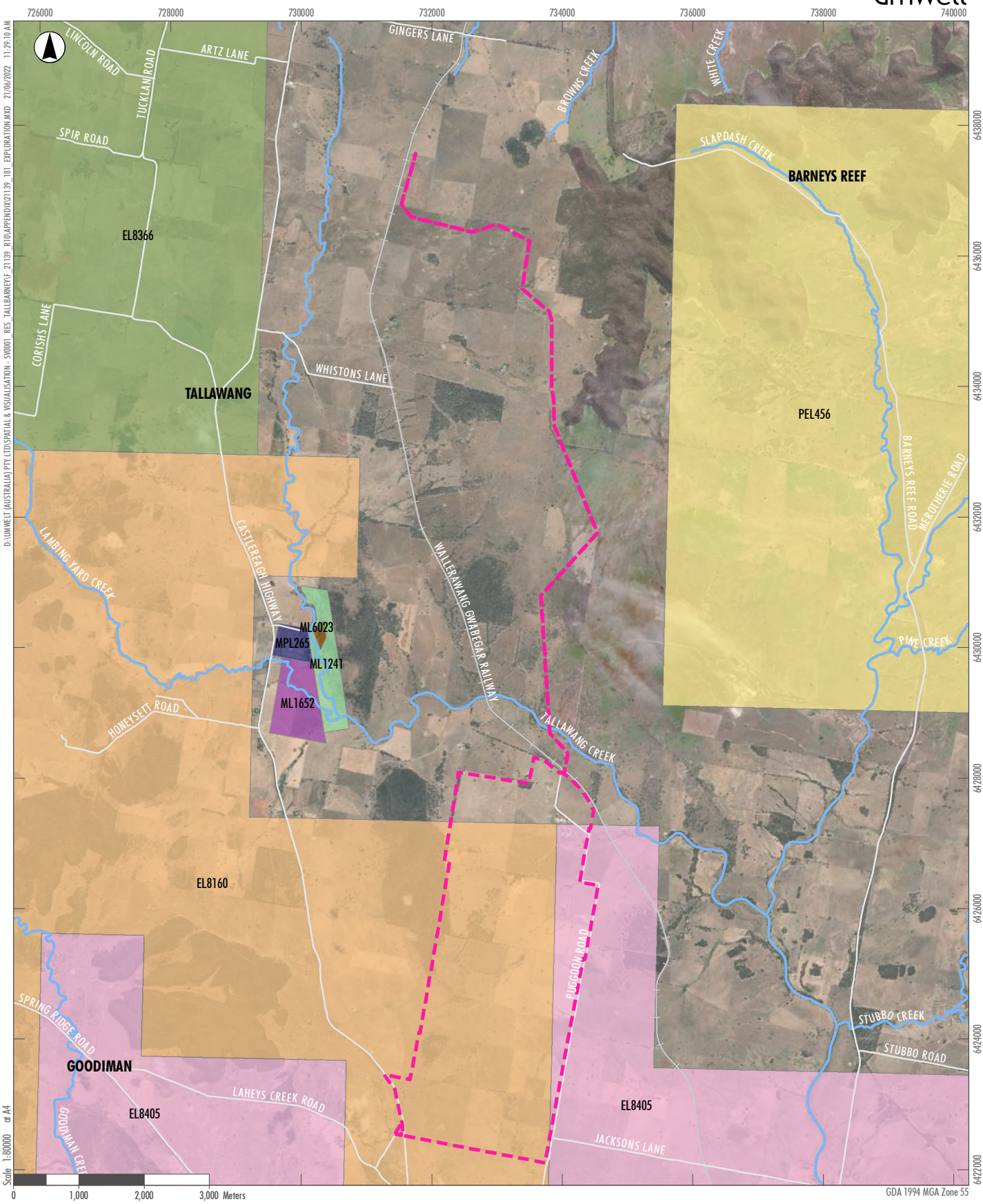
- The Goodiman State Conservation Area is located approximately 8.5 km to the west of the Project Area.
- The Yarrobil National Park is situated 7 km to the west.
- The Tallawang Creek traverses through the Project Area, directly north of the solar farm site.
- The town of Gulgong is situated 8 km south-east of the Project Area.
- The Castlereagh Highway runs along the southwest boundary of the Project Area with the Wallerawang Gwabegar Railway line directly north of the solar farm site.
- The Project Area contains a number of farm dams and drainage lines or creeks that drain into Tallawang Creek and Wialdra Creek.

There are three residential dwellings and other associated structures (such as sheds) located within the Project Area, referred to as host dwellings. The nearest residential receiver to the Project Area is located approximately 200 m to the southwest, along the Castlereagh Highway as shown in **Figure 2.2**. There are 15 residential receivers within 1 km of the Project Area.

2.4 Existing Land Use

The Project Area comprises large paddocks used predominantly for grazing sheep and cattle, with some land used for cropping. The Project Area is largely cleared, with some scattered paddock trees and rows of trees along fence lines. There are some areas within the Project Area with remnant heavily timbered rocky outcrops.

There are three residential dwellings within the Project Area, and other agriculture-based infrastructure such as sheds, stock feeding equipment and a silo. The Project Area is fenced into paddocks with barbed wire and wooden/wire fencing.



Legend

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

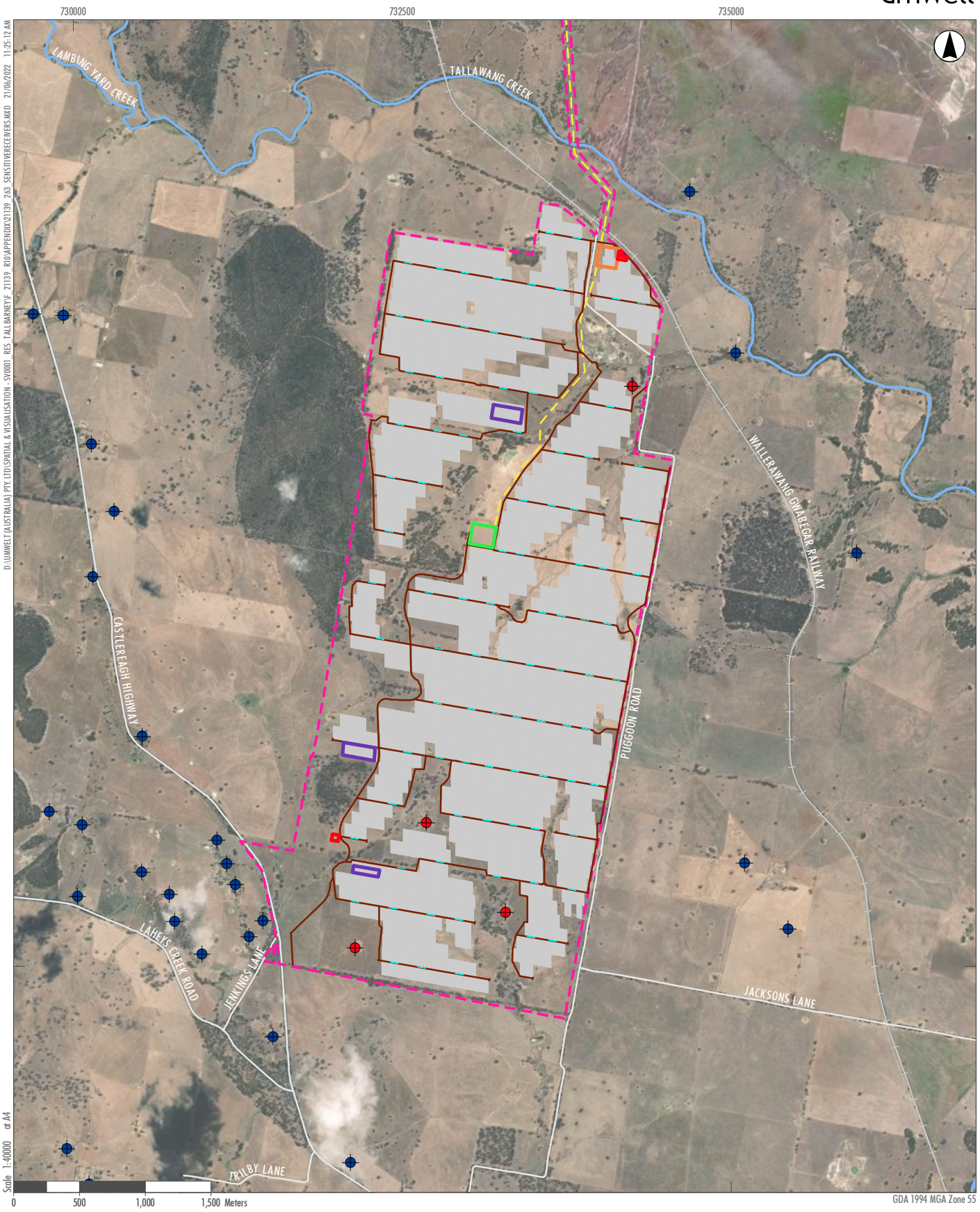
Legend

- EL8160
- EL8366
- EL8405
- ML1241
- ML1652
- ML6023
- MPL265
- PEL456
- PLL1093
- PLL3610

FIGURE 2.1

Exploration and Mining Titles in the Project Area

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



Legend

- Tallawang Solar Farm Project Area
- Non-associated Dwelling
- Involved Landholder Dwelling
- Proposed HV Powerline
- Road
- Railway
- Watercourse

Site Infrastructure

- Construction Compound/Laydown
- O&M Facility
- Proposed Substation (Central Option)
- Proposed Substation (Northern Option)
- Inverter Buildings and Hardstanding
- Solar Panels
- Access Tracks

FIGURE 2.2

Sensitive Noise Receivers

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

2.5 Site Selection

RES selected the proposed Project Area as it provides the optimal combination of:

- Availability of land of a suitable scale for a viable commercial-scale solar farm project.
- Being located within the CWO REZ.
- Proximity to high voltage transmission network.
- Not in flood zone.
- High quality solar irradiance and ideal climatic conditions for a commercial-scale solar farm.
- Compatible land use zoning both on the development site and adjacent land holdings.
- Environmental constraints that can be managed with appropriate mitigation and management.
- Relatively flat landscape reducing the risk of soil disturbance during earthworks.
- Access to the major transport network namely the Castlereagh Highway and the Golden Highway.
- Lease agreements with host landholders.
- The Soils, Land Capability and Agriculture Assessment confirmed the Project Area was not classified as 'high-value agricultural land' and did not identify any major constraints to solar farm development.

2.6 Site History

The Project Area has historically been used for agricultural purposes, including cropping and grazing livestock.

2.7 Site Inspection Outcomes

A site inspection was undertaken in August 2021 as part of the LUCRA. A soil survey was also completed at this time. The outcomes of the soil survey, land capability assessment and other agricultural aspects are covered in the Soil, Land and Agricultural Assessment. It was observed that the Project Area was undulating with gently sloped rolling hills. The Project Area comprises large paddocks that are fenced and used predominantly for cropping and grazing sheep and cattle. Except for some timbered rocky outcrop areas remaining, the majority of the Project Area is cleared with some scattered paddock trees and rows of trees along fence lines. At the time of the site inspection portions of the Project Area were recently cropped and harvested with stubble and straw retained to provide ground cover.

2.8 Consultation

2.8.1 Landholder Consultation

Phone interviews with twelve neighbouring property owners occurred between September and October 2021. A copy of the questionnaire is included in **Appendix B**.

Of these neighbouring properties, it is understood that eight contain just one dwelling, three contain two dwellings, and one property has no residential dwelling. The number of residents across the properties ranges from one person (n=1), two occupants (n=7), with the remaining ranging from four to seven residents (n=4). Two landholders have also recently applied for building permits to construct additional dwellings on their land.

From these interviews, it emerged that neighbouring properties to the Project are used for several purposes. The two most common uses are livestock grazing and cropping. Five properties integrate the two land uses, and two only graze livestock. The five properties that produce crops (hay, grain, and oats) have an annual crop rotation. The other four properties are used for hobby/lifestyle purposes with one growing fruit trees and two running small flocks of sheep. Land on these properties has previously been used in much the same way as it is today, with the grazing of livestock and cropping historically the most predominate land uses.

All neighbouring landholders stated they do not believe that the Project will impact their current land use, however three landholders are concerned about the impact that traffic may have during the construction and their ability to access their properties and cumulative impact on landscape surrounds and local roads due to other projects also proposed or in development in the local area. Only one neighbouring landholder frequently utilises public roads (Jacksons Lane) for the movement of livestock between properties on either side of the road, with another stating they previously have, but now opt to move livestock between their properties via trucks. No neighbouring property owners lease land to others, however one landholder mentioned the utilisation of a Right of Way on their property used by other landholders.

Nine out of the twelve neighbouring properties utilise the Castlereagh Highway to directly access their property. One of these property owners also uses a section (approximately 4 km) of the Highway to move farming equipment between two properties, with some of this equipment including wide load machinery. This could potentially be disrupted due to the increase in traffic caused by the construction of the Project. The children of another respondent board a school bus each day from a bus stop on the junction of Puggoon Road and Castlereagh Highway.

The hours spent working on the properties varies, with three landholders working irregular hours due to employment in other industries away from their properties. Three landholders spend approximately 12 hours per day working on their properties, with another two up to 6 hours a day, with one landholder stating 17 hours per week is their norm. Of those spoken to, only one property owner uses external labour for agricultural operations.

Of the eight landholders who stated using machinery on their properties, all use tractors, five also use quad bikes, four use motorbikes and two use trucks. Only one property utilises an aerial sprayer, however six landholders spray chemicals on their property (fertiliser and herbicides). This is generally carried out with a tractor or boom sprayer. One landholder sprays every six months; however, the frequency was not offered by other landholders.

2.8.2 Agency Consultation

A meeting was held with the Department of Primary Industry (DPI) – Agriculture on 30 November 2021 to introduce the Project and present the draft outcomes of the LUCRA. This is further discussed in Section 3.6 of the Soils, Land and Agriculture Assessment.

2.9 Compatibility with Existing Land uses

The Project will modify existing land uses on the Project Area. Current land uses along the transmission line easement will predominately remain the same. This change of land use could be considered incompatible with the current surrounding land uses without mitigation. Below are the potential incompatibilities (without mitigation) between the surrounding land use and proposed land use that have been identified.

The risk reduction management strategies (mitigation measures) as identified in **Table 3.5** (refer to **Section 3.3**) are to be implemented to reduce the risk these incompatibilities, and thus reduce the risk of land use conflicts from arising.

2.9.1 During Construction

During construction the main incompatibilities identified (without mitigation) include the following:

- Increased noise from construction vehicles (additional to what is reasonably expected from agricultural production).
- Dust generated by construction vehicles and during construction activities (such as land clearing and site preparation).
- Visual impacts during construction activities.
- Erosion and sediment runoff and impacts on surface water quality.
- Damage to local roads from vehicles, including light vehicle and trucks.
- Road incidents with livestock and/or farm machinery crossing or using roads at slow speeds.

The Project intends to use the natural topography of the solar farm site, with earthworks limited to the construction of access tracks, inverter pads, substation pads or site facilities. The transmission line requires the establishment of pylons that may include excavation of a 1 m diameter and 2 m deep excavation. The foundation system for the panelled area will be dependent on the geotechnical soil conditions encountered.

2.9.2 During Operation

During operation the main incompatibilities identified (without mitigation) include the following:

- Inadequate management of invasive weed and feral pest management on the solar farm site.
- Visual impacts associated with the Project for surrounding land users.
- Altered bushfire risk profile for surrounding lands due to the presence of the project.
- Neighbouring farmers spraying paddocks, resulting in potential overspray which may impact Project Area infrastructure.

2.9.3 Decommissioning

During and following decommissioning, the main risks (without mitigation) identified include:

- Inadequate removal of infrastructure including commercial and industrial wastes.
- Land is not in an acceptable condition to be able to be utilised for agricultural production.
- Increased noise from vehicles (additional to what is reasonably expected from agricultural production) associated with decommissioning activities.
- Damage to local roads from vehicles, including light vehicle and trucks.
- Road incidents with livestock and/or farm machinery crossing or using roads at slow speeds.
- Dust generated by vehicles during decommissioning activities (such as site rehabilitation).

3.0 Land Use Conflict Risk Assessment

3.1 Introduction

The LUCRA assessment process based on the *Land Use Conflict Risk Assessment Guide* (2011) utilises a 'probability and consequence' risk assessment matrix (**Table 3.1**) to estimate the potential for land use conflicts. It assesses the environmental, public health and amenity impacts according to the *probability of occurrence* and *consequence of the impact*.

Table 3.1 Risk Rating Matrix

Probability	A	B	C	D	E
Consequence					
1	25	24	22	19	15
2	23	21	18	14	10
3	20	17	13	9	6
4	16	12	8	5	3
5	11	7	4	2	1

The risk rating matrix yields a risk ranking from 25 to 1. It covers each combination of five levels of 'probability' (a letter A to E as defined in **Table 3.2**) and 5 levels of 'consequence', (a number 1 to 5 as defined in **Table 3.3**) to identify the risk ranking of each impact. For example an activity with a 'probability' of D and a 'consequence' of 3 yields a risk rank of 9.

Table 3.2 Probability Table

Level	Descriptor	Description
A	**Almost Certain**	Common or repeating occurrence
B	**Likely**	Known to occur, or 'it has happened'
C	**Possible**	Could occur, or 'I've heard of it happening'
D	**Unlikely**	Could occur in some circumstances, but not likely to occur
E	**Rare**	Practically impossible

Table 3.3 Consequence Table Descriptions

Level	Descriptor	Description
1	**Severe**	• Severe and/or permanent damage to the environment. • Irreversible. • Severe impact on the community. • Neighbours are in prolonged dispute and legal action involved.
2	**Major**	• Serious and/or long-term impact to the environment. • Long-term management implications. • Serious impact on the community. • Neighbours are in serious dispute.

Level	Descriptor	Description
3	**Moderate**	• Moderate and/or medium-term impact to the environment and community. • Some ongoing management implications. • Neighbour disputes occur.
4	**Minor**	• Minor and/or short-term impact to the environment and community. • Can be effectively managed as part of normal operations. • Infrequent disputes between neighbours.
5	**Negligible**	• Very minor impact to the environment and community. • Can be effectively managed as part of normal operations. • Neighbour disputes unlikely.

3.2 Initial Risk Identification and Risk Ranking

Below (**Table 3.4**) is an initial risk evaluation and risk rating of activities that may cause a conflict, potential conflict arising from that activity, and a risk rating generated without mitigation or management measure put in place for the project as described in **Section 2.8**.

Table 3.4 Initial Risk Evaluation

Activity	Identified Potential Conflict	Risk Rating (unmitigated)
Construction	Excess noise generated during the construction of the Project above relevant criteria – impacting amenity. Sources include increased vehicle movements to and from the Project Area, earth moving equipment and physical construction of the PV panels, transmission line and substations.	**8**
Construction	Generation of dust on site(s) due to site preparation and other construction related activities as well as increased traffic movements on unsealed internal tracks which can impact human and environmental health.	**8**
Construction	Increased traffic movements to and from the Project Area resulting in traffic hazard for neighbouring land holders.	**17**
Construction	Land erosion as a result of construction activities resulting in sediment runoff entering nearby water bodies, impacting the surrounding landholder water quality and beneficial use of the water (irrigation or stock water).	**8**
Construction	Increased traffic volumes potentially impacting/degrading the physical condition of local roads, particularly the Castlereagh Highway, used to access the Project Area.	**5**
Livestock grazing	Livestock entering the Project Area causing potential damage to infrastructure.	**5**
Livestock and farm machinery movement over road or along road reserve	Possibility of vehicles during construction or operation being involved in an accident with livestock or farm machinery on roads.	**9**
Operation	Noise generated from power inverters, transformer system, transmission line, substations, tracker motors and maintenance activities.	**2**
Operation	Poor weed and invasive pest management on the Project Area that may spread or impact neighbouring land.	**8**

Activity	Identified Potential Conflict	Risk Rating (unmitigated)
Operation	Loss of local amenity and visual amenity from the Project including from transmission line pylons, substation, and solar panels.	12
Operation	Increase bushfire risk from within the Project area due to mechanical failure	5
Operation	Poorly maintained boundary fences resulting in livestock or pests accessing the Project Area or neighbouring land.	2
Decommissioning	Increased traffic volumes potentially impacting/degrading the physical condition of local roads, particularly the Castlereagh Highway, used to access the Project Area.	8
Decommissioning	Increased traffic movements to and from the Project Area resulting in traffic hazard for neighbouring land holders.	17
Decommissioning	Excess noise generated during decommissioning of the Project above relevant criteria – impacting amenity. Sources include increased vehicle movements to and from the Project Area, earth moving equipment and physical dismantling of the PV panels, transmission line and substations.	8
Decommissioning	Generation of dust on site(s) due to site rehabilitation and other decommissioning related activities as well as increased traffic movements on unsealed internal tracks which can impact human and environmental health.	8
Decommissioning	Inadequate removal of infrastructure including commercial and industrial wastes.	9
Decommissioning	Land is not in an acceptable condition to be able to be utilised for agricultural production following decommissioning.	14

3.3 Risk Reduction Controls

Presented in **Table 3.5** below is the revised risk rating following the identification of mitigation measures.

Table 3.5 Revised Risk Rating

Activity	Identified Potential Conflict	Risk Rating (Unmitigated)	Risk Reduction Management Strategy (mitigation measures)	Risk Rating (mitigated)	Performance Target
Construction	Noise generated during the construction of the solar farm, above relevant criteria – impacting human amenity. Sources include increased vehicle movements to and from site, earth moving equipment and physical construction of the PV panels.	**8**	• Preparation and implementation of a Noise and Vibration Management Plan for the Project. The plan will include details on measures to mitigate noise during the construction, operational and decommissioning phase of the Project. • Ensure potentially affected sensitive receivers have access to a site contact to report noise issues and are consulted as to the potential noise from the Project. • Ensure noise does not exceed the criteria in the adopted *Interim Construction Noise Guidelines* (DECC 2009). • Reduce speed of vehicles accessing the site (covered in the NVMP). • Noise impacts are anticipated to be temporary and manageable, with agreed construction hours.	**5**	No exceedances of the project noise trigger levels.
Construction	Generation of dust on-site and increased traffic movements along internal unsealed tracks resulting in dust generation which can impact human and environmental health.	**8**	The management of dust impacts will be detailed in the Construction Environmental Management Plan (CEMP). As part of the CEMP, develop and implement protocols to minimise the air emissions during construction, including: • water suppression on exposed areas, unsealed roads and stockpile areas when required (if visible dust emissions are observed) • the location and scale of activities which generate dust emissions would be modified and limited during periods of dry and windy weather • engines to switch off when not in use for prolonged periods • development of a complaints procedure to promptly identify and respond to complaints. • once construction has been completed, establish, and maintain ground cover in accordance with the OEMP.	**5**	No exceedances of adopted dust criteria.
Construction	Increased traffic movements to and from the Project Area resulting in traffic hazard for neighbouring land holders.	**17**	• Preparation and implementation of a Traffic Management Plan in consultation with Transport for NSW and Mid-Western Regional Council. • Ensure reduced speeds. • Ensure construction workers are aware of the potential to encounter increased traffic. • Engagement with surrounding road user, including but not limited to school bus routes and agricultural land holders.	**8**	No traffic incidents during construction that are directly related to the solar farm.
Construction	Land erosion as a result of construction activities resulting in sediment runoff entering nearby water bodies, impacting the surrounding landholder water quality and beneficial use of the water (irrigation or stock water).	**8**	• Preparation and implementation of the CEMP to ensure groundcover is maintained. • Given the method of construction, erosion is expected to be limited and manageable.	**8**	Groundcover is maintained where possible and practical. Identified erosion areas do not become further eroded, and are to be progressively rehabilitated in reference to the site's OEMP.
Construction	Increased traffic volumes potentially impacting/ degrading the physical condition of local roads, particularly the partially Castlereagh Highway.	**5**	• Liaising with TfNSW, Mid-Western Regional Council and key road users regarding the ongoing maintenance of the Castlereagh Highway during the construction phase to ensure the road surface are maintained. • Reduced speed limits.	**2**	Any damaged or degraded roads caused by increased construction traffic is to be repaired in a timely fashion.

Activity	Identified Potential Conflict	Risk Rating (Unmitigated)	Risk Reduction Management Strategy (mitigation measures)	Risk Rating (mitigated)	Performance Target
Livestock grazing	Livestock entering the solar farm site – causing potential damage to infrastructure.	**5**	• Install livestock proof boundary fence (perimeter security fence in this instance) and ensure boundary fence is maintained to a suitable standard by regular inspection of the fences. • If livestock enter the Project Area, the surrounding landowners should be contacted to ascertain who own the livestock. • Efforts should be made to ensure the animal is not distressed, and not let out onto public roads.	**2**	Fence repaired immediately following breach, and neighbours contacted immediately.
Livestock and farm machinery movement over road	Possibility of vehicles during construction or operation being involved in an accident with livestock or farm machinery on roads.	**9**	• Preparation and implementation of a Traffic Management Plan highlighting the potential for livestock and or farm machinery (e.g. tractors) to be on or surrounding Castlereagh Highway. • Increased number of road warning signs. • Reduction of speed limits in high-risk areas.	**8**	No incidents with livestock.
Operation	Poor weed & invasive pest management on the Project Area that may spread or impact neighbouring land.	**8**	• Preparation of an Operational Environmental Management Plan for the Project. The plan should detail the frequency of weed spraying required to manage targeted weed species, preferable completed by an external weed management contractor. • Feral animal management (trapping) to be used if required. • Once operational, re-introduction of sheep grazing to control weeds.	**5**	Invasive weed species are managed so that no weeds from the site spread. No complaints from neighbours. Feral animal populations a kept under control.
Operation	Noise generated from power inverters and, transformer system, tracker motors and maintenance activities.	**2**	• Infrastructure designed to not exceed Noise Policy for Industry (NSW EPA 2017) standards and will not cause noise issues for neighbours.	**2**	Noise does not exceed the adopted Noise Policy. Exceedance no greater than 5dBA above background levels.
Operation	Reduction of available agricultural land, reducing agricultural production.	**8**	• Groundcover is maintained and weeds are managed over the Project Area. • Prepare and implement an Operational Environmental Management Plan to manage the land during operation and a Rehabilitation and Decommissioning Management Plan to ensure the land can be successfully returned to agricultural production following decommissioning.	**5**	Groundcover maintained in rows and beneath solar panels.
Operation	Loss of local amenity and visual amenity from solar farm.	**12**	• A landscaping plan will be prepared to minimise visual impacts of the Project on the nearest sensitive receivers. • A 500 m buffer zone will be maintained between the PV panels and the Castlereagh Highway in the southwest corner of the Project Area. This buffer will reduce the visibility of the solar farm to nearby sensitive receivers and passing motorists. • PV panels will be constructed from low reflective material and in a manner that will minimise opportunity for glare and reflectivity for nearby viewers.	**9**	Implementation of the landscape plan within a reasonable time frame.

Operation	Bushfire risk from solar farm.	**5**	• A Bushfire Emergency Management Plan will be developed and implemented for the Project in accordance with PBP 2019 and in consultation with the RFS. The plan will identify all relevant bushfire risks and mitigation measures associated with the construction and operation of the Project, including:
			  ○ detailed measures to prevent or mitigate fires igniting, outlining:
			  ○ APZ locations and management requirements
			  ○ access locations, passing bays and any alternate emergency access
			  ○ water supply and any other bush fire suppression systems (including any drenching systems, static water supply, natural water sources)
			  ○ work that should not be carried out during total fire bans.
			• Sheep grazing to control the amount of potential vegetation fuel under the panels.
			• Non-combustible fencing.
			• Roads will be maintained in the Project Area to allow for safe and accessible travel of emergency vehicles (if required).
				2	No fires caused by the construction, operation and decommissioning of the Project Area.

Operation	Poorly maintained boundary fences resulting in livestock or feral animals accessing the site or neighbouring land.	**2**	• Ensure boundary fence is maintained to a suitable standard. • Regular inspection of fences should be conducted to assess the condition of the fence, and any issues rectified as soon as practical.	**2**	Fences are repaired immediately following any identified damage.

Activity	Identified Potential Conflict	Risk Rating (Unmitigated)	Risk Reduction Management Strategy (mitigation measures)	Risk Rating (mitigated)	Performance Target
Decommissioning	Increased traffic volumes potentially impacting / degrading the physical condition of local roads, particularly the Castlereagh Highway, used to access the Project Area.	**8**	• Liaising with TfNSW, Mid-Western Regional Council and key road users regarding the ongoing maintenance of the Castlereagh Highway during the decommissioning phase to ensure the road surface are maintained. • Reduced speed limits.	**2**	Any damaged or degraded roads caused by increased traffic is to be repaired in a timely fashion.
Decommissioning	Increased traffic movements to and from the Project Area resulting in traffic hazard for neighbouring land holders.	**17**	• Preparation and implementation of a Traffic Management Plan in consultation with Transport for NSW and Mid-Western Regional Council. • Ensure reduced speeds. • Ensure construction workers are aware of the potential to encounter increased traffic. • Engagement with surrounding road user, including but not limited to school bus routes and agricultural land holders.	**8**	No traffic incidents during decommissioning that are directly related to the solar farm.
Decommissioning	Noise generated during decommissioning of the Project above relevant criteria – impacting amenity. Sources include increased vehicle movements to and from the Project Area, earth moving equipment and physical dismantling of the PV panels, transmission line and substations.	**8**	• Continued implementation of a Noise and Vibration Management Plan for the Project. The plan will include details on measures to mitigate noise during the construction, operational and decommissioning phase of the Project. • Ensure potentially affected sensitive receivers have access to a site contact to report noise issues and are consulted as to the potential noise from the Project. • Ensure noise does not exceed the criteria in the adopted *Interim Construction Noise Guidelines* (DECC 2009). • Reduce speed of vehicles accessing the site (covered in the NVMP). • Noise impacts are anticipated to be temporary and manageable, with agreed construction hours.	**5**	No exceedances of the project noise trigger levels.
Decommissioning	Generation of dust on site(s) due to site rehabilitation and other decommissioning related activities as well as increased traffic movements on unsealed internal tracks which can impact human and environmental health.	**8**	The management of dust impacts will be detailed in an Environmental Management Plan (EMP) for the decommissioning phase. As part of the relevant EMP, develop and implement protocols to minimise the air emissions during construction, including: • water suppression on exposed areas and unsealed roads when required (if visible dust emissions are observed) • the location and scale of activities which generate dust emissions would be modified and limited during periods of dry and windy weather • engines to switch off when not in use for prolonged periods • development of a complaints procedure to promptly identify and respond to complaints. • once construction has been completed, establish, and maintain ground cover in accordance with the EMP.	**5**	No exceedances of adopted dust criteria.
Decommissioning	Inadequate removal of infrastructure including commercial and industrial wastes.	**9**	• Removal of infrastructure and remediation of project area to an agreed standard is stipulated in land contracts with project landowners. • Removal of infrastructure and remediation of project area will be a condition of project approval/ consent • The adequacy of removal will be as required through relevant legislation, such as the POEO Act 1997 prior to returning the site back to the landowners		
Decommissioning	Land is not in an acceptable condition to be able to be utilised for agricultural production.	**14**	• Development of a Rehabilitation Management Plan which ensures the Project Area will be rehabilitated to a condition that it was in previous to the construction of the Solar Farm.		

3.4 Key Potential Land Use Conflicts

Following a review of the preliminary risk assessment undertaken as part of the scoping phase, the key potential land use conflicts that have been identified are discussed below. Additionally, the land use conflicts identified are highlighted in the technical assessment reports appended to the EIS.

3.4.1 Noise

Noise is expected to be generated during construction from vehicles and trucks, and during the physical construction of the Project infrastructure (pile driving, earthworks, machinery etc). Construction noise impacts generated from the Project Area will be managed to ensure that the predicted noise levels remain within expectable noise management levels. Construction noise management measures are proposed in the Noise Impact Assessment (NIA) (Umwelt 2021).

During operation of the solar farm, the main sources of noise generated will be from inverters, tracker motors, a BESS, and maintenance activities. The Umwelt (2021) assessment did not identify predicted noise levels exceeding the adopted NSW *Noise Policy for Industry* (NPfI), therefore further noise management or mitigation measures is not considered to be necessary for the Project.

The management strategies outlined in the NIA and draft Noise Management Plan will be complied with throughout the construction and operation of the Project.

3.4.2 Dust

Dust generation during the construction of the Project is expected to occur. The main source of dust and air borne particulates are expected to be from construction activities (i.e. site preparation and minor earthworks) and vehicle movements over the Project Area along unsealed internal tracks. The use of heavy vehicles, equipment and machinery would be largely limited to the construction period and emissions would be localised.

The nearest sensitive receiver is located approximately 200 m west of the Project along the Castlereagh Highway. Given that temporary nature of the construction activities, the fact that this receiver is on the other side of the highway and the physical distance between the receiver and the Project, it is expected that any impacts from dust and exhaust emissions would be minimal.

With the implementation of air quality controls and mitigation measures consistent with the Construction Environmental Management Plan, it is expected that the construction and decommissioning activities would have a negligible impact on local air quality.

3.4.3 Erosion and Sediment Runoff

During construction, exposed soil surfaces may occur during times of rainfall runoff resulting in erosion of site soil and potentially impact neighbouring surface water receivers. Given the relatively flat topography of the solar farm site, the retention of farm dams and the relatively limited impact to the site surface, sediment laden runoff is expected to be minimal. This is the same for the remainder of the Project Area.

Groundcover is expected to be maintained where possible. Sediment load from runoff is not expected to exceed that of the previous highly disturbing land use.

Runoff from the Project Area would not be expected to increase significantly during construction or operation of the Project.

3.4.4 Traffic Access to the Site

The construction period is expected to generate the largest increase in traffic access to the Project Area, with management strategies to mitigate potential conflicts with surrounding landholders outlined in the Traffic and Transport Impact Assessment (Samsa, 2021) and a subsequent Traffic Management Plan.

Traffic access to the Project Area during operation of the Project is expected to cause negligible conflicts with surrounding landholders, as the operation is only expected to employ approximately seven full time employees during the operation of the Project. Workers accessing the Project Area route will be required comply with the Project's Traffic Management Plan and local road rules.

3.4.5 Visual Amenity

The Project will be designed in a manner that will reduce the visual amenity impacts of the Project. The Landscape and Visual Impact Assessment (LVIA) undertaken by Envisage (2021) addresses the potential visual impacts generated from the project.

Visibility to the Project is limited by the surrounding undulating landform and vegetation. However, the highest ridge of the solar farm site is prominent from some viewpoints and visible from at least 8km. The LVIA assesses visual impacts from viewpoints on the Project Area to be minor to moderate visual impacts lessening to negligible to minor potential impacts from viewpoints moving away from the Project Area.

The public viewpoints assessed in the LVIA were selected to be representative of visual impacts from nearby residential dwellings.

Mitigation measures are recommended to further reduce the visual change to landscape character and to views that would occur as a result of the Project. The mitigation measures aim to reduce the visual contrast of the solar farm and transmission line within the landscape, and to screen (or partially break-up) views from outside viewpoints where feasible.

3.5 Limitations and Assumptions

The following limitations and assumptions have been made through the preparation of this report:

- The technical reports prepared by the technical specialists for the EIS are based on the same project description and proposed Project Area.
- We have relied on information provided by the current landholders in the identified locations. Should these landholders change the views, engagement outcomes may also change.

3.6 Key Documents

The following documents have been prepared to support the EIS. The assessments are designed to identify and mitigate the potential environmental, social, and economic impacts of the project. The performance targets noted in **Table 3.5** are also in the assessments below.

- Water Resources Impact Assessment
- Visual and Landscape Impact Assessment
- Noise and Vibration Impact Assessment
- Traffic Impact Assessment
- Social Impact Assessment
- Economic Impact Assessment
- Biodiversity Impact Assessment
- Preliminary Hazard Assessment
- Historical Heritage Impact Assessment
- Aboriginal Cultural Heritage Assessment
- Land and Agricultural Impact Assessment.

To ensure compliance and establish performance monitoring of the mitigation and management strategies, the following management plans will be established:

- Construction Environmental Management Plan
- Operational Environmental Management Plan
- Noise and Vibration Management Plan
- Flora and Fauna Management Plan
- Emergency Management Plan
- Aboriginal Cultural Heritage Management Plan
- Traffic Management Plan.

3.7 Conclusions and Recommendations

This assessment has examined the potential land use conflicts that may arise from the Project located in the locality of Tallawang near Gulgong NSW within the Mid-Western Local Government Area (LGA). It has considered three phases of the development including construction, operations, and decommissioning.

The Project is proposed to be constructed on land deemed to be mostly poor to moderate agricultural land (Umwelt, 2021), mostly LSC 4 land with a small section LSC 6 land. The Project will change the land use from agricultural to electricity generation, however current land use practices will be largely unchanged along the transmission line easement. As noted in this assessment, following construction, sheep grazing will be able to continue within the Project Area. After consultation with surrounding land holders there does not appear to be significant concern with the temporary change in land use.

There are, however, land use conflicts that may arise through the development. A risk identification and ranking process has been undertaken in accordance with DPI Guidelines. Key risks include noise generation, dust generation, erosion control and sediment runoff, increased traffic, and impact on visual amenity. The specialists' reports that have been developed to assess the impact for the EIS have recommended management/mitigation measures. Should these mitigation measures be implemented the potential impact of the change in land use on the surrounding land use and land users will be minimal. Additionally, once decommissioned the Project Area will be remediated to enable agricultural production including cropping and grazing.

4.0 References

Bureau of Meteorology (2021), Climate statistics for Australian locations (bom.gov.au) 2021 (BoM, 2021).

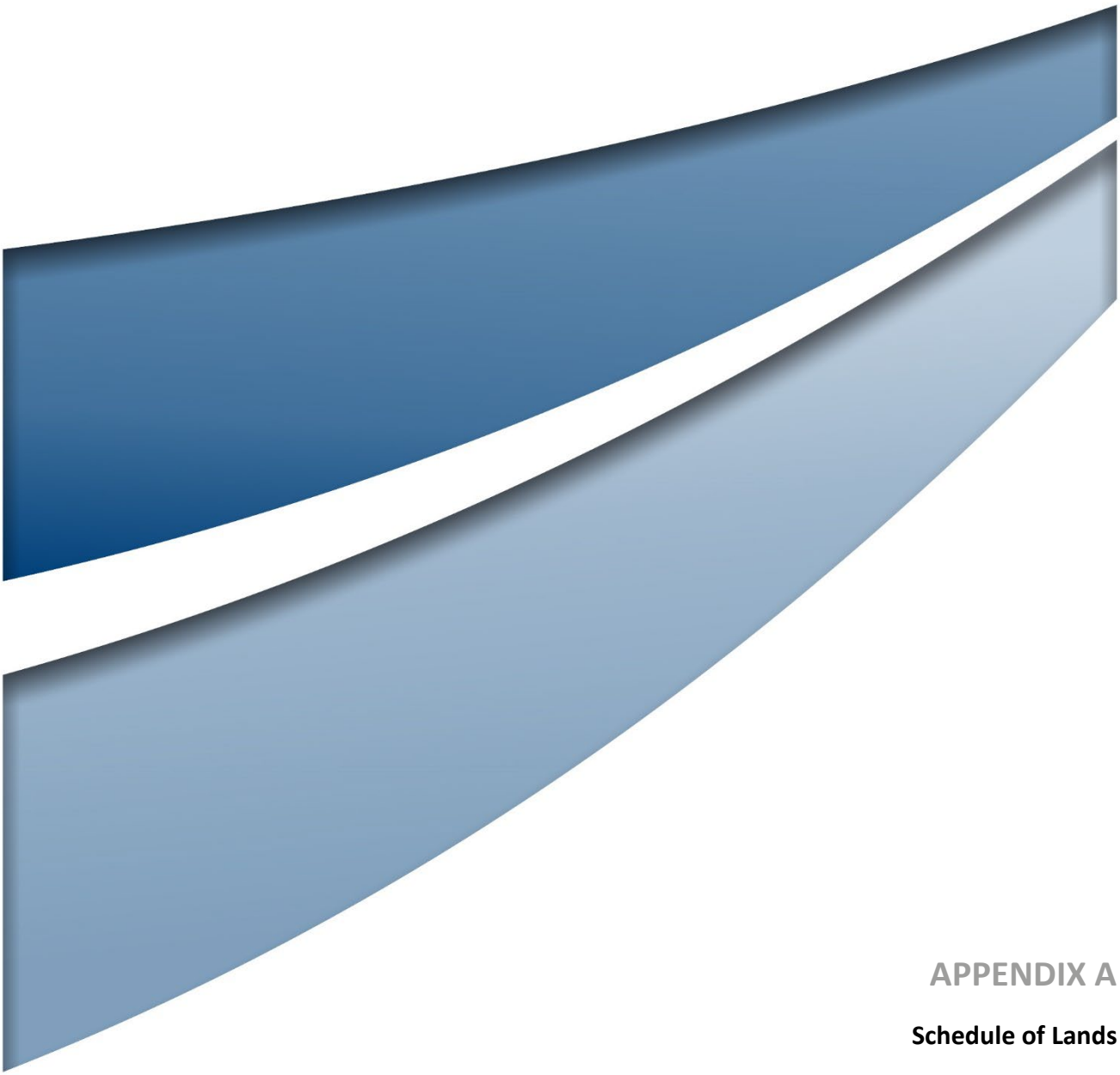
Learmonth, R., Whitehead, R., Boyd, B., & Fletcher, S., (2007). *Living and Working in Rural Areas. A handbook for managing land use conflict issues on the NSW North Coast*, Centre for Coastal Agricultural Landscapes.

Murphy, B.W. & Lawrie, J.W. 1998. *Soil Landscapes of the Dubbo 1:250 000 Sheet*. Department of Land & Water Conservation.

NSW Department of Primary Industries (2011). *Land Use Conflict Risk Assessment Guide 2011* (LUCRA Guide, 2011)

Landcom (2004). Managing Urban Stormwater: Soils and Construction (Landcom, 2004).

Interim Construction Noise Guidelines (2009). *Department of Environment & Climate Change NSW* (DECC, 2009).

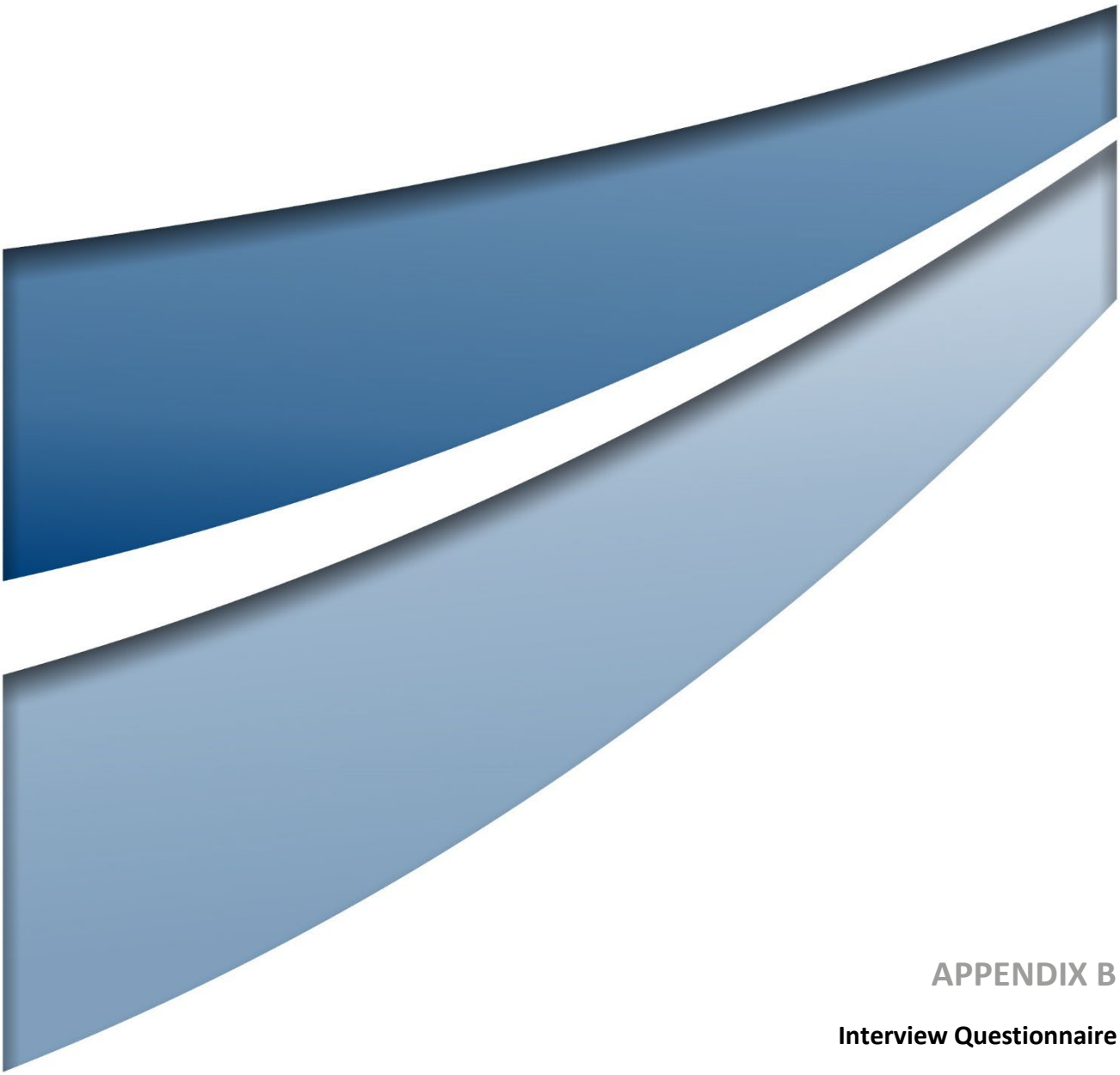


APPENDIX A

Schedule of Lands

TALLAWANG SOLAR FARM
Appendix 4 - Schedule of Lands

LOT	PLAN	PLAN LABEL	CONTROLLING	LANDOWNERSHIP	Host_Mar22
75	750767	DP750767	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
50	457016	DP457016	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
44	750767	DP750767	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
86	750767	DP750767	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
87	750767	DP750767	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
43	750767	DP750767	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
152	750762	DP750762	FREEHOLD	Private	Host landholder - Tallawang
150	750762	DP750762	FREEHOLD	Private	Host landholder - Tallawang
97	750762	DP750762	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
147	750762	DP750762	FREEHOLD	Private	Host landholder - Tallawang
193	750762	DP750762	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
68	750762	DP750762	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
148	750762	DP750762	FREEHOLD	Private	Host landholder - Tallawang
98	750762	DP750762	FREEHOLD	Private	Host landholder - Tallawang
78	750762	DP750762	FREEHOLD	Private	Host landholder - Tallawang
27	750767	DP750767	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
24	750767	DP750767	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
1	332044	DP332044	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
61	750767	DP750767	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
62	750767	DP750767	CROWN	Private	Host Landholder - Tallawang and Barneys
74	750762	DP750762	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
96	750762	DP750762	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
36	750767	DP750767	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
105	750762	DP750762	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
88	750767	DP750767	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
37	750767	DP750767	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
120	750762	DP750762	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
68	750767	DP750767	CROWN	Private	Host Landholder - Tallawang and Barneys
101	1079036	DP1079036	FREEHOLD	Private	Host Landholder - Tallawang and Barneys
2	1208704	DP1208704	FREEHOLD	Transport for NSW	Transport for NSW
113	750762	DP750762	FREEHOLD	Private	Host landholder - Tallawang
114	750762	DP750762	FREEHOLD	Private	Host landholder - Tallawang
89	750762	DP750762	FREEHOLD	Private	Host landholder - Tallawang
112	750762	DP750762	FREEHOLD	Private	Host landholder - Tallawang
90	750762	DP750762	FREEHOLD	Private	Host landholder - Tallawang
			CROWN	Crown	Crown
			CROWN	Crown	Crown
		2693 - 1570	LOCAL GOVERNMENT AUTHORITY	Local Government Authority	Local Government Authority
			CROWN	Crown	Crown
			CROWN	Crown	Crown
			LOCAL GOVERNMENT AUTHORITY	Local Government Authority	Local Government Authority
			LOCAL GOVERNMENT AUTHORITY	Local Government Authority	Local Government Authority
			LOCAL GOVERNMENT AUTHORITY	Local Government Authority	Local Government Authority
			CROWN	Crown	Crown
			CROWN	Crown	Crown
			CROWN	Crown	Crown
		3544 - 1570	LOCAL GOVERNMENT AUTHORITY	Local Government Authority	Local Government Authority
		3284 - 1570	LOCAL GOVERNMENT AUTHORITY	Local Government Authority	Local Government Authority
		3908 - 1570	CROWN	Crown	Crown
			LOCAL GOVERNMENT AUTHORITY	Local Government Authority	Local Government Authority
			LOCAL GOVERNMENT AUTHORITY	Local Government Authority	Local Government Authority
		2630 - 1570	LOCAL GOVERNMENT AUTHORITY	Local Government Authority	Local Government Authority
			CROWN	Crown	Crown
			LOCAL GOVERNMENT AUTHORITY	Local Government Authority	Local Government Authority
		3283 - 1570	LOCAL GOVERNMENT AUTHORITY	Local Government Authority	Local Government Authority
			CROWN	Crown	Crown



APPENDIX B

Interview Questionnaire

Interview with Landholders with involvement or bordering the Project

Land Use Conflict Risk Assessment
We would now like to understand a little more about your property, the land and how you currently use it, with some additional questions. *Your responses will be deidentified and considered in aggregate form within our assessment, meaning that your personal information is not included in any reporting.*
Intro to the Land Use Conflict Risk Assessment (LUCRA) One of the other technical studies being undertaken for the EIS is a Land Use Conflict Risk Assessment (LUCRA), a requirement of the NSW Government for many large-scale projects in rural areas. Umwelt are undertaking this assessment at the moment and are looking for the participation of property owners neighbouring the project to complete a questionnaire for this assessment. The purpose of the consultation is to: • Understand whether the property owner/landholder has any concerns or views regarding the change in land use. • Understand the current land uses of the project surrounds. • Understand the history of the land use surrounding the project. The Tallawang Solar Farm would change the existing land use from primarily agricultural purposes to dual use, energy infrastructure and agriculture.
• Firstly, just to get to know you and your property a little more, how many dwellings are on the property?
• And how many people live on the property?
• What is the current use of your land/extent of current farming activities?
• How do you think this project may impact on the current use of your land? / Do you have any concerns of the proposed development on impacting upon your land or operation?
• Do you have any information on other previous uses of the property that are different to current uses?
• What is your general crop rotation? (for those who answer cropping to previous questions)
• Do you use stock routes or move livestock across areas within your property or across other properties? This could include grazing of livestock in the road reserve.
• How frequent would you say are these stock movements (including any seasonal variability– e.g., more movements in summer or winter)?
• Is any land on your property leased to others? If so, do lessees require access to this property that could potentially be restricted or affected by the projects' construction?
• Typical work hours (including during harvest or lambing seasons)? Number of employees (*if relevant*)?
• What equipment is operated on the land (tractors, trucks, 4 wheelers, motorbikes, aerial spraying etc.)?
• Frequency of spraying and method, *if applicable* (via tractor and boom sprayer, or aircraft)?
• Do you cross or access your property/ies via Castlereagh Hwy or Gingers Lane? E.g. tractors using road to travel to property owned or leased on other side of road or further up the road with no internal paddock access
• Use of fertilisers (Nitrogen/Phosphorous etc.) and chemicals on the property? E.g. herbicide, pesticides, fungicides etc. – for immediate neighbours to solar farm.

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APPENDIX B

Site Descriptions, Photographs and Key Results

Description: Site 1 (BH01)					
Site Reference	BH01	**ASC Name**	Non-Sodic Mesotrophic Yellow Chromosol (mapped as a Sodosol)	**Coordinates**	
Average Slope	Gently Inclined (5%)	**Soil Fertility**	Low	**Lat:** -32.296457	**Lon:** 149.481767
Land Use	Agriculture (cropping)	**LSC Class**	4	**General observations**	
Landform Element	Hillslope	**Micro-Relief**	None	Rill erosion was identified in the general locality of the sampling site, particularly in areas that lacked vegetation cover (along internal access tracks).	
Surface Condition	Cultivated	**Vegetation**	Crop Stubble and new growth (oats)		

Soil Horizon:	Depth (m)	Description
A	0.0-0.15	Dark reddish brown (5YR 3/3) coarse sandy silt, weak pedality and loose with low plasticity, and high moisture content. Moderately acid pH, non-saline and non-sodic, with a high level of coarse fragments. Minor level of roots detected, and fairly loose consistency.
B1	0.15 – 0.4	Reddish yellow (5YR 6/8) silty and gravely clay, firm with high plasticity and high moisture content. Slightly alkaline pH, non-saline and non-sodic, with minor gravel fragments. Low level of roots detected, and poor drainage, and rigid consistency. Massive structure and weak boundary.
B2	0.4 – 0.6	Reddish yellow (7.5 6/8) gravely clay, very firm with medium to high plasticity, and saturated moisture content. Slightly alkaline pH, non-saline and non-sodic, with medium levels of coarse fragments. Nil roots detected, and reasonably free drainage with rigid consistency. Massive structure. Red mottling identified.

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating
0-0.15	0.69	Non-saline	0.49	Non-sodic	4	Negligible/aggregated	5.53	Moderately Acid
0.2-0.4	0.50	Non-saline	0.81	Non-sodic	4	Negligible/aggregated	7.16	Slightly Alkaline
0.45-0.6	0.47	Non-saline	1.9	Non-sodic	4	Negligible/aggregated	7.56	Slightly Alkaline

Photo 1 – Site 1 Landscape (facing east)

Photo 2 – Landscape (showing rill erosion near sampling site)

Photo 3 – Soil Profile (upper layer)

Photo 4 - Surface (lower layers)

Description: Site 2 (BH02)					
Site Reference	BH02	**ASC Name**	Non-Sodic Mesotrophic Red Chromosol (mapped as a Sodosol)	**Coordinates**	
Average Slope	Gently Inclined (5%)	**Soil Fertility**	Low	**Lat:** -32.292354	**Lon:** 149.475200
Land Use	Agriculture (cropping and grazing)	**LSC Class**	4	**General observations**	
Landform Element	Hillslope	**Micro-Relief**	None	Sampling site near crest of low-rise hill. Surface appeared to be a sandy loam. Ground cover high.	
Surface Condition	Disturbed	**Vegetation**	Weed cover		

Soil Horizon:	Depth (m)	Description
A1	0.0-0.1	Yellowish red (5YR 4/6), sandy gravely silt weak pedality and loose with low plasticity and high moisture content. Strongly acidic pH, non-saline and non-sodic, with a high level of coarse fragments. Many roots and good drainage with loose consistency.
A2	0.1-0.3	Yellowish red (5YR 5/8), coarse sand with fine gravel and minor silt. Loose/weak structure and high moisture content. Slightly acidic, non-saline and non-sodic. High level of coarse fragments. Medium level of roots and well drained with loose consistency. Loose to weak structure.
B1	0.3-0.45	Pale olive (5YR 6/4), clay with fine gravel and coarse sand. Firm strength and medium plasticity with high moisture content. Slightly alkaline pH, non-saline and non-sodic, with high level of course fragments. Minor level of roots and medium to well drained with loose to medium consistency. Minor red mottling and minor gleying identified.
B2	0.45-0.8	Olive (5Y 5/4), clay with coarse sand to fine gravel. Weak firmness and low strength and low plasticity, and high moisture content. Slightly alkaline pH, non-saline and non-sodic, with high level of course fragments. Minor level of roots and free draining with loose consistency. Weak structure.

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.35	Non-saline	0.94	Non-sodic	3	Slightly dispersive	5.47	Strongly acidic
0.1-0.3	0.19	Non-saline	1.20	Non-sodic	3	Slightly dispersive	6.07	Slightly acidic
0.3-0.4	0.47	Non-saline	2.00	Non-sodic	3	Slightly dispersive	7.19	Slightly alkaline
0.5-0.6	0.29	Non-saline	2.5	Non-sodic	3	Slightly dispersive	7.08	Slightly alkaline

Photo 5 – Site 2 Landscape

Photo 6 – Soil Profile Sampling Site

Photo 7 – Soil Profile

Photo 8 - Surface layer (Horizon A)

Description: Site 3 (BH03)					
Site Reference	BH03	**ASC Name**	Mottled-Subnatric Sodic Eutrophic Yellow Sodosols (Mapped as a Ferrosol)	**Coordinates**	
				Lat: -32.289458	**Lon:** 149.467962
Average Slope	Gently Inclined (5%)	**Soil Fertility**	Low	**General observations**	
Land Use	Agriculture (grazing)	**LSC Class**	6	Significant rill erosion and exposed earths identified in the general locality of the site, particularly in areas that lacked vegetation cover (along internal access tracks). High percentage of rock outcrops identified, included timber hilly sections and in the arable paddocks.	
Landform Element	Hillslope	**Micro-Relief**	None		
Surface Condition	Disturbed	**Vegetation**	Old Pasture Grasses		

Soil Horizon:	Depth (m)	Description
A	0.0-0.125	Very dark brown (10YR 2/2) minor silt with fine gravel, low firmness, low strength, and low plasticity, with high moisture content. Moderately acidic pH, non-saline and sodic, with minor fine gravel fragments. High level of roots and medium drainage with loose to medium consistency.
A1	0.125-0.3	Very dark greyish brown (2.5YR 3/2) silty clay with fine gravel, medium firmness, high strength, high plasticity, and high moisture content. Slightly alkaline, non-saline and sodic, with low levels of course fragments and some gravel. Minor level of roots and poor drainage with rigid consistency.
B1	0.3-0.5	Olive grey (5Y 4/2) silty clay, very firm, high strength, and high plasticity, with high moisture content. Moderately alkaline, non-saline and sodic, with minor course fragments. Minor levels of roots and poor drainage with rigid consistency.
B2	0.5-0.55	Olive brown (2.5Y 4/3) silty clay and possible weathered rock (granite fragments), medium firmness, medium strength, low plasticity, with medium moisture content. Moderately alkaline, non-saline and sodic, with small percentage of course fragments. Low level of roots and medium drainage with loose consistency. Test pit suspended due to refusal when weathered rock was encountered.

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.52	Non-saline	7.6	Sodic	3	Slightly dispersive	5.86	Moderately acidic
0.15-0.25	1.72	Non-saline	11	Sodic	2	Moderately Dispersive	7.11	Slightly alkaline
0.4-0.5	2.32	Non-saline	12	Sodic	2	Moderately Dispersive	8.26	Moderately alkaline
0.5-0.55	2.34	Non-saline	13	Sodic	2	Moderately Dispersive	8.47	Moderately alkaline

Photo 9 – Site 3 Landscape

Photo 10 – Rocky Landscape Near Sampling Site

Photo 11 – Soil Profile

Photo 12 – Surface layer (A horizon)

Description: Site 4 (BH04)					
Site Reference	BH04	**ASC Name**	Dystrophic Sodic Red Sodosols (mapped as a Sodosol)	**Coordinates**	
Average Slope	Gently Inclined (3%)	**Soil Fertility**	Low	**Lat:** -32.283426	**Lon:** 149.473727
Land Use	Agriculture (grazing)	**LSC Class**	4	**General Observations**	
Landform Element	Undulating Hillslope	**Micro-Relief**	None	Sample site from a simple slope.	
Surface Condition	Disturbed	**Vegetation**	Paddock trees and remnant vegetation		

Soil Horizon:	Depth (m)	Description
A	0.0-0.1	Black (5Y 2.5/1) sandy silt and minor clay, soft firmness, weak strength with low plasticity, and high moisture content. Moderately acidic, non-saline and slight sodic. High level of coarse fragments and high level of fine roots, well drained with loose consistency. Strong boundary.
B1	0.1-0.3	Dark brown (7.5YR 3/3) gravely, sandy silt, soft firmness, weak strength with low plasticity, and saturated moisture content. Moderately acidic, non-saline and slightly sodic and slightly dispersive. High level of coarse fragments with minor gravel, some fine roots, free drainage with loose consistency.
B2	0.3-0.45	Yellowish red (5YR 5/8) weathered rock with high gravel and coarse sand levels. Firm with weak strength, low plasticity, and high moisture content. Moderately acidic, non-saline and sodic. High level of coarse fragments, minor level of fine roots, low drainage with rigid consistency. Refusal at 0.45 m, with infiltration of water from B1 horizon into test pit.

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.37	Non-saline	5.3	Slightly sodic	3	Slightly dispersive	5.50	Moderately acidic
0.1-0.2	0.22	Non-saline	5.4	Slightly sodic	3	Slightly dispersive	5.79	Moderately acidic
0.3-0.4	0.34	Non-saline	8.9	Sodic	2	Moderately dispersive	5.98	Moderately acidic

Photo 13 – Site 3 Landscape

Photo 14 – Soil Profile sampling site

Photo 15 – Soil Profile

Photo 16 - Surface showing high sand / fine gravel content

Description: Site 5 (BH05)					
Site Reference	BH05	**ASC Name**	Mesotrophic Yellow Chromosols (mapped as a Ferrosol)	**Coordinates**	
Average Slope	Gently Inclined (2%)	**Soil Fertility**	Low – moderate	**Lat:** -32.304083	**Lon:** 149.468842
Land Use	Agriculture (cropping)	**LSC Class**	3	**General Observations**	
Landform Element	Undulating Hillslope	**Micro-Relief**	None	Land mapped as BSAL, based on soil type being a Ferrosol (parent material being Basalt). Field survey confirms soil type isn't a Ferrosol. Significant gully erosion features identified in drainage line to the west.	
Surface Condition	Heavily Disturbed	**Vegetation**	Crops and paddock trees		

Soil Horizon:	Depth (m)	Description
A	0.0-0.1	Very dark greyish brown (10YR 3/2) clayey silt with traces of gravel, low firmness, weak strength, medium plasticity, and high moisture content. Slightly acidic, non-saline and non-sodic, and minor gravel fragments. High level of fine roots, fair drainage with loose consistency.
B	0.1-0.2	Brownish yellow (10YR 6/8) gravely silty clay, medium firmness, medium strength, medium plasticity, and saturated moisture content. Slightly acidic, non-saline and slightly sodic and slightly dispersive. Fine to medium gravel fragments, minor level of fine roots, medium drainage with loose consistency.
B2	0.2-0.5	Reddish yellow (7.5YR 6/8) clay, very firm, high strength, high plasticity, and medium moisture content. Slightly acidic, non-saline and slightly sodic and slightly dispersive. Low levels of coarse fragments, minor levels of fine roots, poor drainage with fairly rigid consistency. Minor mottling and gleying identified.

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.57	Non-saline	2.3	Non-sodic	3	Slightly dispersive	6.31	Slightly acidic
0.1-0.2	0.31	Non-saline	3.5	Slightly sodic	3	Slightly dispersive	6.45	Slightly acidic
0.3-0.4	0.82	Non-saline	5.1	Slightly sodic	3	Slightly dispersive	6.64	Slightly acidic

Photo 17 – Site 5 Landscape Location

Photo 18 – Soil Profile Sampling Site

Photo 19 – Sampled Soils

Photo 20 – Sampled Soils

Description: Site 6 (BH06)					
Site Reference	BH06	**ASC Name**	Mesotrophic Brown Chromosols (mapped as a Sodosol)	**Coordinates**	
Average Slope	Gently Inclined (3%)	**Soil Fertility**	Low – moderate	**Lat:** -32.305650	**Lon:** 149.474182
Land Use	Agriculture (grazing)	**LSC Class**	3	**General Observations**	
Landform Element	Undulating Hillslope	**Micro-Relief**	None	Sample site middle slope. No significant erosion features identified.	
Surface Condition	Heavily Disturbed	**Vegetation**	Grazing Pastures and Paddock Trees		

Soil Horizon:	Depth (m)	Description
A	0.0-0.15	Dark reddish brown (5YR 3/2), clayey silt with traces of gravel, low firmness, weak strength, medium plasticity, and high moisture content. Slightly acidic, non-saline and non-sodic with minor gravel fragments. High level of fine roots, fair drainage with loose consistency.
B1	0.15-0.3	Very dark brown (7.5 YR 2.5/3) gravely silty clay, medium firmness, medium strength, medium plasticity, and saturated moisture content. Slightly acidic, non-saline and non-sodic with fine to medium gravel fragments, minor level of fine roots, and medium drainage with loose consistency.
B2	0.3-0.45	Yellowish brown (110YR 5/8) clay, very firm, high strength, high plasticity, and medium moisture content. Slightly acidic, non-saline and non-sodic with low levels of coarse fragments, minor levels of fine roots, and poor drainage with fairly rigid consistency. Minor mottling and gleying identified.

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.33	Non-saline	0.1	Non-sodic	3	Slightly dispersive	6.16	Slightly acidic
0.15-0.3	0.22	Non-saline	0.57	Non-sodic	3	Slightly dispersive	6.80	Slightly acidic
0.35-0.45	0.38	Non-saline	1.9	Non-sodic	4	Slightly dispersive	7.10	Slightly alkaline

Photo 21 – Site 6 Landscape (looking east)

Photo 22 – Landscape (looking south)

Description: Site 7 (BH07)					
Site Reference	BH07	**ASC Name**	Dystrophic Yellow Chromosols (mapped as a Ferrosol)	**Coordinates**	
Average Slope	Gently Inclined (4%)	**Soil Fertility**	Low	**Lat:** -32.299515	**Lon:** 149.468179
Land Use	Agriculture (grazing)	**LSC Class**	3	**General Observations**	
Landform Element	Undulating to Rolling Hillslope	**Micro-Relief**	None	Sampling site on the slope of hill, surrounded by timbered rocky outcrops, near a drainage line with significant gully erosion.	
Surface Condition	Heavily Disturbed	**Vegetation**	Grazing Pastures		

Soil Horizon:	Depth (m)	Description
A	0.0-0.2	Very dark brown (10YR 2/2) clayey silt with traces of gravel, low firmness, weak strength, medium plasticity, and high moisture content. Moderately acidic, non-saline and non-sodic, and minor gravel fragments. High level of fine roots, fair drainage with loose consistency.
B1	0.2-0.6	Dark yellowish brown (10YR 4/6) silty clay with increasing gravel content, low firmness, weak strength, low plasticity, and saturated moisture content. Slightly acidic, non-saline and slightly sodic and slight dispersion. High level of gravel fragments, minor level of fine roots, free drainage with loose consistency.
B2	0.6-0.7	Brownish yellow (10YR 6/8) silty clay with high gravel content, low firmness, weak strength, low plasticity, and saturated moisture content but lower than B1 horizon. Slightly alkaline, non-saline and marginally sodic. Significantly higher level of gravel fragments than B1 horizon and some basalt fragments, minor level of fine roots, free drainage with loose consistency. Some red mottling identified.

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.22	Non-saline	1.7	Non-sodic	3	Slightly dispersive	5.86	Moderately acidic
0.3-0.4	0.21	Non-saline	3.5	Slightly sodic	3	Slightly dispersive	6.63	Slightly acidic
0.6-0.7	0.38	Non-saline	6.1	Marginally sodic	3	Slightly dispersive	7.28	Slightly alkaline

Photo 23 – Sampling Site 7 landscape (looking west)

Photo 24 – Soil Profile sampling site

Photo 25 – Soil from Bore Hole

Photo 26 – Subsurface Soil (showing high gravel content and waterlogging

Description: Site 8 (BH08)					
Site Reference	BH08	**ASC Name**	Dystrophic Sodic Yellow Sodosols (mapped as a Sodosol)	**Coordinates**	
Average Slope	Gently Inclined (2%)	**Soil Fertility**	Low	**Lat:** -32.290165	**Lon:** 149.486611
Land Use	Agriculture (cropping)	**LSC Class**	4	**General Observations**	
Landform Element	Undulating Valley	**Micro-Relief**	None	Substantial rill erosion identified in the drainage lines between the nearby dams.	
Surface Condition	Highly Disturbed	**Vegetation**	Crop and Scattered Paddock Trees		

Soil Horizon:	Depth (m)	Description
A	0.0-0.15	Dark reddish brown (5YR 3/2) sandy silt with fine sand, low firmness, low strength, low plasticity, and high moisture content. Slightly acidic pH, non-saline and non-sodic, with high level of fine sand fragments. High level of fine roots, free drained and loose consistency with minor clay content.
B1	0.15-0.4	Red (2.5YR 5/8) silty clay with fine sand, medium to soft firmness, low to medium strength, low plasticity, and high moisture content. Moderately acidic pH, non-saline and non-sodic, with minor sand fragments. Some fine roots present, free draining, and loose consistency.
B2	0.4-0.6	Brownish yellow (10YR 6/8) gravely clay with minor gravel, fairly high firmness, medium to high strength, medium to high plasticity, with medium moisture content. Slightly alkaline pH, non-saline and sodic with basalt fragments detected. Nil roots detected, fair drainage, and rigid consistency. Minor red mottling identified.

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.65	Non-saline	0.58	Non-sodic	3	Slightly dispersive	6.45	Slightly acidic
0.2-0.3	0.29	Non-saline	1.3	Non-sodic	3	Slightly dispersive	5.65	Moderately acidic
0.45-0.55	0.66	Non-saline	8.2	Sodic	3	Negligible/aggregated	7.27	Slightly alkaline

Photo 27 – Site 8 landscape (looking west)

Photo 28 – Site 8 Landscape (looking north)

Photo 29 – Soil Profile sampling site

Photo 30 – Sodic Subsoil

Description: Site 9 (BH09)					
Site Reference	BH09	**ASC Name**	Dystrophic Yellow Chromosols (mapped as a Sodosol).	**Coordinates**	
Average Slope	Gently Inclined (2%)	**Soil Fertility**	Low	**Lat:** -32.308694	**Lon:** 149.481523
Land Use	Agriculture (grazing)	**LSC Class**	4	**General Observations**	
Landform Element	Undulating to Rolling Hillslope	**Micro-Relief**	None	Paddocks used for grazing only. Some scattered paddock trees. Pastures appear to be a mix of native and improved.	
Surface Condition	Heavily Disturbed	**Vegetation**	Grazing Pastures with Scattered Paddock Trees		

Soil Horizon:	Depth (m)	Description
A	0.0-0.1	Very dark greyish brown (10YR 3/2) sandy silt, soft firmness, weak strength, low plasticity and moist. Moderately acidic pH, non-saline and non-sodic, with high level of coarse fragments. High level of fine roots, free draining, and loose consistency.
B1	0.1-0.45	Light yellowish brown (10YR 6/4) silty sand with high fine gravel content, soft firmness, weak strength, low plasticity and moist. Moderately acidic pH, non-saline and non-sodic with high level of coarse fragments. Minor level of fine roots, free draining, and loose consistency.
B2	0.45-0.8	Brownish yellow (10YR 6/6) sandy clay, medium firmness, medium strength, medium plasticity, and moist. Slightly acidic pH, non-saline and non-sodic with high level of weathered rock, flecks of quarts, and minor gravel fragments. Nil fine roots detected, low drainage, and medium rigid consistency. Minor mottling and minor gleying identified.

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.53	Non-saline	-0.2	Non-sodic	3	Slightly dispersive	5.93	Moderately acidic
0.15-0.25	0.32	Non-saline	-0.4	Non-sodic	3	Slightly dispersive	5.80	Moderately acidic
0.5-0.6	0.22	Non-saline	0.51	Non-sodic	2	Moderately dispersive	6.42	Slightly acidic

Photo 31 - Sampling Site 9 landscape (facing north)

Photo 32 – Sampling site

Photo 33 – Soil Profile

Photo 34 - Subsurface soils (high gravel content evident)

Description: Site 10 (BH10)					
Site Reference	BH10	**ASC Name**	Mottled-Subnatric Mesotrophic Sodic Yellow Sodosols (mapped as a Sodosol)	**Coordinates**	
Average Slope	Gently Inclined (3%)	**Soil Fertility**	Low	**Lat:** -32.266457	**Lon:** 149.471471
Land Use	Agriculture (grazing)	**LSC Class**	4	**General Observations**	
Landform Element	Undulating Hillslope	**Micro-Relief**	None	Previously cropped paddock, currently in fallow. Vegetation appears to mostly be a mix of pasture improved, native grass, and weed species.	
Surface Condition	Heavily Disturbed	**Vegetation**	Old and Dry Pasture		

Soil Horizon:	Depth (m)	Description
A	0.0-0.15	Very dark brown (7.5YR 2.5/2) sandy silt with minor clay, soft firmness, weak strength, medium to below medium plasticity, and high moisture content. Strongly acidic pH, non-saline and non-sodic, with high levels of coarse fragments. High levels of fine roots, free drainage, and loose consistency.
B1	0.15-0.3	Brown (7.5YR 5/4) coarse sand with fine gravel and minor clay, soft firmness, weak strength, low plasticity, and saturated moisture content. Moderately acidic pH, non-saline and slightly sodic and dispersion can only occur under raindrop impact in surface soils. High level of coarse fragments, minor level of fine roots, free drainage, and loose consistency.
B2	0.3-0.6	Light olive grey (5Y 6/2) sandy clay with coarse sand, medium firmness, medium strength, medium to high plasticity and moist. Slightly acidic pH, non-saline and sodic, with medium to high coarse fragments detected. Fine roots detected, poor drainage, and medium rigid consistency. Minor mottle and gleying identified.

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.30	Non-saline	2.1	Non-sodic	3	Slightly dispersive	5.27	Strongly acidic
0.15-0.25	0.22	Non-saline	3.2	Slightly sodic	3	Slightly dispersive	5.88	Moderately acidic
0.35-0.45	0.86	Non-saline	12	Sodic	2	Moderately dispersive	6.45	Slightly acidic

Photo 35 – Landscape Site 10 (looking north)

Photo 36 – Landscape (looking south)

Photo 37 – Soil Profile sampling site

Photo 38 – Subsoils

Description: Site 11 (BH11)					
Site Reference	BH11	**ASC Name**	Mottled-Subnatric Mesotrophic Sodic Yellow Sodosols (mapped as a Sodosol)	**Coordinates**	
Average Slope	Gently Inclined (3%)	**Soil Fertility**	Low	**Lat:** -32.262737	**Lon:** 149.485046
Land Use	Agriculture (grazing)	**LSC Class**	4	**General Observations**	
Landform Element	Undulating to Hilly Landscape	**Micro-Relief**	None	Soils possibly colluvium derived due to poorly sorted gravel content of soil.	
Surface Condition	Heavily Disturbed	**Vegetation**	Grazing Pastures		

Soil Horizon:	Depth (m)	Description
A	0.0-0.1	Black (10YR 2/1) Clayey sandy silt, soft firmness, weak strength, low plasticity, and high moisture content. Moderately acidic pH, non-saline and slightly sodic and slightly dispersive. Minor gravel fragments, high level of fine roots, fair drainage, and loose consistency.
B1	0.1-0.2	Brown (7.5YR 4/3) gravel conglomerate with minor clay, weak firmness, weak strength, low plasticity, and saturated moisture content. Moderately acidic pH, non-saline and sodic, with high levels of coarse fragments. Some roots detected, free drainage, and loose consistency.
B2	0.2-0.4	Pale olive (5Y 6/4) sandy clay with high gravel content, medium to high firmness, medium to high strength, medium to high plasticity, and saturated moisture content. Slightly acidic pH, non-saline and sodic, with high levels of coarse fragments. Some gravel veins in profile. Some roots detected, poor drainage, and rigid consistency. Red mottling and gleying identified. Refusal at 0.4m due to high gravel content and water infiltration.

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.52	Non-saline	5.9	Slightly sodic	3	Slightly dispersive	5.50	Moderately acidic
0.1-0.2	0.29	Non-saline	6.3	Sodic	3	Slightly dispersive	5.75	Moderately acidic
0.25-0.35	0.78	Non-saline	10	Sodic	2	Moderately dispersive	6.15	Slightly acidic

Photo 39 – Sampling Site 11 Location

Photo 40 – Soil Profile sampling site

Photo 41 – Soil Profile (Top View)

Photo 42 – Subsoils

Description: Site 12 (BH12)					
Site Reference	BH12	**ASC Name**	Bleached-Sodic Dystrophic Red Chromosols (mapped as a Sodosol)	**Coordinates**	
Average Slope	Gently Inclined (5%)	**Soil Fertility**	Low - moderate	**Lat:** -32.159450	**Lon:** 149.470681
Land Use	Agriculture (grazing)	**LSC Class**	4	**General Observations**	
Landform Element	Undulating to Rolling Hillslope	**Micro-Relief**	None	Sampling site mid slope. Some evidence of erosion near gate to the immediate north. Location of proposed substation.	
Surface Condition	Heavily Disturbed	**Vegetation**	Pasture Grasses		

Soil Horizon:	Depth (m)	Description
A	0.0-0.15	Reddish yellow (7.5YR 6/6) sandy silt, weak firmness, weak strength, low plasticity and moist. Slightly acidic pH, non-saline and non-sodic, with high levels of coarse fragments. High levels of roots, free draining, and loose consistency.
B1	0.15-0.5	Dark reddish brown (5YR 3/2) silty sand, soft firmness, weak strength, low plasticity, and moist. Moderately acidic pH, non-saline and non-sodic, with high levels of coarse fragments. Some roots detected, free drainage, and loose consistency.
B2	0.5-0.7	Red (10YR 4/8) sandy clay, firm, medium to strong strength, high plasticity, and moist. Slightly acidic pH, non-saline and slightly sodic and dispersive. Some coarse fragments detected, and minor roots detected. Free draining and loose consistency. Red mottling and minor gleying identified.

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.15	Non-saline	2.1	Non-sodic	3	Slightly dispersive	6.32	Slightly acidic
0.2-0.3	0.25	Non-saline	0.86	Non-sodic	3	Slightly dispersive	5.77	Moderately acidic
0.5-0.6	0.42	Non-saline	4.6	Slightly sodic	3	Slightly dispersive	6.57	Slightly acidic

Photo 43 – Sampling Site 12 landscape (looking south)

Photo 44 – Soil Profile sampling site

Photo 45 – Mid Soil Profile

Photo 46 – Subsoil Horizon showing sandy clay Layer

Erosion Areas

Photo 47 – Erosion near Site 3 (confirmed Sodosol)

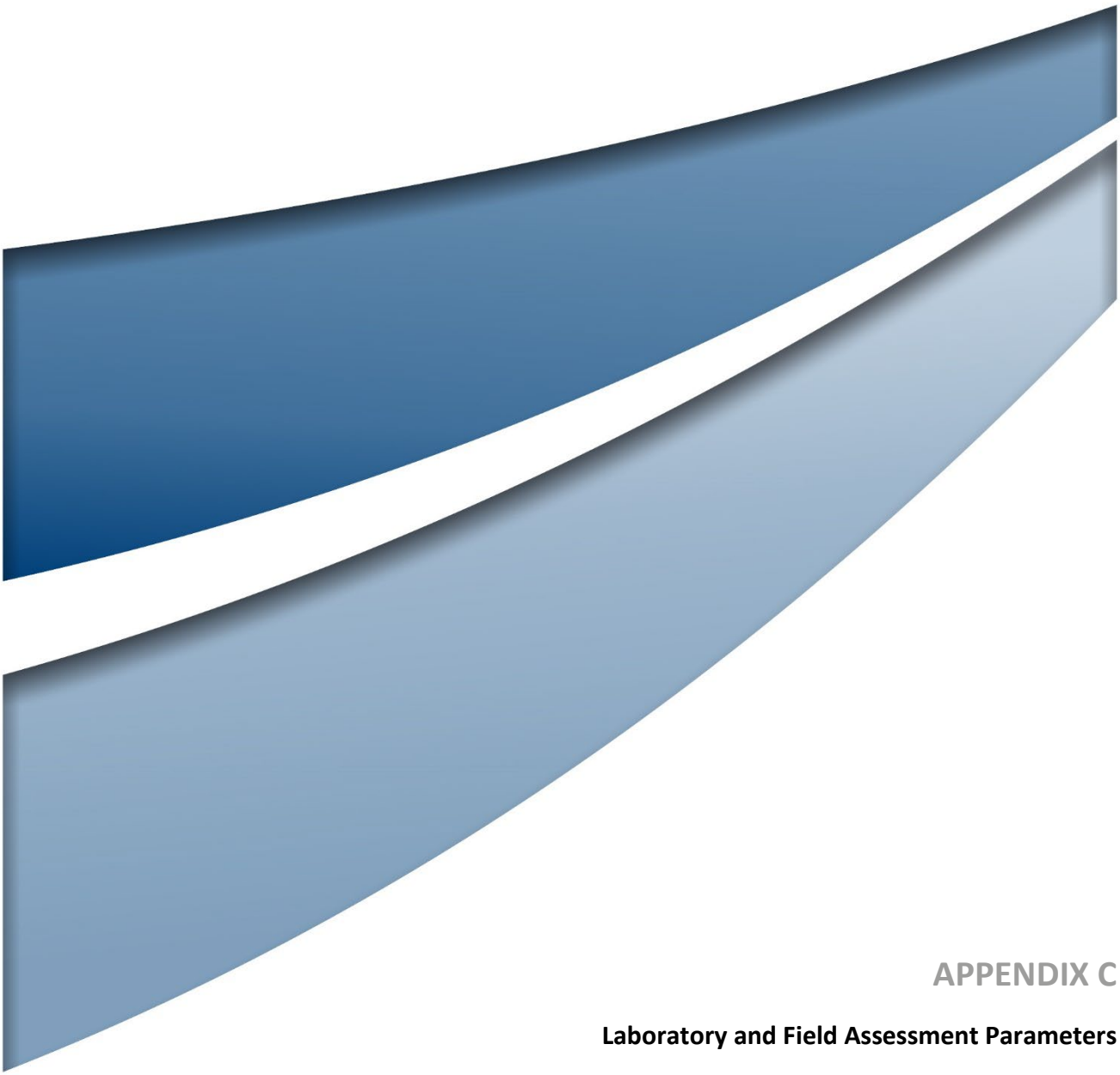
Photo 48 – Erosion on access point (northwest of Site 1)

Photo 49 – Erosion between Site 1 and 2

Photo 50 – Erosion near drainage line near Site 7

Photo 51 – Gully erosion west of Site 5

Photo 51 – Erosion near dam in north section of site



APPENDIX C

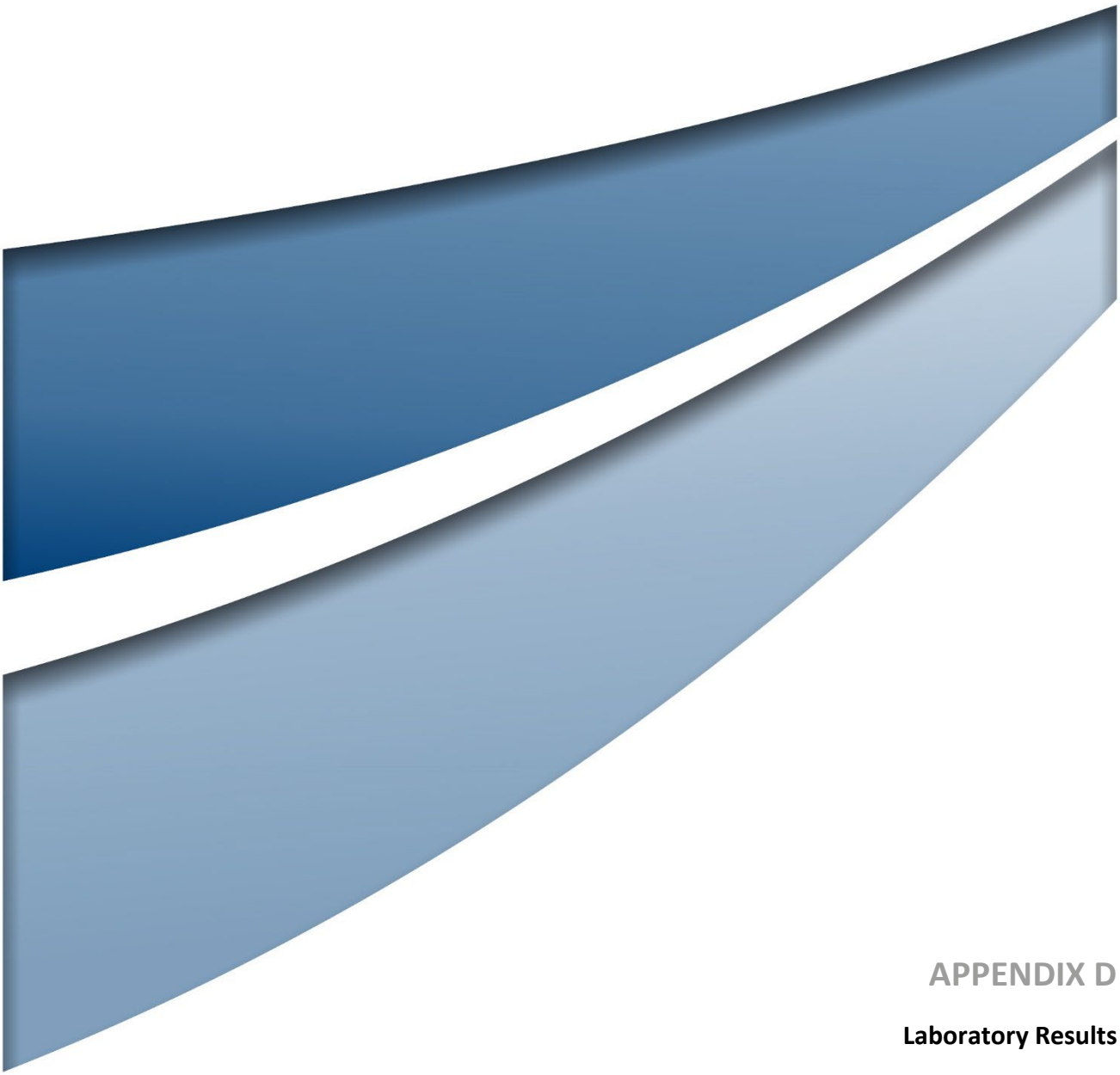
Laboratory and Field Assessment Parameters

Table C.1 - Laboratory Analysis Parameters

Parameter	Reference Method
PH and EC (1:5 water), pH (CaCl)	Rayment & Lyons 2011-4A1
Available Ammonium, Nitrate, Sulfur	Rayment & Lyons 2011-3A1
Exchangeable Sodium, Potassium, Calcium, Magnesium, Hydrogen, Aluminium	Rayment & Lyons 2011-15D3
Cation Exchange Capacity	Rayment & Lyons 2011 15M1
Colwell Phosphorus	Rayment & Lyons 2011-15J1
Available Micronutrients Zinc, Manganese, Iron, Copper, Boron, Silicon	Rayment & Lyons 2011-9B2
Total Carbon (TC)	Rayment & Lyons 2011-12A1
Total Nitrogen (TN)	Rayment & Lyons 2011-6B2b
TC/TN Ratio	Rayment & Lyons 2011-7A5
Organic Matter	Rayment & Lyons 2011-8A1
Available Ammonium, Nitrate, Sulfur	% C x 1.75
Basic Colour	Munsell Colour Chart
Basic Texture	CSIRO 'Yellow Book'
Emerson Aggregate test (EAT)	AS1289.3.8.1

Table C.2 -Field Assessment Parameters

Horizon depth including distinctiveness and shape	Pan presence and form
Field texture grade	Permeability and drainage
Field colour (Munsell colour chart)	Field pH
Pedality structure, grade and consistence	Field moisture
Soil fabric and stickiness	Surface condition
Stones (abundance and size)	Landform pattern / element
Mottles (amount, size and distinctiveness)	Current land use and previous disturbance
Segregations (abundance, nature, form and size)	Vegetation



APPENDIX D

Laboratory Results

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AGRICULTURAL SOIL ANALYSIS REPORT

38 samples supplied by Umwelt (Australia) Pty Ltd on 9/08/2021 . Lab Job No.M0075
Analysis requested by David McQueeney. Your Job: 21139
Office 4 ORANGE NSW 2800

			Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
		Sample ID:	BH01 0.0-0.15	BH01 0.2-0.4	BH01 0.45-0.6	BH02 0.0-0.1	BH02 0.1-0.3	BH02 0.3-0.4
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	RES	RES	RES	RES	RES	RES
	Parameter	Method reference	M0075/1	M0075/2	M0075/3	M0075/4	M0075/5	M0075/6
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	469	735	853	281	260	711
	Soluble Magnesium (mg/kg)		75	123	217	59	82	581
	Soluble Potassium (mg/kg)		169	63	27	46	44	41
	Soluble Phosphorus (mg/kg)		2.5	<1	<1	2.2	<1	<1
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	15	1.4	1.2	19	4.2	1.4
		**Rayment & Lyons 2011 - 9B2 (Colwell)	60	20	20	44	22	17
		**Inhouse S3A (Bray 2)	26	2.7	2.4	26	5.6	2.8
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	5.7	3.8	3.2	1.5	0.94	0.90
	Ammonium Nitrogen (mg/kg N)		3.8	1.1	0.81	2.8	1.4	0.87
	Sulfur (mg/kg S)		8.2	5.1	4.9	2.2	<1	1.2
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.53	7.16	7.56	5.47	6.07	7.19
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.049	0.036	0.033	0.025	0.014	0.033
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	3.5	0.97	0.62	3.6	0.81	0.78
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	3.4	6.3	6.3	2.0	1.8	7.0
	Exchangeable Calcium (kg/ha)		1,527	2,838	2,809	903	806	3,156
	Exchangeable Calcium (mg/kg)		682	1,267	1,254	403	360	1,409
	Exchangeable Magnesium (cmol+/kg)		0.74	1.7	2.5	0.61	0.84	8.8
	Exchangeable Magnesium (kg/ha)		202	449	691	165	228	2,392
	Exchangeable Magnesium (mg/kg)		90	201	309	74	102	1,068
	Exchangeable Potassium (cmol+/kg)		0.69	0.47	0.58	0.21	0.18	0.33
	Exchangeable Potassium (kg/ha)		608	408	508	181	159	286
	Exchangeable Potassium (mg/kg)		271	182	227	81	71	127
	Exchangeable Sodium (cmol+/kg)		<0.065	0.07	0.18	<0.065	<0.065	0.33
	Exchangeable Sodium (kg/ha)		<33	35	93	<33	<33	169
	Exchangeable Sodium (mg/kg)		<15	16	41	<15	<15	75
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.04	0.02	0.02	0.07	0.05	0.02
	Exchangeable Aluminium (kg/ha)		7.8	4.3	3.7	15	11	4.1
	Exchangeable Aluminium (mg/kg)		3.5	1.9	1.7	6.6	4.7	1.8
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.53	<0.01	<0.01	<0.01	0.21	<0.01
	Exchangeable Hydrogen (kg/ha)		12	<1	<1	<1	4.6	<1
	Exchangeable Hydrogen (mg/kg)		5.3	<1	<1	<1	2.1	<1
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	5.4	8.5	9.6	2.9	3.1	16
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	63	74	65	69	58	43
	Magnesium (%)		14	19	27	21	27	53
	Potassium (%)		13	5.5	6.1	7.0	5.8	2.0
	Sodium - ESP (%)		0.49	0.81	1.9	0.94	1.2	2.0
	Aluminium (%)		0.71	0.25	0.19	2.5	1.7	0.12
	Hydrogen (%)		9.7	0.00	0.00	0.00	6.6	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	4.6	3.8	2.5	3.3	2.1	0.80

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AGRICULTURAL SOIL ANALYSIS REPORT

38 samples supplied by Umwelt (Australia) Pty Ltd on 9/08/2021 . Lab Job No.M0075
Analysis requested by David McQueeney. Your Job: 21139
Office 4 ORANGE NSW 2800

			Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
		Sample ID:	BH01 0.0-0.15	BH01 0.2-0.4	BH01 0.45-0.6	BH02 0.0-0.1	BH02 0.1-0.3	BH02 0.3-0.4
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	RES	RES	RES	RES	RES	RES
	Parameter	Method reference	M0075/1	M0075/2	M0075/3	M0075/4	M0075/5	M0075/6
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	1.3	<0.5	<0.5	1.5	<0.5	<0.5
	Manganese (mg/kg)		63	6.9	6.3	18	6.2	0.27
	Iron (mg/kg)		296	12	7.1	245	33	18
	Copper (mg/kg)		0.93	0.36	0.22	0.32	0.42	0.21
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.58	0.54	0.37	0.30	0.26	0.27
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	57	28	14	37	33	22
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	2.0	0.55	0.36	2.1	0.46	0.45
	Total Nitrogen (%)		0.16	0.05	0.03	0.16	0.03	0.03
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	13	12	12	13	15	14
	Basic Texture	**Inhouse S65	Clay Loam	Clay	Clay	Loam	Clay Loam	Clay
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	31	23	21	16	8.8	21
	pH	**Rayment & Lyons 2011 - 4B4 ($CaCl_2$)	4.6	6.3	6.6	4.6	5.0	6.1

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
13. ** NATA accreditation does not cover the performance of this service.
14. Analysis conducted between sample arrival date and reporting date.
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17. This report was issued on 18/08/2021.

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Quality Checked: Kris Saville
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Analysis requested by David McQueeney. Your Job: 21139
Office 4 ORANGE NSW 2800

	Parameter	Method reference	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
	Sample ID:		BH02 0.5-0.6	BH03 0.0-0.1	BH03 0.15-0.25	BH03 0.4-0.5	BH03 0.5-0.55	BH04 0.0-0.1
	Crop:		Soil	Soil	Soil	Soil	Soil	Soil
	Client:		RES	RES	RES	RES	RES	RES
			M0075/7	M0075/8	M0075/9	M0075/10	M0075/11	M0075/12
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	515	263	94	36	19	105
	Soluble Magnesium (mg/kg)		477	255	950	1,198	1,206	149
	Soluble Potassium (mg/kg)		<25	45	71	84	87	<25
	Soluble Phosphorus (mg/kg)		<1	<1	<1	<1	<1	<1
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	1.7	4.5	2.2	1.6	1.9	9.7
		**Rayment & Lyons 2011 - 9B2 (Colwell)	18	24	19	18	19	36
		**Inhouse S3A (Bray 2)	4.4	7.6	2.8	2.5	2.6	18
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	0.84	1.4	1.1	0.75	0.78	0.73
	Ammonium Nitrogen (mg/kg N)		0.98	1.4	1.5	1.6	1.3	2.2
	Sulfur (mg/kg S)		<1	3.4	4.5	3.8	1.9	6.7
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.08	5.86	7.11	8.26	8.47	5.50
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.021	0.037	0.123	0.166	0.167	0.027
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	0.32	3.6	1.2	0.63	0.60	8.5
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	4.5	2.1	0.96	0.32	0.19	0.96
	Exchangeable Calcium (kg/ha)		2,017	953	432	145	87	431
	Exchangeable Calcium (mg/kg)		901	425	193	65	39	193
	Exchangeable Magnesium (cmol+/kg)		5.8	3.1	18	24	21	1.2
	Exchangeable Magnesium (kg/ha)		1,586	844	5,012	6,603	5,785	318
	Exchangeable Magnesium (mg/kg)		708	377	2,238	2,948	2,583	142
	Exchangeable Potassium (cmol+/kg)		0.13	0.28	0.55	0.64	0.59	<0.12
	Exchangeable Potassium (kg/ha)		114	241	484	563	516	<112
	Exchangeable Potassium (mg/kg)		51	108	216	251	231	<50
	Exchangeable Sodium (cmol+/kg)		0.27	0.54	2.3	3.5	3.3	0.21
	Exchangeable Sodium (kg/ha)		141	277	1,210	1,822	1,701	109
	Exchangeable Sodium (mg/kg)		63	124	540	813	759	49
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.01	0.23	0.03	0.02	0.02	0.55
	Exchangeable Aluminium (kg/ha)		2.5	46	6.4	3.4	3.3	110
	Exchangeable Aluminium (mg/kg)		1.1	21	2.9	1.5	1.5	49
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	0.78	<0.01	<0.01	<0.01	1.0
	Exchangeable Hydrogen (kg/ha)		<1	18	<1	<1	<1	23
	Exchangeable Hydrogen (mg/kg)		<1	7.8	<1	<1	<1	10
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	11	7.0	22	29	25	4.0
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	42	30	4.3	1.1	0.76	24
	Magnesium (%)		54	44	83	84	84	29
	Potassium (%)		1.2	3.9	2.5	2.2	2.3	2.5
	Sodium - ESP (%)		2.5	7.6	11	12	13	5.3
	Aluminium (%)		0.12	3.2	0.14	0.06	0.06	14
	Hydrogen (%)		0.00	11	0.00	0.00	0.00	25
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	0.77	0.68	0.05	0.01	0.01	0.82

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	Parameter	Method reference	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
	Sample ID:		BH02 0.5-0.6	BH03 0.0-0.1	BH03 0.15-0.25	BH03 0.4-0.5	BH03 0.5-0.55	BH04 0.0-0.1
	Crop:		Soil	Soil	Soil	Soil	Soil	Soil
	Client:		RES	RES	RES	RES	RES	RES
			M0075/7	M0075/8	M0075/9	M0075/10	M0075/11	M0075/12
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Manganese (mg/kg)		0.41	15	0.94	0.12	0.14	4.4
	Iron (mg/kg)		17	133	53	19	26	294
	Copper (mg/kg)		0.18	0.22	0.14	0.12	0.20	0.22
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.15	0.21	0.15	0.17	0.28	0.50
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	45	26	39	64	107	19
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	0.19	2.1	0.69	0.36	0.34	4.9
	Total Nitrogen (%)		<0.02	0.09	0.04	0.02	0.02	0.16
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	13	22	18	15	16	31
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay	Clay	Clay	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	13	24	79	106	107	17
	pH	**Rayment & Lyons 2011 - 4B4 ($CaCl_2$)	6.0	4.6	6.0	7.2	7.4	4.5

Notes:

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3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
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	Parameter	Method reference	Sample 13	Sample 14	Sample 15	Sample 16	Sample 17	Sample 18
	Sample ID:		BH04 0.1-0.2	BH04 0.3-0.4	BH05 0.0-0.1	BH05 0.1-0.2	BH05 0.3-0.4	BH06 0.0-0.1
	Crop:		Soil	Soil	Soil	Soil	Soil	Soil
	Client:		RES	RES	RES	RES	RES	RES
			M0075/13	M0075/14	M0075/15	M0075/16	M0075/17	M0075/18
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	49	28	363	194	432	405
	Soluble Magnesium (mg/kg)		97	156	51	63	453	76
	Soluble Potassium (mg/kg)		<25	<25	125	56	86	150
	Soluble Phosphorus (mg/kg)		<1	<1	1.4	<1	<1	1.5
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	3.7	1.9	16	2.1	1.3	7.7
		**Rayment & Lyons 2011 - 9B2 (Colwell)	22	21	49	19	16	34
		**Inhouse S3A (Bray 2)	5.1	2.5	24	2.5	1.6	11
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	0.73	0.85	0.84	0.75	0.85	1.4
	Ammonium Nitrogen (mg/kg N)		0.81	0.69	3.3	0.57	1.2	1.6
	Sulfur (mg/kg S)		2.1	8.2	5.7	2.2	14	4.4
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.79	5.98	6.31	6.45	6.64	6.16
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.016	0.025	0.040	0.022	0.059	0.024
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	3.2	1.4	1.9	0.39	0.67	1.5
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.31	0.17	2.7	1.2	4.1	3.1
	Exchangeable Calcium (kg/ha)		139	75	1,224	525	1,839	1,373
	Exchangeable Calcium (mg/kg)		62	33	546	235	821	613
	Exchangeable Magnesium (cmol+/kg)		1.1	1.7	0.56	0.66	7.3	0.80
	Exchangeable Magnesium (kg/ha)		288	473	152	179	1,993	217
	Exchangeable Magnesium (mg/kg)		128	211	68	80	890	97
	Exchangeable Potassium (cmol+/kg)		<0.12	<0.12	0.59	0.22	0.81	0.63
	Exchangeable Potassium (kg/ha)		<112	<112	513	191	708	548
	Exchangeable Potassium (mg/kg)		<50	<50	229	85	316	245
	Exchangeable Sodium (cmol+/kg)		0.14	0.26	0.10	0.08	0.66	<0.065
	Exchangeable Sodium (kg/ha)		73	132	50	40	339	<33
	Exchangeable Sodium (mg/kg)		32	59	22	18	152	<15
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.26	0.13	0.02	0.03	0.02	0.02
	Exchangeable Aluminium (kg/ha)		53	26	4.6	5.1	5.0	4.6
	Exchangeable Aluminium (mg/kg)		24	11	2.1	2.3	2.2	2.1
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.76	0.52	0.16	0.07	<0.01	0.24
	Exchangeable Hydrogen (kg/ha)		17	12	3.5	1.5	<1	5.5
	Exchangeable Hydrogen (mg/kg)		7.6	5.2	1.6	<1	<1	2.4
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	2.6	2.9	4.1	2.2	13	4.8
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	12	5.8	66	53	32	64
	Magnesium (%)		40	60	13	30	57	17
	Potassium (%)		3.4	3.0	14	9.8	6.3	13
	Sodium - ESP (%)		5.4	8.9	2.3	3.5	5.1	0.10
	Aluminium (%)		10	4.4	0.55	1.1	0.19	0.48
	Hydrogen (%)		29	18	3.8	3.1	0.00	5.1
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	0.29	0.10	4.9	1.8	0.56	3.8

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			Sample 13	Sample 14	Sample 15	Sample 16	Sample 17	Sample 18
		Sample ID:	BH04 0.1-0.2	BH04 0.3-0.4	BH05 0.0-0.1	BH05 0.1-0.2	BH05 0.3-0.4	BH06 0.0-0.1
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	RES	RES	RES	RES	RES	RES
	Parameter	Method reference	M0075/13	M0075/14	M0075/15	M0075/16	M0075/17	M0075/18
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	<0.5	<0.5	0.70	<0.5	<0.5	<0.5
	Manganese (mg/kg)		1.1	0.50	167	12	1.6	80
	Iron (mg/kg)		160	34	65	17	20	38
	Copper (mg/kg)		0.16	0.14	1.2	0.43	0.55	0.72
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.29	0.33	0.39	0.18	0.37	0.31
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	19	32	35	33	30	30
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	1.8	0.78	1.1	0.23	0.38	0.88
	Total Nitrogen (%)		0.04	0.02	0.07	<0.02	0.04	0.06
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	45	36	15	13	10	15
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay	Clay	Clay	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	10	16	26	14	38	15
	pH	**Rayment & Lyons 2011 - 4B4 ($CaCl_2$)	4.5	4.6	5.4	5.5	5.6	5.1

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil re
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
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AGRICULTURAL SOIL ANALYSIS REPORT

38 samples supplied by Umwelt (Australia) Pty Ltd on 9/08/2021 . Lab Job No.M0075
Analysis requested by David McQueeney. Your Job: 21139
Office 4 ORANGE NSW 2800

			Sample 19	Sample 20	Sample 21	Sample 22	Sample 23	Sample 24
		Sample ID:	BH06 0.15-0.3	BH06 0.35-0.45	BH07 0.0-0.1	BH07 0.3-0.4	BH07 0.6-0.7	BH08 0.0-0.1
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	RES	RES	RES	RES	RES	RES
	Parameter	Method reference	M0075/19	M0075/20	M0075/21	M0075/22	M0075/23	M0075/24
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	397	581	398	345	446	196
	Soluble Magnesium (mg/kg)		70	190	91	120	269	58
	Soluble Potassium (mg/kg)		80	55	32	<25	<25	345
	Soluble Phosphorus (mg/kg)		<1	<1	<1	<1	<1	2.6
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	1.5	1.2	1.5	1.2	<1	24
		**Rayment & Lyons 2011 - 9B2 (Colwell)	18	17	19	18	16	76
		**Inhouse S3A (Bray 2)	2.0	1.6	2.1	2.0	1.6	35
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	1.1	0.91	0.90	0.85	1.0	3.8
	Ammonium Nitrogen (mg/kg N)		1.2	1.1	1.7	1.0	0.80	2.7
	Sulfur (mg/kg S)		1.8	7.2	2.9	5.6	7.0	1.9
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.80	7.10	5.86	6.63	7.28	6.45
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.016	0.027	0.016	0.015	0.027	0.047
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	0.89	0.64	1.7	0.81	0.59	2.3
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	2.7	4.7	3.0	2.6	3.7	1.5
	Exchangeable Calcium (kg/ha)		1,216	2,100	1,362	1,158	1,679	692
	Exchangeable Calcium (mg/kg)		543	938	608	517	749	309
	Exchangeable Magnesium (cmol+/kg)		0.76	2.5	1.0	1.4	3.7	0.60
	Exchangeable Magnesium (kg/ha)		206	682	280	390	1,007	164
	Exchangeable Magnesium (mg/kg)		92	305	125	174	450	73
	Exchangeable Potassium (cmol+/kg)		0.34	0.44	0.17	0.13	0.16	1.3
	Exchangeable Potassium (kg/ha)		297	389	148	114	143	1,152
	Exchangeable Potassium (mg/kg)		133	173	66	51	64	514
	Exchangeable Sodium (cmol+/kg)		<0.065	0.15	0.08	0.15	0.50	<0.065
	Exchangeable Sodium (kg/ha)		<33	77	40	77	256	<33
	Exchangeable Sodium (mg/kg)		<15	34	18	34	114	<15
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.03	0.02	0.03	0.02	0.02	0.03
	Exchangeable Aluminium (kg/ha)		5.1	4.3	5.9	4.1	4.4	6.3
	Exchangeable Aluminium (mg/kg)		2.3	1.9	2.6	1.8	2.0	2.8
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	0.35	<0.01	<0.01	0.22
	Exchangeable Hydrogen (kg/ha)		<1	<1	7.8	<1	<1	4.9
	Exchangeable Hydrogen (mg/kg)		<1	<1	3.5	<1	<1	2.2
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	3.9	7.8	4.7	4.3	8.1	3.7
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	70	60	65	60	46	41
	Magnesium (%)		20	32	22	33	46	16
	Potassium (%)		8.8	5.7	3.6	3.0	2.0	35
	Sodium - ESP (%)		0.57	1.9	1.7	3.5	6.1	0.58
	Aluminium (%)		0.66	0.28	0.63	0.47	0.27	0.83
	Hydrogen (%)		0.00	0.00	7.4	0.00	0.00	5.9
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	3.6	1.9	3.0	1.8	1.0	2.6

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	Parameter	Method reference	Sample 19	Sample 20	Sample 21	Sample 22	Sample 23	Sample 24
	Sample ID:		BH06 0.15-0.3	BH06 0.35-0.45	BH07 0.0-0.1	BH07 0.3-0.4	BH07 0.6-0.7	BH08 0.0-0.1
	Crop:		Soil	Soil	Soil	Soil	Soil	Soil
	Client:		RES	RES	RES	RES	RES	RES
			M0075/19	M0075/20	M0075/21	M0075/22	M0075/23	M0075/24
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	<0.5	<0.5	0.61	<0.5	<0.5	1.1
	Manganese (mg/kg)		40	5.1	105	49	25	23
	Iron (mg/kg)		17	8.2	64	32	14	192
	Copper (mg/kg)		0.51	0.27	0.91	0.55	0.36	0.50
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.28	0.50	0.47	0.34	0.45	0.33
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	37	26	39	41	25	45
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	0.51	0.37	0.95	0.46	0.34	1.3
	Total Nitrogen (%)		0.03	0.03	0.05	0.03	0.03	0.09
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	16	13	18	14	12	14
	Basic Texture	**Inhouse S65	Clay Loam	Clay	Clay	Clay	Clay	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	10	18	10	9.8	17	30
	pH	**Rayment & Lyons 2011 - 4B4 ($CaCl_2$)	5.8	6.2	4.8	5.5	6.1	5.2

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,
   Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil re
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    122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
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			Sample 25	Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
		Sample ID:	BH08 0.2-0.3	BH08 0.45-0.55	BH09 0.0-0.1	BH09 0.15-0.25	BH09 0.5-0.6	BH10 0.0-0.1
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	RES	RES	RES	RES	RES	RES
	Parameter	Method reference	M0075/25	M0075/26	M0075/27	M0075/28	M0075/29	M0075/30
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	173	454	162	106	420	117
	Soluble Magnesium (mg/kg)		45	273	35	26	118	39
	Soluble Potassium (mg/kg)		94	33	199	83	61	<25
	Soluble Phosphorus (mg/kg)		<1	<1	1.9	<1	<1	1.6
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	3.6	1.5	10	1.9	1.4	52
		**Rayment & Lyons 2011 - 9B2 (Colwell)	24	24	38	20	7.9	122
		**Inhouse S3A (Bray 2)	4.6	2.8	12	2.6	2.0	83
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	2.2	2.3	1.8	2.4	1.9	2.5
	Ammonium Nitrogen (mg/kg N)		1.1	1.4	4.3	2.5	1.4	5.4
	Sulfur (mg/kg S)		7.2	8.4	7.7	7.0	4.8	7.4
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.65	7.27	5.93	5.80	6.42	5.27
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.021	0.047	0.038	0.023	0.015	0.021
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	0.85	0.66	1.7	0.40	0.29	3.3
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	1.2	3.7	1.1	0.65	3.5	0.74
	Exchangeable Calcium (kg/ha)		521	1,647	479	292	1,549	333
	Exchangeable Calcium (mg/kg)		232	735	214	130	692	149
	Exchangeable Magnesium (cmol+/kg)		0.48	3.7	0.35	0.27	1.6	0.37
	Exchangeable Magnesium (kg/ha)		132	1,001	94	74	437	101
	Exchangeable Magnesium (mg/kg)		59	447	42	33	195	45
	Exchangeable Potassium (cmol+/kg)		0.35	0.28	0.71	0.26	0.33	<0.12
	Exchangeable Potassium (kg/ha)		306	243	625	229	290	<112
	Exchangeable Potassium (mg/kg)		137	108	279	102	129	<50
	Exchangeable Sodium (cmol+/kg)		<0.065	0.69	<0.065	<0.065	<0.065	<0.065
	Exchangeable Sodium (kg/ha)		<33	353	<33	<33	<33	<33
	Exchangeable Sodium (mg/kg)		<15	158	<15	<15	<15	<15
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.05	0.03	0.04	0.03	0.01	0.25
	Exchangeable Aluminium (kg/ha)		9.6	5.7	7.7	5.3	2.9	50
	Exchangeable Aluminium (mg/kg)		4.3	2.5	3.4	2.4	1.3	22
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.37	<0.01	0.35	0.15	0.13	0.93
	Exchangeable Hydrogen (kg/ha)		8.2	<1	7.7	3.4	2.8	21
	Exchangeable Hydrogen (mg/kg)		3.7	<1	3.5	1.5	1.3	9.3
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	2.4	8.3	2.5	1.4	5.6	2.5
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	48	44	43	48	62	30
	Magnesium (%)		20	44	14	20	29	15
	Potassium (%)		14	3.3	28	19	6.0	4.6
	Sodium - ESP (%)		1.3	8.2	-0.2	-0.4	0.51	2.1
	Aluminium (%)		2.0	0.34	1.5	2.0	0.26	10
	Hydrogen (%)		15	0.00	14	11	2.3	38
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	2.4	1.00	3.1	2.4	2.2	2.0

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			Sample 25	Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
		Sample ID:	BH08 0.2-0.3	BH08 0.45-0.55	BH09 0.0-0.1	BH09 0.15-0.25	BH09 0.5-0.6	BH10 0.0-0.1
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	RES	RES	RES	RES	RES	RES
	Parameter	Method reference	M0075/25	M0075/26	M0075/27	M0075/28	M0075/29	M0075/30
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	<0.5	<0.5	<0.5	<0.5	<0.5	0.78
	Manganese (mg/kg)		19	9.2	52	18	10	20
	Iron (mg/kg)		40	12	67	17	15	286
	Copper (mg/kg)		0.46	0.21	0.65	0.47	0.31	0.52
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.38	0.33	0.32	0.20	0.30	0.19
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	28	17	27	31	60	19
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	0.49	0.38	0.97	0.23	0.17	1.9
	Total Nitrogen (%)		0.03	0.03	0.07	<0.02	<0.02	0.12
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	16	12	14	12	13	16
	Basic Texture	**Inhouse S65	Clay Loam	Clay	Clay Loam	Clay Loam	Clay Loam	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	13	30	24	15	9.9	14
	pH	**Rayment & Lyons 2011 - 4B4 ($CaCl_2$)	4.6	6.1	4.8	4.9	5.5	4.6

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
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			Sample 31	Sample 32	Sample 33	Sample 34	Sample 35	Sample 36
		Sample ID:	BH10 0.15-0.25	BH10 0.35-0.45	BH11 0.0-0.1	BH11 0.1-0.2	BH11 0.25-0.35	BH12 0.0-0.1
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	RES	RES	RES	RES	RES	RES
	Parameter	Method reference	M0075/31	M0075/32	M0075/33	M0075/34	M0075/35	M0075/36
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	142	154	158	87	86	281
	Soluble Magnesium (mg/kg)		49	400	153	116	636	59
	Soluble Potassium (mg/kg)		<25	<25	<25	<25	<25	27
	Soluble Phosphorus (mg/kg)		<1	<1	1.2	<1	<1	1.6
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	7.4	1.6	19	12	2.9	3.9
		**Rayment & Lyons 2011 - 9B2 (Colwell)	28	18	72	38	17	25
		**Inhouse S3A (Bray 2)	9.5	2.1	37	18	2.6	4.1
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	1.0	0.89	0.83	0.82	0.90	0.93
	Ammonium Nitrogen (mg/kg N)		1.6	1.4	5.1	2.3	2.1	1.5
	Sulfur (mg/kg S)		2.9	5.2	5.4	3.6	7.9	<1
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.88	6.45	5.50	5.75	6.15	6.32
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.016	0.062	0.037	0.021	0.056	0.011
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	0.64	0.53	5.3	1.5	1.0	0.62
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.77	1.2	1.2	0.52	0.80	1.8
	Exchangeable Calcium (kg/ha)		345	537	529	234	357	786
	Exchangeable Calcium (mg/kg)		154	240	236	104	159	351
	Exchangeable Magnesium (cmol+/kg)		0.43	5.2	1.7	1.2	10	0.60
	Exchangeable Magnesium (kg/ha)		117	1,404	462	321	2,749	164
	Exchangeable Magnesium (mg/kg)		52	627	206	143	1,227	73
	Exchangeable Potassium (cmol+/kg)		<0.12	0.14	<0.12	<0.12	<0.12	<0.12
	Exchangeable Potassium (kg/ha)		<112	121	<112	<112	<112	<112
	Exchangeable Potassium (mg/kg)		<50	54	<50	<50	<50	<50
	Exchangeable Sodium (cmol+/kg)		<0.065	0.93	0.26	0.17	1.3	<0.065
	Exchangeable Sodium (kg/ha)		<33	481	136	88	684	<33
	Exchangeable Sodium (mg/kg)		<15	215	61	39	305	<15
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.08	0.03	0.29	0.14	0.09	0.04
	Exchangeable Aluminium (kg/ha)		17	6.9	59	29	18	8.2
	Exchangeable Aluminium (mg/kg)		7.4	3.1	26	13	7.9	3.7
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.31	0.33	0.98	0.65	0.49	0.16
	Exchangeable Hydrogen (kg/ha)		6.9	7.3	22	15	11	3.5
	Exchangeable Hydrogen (mg/kg)		3.1	3.3	9.8	6.5	4.9	1.6
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	1.7	7.8	4.5	2.7	13	2.7
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	44	15	26	19	6.2	65
	Magnesium (%)		25	66	38	43	78	22
	Potassium (%)		4.7	1.8	2.1	1.9	0.88	3.9
	Sodium - ESP (%)		3.2	12	5.9	6.3	10	2.1
	Aluminium (%)		4.8	0.44	6.5	5.3	0.68	1.5
	Hydrogen (%)		18	4.2	22	24	3.8	5.7
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	1.8	0.23	0.69	0.44	0.08	2.9

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AGRICULTURAL SOIL ANALYSIS REPORT

38 samples supplied by Umwelt (Australia) Pty Ltd on 9/08/2021 . Lab Job No.M0075
Analysis requested by David McQueeney. Your Job: 21139
Office 4 ORANGE NSW 2800

	Parameter	Method reference	Sample 31	Sample 32	Sample 33	Sample 34	Sample 35	Sample 36
	Sample ID:		BH10 0.15-0.25	BH10 0.35-0.45	BH11 0.0-0.1	BH11 0.1-0.2	BH11 0.25-0.35	BH12 0.0-0.1
	Crop:		Soil	Soil	Soil	Soil	Soil	Soil
	Client:		RES	RES	RES	RES	RES	RES
			M0075/31	M0075/32	M0075/33	M0075/34	M0075/35	M0075/36
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Manganese (mg/kg)		4.1	0.53	7.8	5.0	0.27	10
	Iron (mg/kg)		61	64	294	294	49	23
	Copper (mg/kg)		0.26	0.22	0.22	0.39	0.16	0.36
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.13	0.19	0.26	0.16	0.14	<0.1
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	18	49	21	25	30	23
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	0.36	0.31	3.0	0.83	0.59	0.35
	Total Nitrogen (%)		<0.02	0.02	0.20	0.05	0.04	0.02
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	19	13	15	18	15	15
	Basic Texture	**Inhouse S65	Loam	Clay Loam	Clay Loam	Clay	Clay Loam	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	10.0	39	24	13	36	7.1
	pH	**Rayment & Lyons 2011 - 4B4 ($CaCl_2$)	5.1	5.2	4.8	4.8	4.8	5.6

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,
   Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil re
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium,
    122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimat
13. ** NATA accreditation does not cover the performance of this service.
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16. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditio
17. This report was issued on 18/08/2021.

Quality Checked: Kris Saville
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	Parameter		Method reference	Sample 37 BH12 0.2-0.3 Soil RES M0075/37	Sample 38 BH12 0.5-0.6 Soil RES M0075/38	*Heavy Soil* *Clay* Indicative guidelines - refer to Notes 6 and 8	*Medium Soil* *Clay Loam*	*Light Soil* *Loam*	*Sandy Soil* *Loamy Sand*
	Soluble Calcium (mg/kg)		**Inhouse S10 - Morgan 1	340	577	*1150*	*750*	*375*	*175*
	Soluble Magnesium (mg/kg)			53	450	*160*	*105*	*60*	*25*
	Soluble Potassium (mg/kg)			61	39	*113*	*75*	*60*	*50*
	Soluble Phosphorus (mg/kg)			1.5	<1	*15*	*12*	*10*	*5.0*
	Phosphorus (mg/kg P)		**Rayment & Lyons 2011 - 9E2 (Bray 1)	25	1.3	*45 note 8*	*30 note 8*	*24 note 8*	*20 note 8*
			**Rayment & Lyons 2011 - 9B2 (Colwell)	71	18	*80*	*50*	*45*	*35*
			**Inhouse S3A (Bray 2)	35	1.8	*90 note 8*	*60 note 8*	*48 note 8*	*40 note 8*
	Nitrate Nitrogen (mg/kg N)		**Inhouse S37 (KCl)	2.0	0.86	*15*	*13*	*10*	*10*
	Ammonium Nitrogen (mg/kg N)			4.1	1.7	*20*	*18*	*15*	*12*
	Sulfur (mg/kg S)			2.1	9.9	*10.0*	*8.0*	*8.0*	*7.0*
	pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.77	6.57	*6.5*	*6.5*	*6.3*	*6.3*
	Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.018	0.030	*0.200*	*0.150*	*0.120*	*0.100*
	Estimated Organic Matter (% OM)		**Calculation: Total Carbon x 1.75	2.1	0.59	*> 5.5*	*>4 .5*	*> 3.5*	*> 2.5*
	Exchangeable Calcium	**(cmol$_+$/kg)**	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	2.4	5.7	*15.6*	*10.8*	*5.0*	*1.9*
		(kg/ha)		1,066	2,562	*7000*	*4816*	*2240*	*840*
		(mg/kg)		476	1,144	*3125*	*2150*	*1000*	*375*
	Exchangeable Magnesium	**(cmol$_+$/kg)**		0.54	7.1	*2.4*	*1.7*	*1.2*	*0.60*
		(kg/ha)		146	1,935	*650*	*448*	*325*	*168*
		(mg/kg)		65	864	*290*	*200*	*145*	*75*
	Exchangeable Potassium	**(cmol$_+$/kg)**		0.24	0.31	*0.60*	*0.50*	*0.40*	*0.30*
		(kg/ha)		214	271	*526*	*426*	*336*	*224*
		(mg/kg)		95	121	*235*	*190*	*150*	*100*
	Exchangeable Sodium	**(cmol$_+$/kg)**		<0.065	0.63	*0.3*	*0.26*	*0.22*	*0.11*
		(kg/ha)		<33	325	*155*	*134*	*113*	*57*
		(mg/kg)		<15	145	*69*	*60*	*51*	*25*
	Exchangeable Aluminium	**(cmol$_+$/kg)**	**Inhouse S37 (KCl)	0.06	0.03	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)		11	6.2	*121*	*101*	*73*	*30*
		(mg/kg)		5.1	2.8	*54*	*45*	*32*	*14*
	Exchangeable Hydrogen	**(cmol$_+$/kg)**	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.46	<0.01	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)		10	<1	*13*	*11*	*8*	*3*
		(mg/kg)		4.6	<1	*6*	*5*	*4*	*2*
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	3.7	14	*20.1*	*14.3*	*7.8*	*3.3*
	Calcium (%)		**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	64	41	*77.6*	*75.7*	*65.6*	*57.4*
	Magnesium (%)			15	52	*11.9*	*11.9*	*15.7*	*18.1*
	Potassium (%)			6.6	2.2	*3.0*	*3.5*	*5.2*	*9.1*
	Sodium - ESP (%)			0.86	4.6	*1.5*	*1.8*	*2.9*	*3.3*
	Aluminium (%)			1.5	0.22	*6.0*	*7.1*	*10.5*	*12.1*
	Hydrogen (%)			12	0.00				
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol$_+$/kg)	4.4	0.80	*6.5*	*6.4*	*4.2*	*3.2*

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AGRICULTURAL SOIL ANALYSIS REPORT

38 samples supplied by Umwelt (Australia) Pty Ltd on 9/08/2021 . Lab Job No.M0075
Analysis requested by David McQueeney. Your Job: 21139
Office 4 ORANGE NSW 2800

			Sample 37	Sample 38	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
		Sample ID:	BH12 0.2-0.3	BH12 0.5-0.6				
		Crop:	Soil	Soil				
		Client:	RES	RES	*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter	**Method reference**	**M0075/37**	**M0075/38**	**Indicative guidelines - refer to Notes 6 and 8**			
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	1.3	<0.5	*6.0*	*5.0*	*4.0*	*3.0*
	Manganese (mg/kg)		44	0.87	*25*	*22*	*18*	*15*
	Iron (mg/kg)		110	28	*25*	*22*	*18*	*15*
	Copper (mg/kg)		0.49	0.25	*2.4*	*2.0*	*1.6*	*1.2*
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.16	0.14	*2.0*	*1.7*	*1.4*	*1.0*
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	23	39	*50*	*45*	*40*	*35*
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	1.2	0.34	*> 3.1*	*> 2.6*	*> 2.0*	*> 1.4*
	Total Nitrogen (%)		0.08	0.03	*> 0.30*	*> 0.25*	*> 0.20*	*> 0.15*
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	14	13	*10–12*	*10–12*	*10–12*	*10–12*
	Basic Texture	**Inhouse S65	Clay	Clay	..	..	..	..
	Basic Colour		Brownish	Brownish	..	..	..	..
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	12	19	..	..	..	..
	pH	**Rayment & Lyons 2011 - 4B4 ($CaCl_2$)	5.2	5.3	..			

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,
   Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
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Quality Checked: Kris Saville
Agricultural Co-Ordinator KS

RESULTS OF SOIL ANALYSIS

38 samples supplied by Umwelt (Australia) Pty Ltd on 9/08/2021 . Lab Job No. M0075.
Samples submitted by David McQueeney. Your Job: 21139.
Office 4 ORANGE NSW 2800

SAMPLE ID	Job No.	Emerson Dispersion Class	Wet Munsell Colour		Wet Munsell Mottle Colour		
			Code	Description	Code	Description	Degree of Mottling (%)
	Method	*See sheet 2 - Emerson Aggregate Test (EAT)*					
BH01 0.0-0.15	*M0075/1*	4	5YR 3/3	Dark reddish brown	..	..	..
BH01 0.2-0.4	*M0075/2*	4	5YR 6/8	Reddish yellow	..	..	..
BH01 0.45-0.6	*M0075/3*	4	7.5YR 6/8	Reddish yellow	..	..	..
BH02 0.0-0.1	*M0075/4*	3	5YR 4/6	Yellowish red	..	..	..
BH02 0.1-0.3	*M0075/5*	3	5YR 5/8	Yellowish red	..	..	..
BH02 0.3-0.4	*M0075/6*	3	5Y 6/4	Pale olive	2.5YR 4/6	Red	50
BH02 0.5-0.6	*M0075/7*	3	5Y 5/4	Olive	2.5YR 4/6	Red	10
BH03 0.0-0.1	*M0075/8*	3	10 YR 2/2	Very dark brown	..	..	..
BH03 0.15-0.25	*M0075/9*	2	2.5YR 3/2	Very dark greyish brown	..	..	..
BH03 0.4-0.5	*M0075/10*	2	5Y 4/2	Olive grey	5YR 5/6	Yellowish red	5
BH03 0.5-0.55	*M0075/11*	2	2.5Y 4/3	Olive brown	5Y 7/8	Yellow	2
BH04 0.0-0.1	*M0075/12*	3	5Y 2.5/1	Black	..	..	..
BH04 0.1-0.2	*M0075/13*	3	7.5YR 3/3	Dark brown	..	..	..
BH04 0.3-0.4	*M0075/14*	2	5YR 5/8	Yellowish red	..	..	..
BH05 0.0-0.1	*M0075/15*	3	10YR 3/2	Very dark greyish brown	..	..	..
BH05 0.1-0.2	*M0075/16*	3	10YR 6/8	Brownish yellow	..	..	..
BH05 0.3-0.4	*M0075/17*	3	7.5YR 6/8	Reddish yellow	..	..	..
BH06 0.0-0.1	*M0075/18*	3	5YR 3/2	Dark reddish brown	..	..	..
BH06 0.15-0.3	*M0075/19*	3	7.5YR 2.5/3	Very dark brown	2.5YR 4/6	Red	30
BH06 0.35-0.45	*M0075/20*	4	10YR 5/8	Yellowish brown	..	..	..
BH07 0.0-0.1	*M0075/21*	3	10YR 2/2	Very dark brown	..	..	..
BH07 0.3-0.4	*M0075/22*	3	10YR 4/6	Dark yellowish brown	..	..	..
BH07 0.6-0.7	*M0075/23*	3	10YR 6/8	Brownish yellow	..	..	..
BH08 0.0-0.1	*M0075/24*	3	5YR 3/2	Dark reddish brown	..	..	..
BH08 0.2-0.3	*M0075/25*	3	2.5YR 5/8	Red	..	..	..
BH08 0.45-0.55	*M0075/26*	4	10YR 6/8	Brownish yellow	..	..	..
BH09 0.0-0.1	*M0075/27*	3	10YR 3/2	Very dark greyish brown	..	..	..
BH09 0.15-0.25	*M0075/28*	3	10YR 6/4	Light yellowish brown	..	..	..
BH09 0.5-0.6	*M0075/29*	2	10YR 6/6	Brownish yellow	2.5YR 4/4	Reddish brown	20
BH10 0.0-0.1	*M0075/30*	3	7.5YR 2.5/2	Very dark brown	..	..	..
BH10 0.15-0.25	*M0075/31*	3	7.5YR 5/4	Brown	..	..	..
BH10 0.35-0.45	*M0075/32*	2	5Y 6/2	Light olive grey	..	..	..
BH11 0.0-0.1	*M0075/33*	3	10YR 2/1	Black	..	..	..
BH11 0.1-0.2	*M0075/34*	3	7.5YR 4/3	Brown	..	..	..
BH11 0.25-0.35	*M0075/35*	2	5Y 6/4	Pale olive	5YR 5/6	Yellowish red	20
BH12 0.0-0.1	*M0075/36*	3	7.5YR 6/6	Reddish yellow	..	..	..
BH12 0.2-0.3	*M0075/37*	3	5YR 3/2	Dark reddish brown	..	..	..
BH12 0.5-0.6	*M0075/38*	3	10R 4/8	Red	2.5Y 6/8	Olive yellow	10

Notes:

1. All results as dry weight DW - samples were dried at 40oC for 24-48hrs prior to crushing and analysis.

2. Australian Standard 1289.3.8.1-1997 (see summary attached as sheet 2)

3. Analysis conducted between sample arrival date and reporting date.

4. ** NATA accreditation does not cover the performance of this service.

5. .. Denotes not requested.

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8. This report was issued on 19/08/2021.

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checked:.....
Graham Lancaster

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