Vast Solar

Jemalong Hybrid Solar Park

PV Field Existing Conditions Technical Summary

Rev 1 | 16 November 2017

Job number 258584

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Document Verification

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Contents

1 Introduction

1.1 Project description

Vast Solar have engaged Arup Pty Ltd to provide multi-disciplinary engineering services for a proposed solar farm site located near the town of Jemalong. As part of this engagement, Arup Geotechnics have carried out a desk study of the area and undertaken a preliminary geotechnical investigation of the proposed site. Geotechnical interpretation will be provided in two geotechnical interpretive reports, the Photovoltaic (PV) field and Concentrating Solar Thermal Park (CSP) sites respectively.

This report presents the factual information for the PV field relevant to the EIS (Environmental Impact Statement).

1.2 Projection and datum

For all positioning presented in this report, the following datum have been adopted:

- Horizontal datum: Geocentric Datum of Australia, GDA94
- Projection: Map Grid of Australia (MGA)
- Zone: 55
- Vertical datum: Australian Height Datum (AHD)

2 Site Description and Geology

2.1 Location

The site is located along Naroo Lane in Jemalong, approximately 3.5km southwest of the town of Jemalong and 36km west of the town of Forbes in western NSW.

The PV field occupies approximately 86 hectares and consists of generally open terrain with some areas of vegetation at the northern boundary of the site.

A site plan is included in Figure 1.

2.2 Site description

The site is on private property which is currently vacant and seasonally used as a grazing field. Desiccation cracks were observed across the site at ground surface with an aperture of up to 10 mm approximately 60 mm deep. Other site observations are shown on Figure 6.

2.3 Topography

The site is generally very flat with a slight grade down towards the south west of roughly less than 5°.

Preliminary LIDAR and survey data has been included in the attached plans.

2.4 Soil landscape

Reference to the 1:250 000 Soil Landscape Map Sheet SI/55-07 (ref [1]) for Forbes indicates the site is primarily underlain by the Corinella (co) soil landscape, with the Scrubby Plains (sb) present towards the north of the site.

The Corinella soil unit is commonly described as a Quaternary alluvium, with typically red brown earths. Limitations of this unit include: Flood hazard (localised); soil structure decline hazard; alkaline soils with sodic/dispersible subsoils, hardsetting surfaces (localised), high shrink-swell potential (localised) and low fertility.

The Scrubby Plains soil unit is commonly described as Quaternary alluvium, predominately comprising of grey, brown and red clays. Limitations of this unit include: Foundation hazard; flood hazard (localised); seasonal waterlogging (localised); sodic, highly plastic, dispersible soils with low permeability, high shrink-swell potential and localised subsoil salinity.

A soil landscape map has been included as Figure 3.

2.5 Geology

Reference to the 1:250 000 Geological Map Sheet SI/55-07 (ref [2]) for Forbes indicates the site is underlain by two strata units: Alluvial Sediments (Qa) described as active depositional plains and terraces containing present day drainage and Cainozoic Alluvial Plains (Cza) described as inactive alluvial plains.

A nearby cross-section from the geology map approximately 8 km north of the site shows two rock units at depth: the Cotton Formation (O-Sc) described as siltstone, chert, sandstone, marl, minor limestone and conglomerate and the Calarie Sandstone (S-Ddc) described as cross-bedded pebbly to planar-bedded medium grained sandstone.

The geological image (ref [2]) shows the Forbes Anticline running approximately from north to south through Naroo Lane and the eastern paddock of the CSP site.

A geology map has been included as Figure 4.

2.6 Acid sulphate soils

Published acid sulphate soil risk mapping shows no known occurrence of acid sulphate soils at the site.

2.7 Groundwater

The site falls within the Lachlan River Catchment. Immediately north of the site is the Thurumbidgee Lagoon. Reference to aerial photographs indicate the lagoon and surrounding area is prone the flood during periods of heavy rainfall.

Aerial photography supplied by the client shows flood water surrounding the western and southern sides of the site. The flooding appears to be controlled by local farm levees.

The NSW Groundwater Bore Database (ref [3]) contains one bore within the site (GW019740). The bore recorded clay to 8.23m below ground level, with 'sand water bearing' recorded from 8.23m to 9.75m below ground level.

2.8 Climate

The site lies in a dry temperate / semi-arid region (Smith, 2004), indicating a Thornwaite Moisture Index (TMI) Range of approximately -25. The TMI is a ratio between available rainfall and the potential for evapotranspirative loss at a particular location. Lower TMI values indicate larger changes in soil moisture content.

Figure 1 shows the monthly rainfall for 2017 and historical data, obtained from the Australian Government Bureau of Meteorology from Forbes Airport, approximately 26km from the site.

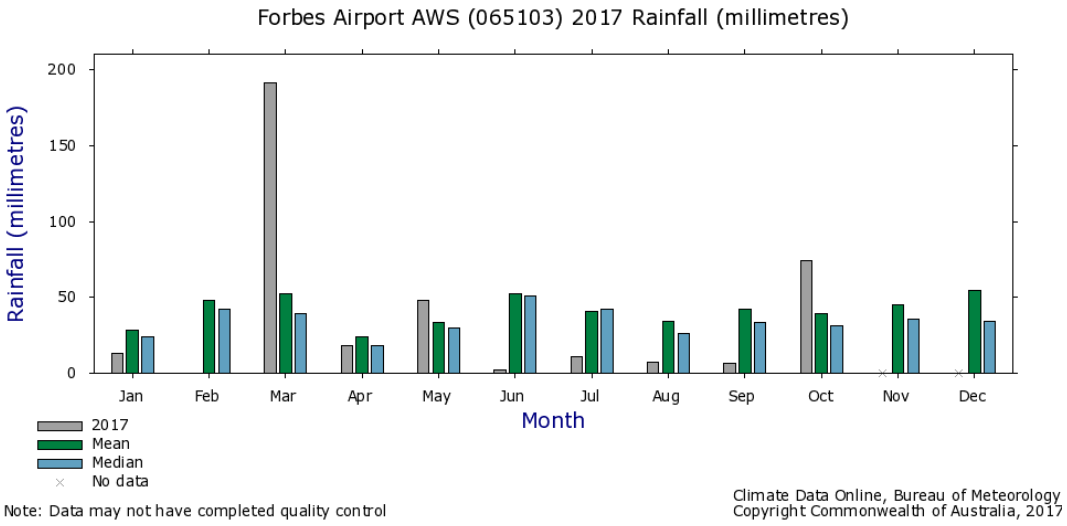


Figure 1 Forbes Airport Rainfall

2.9 Utilities

Dial Before You Dig (DBYD) plans were reviewed for the site. They highlighted Essential Energy and Telstra assets within the site boundary.

The plans show two Telstra trenches. The first traverses east to west along the northern boundary of the CSP site. The second traverses from north to south along the eastern boundary of the CSP site. The plans also showed power lines present on

the site which were generally along the perimeter of each paddock close to the fence lines.

There is one underground irrigation pipe at the southern edge of the study boundary. This pipe transports water from one irrigation channel under an area of low ground to the next irrigation channel.

3 Laboratory Testing and Groundwater Observations

3.1 Laboratory testing

Geotechnical laboratory testing of recovered soil samples was scheduled by Arup and performed by Macquarie Geotechnical Pty Ltd, a NATA accredited laboratory.

A rigorous and very comprehensive contamination testing procedure was undertaken by Envirolab Pty Ltd, a NATA accredited laboratory. Soils were tested in duplicate at a central location within the proposed site of the proposed PV infrastructure.

A summary of the completed soil and rock testing schedule as well as the relevant sections of the standards and abbreviations for each test are presented in Table 1. Geotechnical laboratory testing results are presented in Section 3.1.1. Laboratory certificates are presented in Appendix A.

Table 1: Summary of laboratory testing

Material	Test	Standard	Abbreviation	Number of tests
Soil	Emerson Crumb	AS1289 3.8.1	EM	9
	Soil Combo 10a: Total Recoverable Hydrocarbons, Benzene, Toluene, Ethylbenzene, Xylene, Polycyclic Aromatic Hydrocarbon, Organochloride, Organophsosphorous, Polycholrinated Biphenyl, Arsenic, Cadmium, Chromium, Copper, Mercury, Nickel, Lead, Zinc, Phenols. Cyanide, Asbestos,	USEPA 8000, USEPA 8081, 8082, 8260, , 8270, APHA 4500CN, AS4964-2004	10a	2
	NAGD8 asbestos	USEPA 8270	NAGD8	2
Water	Aggressivity Suite (chloride, sulphate, pH, resistivity)	APHA, in house	AGG	1

Available laboratory certificates are presented in Appendix A.

3.1.1 Lab Results

3.1.1.1 Emerson crumb

Nine Emerson Crumb tests were completed. A summary of the test results is presented in Table 2 and laboratory certificates are presented in Appendix A.

Table 2: Summary of Emerson Crumb Results

Investigation Location	Top Depth (m below ground level)	Bottom Depth (m below ground level)	Material	Emerson Crumb Result
TP101	0.00	0.10	Alluvium – Clayey silt	6
TP102	0.00	0.10	Alluvium – Clayey silt	5
TP103	0.00	0.10	Topsoil – Silty clay	5
TP105	0.00	0.10	Alluvium – Clay	5
TP106	0.00	0.10	Topsoil – Clayey silt	5
TP108	0.00	0.10	Alluvium – Clay	5
TP109	0.00	0.10	Topsoil – Clayey silt	4

3.1.1.2 Contamination testing

Two contamination testing suites have been completed (refer to Table 1 for the test types), with the laboratory certificates presented in Appendix A.

Results indicated no traces of contamination of any kind, consistent with the working history of the site as pastoral/cropping following European settlement.

The soil was moderately moist for this type, 14-18% with relatively neutral pH.

In respect to organics; total recoverable hydrocarbons, benzene, toluene, xylene and ethylbenzene, polyaromatic hydrocarbons, volatile and semi-volatile organics were all below the limit of detection for testing.

In respect to pesticides and herbicides; organochlorine pesticides, organophosphorous pesticides, triazine herbicides and synthetic pyrethroids were all below the limit of detection for testing.

In respect to other contaminants; polychlorinated biphenyl, carbamates, and cyanide were all below the limit of detection.

In respect to metals; arsenic cadmium and mercury were all below the limit of detection for testing; whilst all other metals were below heath or ecological investigation levels and at typical background levels found in soil.

No asbestos fibres were detected in soil samples.

3.1.1.3 Aggressivity testing

Groundwater aggressivity testing has been completed, with the results indicating mild to non-aggressive conditions for concrete piles and non-aggressive conditions for steel piles in accordance with AS2159-2009 [9]. Testing indicated A1 conditions for concrete in accordance with AS3600 [6].

3.2 Groundwater observations

Groundwater was encountered in BH101 and BH102. A summary of the depths to groundwater is presented in Table 3.

Table 3: Encountered depths of groundwater

Location ID	Groundwater Type	Depth (mbgl)	Reduced Level (m AHD)
BH101	Ingress	7.0	208.1
BH101	Standing level in standpipe	5.9	209.2
BH102	Ingress	10.0	206.9

4 Geotechnical Considerations

The following observations have been made across the site:

- The dry temperate / semi-arid climate, as well as flooding results in large moisture changes in the soil. Desiccation cracks were observed during the site investigations, indicating that reactive soils (high shrink-swell potential) are likely present on the site.
- The site is used for grazing of animals and growing of crops. There is therefore the potential for a deep organic topsoil layer to be present where crops are being grown.
- Lab tests results generally indicate an Emerson Class of 5 and 6 across the site, indicating non-dispersive soils.
- Groundwater levels were observed in two boreholes at depths of between 5.9m and 10m below the existing ground level.
- Acid sulphate soil risk mapping does not indicate the presence of acid sulphate soils on the site.
- Contamination testing results indicated no traces of contamination of any kind, consistent with the working history of the site as pastoral/cropping following European settlement.

5 Limitations

There are inherent uncertainties in geotechnical and environmental engineering. The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical and environmental engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground and groundwater on a particular site under certain conditions. Arup may report such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so they are directly relevant only to the ground and groundwater at the place where, and the time when, the investigation was carried out and are believed to be reported accurately.

6 References

[1] King, D.P., 2010, Soil Landscape Map of Forbes 1:250,000 Sheet SI55-7, Department of Environment, Climate Change and Water New South Wales,

[2] Raymond O.L., Duggan M.B., Lyons P., Scott M.M., Sherwin L., Wallace D.A., Krynen J.P., Young G.C., Wyborn D, Glen R.A., Percival I.G. and Leys M., 2000, Forbes 1:250 000 Geological Sheet SI/55-07, 2nd edition, Geological Survey of New South Wales, Sydney. Geoscience Australia, Canberra

[3] NSW Department of Primary Industries (2017), "Real-time water data". Accessed 16th October 2017. http://realtimedata.water.nsw.gov.au/

[4] Bureau of Meteorology (2017), "Daily Rainfall Forbes Airport AWS", accessed 3rd November 2017. http://www.bom.gov.au/

[5] Standards Australia, AS 1726 – 2017, Geotechnical site investigations, 2017.

[6] Standards Australia, AS 3600 – 2009, Concrete Structures.

[7] Standards Australia, AS1289.6.3.2 – 1997 (R2013), Methods of testing soils for engineering purposes – Method 6.3.2: Soil strength and consolidation tests – Determination of the penetration resistance of a soil – 9 kg dynamic cone penetrometer test, 1997.

[8] Smith, R. L., 2004, Achieving the Goal of Management of Reactive Clays: Recent Developments in NSW, Presented at Australian Institute of Building Surveyors (NSW Chapter) Conference Manly, NSW, 19-20 July 2004

[9] Standards Australia, AS2159 – 2009, Piling – Design and Installation.

[10] Giummarra, G. (ed.) (in press), Unsealed roads manual: guidelines to good practice, 3rd edn, ARRB Group, Vermont South, Vic, 2009.

Figures

Paddock 1

Photovoltaic Field (PV) Site

Paddock 2

Concentrating Solar Thermal Park (CSP) Site

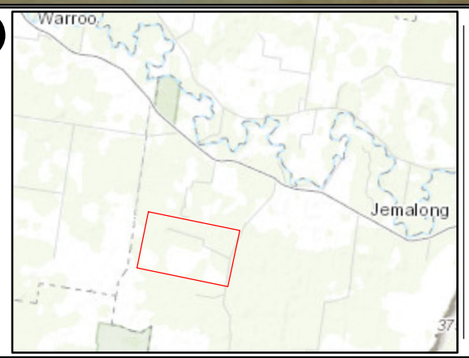
Naroo Lane

Wilbertroy Lane

Paddock 3

Legend

- Study Boundary
- Fencing



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Vast Solar

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P1	01-11-2017	DDC	TBA	TBA

Job Title
Jemalong Hybrid Solar Park

Drawing Title
Site Location Plan

ARUP
Level 10, 201 Kent Street
Sydney, NSW 2000
Tel +61 (2) 9320 9320
www.arup.com

Scale at A3
1:15,000

Drawing Status
Draft

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MGA94, zone 55

Horizontal Datum
GDA94

Vertical Datum
AHD

Map Units
Metres

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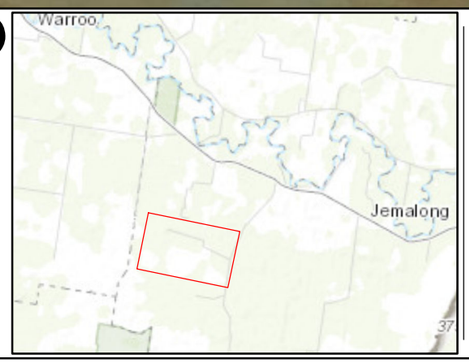
BH101
BH102
BH103
BH104
TP101
TP102
TP103
TP104
TP105
TP106
TP107
TP108
TP109
DCP101
DCP102
DCP103
DCP104
DCP105
DCP106
DCP107
DCP108
DCP109
DCP110

Legend

- Boreholes with standpipe installed
- Boreholes
- Test Pits
- DCP's
- Study Boundary
- Contours



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Job Title
Jemalong Hybrid Solar Park

Drawing Title
Site Topography

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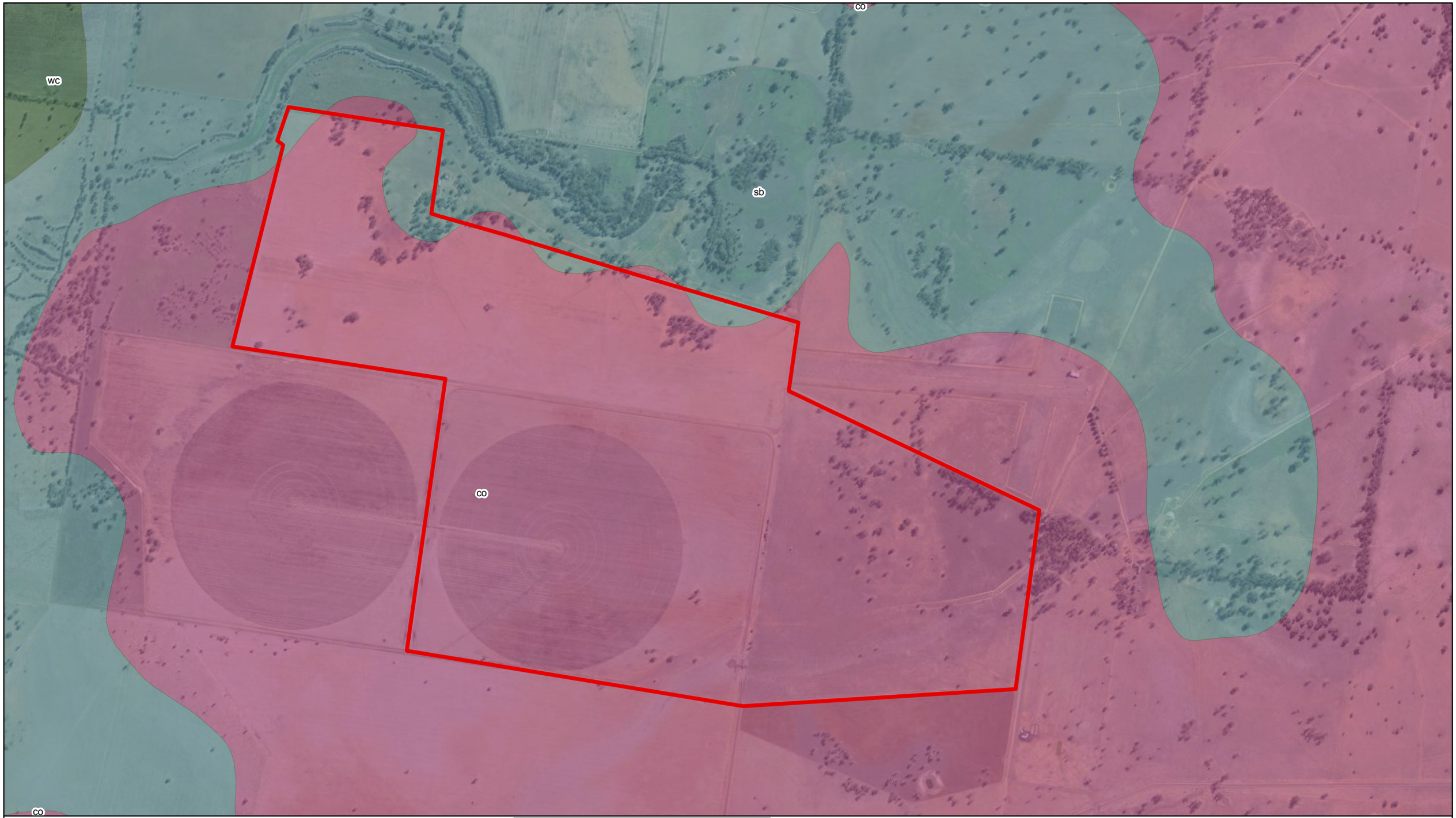
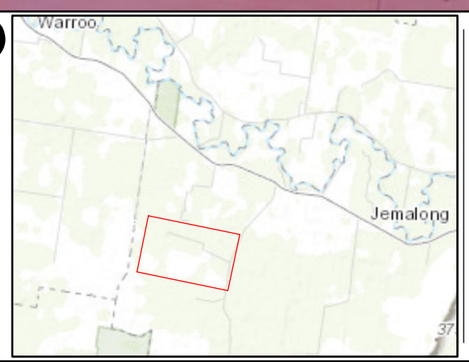


Legend

- co - CORINELLA. Alluvial, typically red brown earths
- sb - SCRUBBY PLAINS. Stagnant alluvial, typically grey, brown and red clay
- wc - WARROO CHANNEL. Alluvial, typically sands with some interbedded silts, clays and gravels



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Job Title
Jemalong Hybrid Solar Park

Drawing Title
Soil Landscape Map

ARUP
Level 10, 201 Kent Street
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Scale at A3	Coordinate System	Horizontal Datum	Vertical Datum	Map Units
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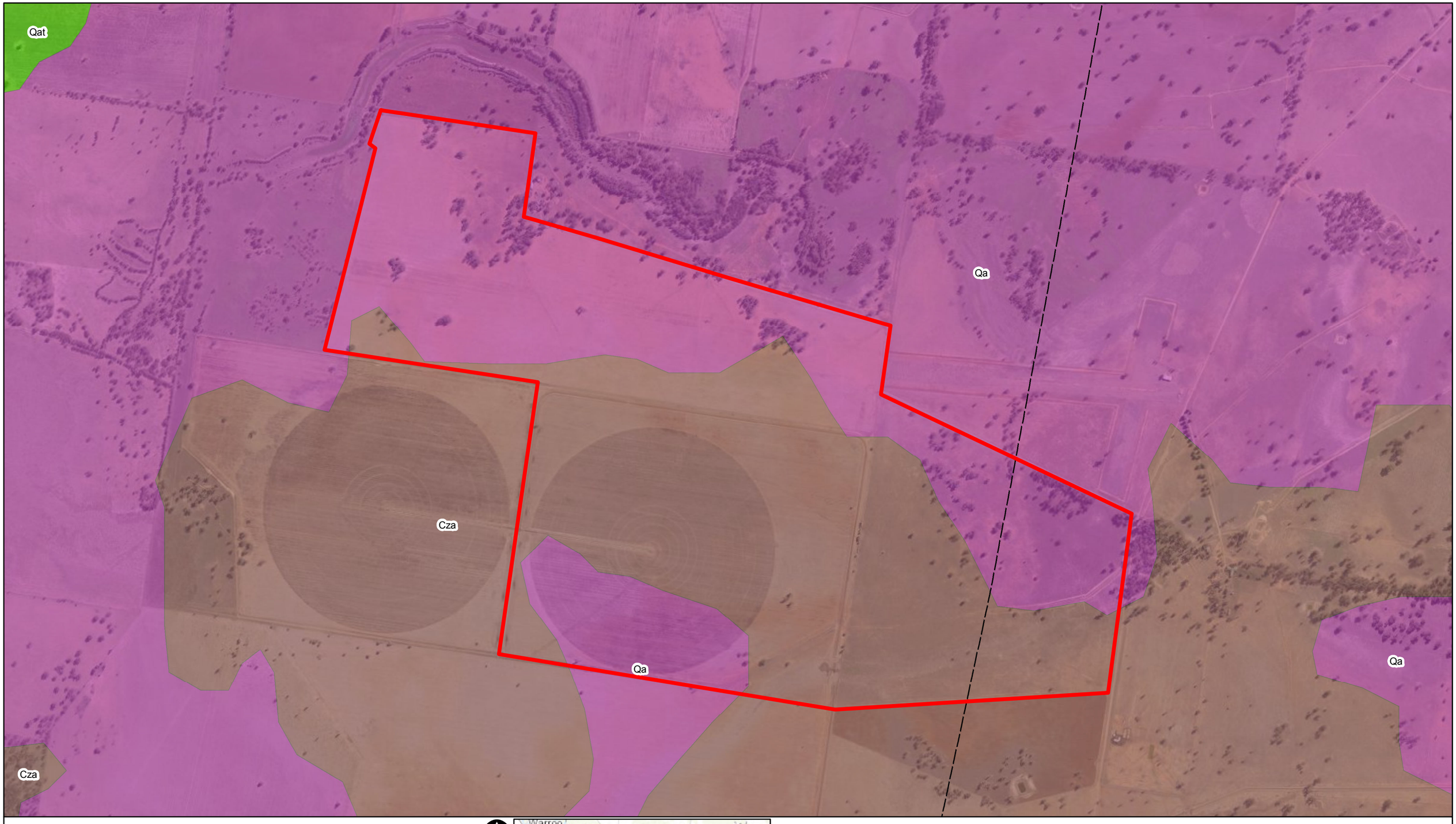
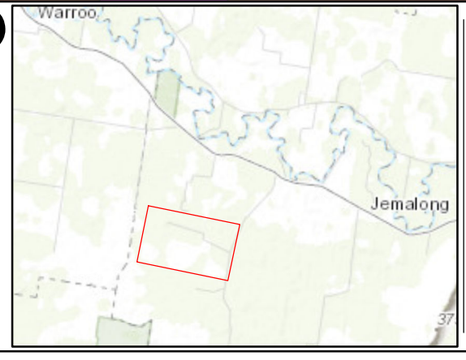


Legend

- Study Boundary
- Forbes Anticline
- Qa - Alluvium, active depositional plains and terraces containing present day drainage
- Cza - Inactive alluvial plains
- Qat - Low thorium alluvium, predominantly in the modern day flood plain of the Lachlan River



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Job Title
Jemalong Hybrid Solar Park

Drawing Title
Geology Map

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Horizontal Datum
GDA94

Vertical Datum
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Map Units
Metres

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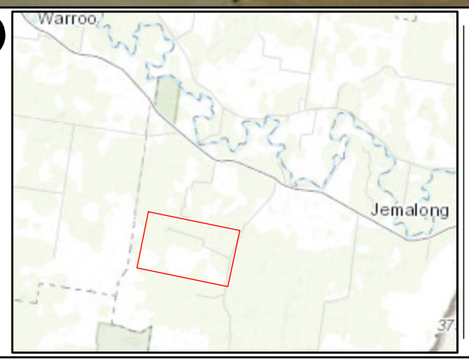
BH101
TP101
TP103
TP104
TP105
TP102
TP107
TP109
TP106
TP108
DCP101
BH102
DCP102
DCP103
DCP107
DCP104
BH103
DCP105
DCP108
DCP110
BH104
DCP109
DCP106

Legend

- Boreholes with standpipe installed
- Boreholes
- Test Pits
- DCP's
- Study Boundary



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Client
Vast Solar

Job Title
Jemalong Hybrid Solar Park

Drawing Title
Investigation Test Locations

ARUP
Level 10, 201 Kent Street
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Scale at A3
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Drawing Status
Draft

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MGA94, zone 55

Horizontal Datum
GDA94

Vertical Datum
AHD

Map Units
Metres

Job No	Drawing No	Issue
258584	005	D1

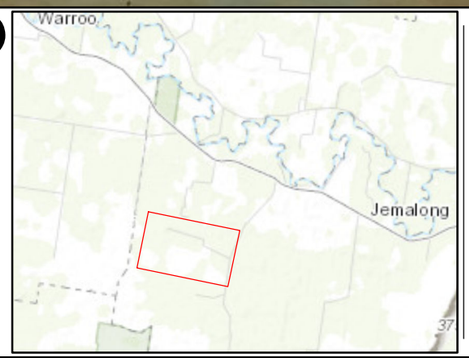
Paddock 1

Paddock 2

Paddock 3

Legend

- Study Boundary
- Telstra
- Assumed Irrigation Pipes
- Man-made Trench (with Irrigation Pipes)
- Man-made Trench (dry)
- Man-made Trench (with water)
- Fencing
- Access Track
- Power Lines
- Gate
- Water Tank
- Softer ground



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Vast Solar

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Issue	Date	By	Chkd	Appd
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Job Title
Jemalong Hybrid Solar Park

Drawing Title
Site Observations

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Scale at A3
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Draft

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Horizontal Datum
GDA94

Vertical Datum
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Map Units
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