APPENDIX A – Letter Report - Pink-tailed Worm-lizard Monitoring Report March 2022-Area Environmental & Heritage Consultants (AREA Mar 2022)

Biodiversity Offset Area –Analogue Vegetation Plot Monitoring June 2022 (AREA June 2022)

Australian Strategic Materials Ltd
Dubbo Project

Biodiversity Offset Area – 2021 analogue vegetation plot monitoring
Dubbo Regional LGA NSW

AREA Environmental & Heritage Consultants ABN:29 616 529 867

- ✓ Environmental impact assessments and approvals
- ✓ High level preliminary environmental assessment (PEA)
- ✓ Review of environmental factors (REF)
- ✓ Peer review
- ✓ Community engagement
- ✓ Biobanking and biodiversity offsetting assessments
- ✓ Aboriginal heritage assessments and community walkovers
- ✓ Landscape design

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of the country on which we work

EXECUTIVE SUMMARY

AREA Environmental Consultants & Communication (AREA) was commissioned by Australian Strategic Materials Ltd (the proponent) to complete annual monitoring of five established analogue vegetation monitoring points in and nearby the Dubbo Project (previously known as the Dubbo Zirconia Project) Biodiversity Offset Area, Toongi NSW.

The Dubbo Project was approved as SSD-5251 by the NSW Planning Assessment Commission (PAC) on 28 May 2015 assessed under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Annual monitoring of five analogue plots is required by the Biodiversity Management Plan. Prior to 2021 vegetation monitoring was conducted using the now defunct BioBanking Assessment Method. The 2021 monitoring used the current assessment framework of the NSW government, the Biodiversity Assessment Method (BAM 2020).

The number of parameters which scored below benchmark for the Plant Community Type varied across all five vegetation monitoring plots.
- Plots 2 and 3 had two of the fifteen parameters below 25% of benchmark.
- Plots 1 and 4 had four of the fifteen parameters below 25% of benchmark.
- Plot 5 had six of fifteen parameters below 25% of the benchmark value making it the poorest performing site across all five plots.

Overall, improvement in native vegetation quantity recorded has occurred over time. The increase in parameters at or above 25% of benchmark is consistent with change in weather patterns across all survey years combined with appropriate on site management such as restricted grazing has favoured reestablishment of native species.

Document Controls

Proponent	Australian Strategic Materials Ltd (ASM)
Client	ASM
Quote number	N/A
Project No / Purchase Order No	N/A
Document Description	Biodiversity Offset Area Monitoring Points Spring 2021
Clients Representative Managing this Document	Mike Sutherland
AREA Person(s) Managing this Document	Phil Cameron
Cover image	Section of the proposed alignment

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FINAL (Draft approved by client)	**Date**	**Action**
V3.0		

Prepared for	Mike Sutherland General Manager NSW Australian Strategic Materials Ltd Office: 6882 2866 Fax: 6882 9282 Mobile: 0427 691 733
Prepared by 	Gabrielle Green – Cadet Environmental Consultant and Phillip Cameron – Managing Director AREA Environmental Consultants & Communication Pty Ltd 'Old Macquarie Brewery' c1876, 72 Brisbane Street Dubbo, NSW 2830 M 0409 852 098 E phil@areaenv.com.au ABN:29 616 529 867

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Terms and acronyms used in this document

Acronym	Definition
BOM	Bureau of Meteorology
BOS	Biodiversity Offset Strategy
EEC	Endangered Ecological Community
LGA	Local Government Area
NSW	New South Wales
DPE	Department of Planning and Environment
PCT	Plant Community Types
VIS	Vegetation Information System

1   Introduction

1.1   Background

AREA Environmental & Heritage Consultants (AREA) was commissioned by Australian Strategic Materials (the proponent) to undertake annual monitoring of five established analogue vegetation monitoring points in the Dubbo Project Biodiversity Offset Area (n=3) and local plots (n=2) (Figure 1-1 to 1-3) near Toongi, NSW.

The Dubbo Zirconia Project (now the Dubbo Project) was approved as SSD-5251 by the NSW Planning Assessment Commission (PAC) on 28 May 2015 assessed under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

In 2017, the NSW legislation governing how vegetation is measured changed. The BioBanking Assessment Method (BAM) has been superseded by the Biodiversity Assessment Method (BAM). The BAM provides a system for measuring vegetation which is more transparent, repeatable, and objective. The BAM as it pertains to vegetation assessment plots is described in section 2.2.

Data collected using BAM generates four numbers as a score out of 100, which provide a measure of the vegetation quality. These are:
- Composition – a measure of the species count / richness
- Structure – a measure of the cover provided by each growth form
- Function – a measure of the habitat values such as leaf litter, large logs, and tree hollows
- Vegetation Integrity – an overall measure of quality.

Comparison of these four figures over time can be used to map changes in vegetation quality.

BAM was used for the 2021 Dubbo Project Biodiversity Offset Area vegetation monitoring. This report will present the results from the 2021 monitoring but will avoid comparisons where there is not a consistent technique used.

A comparison between the results of the 2016 survey where biobanking sampling method was used and reporting years where the BAM sampling method was used have been removed from 2021 and future monitoring reports. The comparison in sampling methods have been removed as 2021 is the third year using BAM method therefore only the BAM 2020 method results are applicable in future reports.

The fieldwork for the 2021 survey was delayed due to limitations experienced including increased rainfall, site accessibility and impacts from COVID-19.

The fieldwork for the 2021 Dubbo Project Biodiversity Offset Area vegetation monitoring report was completed on 11 June 2022. The latest data is reflective of the progress and conditions which occurred throughout 2021 and the first half of 2022 which had above average rainfalls.

As discussed in the 2019 monitoring report, the recognised vegetation descriptions have changed since the original monitoring events. Benson vegetation classifications based on Catchment Management Areas have been replaced with Plant Community Types (PCT) within Bioregions and subregions. These new vegetation classifications include a new set of benchmarks which define each PCT. Data collected during the 2021 monitoring event will be measured against the benchmarks for the Plant Community Types.

Table 1-1: Change to vegetation classification

Plot ID	Superseded classification (Biobanking)	Current classification (BAM 2020)
1	White Cypress Pine monoculture – no classification determined	PCT267 - White Box - White Cypress Pine - Western Grey Box shrub/grass/forb woodland in the NSW South Western Slopes Bioregion
2	CW213 - White Box - White Cypress Pine - Inland Grey Box woodland on the western slopes of NSW (Benson 267)	PCT267 - White Box - White Cypress Pine - Western Grey Box shrub/grass/forb woodland in the NSW South Western Slopes Bioregion
3	CW138 - Fuzzy Box - Inland Grey Box on alluvial brown loam soils of the NSW South Western Slopes Bioregion and southern BBS Bioregion (Benson 201)	PCT201 -Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion
4	CW145 - Inland Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions (Benson 76)	PCT76 - Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions
5	CW212 - White Box - Tumbledown Gum woodland on fine-grained sediments on the NSW central western slopes (Benson 270)	PCT270 - White Box - Tumbledown Red Gum - Long-leaved Box shrub/grass woodland on fine-grained sediments of the upper Macquarie River gorge, NSW central western slopes

1.2 Locality

The Biodiversity Offset Area is located approximately 20 kilometers south of Dubbo near Toongi, NSW in the Dubbo Regional Local Government Area (LGA).

Figure 1-1 to Figure 1-5 show the location and local context of the Biodiversity Offset Area.

Regional context of the study area is provided in Table 1-2.

Table 1-2: Regional context of the Biodiversity Offset Area

Criteria	Site context
Interim Biogeographic Regionalisation for Australia (IBRA Region)	NSW South Western Slopes (Inland Slopes) Bioregion
State	New South Wales
Topographical map sheet	Dubbo 8633
Local Government Area	Dubbo Regional
Nearest town / locality	Toongi (locality) Dubbo (Town)
Accessed from nearest town by	Dubbo accessed by Eulandool Road then The Springs Road, then Obley Road.
Land use / disturbance	Agriculture (ploughed landscapes) and time control grazing.
Nearest waterway (Name, Strahler Order)	No named waterways occur within the Biodiversity Offset Area (BOA). However, within 1500m Wambangalang Creek occurs to the north west, Paddys Creek occurs to the south west. Cockabroo Creek occurs to the south east, and a small section lies within the project boundary. These are all third or higher Strahler Order waterways Numerous unnamed first, second and third Strahler Order waterways are mapped within the BOA. .
Spot point Australian Height Datum (AHD)	Approximately 280m to 420m
Surrounding land use	Grazing, ploughed agriculture, Biodiversity Offset Area and road reserve

Figure 1-1: Location
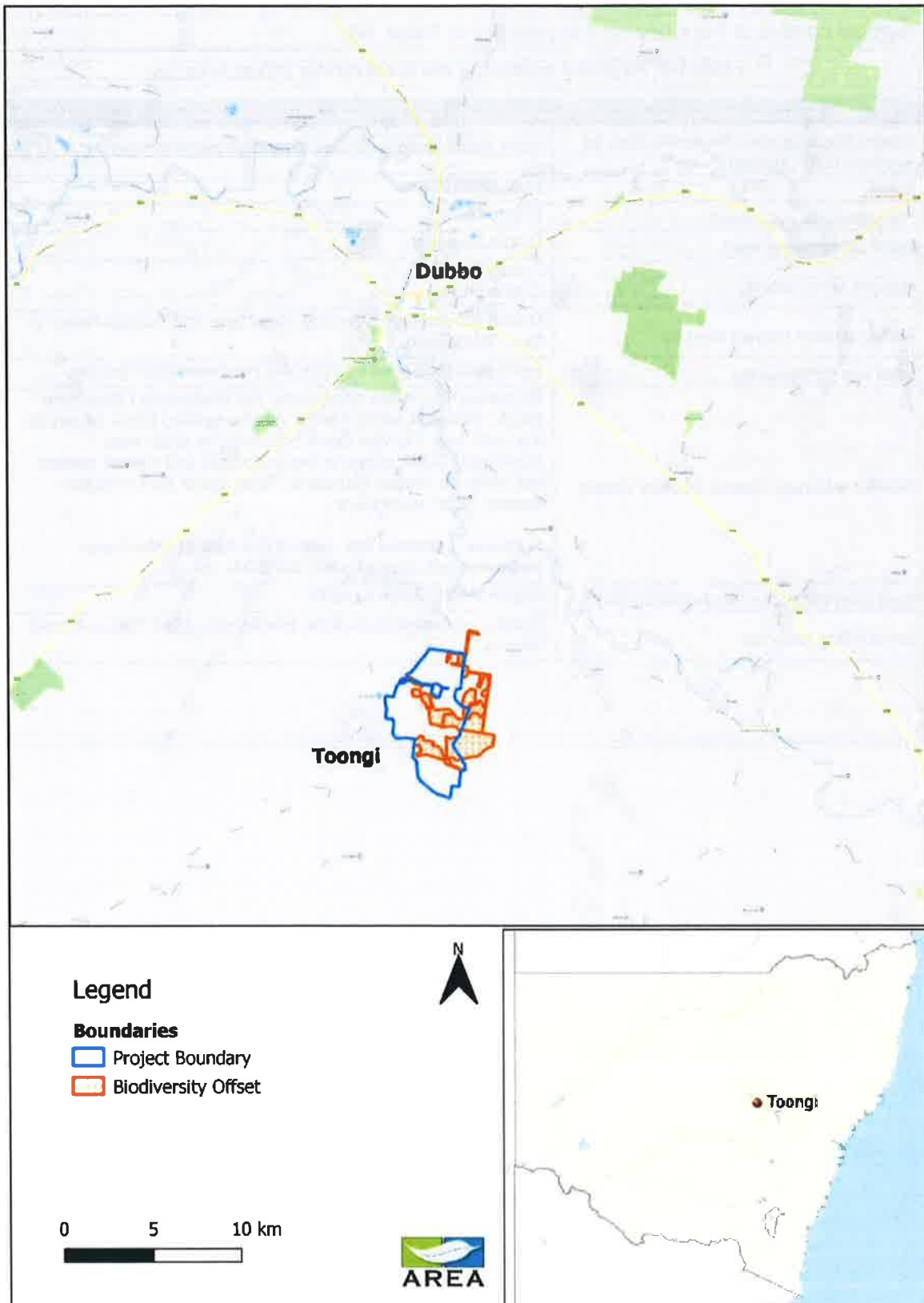
Figure 1-2: Biodiversity Offset Area (aerial)

Legend

Boundaries

☐ Project Boundary
☐ Biodiversity Offset

| 0 | 750 | 1500 | 2250 | 3000 m |
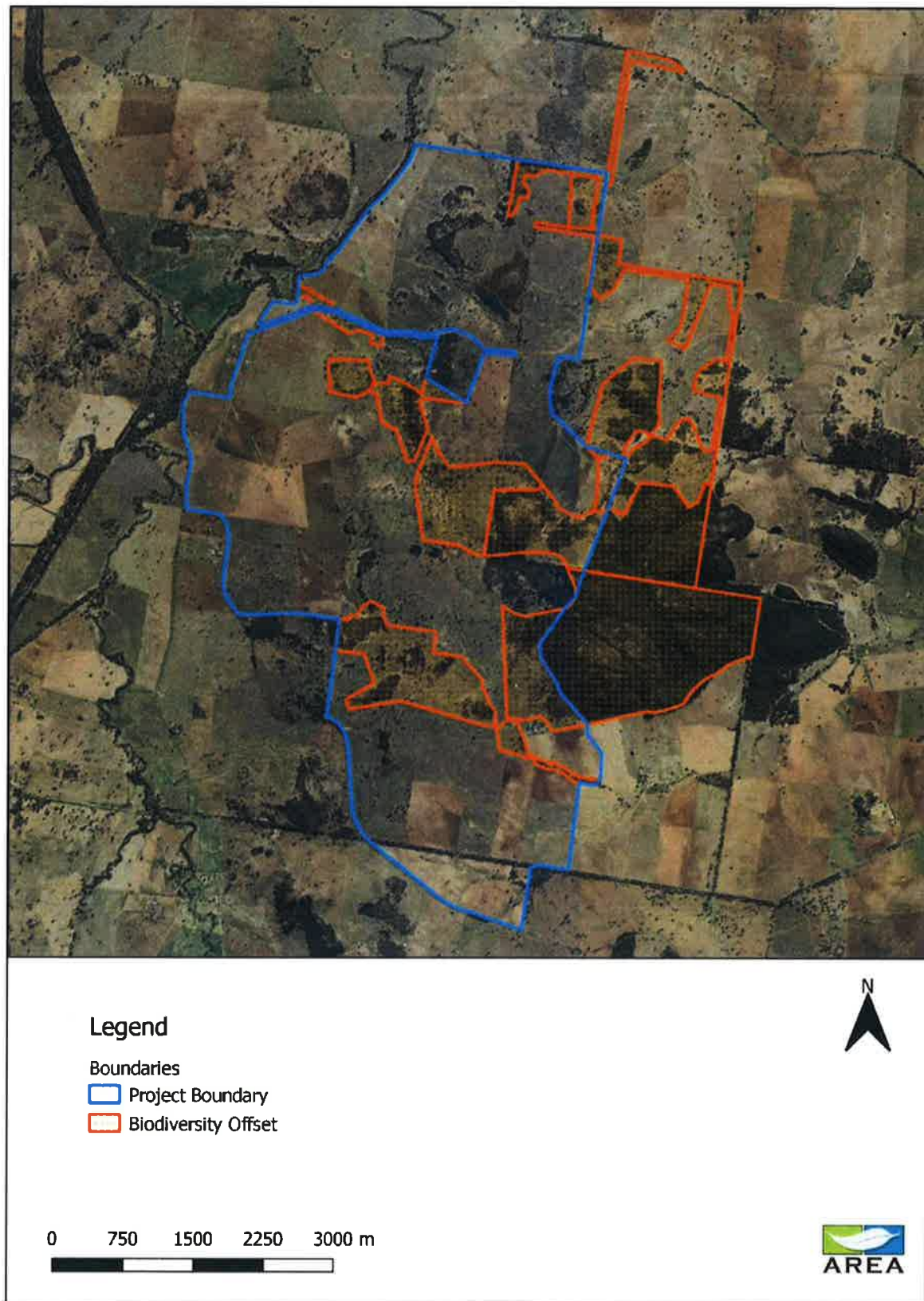
Figure 1-3: Biodiversity Offset Area (topo)

Legend

Boundaries
- Project Boundary
- Biodiversity Offset
- contour
- hydroarea
- hydroline

| 0 | 750 | 1500 | 2250 | 3000 m |

Figure 1-4: Biodiversity Offset Area (Lots and DPs)

Figure 1-5: Waterways

Legend

Boundaries
- Project Boundary
- Biodiversity Offset

hydroline
- COCKABROO
- MEADOWS
- PADDYS
- WAMBANGALANG
- Un-named

0   750   1500   2250   3000 m

AREA

2 Methods

Field survey was conducted on Saturday 11 June 2022 by two AREA ecologists. The survey included assessment of five established analogue vegetation plots using the BAM (2020). Most nested plots are marked with rock cairns or star pickets at the start of the midline. The 50-metre midline and the 20 by 20-meter plot boundary were defined using 100-meter tape measures.

2.1 Project personnel

This monitoring and preparation of this monitoring report was carried out by appropriately qualified and experienced staff (Table 2-1).

Table 2-1: Summary of AREA project teams' qualifications

Name	Position	CV Details	Role in this project
Phillip Cameron	Principal consultant	- BSc. Major in Biology. Macquarie University - Ass Dip App Sci. University of Queensland - Certified Environmental Practitioner (EIANZ) - NSW Biodiversity Assessment Method Accredited Assessor (Number BAAS17082) - NSW DPIE BioBanking and Bio-certification Assessor: accreditation number 0117 - NSW DPIE Scientific License: 101087 - NSW DPI Ethics Approval 11/5475 - Practicing member of the NSW Ecological Consulting Association - Practicing member of the Environment Institute of Australia and New Zealand (EIANZ) - WHS White Card and Blue Card - Apply First Aid (Parasol) ID: 6007221.	- Project Management - Fieldwork - QMS
Gabrielle Green	Cadet Consultant	B. Env. Sc. University of New England (incomplete) - WHS – White Card (OL8644384) - First Aid Certificate (6995717-7487049) - White card – CIC1667253 - RMS-worker on foot training - AHCPM201- Recognising grasses	Report Writing
Michelle Glover	Consultant	B. Env. Sc. University of New England - Certificate IV in Project Management - Management planning and environmental assessments under the *Environment Protection and Biodiversity Conservation Act 1999* - Indigenous and stakeholder engagement - Provide First Aid. Certificate number: 12249475-7913132	- Fieldwork - Report Writing

2.2   Vegetation integrity survey plots

Five BAM 2020 plots were monitored within the study area (Table 2-2 and Figure 2-1). Plot sheets are provided in Appendix A. Plots are not permanently marked, however rock cairns are in place to mark most plots.

Table 2-2: Coordinates in GDA z55 of the monitoring plots

Plot ID	Easting (GDA94 Zone 55)	Northing (GDA94 Zone 55)
1	652426	6405475
2	652663	6406659
3	648677	6408583
4	648032	6407720
5	652722	6407476

Figure 2-1: Vegetation plot location

Legend

Boundaries
☐ Project Boundary
☐ Biodiversity Offset

Survey effort
● Vegetation monitoring plot

| 0 | 750 | 1500 | 2250 | 3000 m |
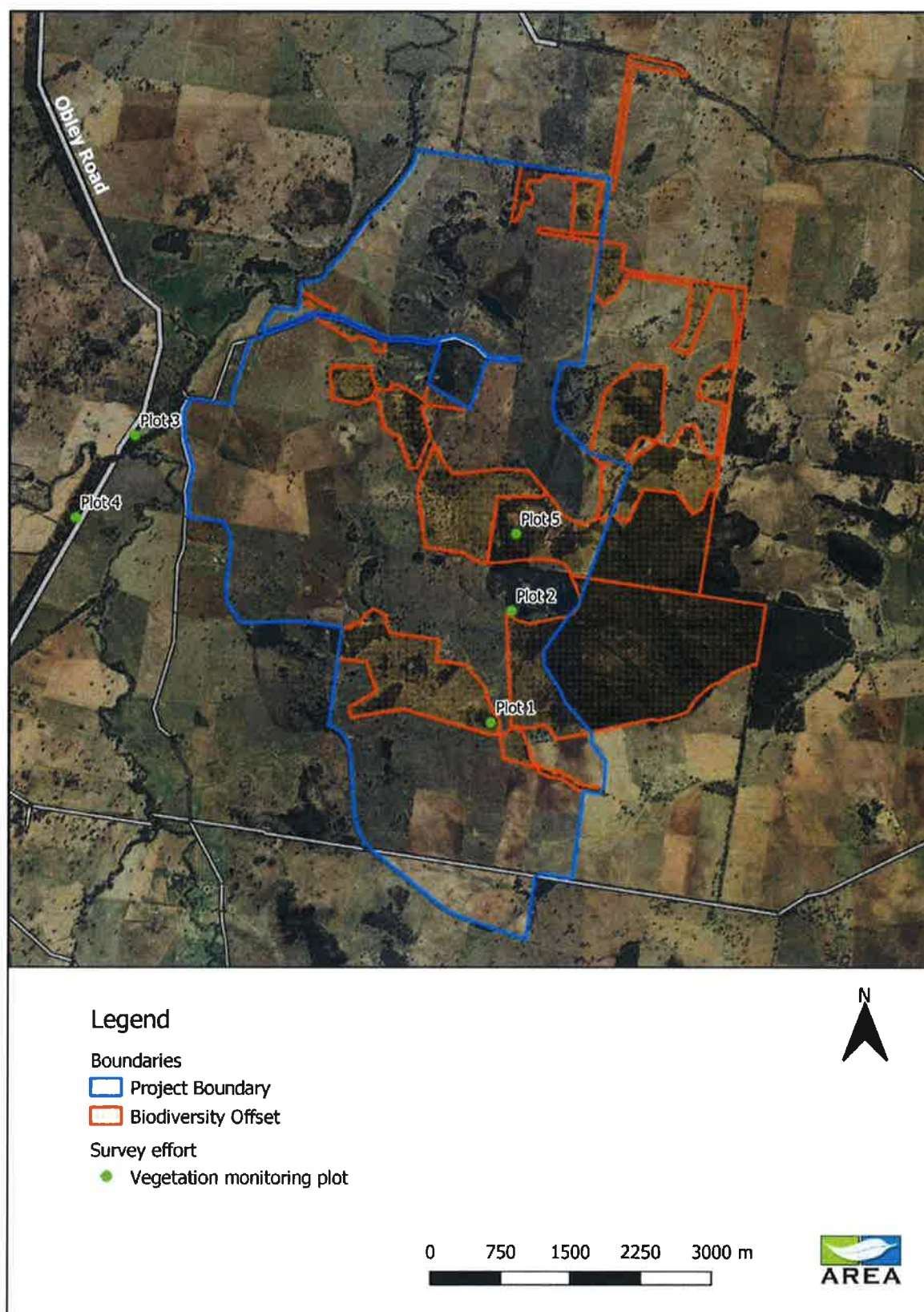
The annual monitoring followed the points listed below:

- All five plots were assessed.
- Access to these plots was achieved by vehicle and a short walk.
- Conditions during this monitoring event did not reduce accessibility of the plots.
- All plots are not permanently marked, however plot coordinates, and photos from previous years of monitoring were used to confirm correct location of the assessment in 2022 for the 2021 reporting period.
- The assessors implemented the monitoring using a nested plot around a central 50m transect as follows:
  - One 400m² plot (standard 20m x 20m) was used to assess all the composition (species richness) and structure (percent cover) attributes set out in the BAM Plot – Field Survey Form.
  - One 1000m² (standard 20m x 50m) plot was used to assess the function attributes: number of large trees, stem size class, tree regeneration and length of logs.
  - Five 1m² sub-plots are used to assess average litter cover (and other optional groundcover components) for the plot.

Figure 2-2: Nested plot layout (20x20m = composition and structure plot, 20x50m = function attribute assessment plot, 1x1m = litter cover plot)

Not to scale
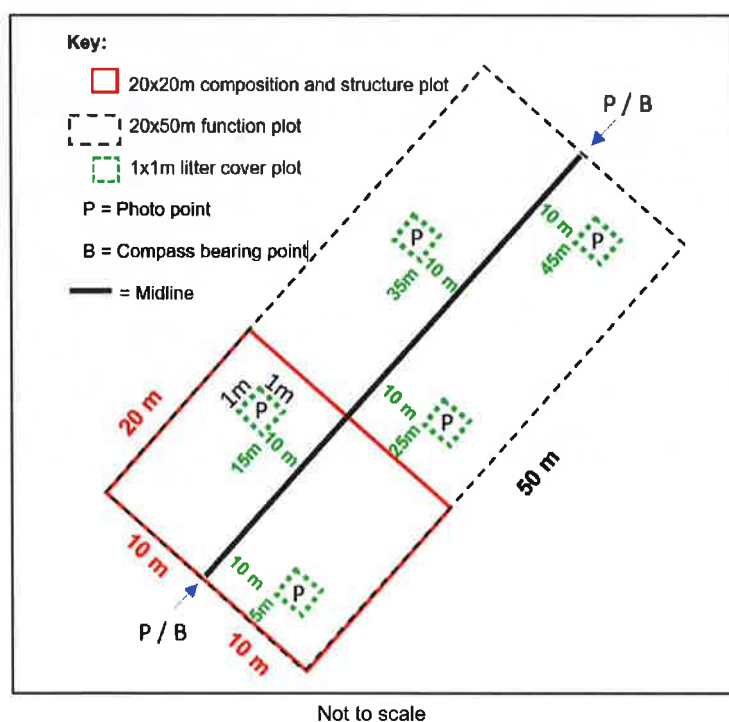
2.2.1 Composition

- Assessment of composition was based on the number of native plant species (richness) observed and recorded by the assessor within each 20m x 20m plot for each growth form group shown in Table 3 of the NSW Office of Environment & Heritage document Biodiversity Assessment Methodology 2020 (hereafter BAM 2017).
- The assessor allocated each species to one growth form group based on the adult/mature growth form of the species and according to the definitions set out in Appendix 4 of BAM (2020).
- The minimum vegetation survey data recorded by the assessor for composition within each of the five 20m x 20m condition plots was:
  - Scientific name for the three dominant native species within each growth form group. Dominant native species means those native species that contribute most to the total cover of the growth form group.
  - Whether each species is native, exotic or high threat exotic.
  - The growth form group to which each native species has been allocated.
  - The composition of each growth form group was assessed by counting the number of different native plant species recorded within each growth form group within each of the five 20m × 20m condition plots.

2.2.2 Structure

- Structure is the assessment of foliage cover for each growth form group within each of the five 20m x 20m plot boundaries. Foliage cover for a growth form group is the percentage of cover of all living plant material of all individuals of the species present for that group. This includes leaves, twigs, branchlets and branches as well as canopy overhanging the plot even if the stem is outside the plot.
- The assessor recorded an estimate of the foliage cover for each native and exotic species present within the 20m x 20m plot. Foliage cover estimates for each species was drawn from the following number series: 0.1, 0.2, 0.3,1, 2, 3,10, 15, 20, 25,100 per cent.
- The structure of each growth form group for the 20m x 20m plot was recorded by the assessor as the sum of all the individual foliage cover estimates of all native plant species recorded within each growth form group within each Plot.
- The assessor assigned each non-native (exotic) plant species a foliage cover estimates and either E (exotic) or HTE (high threat exotic).

2.2.3 Function

- The number of large trees, tree stem size class, tree regeneration and length of fallen logs was recorded within each 1000m^2 plot as specified in Paragraph 5.3.4.8 of BAM (2020).
- Tree stem size classes was measured at 1.3m above ground height, referred to as 'diameter at breast height over bark' or DBH.
- Tree stem size classes are: <5, 5–9, 10–19, 20–29, 30–49, 50–79, and 80+ cm DBH and include all species in the tree growth form group.
- Only living trees contributed to counts for determination of presence and for a multi-stemmed tree, only the largest living stem is included in the count for determining the presence or absence of stems within each size class.

- The number of large trees is a count of all living stems with a DBH equal to or greater than the large tree benchmark DBH size for that PCT or vegetation class.
- For a multi-stemmed tree, at least one living stem equal to or greater than the large tree benchmark DBH size to count as a large tree was used.
- Stem size classes were based on the presence or absence of living tree stems within size classes that fall between regenerating stems (<5cm DBH) and the large tree benchmark DBH size(s).
- Regeneration was based on the presence or absence of living trees with stems <5cm DBH.
- The length of fallen logs is the total length in metres of all woody material greater than 10cm in diameter that is dead and entirely or in part on the ground within the 20m x 50m plot. Where logs extend outside of the plot, the assessor only recorded the length of fallen log that is contained within the plot.
- Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots evenly located along the central transect of each plot, specified in Paragraph 5.3.4.8 of BAM (2020).
- Litter cover includes leaves, seeds, twigs, branchlets and branches (<10cm in diameter). The assessment of litter cover included all plant material that was detached from a living plant. Dead material still attached to a living plant (such as a grass) is assessed as litter cover where it is in contact with the ground. Dead material still attached to a living plant that is not in contact with the ground, or litter suspended in the canopies of other plants is not assessed as litter cover. Litter cover was considered as the two-dimensional litter layer and includes litter under the canopies of erect plants.
- The number of trees with hollows was determined by counting the number of trees with hollows that are visible from the ground in the 20m x 50m plot. The number of trees with hollows included native species allocated to the shrub growth form group. It included both living and dead trees.
- The number of trees with hollows did not contribute to the vegetation integrity score. The presence of hollow bearing trees is used as part of the habitat suitability assessment for some threatened species in Chapter 6 of BAM (2020) and for identifying the credit class for biodiversity credits in Chapter 11 of BAM (2020).

3 Limitations

There were certain limitations surrounding the completion of this fieldwork in Spring 2021 including higher than average rainfall across the area at the preferred time of the survey, accessibility of site and COVID-19 impacts.

4 Results

A list of fauna observed opportunistically during the assessment is provided in Appendix B.

4.1 Preceding rainfall

Average annual rainfall for Dubbo is 569.6 millimeters (Bureau of Meteorology, Table 4-2). Twelve-month rainfall for Dubbo prior to field surveys (May 2021 to May 2022 inclusive) far exceeded the annual average at 1061.40 millimeters (Table 4-1). The monitoring event was undertaken during a time of increased rainfall for NSW.

Table 4-1: Rainfall Dubbo Airport Weather Station

Lat: 32.22° S; Lon: 148.58° E; Elevation: 284m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2010	25.6		69.6	62.2	54.6	34.2	64.4	58.4	51.8	54.0	144.0	167.6	
2011	8.6	37.8	49.4	28.4	60.0	11.2	8.4	59.8	81.8	55.4	101.6	74.8	577.2
2012	98.0	118.0	125.0	1.6	85.4	41.6	44.6	9.8	31.6	9.4	38.2	5.4	608.6
2013	63.4	27.8	80.8	0.4	27.0	126.0	23.2	5.4	83.2	5.2	3.0	47.6	493.0
2014	49.8	50.8	142.4	57.8	26.8	57.6	55.6	15.4	15.6	11.6	11.2	77.0	571.6
2015	130.6	31.8	8.4	81.8	47.8	72.2	60.2	39.4	6.8	46.4	66.6	59.6	651.6
2016	122.8	3.2	16.2	25.0	55.4	151.6	105.2	50.4	157.8	56.2	34.0	138.6	916.4
2017	14.8	1.6	223.0	9.4	5.2	9.2	3.0	20.6	5.0	84.6	34.8	54.2	465.4
2018	28.6	2.4	4.0	6.8	13.0	18.6	1.6	36.4	6.8	90.4	68.6	34.4	311.6
2019	64.4	18.4	46.8	0.0	23.4	10.4	6.4	6.8	11.0	1.6	19.4	2.6	211.2
2020	36.0	81.8	145.0		28.8	32.6	82.2	39.0	47.6	60.6	12.6	120.6	
2021	54.0	114.4	187.2	1.8	21.0	93.8	91.8	34.0	36.8	35.4	180.8	73.4	924.4
2022	130.0	41.0	56.4	191.2	75.8								

(Yellow fill = below average)

Table 4-2: Rainfall summary statistics for all months in 2021 (Source: BoM)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	58.7	45.0	68.0	36.4	39.5	49.9	43.3	34.3	41.5	45.8	61.8	61.7	569.6
Lowest	3.8	1.6	4.0	0.0	0.6	4.0	1.6	0.4	0.6	1.2	0.0	2.6	211.2
5th %ile	7.8	2.6	8.8	0.2	4.4	9.6	3.3	3.6	5.5	1.9	5.3	5.5	232.7
10th %ile	10.4	5.1	11.6	0.5	5.1	10.9	5.4	6.2	6.8	2.8	11.0	11.4	318.6
Median	41.2	30.6	47.5	23.5	28.8	36.6	37.0	20.6	35.2	50.6	66.6	49.2	568.8
90th %ile	130.2	98.1	159.4	83.1	79.6	105.1	91.9	66.1	82.4	86.9	123.6	150.2	846.8
95th %ile	146.4	117.1	183.9	100.4	86.4	124.8	101.2	103.5	103.1	103.6	169.8	168.9	913.1
Highest	191.0	218.2	223.0	191.2	102.2	151.6	138.0	151.6	157.8	112.0	181.8	188.8	924.4

4.2 Plot data

4.2.1 Plot results compared to benchmarks for the PCT

The results of processed plot data were compared to PCT benchmark information in the NSW VIS database (BioNet Vegetation Classification). Vegetation and habitat parameters recorded in each plot were compared against benchmarks described by the NSW government for the relevant PCT.

Table 4-3: June 2022 Individual plot data and benchmarks for Plot 1 and 2 (PCT267).

PCT267 - White Box - White Cypress Pine - Western Grey Box shrub/grass/forb woodland in the NSW South Western Slopes Bioregion					
Class/IBRA: Western Slopes Grassy Woodlands / NSW South Western Slopes					
Attribute	Benchmark value	25% benchmark	75% benchmark	Plot 1	Plot 2
Tree Richness	3	0.75	2.25	2	2
Shrub Richness	3	0.75	2.25	1	5
Grass and Grass Like Richness	8	2	6	8	6
Forb Richness	9	2.25	6.75	14	15
Fern Richness	1	0.25	0.75	1	1
Other Richness	1	0.25	0.75	0	0
Tree Cover	18	4.5	13.5	35.2	8.1
Shrub Cover	1	0.25	0.75	0.1	0.1
Grass and Grass Like Cover	30	7.5	22.5	47.1	92.2
Forb Cover	6	1.5	4.5	34	17.5
Fern Cover	0	0	0	0.2	15
Other Cover	0	0	0	0	0
Total length of fallen logs	41	10.25	30.75	36	12
Litter Cover	55	13.75	41.25	11.8	34
Number of Large Trees (>50dbh)	4	1	3	0	1

Table 4-4: June 2022 Individual plot data and benchmarks for Plot 3 (PCT201)

Attribute	Benchmark value	25% benchmark	75% benchmark	Plot 3
PCT201 - Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion				
Class/IBRA: Western Slopes Grassy Woodlands / NSW South Western Slopes				
Tree Richness	3	0.75	2.25	1
Shrub Richness	3	0.75	2.25	1
Grass and Grass Like Richness	8	2	6	12
Forb Richness	9	2.25	6.75	11
Fern Richness	1	0.25	0.75	1
Other Richness	1	0.25	0.75	0
Tree Cover	18	4.5	13.5	35
Shrub Cover	1	0.25	0.75	0.1
Grass and Grass Like Cover	30	7.5	22.5	19.9
Forb Cover	6	1.5	4.5	16.5
Fern Cover	0	0	0	4
Other Cover	0	0	0	0
Total length of fallen logs	41	10.25	30.75	27
Litter Cover	55	13.75	41.25	41
Number of Large Trees (>50dbh)	4	1	3	5

Table 4-5: June 2022 Individual plot data and benchmarks for Plot 4 (PCT76)

Attribute	Benchmark value	25% benchmark	75% benchmark	Plot 4
PCT76 - Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions				
Class/IBRA: Floodplain Transition Woodlands / NSW South Western Slopes				
Tree Richness	3	0.75	2.25	1
Shrub Richness	5	1.25	3.75	0
Grass and Grass Like Richness	7	1.75	5.25	3
Forb Richness	11	2.75	8.25	11
Fern Richness	1	0.25	0.75	0
Other Richness	1	0.25	0.75	0
Tree Cover	31	7.75	23.25	30
Shrub Cover	2	0.5	1.5	0
Grass and Grass Like Cover	23	5.75	17.25	80.3
Forb Cover	5	1.25	3.75	26.8
Fern Cover	0	0	0	0
Other Cover	0	0	0	0
Total length of fallen logs	49	12.25	36.75	65
Litter Cover	65	16.25	48.75	57
Number of Large Trees (>50dbh)	3	0.75	2.25	5

Table 4-6: June 2022 Individual plot data and benchmarks for Plot 5 (PCT270)

PCT270 - White Box - Tumbledown Red Gum - Long-leaved Box shrub/grass woodland on fine-grained sediments of the upper Macquarie River gorge, NSW central western slopes				
Class/IBRA: Western Slopes Dry Sclerophyll Forests / NSW South Western Slopes				
Attribute	**Benchmark value**	**25% benchmark**	**75% benchmark**	**Plot 5**
Tree Richness	5	1.25	3.75	4
Shrub Richness	9	2.25	6.75	1
Grass and Grass Like Richness	6	1.5	4.5	4
Forb Richness	8	2	6	14
Fern Richness	1	0.25	0.75	1
Other Richness	1	0.25	0.75	0
Tree Cover	61	15.25	45.75	8.1
Shrub Cover	10	2.5	7.5	0.1
Grass and Grass Like Cover	15	3.75	11.25	55.3
Forb Cover	4	1	3	19.1
Fern Cover	0	0	0	15
Other Cover	0	0	0	0
Total length of fallen logs	67	16.75	50.25	22
Litter Cover	66	16.5	49.50	13
Number of Large Trees (>50dbh)	1	0.25	0.75	0

The number of parameters which scored below benchmark varied across all five vegetation monitoring plots.

- Plots 2 and 3 had two of the fifteen parameters below 25% of benchmark. The two parameters below 25% of the benchmark for both plots were other richness and shrub cover.

Table 4-7: Plot 2 and plot 3 parameters below 25% of the benchmark value

Plot 2 and 3
Other Richness
Shrub cover

- Plots 1 and 4 had four of the fifteen parameters below 25% of benchmark.

Table 4-8: Plot 1 and plot 4 parameters below 25% of the benchmark value

Plot 1	Plot 4
Other Richness	Shrub Richness
Shrub cover	Fern Richness
Litter cover	Other Richness
Number of large trees	Shrub Cover

- Plot 5 had six of fifteen parameters below 25% of the benchmark value making it the poorest performing site across all five plots.

Table 4-9: Plot 5 parameters below 25% of the benchmark value

Plot 5
Shrub Richness
Other Richness
Tree Cover
Shrub Cover
Litter Cover
Number of large trees

Across all five plots two parameters recorded to occur below 25% of the benchmark was other richness and shrub cover.

4.2.2 Photographic record

Table 4-10: Plot photographs June 2022

2021 monitoring
PLOT 1

Midline start

Midline end

Groundcover quadrats

PLOT 2

Midline start

No Midline start image recorded for 2021

Midline end

Groundcover quadrats
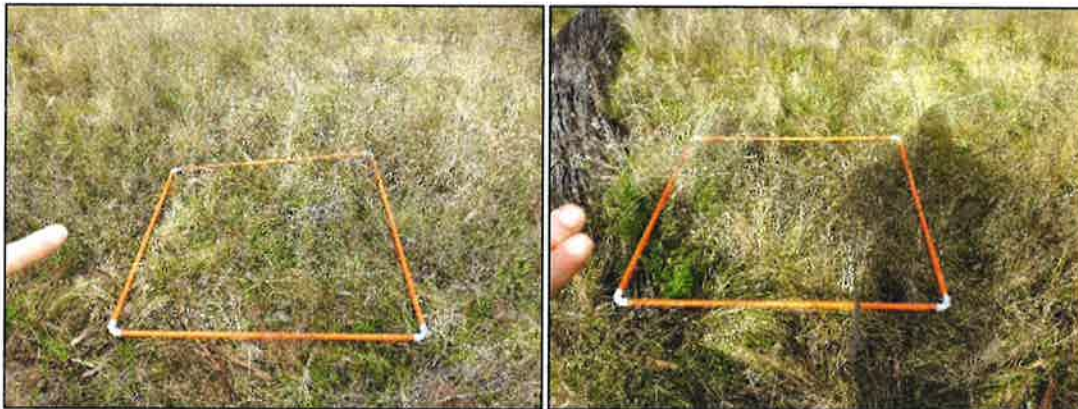
PLOT 3

Midline start

Midline end
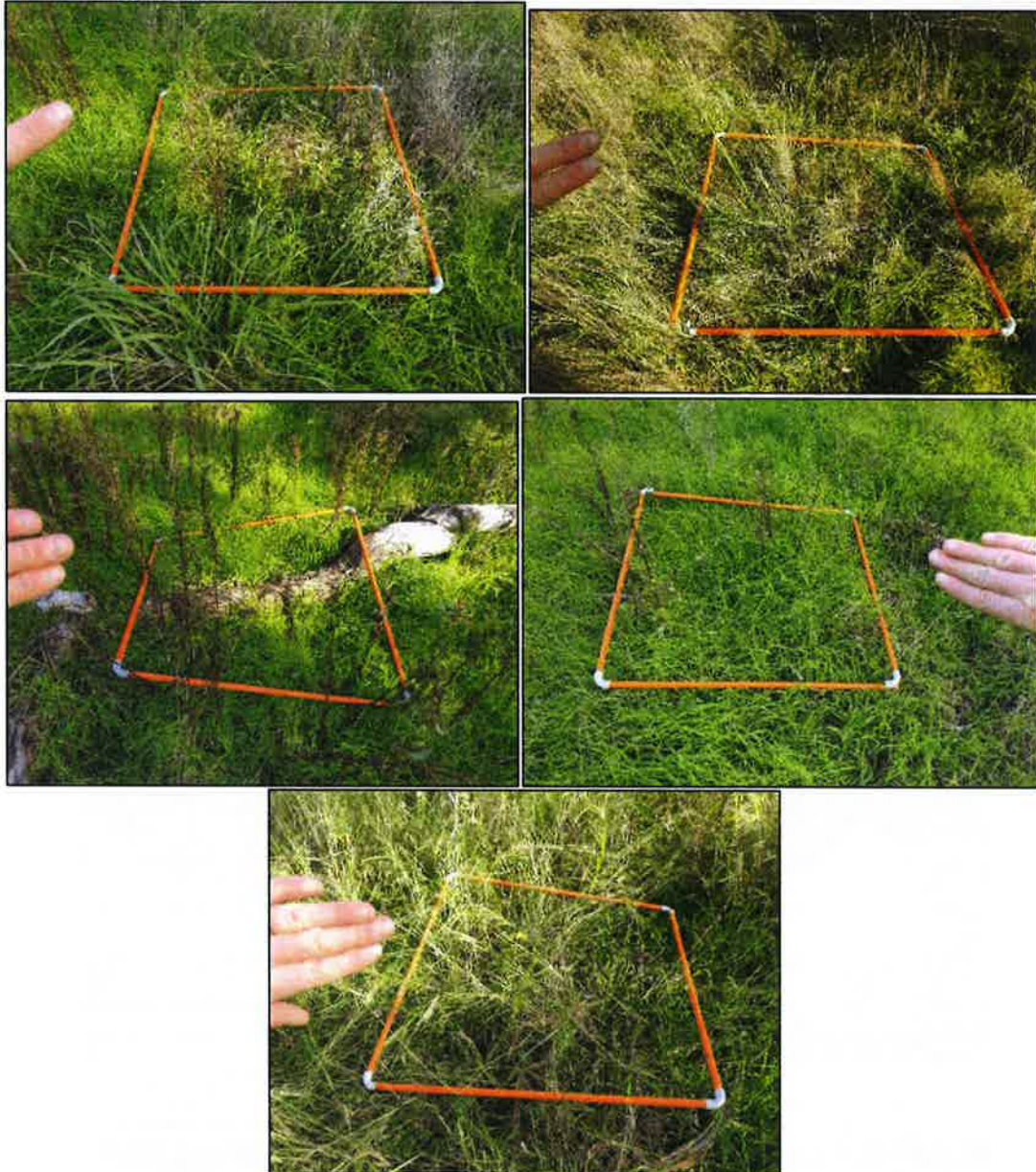
Groundcover quadrats

PLOT 4

Midline start

Midline end

Groundcover quadrats
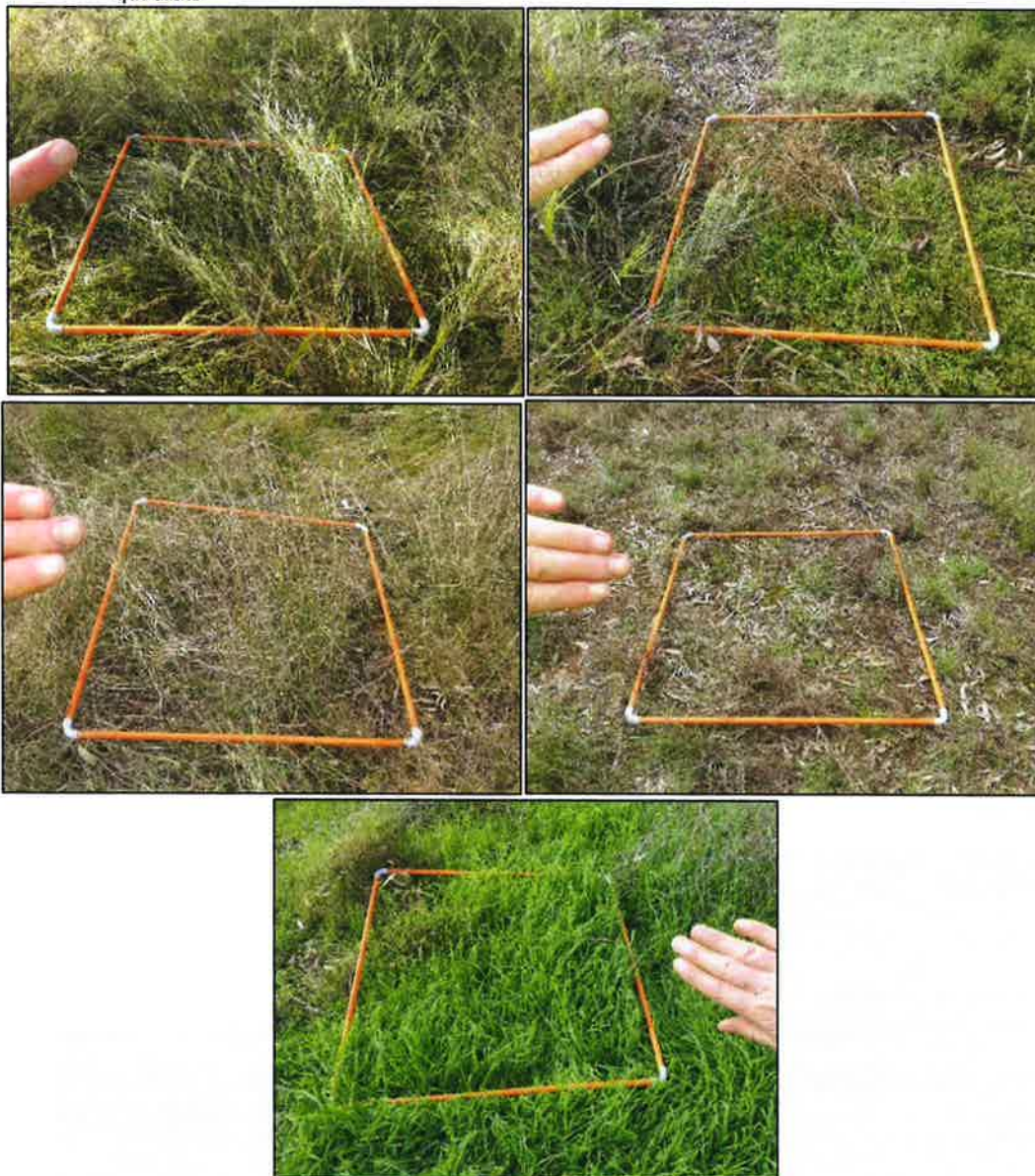
PLOT 5

Midline start

Midline end

Groundcover quadrats
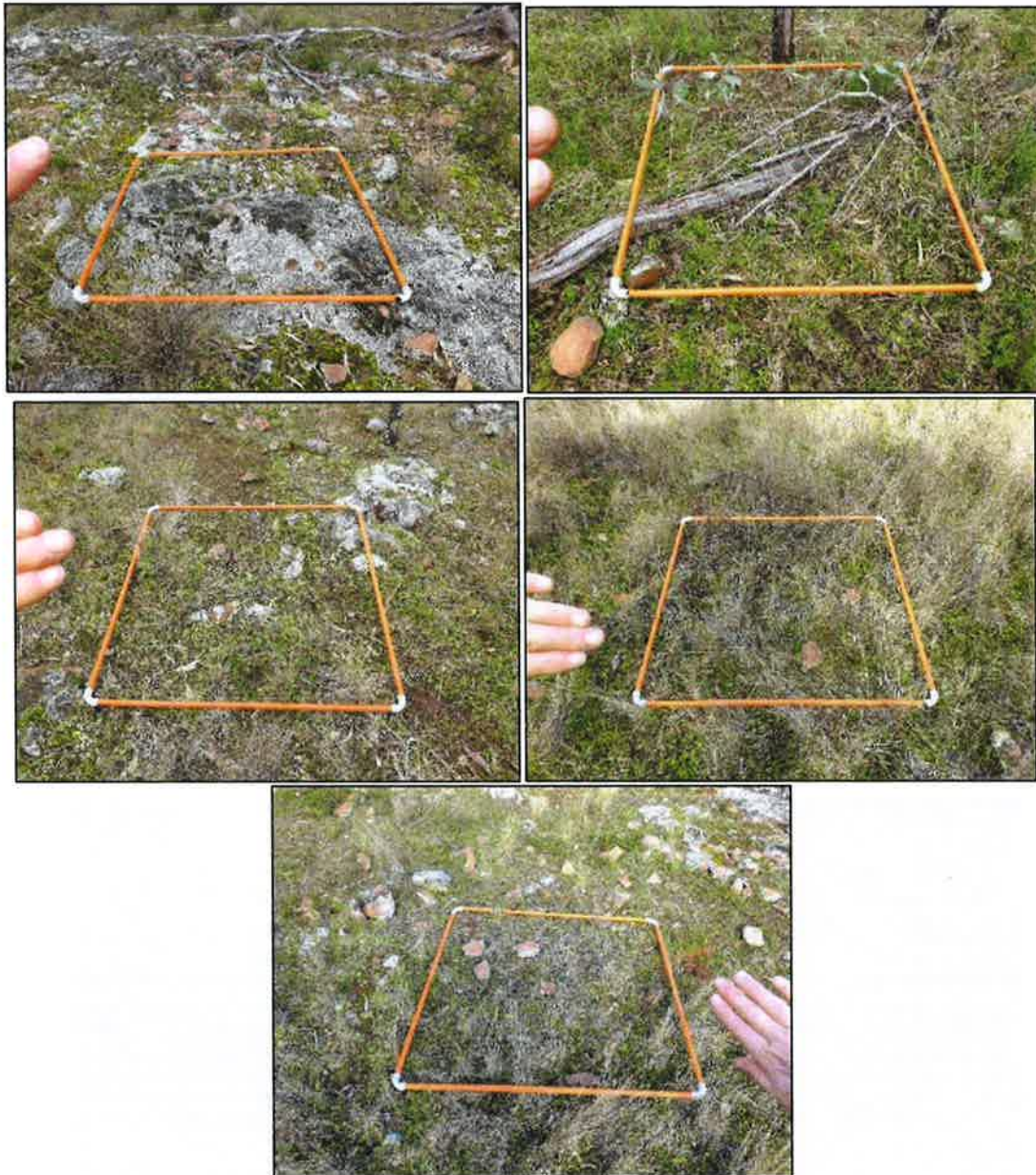
Table 4-11: Photo point comparison

| From Biodiversity Management Plan (2016) | Monitoring September 2019 |
| PLOT 1 | |

| Monitoring September 2020 | Monitoring June 2022 |
| PLOT 1 | PLOT 1 |

| From Biodiversity Management Plan (2016) | Monitoring September 2019 |
| PLOT 2 | |

Monitoring September 2020	Monitoring June 2022
PLOT 2	
	No midline start recorded for 2021
Biodiversity Management Plan (2016)	Monitoring September 2019
PLOT 3	
Monitoring September 2020	Monitoring June 2022
PLOT 3	

Biodiversity Management Plan (2016)	Monitoring September 2019
PLOT 4	

Monitoring September 2020	Monitoring June 2022
PLOT 4	

Biodiversity Management Plan (2016)	Monitoring September 2019
PLOT 5	

	PLOT 5	
Monitoring September 2020		Monitoring June 2022
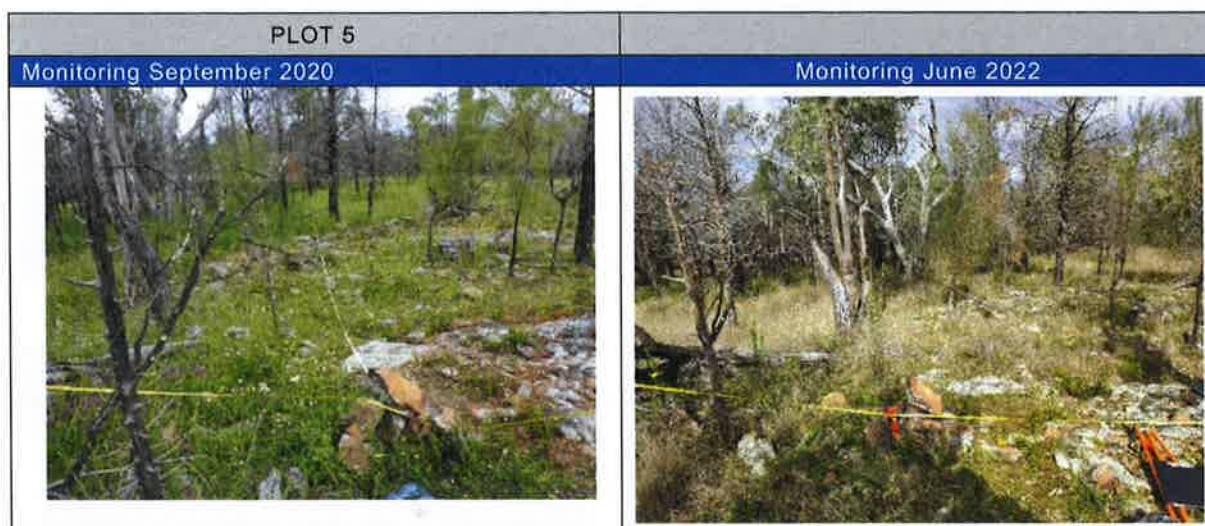
4.2.3   BAM calculations

Results from the BAM Calculator are provided in Table 4-12.

Green shading indicates 75% or greater of benchmark (good), yellow indicates between 25% and 75% of benchmark (average) and red indicates less than 25% of the benchmark (poor) value has been recorded.

Table 4-12: BAM results June 2022 data for 2021 reporting period

Plot number	Composition score	Structure score	Function score	Vegetation integrity score
1	81.5	98.2	48.4	72.9
2	87.4	81.7	80.8	83.2
3	74.7	89.4	79.4	80.9
4	50.5	95.2	71.9	70.2
5	65.6	24.3	38.2	39.4

These data show:

- The Composition score measures biodiversity.
  - This score represents the number of expected native species within the plot as a per cent of the expected benchmark for the PCT (Note: 100% is a very good example of the PCT.
  - Any score above 25 per cent of the benchmark is considered to be 'within benchmark'.
  - Plots 1 and 2 have calculated a good benchmark value opposed to plots 3,4 and 5 which have calculated an average benchmark value for composition.
- A structure score indicates how dense a vegetation type is (canopy species, shrubs, grasses, forbs, ferns other) as a per cent of the expected benchmark for the PCT.
  - The structure scores in Plots 1 to 4 are all within benchmark however Plot 5 is below benchmark.
  - Plots 1 to 4 have all scored above 75% of the benchmark value for structure with the lowest score of 81.7%, however plot 5 has returned a poor benchmark score of 24.3%.

- A function score is a proxy for suitable habitat for a suite of native species.
  - The structure score measures diameter of breast height size classes of trees (indicating the age cohorts), presence or absence of regeneration, number of trees with hollows, logs, per cent of leaf litter.
  - All 5 plots scored above 25% for function value, plots 2 and 3 recorded a good benchmark value above 75%
- Vegetation integrity: the condition of native vegetation assessed for each vegetation zone against the benchmark for the PCT.

  - the BAM calculator results for June 2022 vegetation integrity score has resulted in plots 2 and 3 receiving a good benchmark value.
  - The remaining plots 1, 4 and 5 have received an average benchmark value, the lowest score generated was for plot 5 at 37.10.

4.2.4 Comparison of BAM calculations

Green shading indicates 75% or greater of benchmark (good), yellow indicates between 25% and 75% of benchmark (average) and red indicates less than 25% of the benchmark (poor) value has been recorded.

Composition score

Plot number	2019	2020	June 2022
1	73.6	65.7	81.5
2	75.8	79	87.4
3	67.6	76.7	74.7
4	74.1	62.7	50.5
5	41.8	64	65.6

Structure score

Plot number	2019	2020	June 2022
1	50.3	43.7	98.2
2	55.3	66.2	81.7
3	98.2	89.5	89.4
4	96.5	73.5	95.2
5	20.6	21.5	24.3

Function score

Plot number	2019	2020	June 2022
1	55.8	46.9	48.4
2	79.3	61.3	80.8
3	72.2	58.7	79.4
4	70.6	67.3	71.9
5	54.3	32.1	38.2

Vegetation integrity score

Plot number	2019	2020	June 2022
1	59.1	51.3	72.9
2	69.3	68.4	83.2
3	78.3	73.9	80.9
4	79.6	67.7	70.2
5	36	35.3	39.4

The data collected under BAM 2020 for the last three survey years has been compiled in comparison tables to demonstrate the overall change in health for plots 1 to 5.

The data collected in 2019 shows native ground cover compared to 2020 is higher. This result reflects that in 2019 during drought, exotic species died therefore the majority of living plants were native species (fewer weeds meant the score for native biodiversity was higher).

In 2020 the increase in rainfall resulted in an overall decrease in biodiversity value due to the increase in exotic species recorded (more weeds meant the score for native biodiversity was lower).

The June 2022 survey shows a decrease in exotic species. This is considered to be a result of the effects of inundating rain in 2021 to 2022 and the positive combined effects of restricted grazing resulting in native species dominating the ground stratum (and contributing to the soil seedbank).

4.2.5 Weeds

Two High Threat Exotic weeds and no Weeds of National Significance were recorded.

High Threat Exotic weeds recoded in the plots were:

Scientific name	Common name
Bidens pilosa	Cobblers Peg
Paspalum dilatatum	Paspalum

Exotic species recoded in the plots were:

Scientific name	Common name
Medicago	Barrel Clover
Cirsium vulgare	Spear Thistle
Conyza elator	Tall Fleabane
Fumaria muralis	Wall Fumitory
Marrubium vulgare	White Horehound
Salvia verbenaca L.	Wild Sage
Hordeum glaucum	Barley Grass
Hordeum vulgare	Barley Grass
Solanum nigrum	Blackberry Nightshade
Solanum linnaeanum	Apple of Sodom
Anagallis arvensis	Scarlet Pimpernel
Taraxacum sp.	Milk Thistle
Taraxacum officinale	Dandelion

5 Conclusions

This document addressed monitoring actions in the approved Biodiversity Management Plan shown on Table 5-1.

Table 5-1: Project comments against Development Conditions of Consent

Location	Monitoring action	Frequency	Comment
Control Site and Analogue Sites 1 to 5	**BioMetric Vegetation Condition Benchmark**	Annual	Monitoring completed – June 2022

The number of parameters which scored below benchmark for the Plant Community Type varied across all five vegetation monitoring plots.
- Plots 2 and 3 had two of the fifteen parameters below 25% of benchmark.
- Plots 1 and 4 had four of the fifteen parameters below 25% of benchmark.
- Plot 5 had six of fifteen parameters below 25% of the benchmark value making it the poorest performing site across all 5 plots.

Across all five plots two parameters recorded to occur below 25% of the benchmark was 'other richness' and 'shrub cover'.

Data collected in 2019 showed some species of exotic species can survive drought which negatively contribute to the biodiversity value (but many species died off). With the increased rainfall and breaking of drought in 2020, exotic species increased significantly driving down the biodiversity value. While the 2020 inundating rains resulting in weed population explosion interestingly continued rainfall throughout 2021 resulted in a decrease in exotic species and an increase in native species, this in turn has driven the increase in biodiversity value within all plots surveyed.

Overall, the quantity and condition of native vegetation recorded in plots 1 to 5 is improving with time.

The increase in parameters at or above 25% of benchmark is consistent with change in weather patterns across all survey years. The survey data demonstrates the impacts of drought and increased rainfall within a particular area.

6 References

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Appendix A - 2020 BAM Plot sheets

Site sheet # 1 of   **Date** 11/6/22   **Survey name** Dubbo Project   _Alkane/ASM_   **Plot identifier** Pine Hill Plot

Recorders Phil Cameron Michelle G   **IBRA region** SE Highlands   **Veg zone ID**

¹Datum GDA   **Coordinate system** □ Projected □ Geographic   **MGA zone** 55   **¹X coordinate** 652444   **¹Y coordinate** 6405473

Location description _descriptive notes to locate site without grid reference_

¹Plot dimensions For composition & structure 400m²] 20 m × 25 m ✓   Fire function [1000m²] 20 m × 50 m   **¹Orientation of midline from 0 m point** Magnetic ✓   **Photo #**

Datum: AGD66, WGS84, GDA94, GDA2020 or Other (specify). MGA Zone (for Projected coordinate, system only): 56 (Coastal NSW), 55 (Central NSW or 54 (Western NSW). X/Y coordinate: Long/Lat (for Projected coordinate, system), Easting/Northing (for geographic coordinate, system)

Vegetation integrity

Composition and structure sum values may be completed after entering data into available tools. It is not required while in the field.

AS per last yrs data

Composition (400 m² plot)		Sum values	Structure (400 m² plot)		Sum values (%) (may sum to >100%)	Function (1000 m² plot) ¹Tree stem size class (DBH)	If data are to be used as more appropriate local data i.e. to generate local benchmarks, stems must be counted
Total count of native plant species (richness) in each growth form group (not individual plants within each growth form)	Trees (TG)	2	Sum of ² foliage cover of native plant species by growth form group	Trees (TG)	35·2	80 + cm	Count
	Shrubs (SG)	1		Shrubs (SG)	0·1	50 – 79 cm	Count (best practice)/tick. If "large tree benchmark size 250 cm count
	Grasses etc. (GG)	8		Grasses etc. (GG)	47–1	30 – 49 cm	Count (best practice)/tick. If "large tree benchmark size > 31 cm count
	Forbs (FG)	14		Forbs (FG)	34	20 – 29 cm	Count (best practice)/tick. If "large tree benchmark size > 26 cm count
	Ferns (EG)	1		Ferns (EG)	0·2	10 – 19 cm	Count (best practice)/tick.
	Other (OG)			Other (OG)		5 – 9 cm	Count (best practice)/tick.
					—	⁴Tree regeneration <5 cm	Tick
			Total high threat weed cover		0·1	⁵Length of fallen logs	Tally space Total m
						⁶Hollow bearing trees	Tick —

Vegetation Integrity - function cont. (five 1 m² plots)

	⁷Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each)	6	20	8	10	150	0	0	0	0	0·5	0	0	0	0	0	15	40	50	40	25
Average of the 5 subplots	11·8					0·1					0					34				

These attributes require consideration of site observations and may be completed after field work:

Vegetation class   **⁸Large tree benchmark size** 20/ 30/ 50/ 80 DBH   **Confidence** H/ M/ L

Plant community type (PCT)   **EEC** Tick   **Confidence** H/ M/ L

Physiography and site features that may help in determining PCT and management zone (optional) or for BioNet systematic flora survey purposes:

Morphological type	Trachite	Landform element	Hill	Landform pattern	Foothill	Microrelief	± 30cm
Lithology	Red Chromosol	Soil surface texture	loam	Soil colour	Brown	Soil depth	Shallow
Slope	2–4°	Aspect	E	Site drainage	Good	Distance to nearest water and type	75m

Disturbance	Severity code	Age code
Clearing (inc. logging)		
Cultivation (inc. pasture)		
Soil erosion		
Firewood / CWD removal		
Grazing (id. native/stock)		
Fire damage		
Storm damage		
Weediness		
Other		

Brief site description or other notes

Annual monitoring site. Significantly less weedy, white grasses?

Emergents heights			Upper stratum heights			Middle stratum heights			Lower stratum heights		
Top	Mid	Bottom	Top	Mid	Bottom	Top	Mid	Bottom	Top	Mid	Bottom
m	m	m	m	m	m	m	m	m	m	m	m

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe   Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

400 m² floristics plot: **Survey name**   **Plot identifier**   **Recorders**

Date 11 06 22   Dubbo Project   Pine Hill Plot   MC + PJC

GF code	Species name Full species name, or a unique means of identifying separate taxa within a survey is mandatory. Data from here will be used to assign growth form richness and cover.		N, HTW or non-HTW	Foliage cover	Abund-ance	Voucher
TG	Cypress glaucophylla	White Cypress	N	35	15	
T	Beulah cluster populence		N	0.2	2	
F	Dichondra repens		N	30	>58	
F	Hibbertia obtusifolia		N	0.1	10	
G	Stipa verticillata		N	8,15	1250	
C	Panicum decompositum		N	8	800	
-	Solanum nigrum	Poison Blackberry	E	0.1	30	
EG	Cheilanthes sieberi	Rock fern	N	0.2	210	
F	Glycine clandestina		N	0.1	50	
G	Microlaena stipoides		N	8	820	
-	Medicago sp		E	15	2000	
-	Solanum linneanum	Apple of Sodom	C	0.1	5	
-	Bidens pilosa	Cobbler's Pegs	HTE	0.1	25	
G	Austrostipa nodosa		N	5	400	
-	Salvia verbenaca	Wild Sage	E	0.1	2	
-	Sonchus sp.	Milk thistle	E	5	1000	
-	Conyza elatior	Tall fleabane	E	0.1	10	
F	Erodium cicutarium	Stork's bill	N	0.2	700	
F	Casuarina sp		N	0.1	1	
F	Hydrocotyle acutiloba	Pennywort	N	0.3	100	
F	Desmodium brachypodum	large leaf tick trefoil	W	0.1	10	
F	Carduus nutans	nutans	N	0.1	16	
G	Paspalidium constrictum	Box Grass	N	3	200	
G	Aristida jerichoensis	Spey Grass	N	5	4000	
F	Anagallis arvensis	Scarlet Pimpernel	E	0.2	200	
F	Vittadinia cuneata	Fuzzweed	N	0.1	50	
S	Eremophila sp Pimelea sygebockia		N	0.1	15	
-	Cassia senna	Pepperleaf Senna	N	0.1	15	
F	Bulbine bulbosa	Bladder clam	N	0.1	5	
-	Wahlenbergia communis	Blue Bell	N	0.1	10	
E	Hordeum vulgare	Barley Grass	E	15	300	
F	Chrysocephalum sp.		N	0.2	2550	
F	Plantago cunninghamiana	Sage weed	N	0.1	10	
G	Poa brownii		N	0.1	5	
G	Aristida scabra	Rough spear Grass	N	3	400	

Print more copies of this page to allow for higher species counts at a plot. All vascular plant species in a plot need to be recorded.

GF Code: see growth form definitions in BAM 2020 Appendix F. **N**: native, **HTW**: high threat weed.

² **Foliage cover:** 0.1, 0.2, 0.3, …, 1, 2, 3, 4, 5, 10, 15, 20, 25, …100%; Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m. Note the top 3 dominant native species within each GF group.

Abundance: Count 1, 2, 3 …, when ≤10, estimate when >10, 20, 30 … 100, 200, 300 …, 1000, 2000, 3000 … (as integer values).

Site sheet #	1 of	Date: 11/6/22	Survey name	Dubbo Project		Plot Identifier	2 White Box Plot
Recorders		Phil Cameron Middle Ridge	IBRA region	SE Highlands		Veg zone ID	

Datum	GDA	Coordinate system	☐ Projected ☐ Geographic	MGA zone	55	X coordinate 652673	Y coordinate 6406659

Location description descriptive notes to locate site without grid reference

Plot dimensions For composition & structure (400m²): 20 m x 20 m ✓
For function (1000m²): 20 m x 50 m

Orientation of midline from 0 m point Magnetic° Photo #

Datum: AGD66, WGS84, GDA94, GDA2020 or Other (specify). MGA Zone (for Projected coordinate system only): 56 (Coastal NSW), 55 (Central NSW or 54 (Western NSW). X/Y coordinate: Long/Lat (for Projected coordinate system), Easting/Northing (for geographic coordinate system)

Vegetation integrity

Composition and structure sum values may be completed after entering data into available tools. It is not required while in the field

Composition (400 m² plot)		Sum values	Structure (400 m² plot)		Sum values (%) (may sum to >100%)	Function (1000 m² plot) [3] Tree stem size class (DBH)	If data are to be used as more appropriate local data i.e. to generate local benchmarks, stems must be counted
Total count of native plant species (richness) in each growth form group (not individual plants within each growth form)	Trees (TG)	2	Sum of [2] foliage cover of native plant species by growth form group	Trees (TG)	81	80 + cm	Count
	Shrubs (SG)	5		Shrubs (SG)	01	50 – 79 cm	Count (best practice)/tick. If large tree benchmark size ≥50 cm, count
	Grasses etc. (GG)	6		Grasses etc. (GG)	92.3	30 – 49 cm	Count (best practice)/tick. If large tree benchmark size ≥ 30 cm, count
	Forbs (FG)	15		Forbs (FG)	17.5	20 – 29 cm	Count (best practice)/tick. If large tree benchmark size ≥ 20 cm, count
	Ferns (EG)	1		Ferns (EG)	15	10 – 19 cm	Count (best practice)/tick
	Other (OG)	0		Other (OG)	0	5 – 9 cm	Count (best practice)/tick
						[4] Tree regeneration <5 cm	Tick ✓
			Total high threat weed cover		0 %	[5] Length of fallen logs	Tally space Total 45 m
						[6] Hollow bearing trees	Tick 1

Vegetation integrity - function cont. (five 1 m² plots)	[7] Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	25 30 20 25 70	2 2 5 3 0	0 0 1 0 0	0 0 0 0 0
Average of the 5 subplots	34	2.4	0.2	0

These attributes require consideration of site observations and may be completed after field work:

Vegetation class		[8] Large tree benchmark size	20/ 30/ 50/ 80 DBH	Confidence	H/ M/ L
Plant community type (PCT)			EEC Tick	Confidence	H/ M/ L

Physiography and site features that may help in determining PCT and management zone (optional) or for BioNet systematic flora survey purposes:

Morphological type		Landform element		Landform pattern		Microrelief	
Lithology		Soil surface texture		Soil colour		Soil depth	
Slope		Aspect		Site drainage		Distance to nearest water and type	

Disturbance	Severity code	Age code	Brief site description or other notes
Clearing (inc. logging)			Annual thinning point
Cultivation (inc. pasture)			
Soil erosion			
Firewood / CWD removal			
Grazing (ie. native/stock)			
Fire damage			
Storm damage			

			Emergents heights			Upper stratum heights			Middle stratum heights			Lower stratum heights		
			Top	Mid	Bottom	Top	Mid	Bottom	Top	Mid	Bottom	Top	Mid	Bottom
Weediness						15 m	20	2 m	1.8 m	1 m	0.2 m	0.4	0.2	0.1 m
Other			m	m	m									

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe   Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

400 m² floristics plot:	Survey name	Plot Identifier	Recorders				
Date 11.6.22	Dubbo Project	White Box	PJC + NK				

GF code	Species name Full species name, or a unique means of identifying separate taxa within a survey is mandatory. Data from here will be used to assign growth form richness and cover.	N, HTW or non-HTW	² Foliage cover	Abund -ance	Voucher
T	Eucalyptus albens White Box	N	8	10	
T	Cupressus glaucophylla	N	0.1	1	
F	Dianella revoluta	N	0.1	1	
S	Dodonea cuneata	N	0.1	4	
EL	Cheilanthes sieberi Prince Rock fern	N	15	1400	
G	Austrostipa scabra Spear Grass	N	80	5L	
G	Aristida scabra	N	5	400	
F	Calotis lappulacea	N	5	400	
F	Calotis cuneata	N	5	400	
F	Vittadinia cuneata Fuzzweed	N	5	1000	
F	Panicum umbellula	N	1	100	
—	Medicago sp.	N	0.2		
G	Enteropogon acicularis Curly Windmill	N	2	500	
G	Panicum decompositum	N	5	500	
F	Wahlenbergia communis Bluebell	N	0.1	100	
G	Chloris truncata	N	0.1	50	
F	Brachiaria downsii Tar Vine	N	0.1	5	
F	Glycine clandestina	N	0.1	10	
—					
	Cirsium vulgare Yellow Spear thistle	E	0.1	50	
G	Juncus sp. 1	N	0.1	2	
F	Bulbine bulbosa	N	0.1	1	
F	Apium prostratum Native Celery	N	0.1	1	
F	Desmodium brachypodium	N	0.1	5	
G	Rhytidosperma sp.	N	0.1	50	
—	Fumaria Verbena furrow Fumary Weed	E	0.1	1	
F	Senecio sp.	N	0.1	1	
F	Dichondra repens	N	0.3	50	
F	Erodium cicutarium	N	0.3	50	
—	Conyza elata Tall fleabane	E	0.1	1	
F	Hydrocotyle acutiloba Kidney weed	N	0.1	10	
—	Taraxacum officinale	L	0.1	50	

Print more copies of this page to allow for higher species counts at a plot. All vascular plant species in a plot need to be recorded.

GF Code: see growth form definitions in BAM 2020 Appendix F. **N:** native, **HTW:** high threat weed.

² **Foliage cover:** 0.1, 0.2, 0.3, ..., 1, 2, 3, 4, 5, 10, 15, 20, 25, ...100%; Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately *1.4 x 1.4 m*, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m. Note the top 3 dominant native species within each GF group.

Abundance: Count 1, 2, 3 ..., when ≤10, estimate when >10, 20, 30 ... 100, 200, 300 ..., 1000, 2000, 3000 ... (as integer values).

Site sheet #	1 of	Date	11/6/22	Survey name	Dubbo Project ALKANE		Plot Identifier	3 Fuzzy Box
Recorders	Phil Cameron	Middle Glover		IBRA region	SE Highlands		Veg zone ID	
Datum	GDA	Coordinate system	□ Projected □ Geographic	MGA zone	55	X coordinate 648684	Y coordinate	6408581

Location description — descriptive notes to locate site without grid reference

'Plot dimensions	For composition & structure (400m²): 20 m x 20 m ✓ For function (1000m²): 20 m x 50 m	'Orientation of midline from 0 m point	Magnetic '	Photo #

Datum: AGD66, WGS84, GDA94, GDA2020 or Other (specify). MGA Zone (for Projected coordinate. system only): 56 (Coastal NSW), 55 (Central NSW or 54 (Western NSW). X/Y coordinate: Long/Lat (for Projected coordinate. system), Easting/Northing (for geographic coordinate. system)

Vegetation integrity

Composition and structure sum values may be completed after entering data into available tools. It is not required while in the field

Composition (400 m² plot)		Sum values	Structure (400 m² plot)		Sum values (%) (may sum to >100%)	Function (1000 m² plot) ³Tree stem size class (DBH)	If data are to be used as more appropriate local data i.e. to generate local benchmarks, stems must be counted
Total count of native plant species (richness) in each growth form group (not individual plants within each growth form)	Trees (TG)	1	Sum of ² foliage cover of native plant species by growth form group	Trees (TG)	35	80 + cm	Count
	Shrubs (SG)	1		Shrubs (SG)	0.1	50 – 79 cm	Count (best practice)/tick. If large tree benchmark size >50 cm, count
	Grasses etc. (GG)	12		Grasses etc. (GG)	19.9	30 – 49 cm	Count (best practice)/tick. If large tree benchmark size ≥ 30 cm, count
	Forbs (FG)	11		Forbs (FG)	16.5	20 – 29 cm	Count (best practice)/tick. If ³large tree benchmark size ≥ 20 cm, count
	Ferns (EG)	1		Ferns (EG)	4	10 – 19 cm	Count (best practice)/tick
	Other (OG)	—		Other (OG)	—	5 – 9 cm	Count (best practice)/tick
			Total high threat weed cover	— %		⁴Tree regeneration <5 cm	Tick ✓
						⁵ Length of fallen logs	Tally space Total 27 m
						⁶ Hollow bearing trees	Tick

Vegetation integrity - function cont. (five 1 m²) plots)	⁷Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	30 25 30 30 90	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0 0
Average of the 5 subplots	41	0	0	0

These attributes require consideration of site observations and may be completed after field work.

Vegetation class		⁸Large tree benchmark size	20/ 30/ 50/ 80 DBH	Confidence	H/ M/ L
Plant community type (PCT)			EEC Tick	Confidence	H/ M/ L

Physiography and site features that may help in determining PCT and management zone (optional) or for BioNet systematic flora survey purposes:

Morphological type		Landform element		Landform pattern		Microrelief	
Lithology		Soil surface texture		Soil colour		Soil depth	
Slope		Aspect		Site drainage		Distance to nearest water and type	

Disturbance	Severity code	Age code	Brief site description or other notes
Clearing (inc. logging)			
Cultivation (inc. pasture)			
Soil erosion			
Firewood / CWD removal			
Grazing (id. native/stock)			
Fire damage			
Stem damage			
Weediness			
Other			

			Emergents heights			Upper stratum heights			Middle stratum heights			Lower stratum heights		
			Top	Mid	Bottom	Top	Mid	Bottom	Top	Mid	Bottom	Top	Mid	Bottom
			m	m	m	m	m	m	m	m	m	m	m	m

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe   Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

400 m² floristics plot:	Survey name	Plot Identifier	Recorders				
Date 11/6/22	Dubbo Project Alkane	Fuzzy Box	Phil Cameron, Michelle Glover				

GF code	Species name Full species name, or a unique means of identifying separate taxa within a survey is mandatory. Data from here will be used to assign growth form richness and cover.		N. HTW or non-HTW	² Foliage cover	Abund -ance	Voucher
T	Eucalyptus conica	Fuzzy Box	N	35	1	—
G	Chloris verticillata		N	5	250	
G	Austrostipa verticillata		N	2	150	
—	Paspalum dillatatum		HTE	0.2	15	
—	Bidens pilosa	Cobblers Pegs	HTE	0.1	300	
G	Carex sp.		N	3	300	
G	Paspalidium constrictum	Box Grass	N	2	150	
—	Marrubium vulgare	White Horehound	E	0.1	5	
—	Salvia verbenaca	Wild Sage	E/N	0.1	5	
G	Sporobolis creber		N	0.3	200	
G	Rhitosperma sp	Wallaby Grass	N	0.3	200	
F	Calotis cuneata	Purple Burr daisy	N	0.8	400	
G	Bothriochloa macra			0.1	10	
—	Conyza elata	Tall Fleabine	E	0.1	10	
F	Bulbine bulbosa		N	0.1	12	
F	Vittadinia cuneata	Fuzz weed	N	5	>2k	
—	Bromus hordeum	Barley Grass	E	40	>3k	
F	Calotis lappulacea	Yellow Burr Daisy	N	5	400	
—	Lepidium sp	Shepherds Purse	E	0.1	50	
F	Erodium circicaurum		N	0.1	65	
F	Hydrocotyle acutiloba	Penny weed	N	0.1	200	
F	Glycene clandestina		N	0.1	200	
EG	Cheilanthes sieberi	Poison Rockfern	N	4	500	
—	Taraxacum officinale	Dandelion	L	0.1	500	
—	Medicago sp.		E	0.8	300	
F	Swainsona sp A.		N	0.1	10	
G	Austrostipa nodosa		N	3	100	
G	Panicum buncii		N	3	100	
F	Eriandinae nutans		N	5	400	
G	Aristida lanosa		N	3	100	
G	Austrostipa scabroensis		N	3	100	
F	Wahlenbergia communis		N	0.1	5	
S	Cassia senna	Punty Bush Senna	N	0.1	3	
F	Dianella revoluta		N	0.1	1	
G	Enteropogon acicularis		N	0.2	50	

Print more copies of this page to allow for higher species counts at a plot. All vascular plant species in a plot need to be recorded.

GF Code: see growth form definitions in BAM 2020 Appendix F. **N:** native, **HTW:** high threat weed.

² **Foliage cover:** 0.1, 0.2, 0.3, …, 1, 2, 3, 4, 5, 10, 15, 20, 25, …100%; Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately *1.4 x 1.4 m*, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m. Note the top 3 dominant native species within each GF group.

Abundance: Count 1, 2, 3 …, when ≤10, estimate when >10, 20, 30 … 100, 200, 300 …, 1000, 2000, 3000 … (as integer values).

Site sheet #	1 of	Date	11/6/22	Survey name	Dubbo Project ALKANE		Plot Identifier	4	Inland Grey Box Plot

Recorders	Phil Cameron Michael Graham	IBRA region	SE Highlands		Veg zone ID	

¹Datum	GDA	Coordinate system	☐ Projected ☐ Geographic	MGA zone	55	X coordinate	648037	Y coordinate	64θ7727

Location description — descriptive notes to locate site without grid reference

¹Plot dimensions	For composition & structure (400m²): 20 m x 20 m ✓ For function (1000m²): 20 m x 50 m ✓	¹Orientation of midline from 0 m point	Magnetic °	Photo #

Datum: AGD66, WGS84, GDA94, GDA2020 or Other (specify). MGA Zone (for Projected coordinate system only): 56 (Coastal NSW), 55 (Central NSW) or 54 (Western NSW). X/Y coordinate: Long/Lat (for Projected coordinate system), Easting/Northing (for geographic coordinate system)

Vegetation Integrity

Composition and structure sum values may be completed after entering data into available tools. It is not required while in the field

Composition (400 m² plot)		Sum values	Structure (400 m² plot)		Sum values (%) (may sum to >100%)	³Tree stem size class (DBH)		If data are to be used as more appropriate local data i.e. to generate local benchmarks, stems must be counted
Total count of native plant species (richness) in each growth form group (not individual plants within each growth form)	Trees (TG)	1	Sum of ²foliage cover of native plant species by growth form group	Trees (TG)	30	80 + cm	—	Count
	Shrubs (SG)	0		Shrubs (SG)	0	50 – 79 cm	✝✝✝	Count (best practice)/tick. If ⁴large tree benchmark size ≥50 cm, count
	Grasses etc. (GG)	3		Grasses etc. (GG)	80.3	30 – 49 cm	l	Count (best practice)/tick. If ⁴large tree benchmark size ≥ 30 cm, count
	Forbs (FG)	11		Forbs (FG)	26.8	20 – 29 cm	—	Count (best practice)/tick. If ⁴large tree benchmark size ≥ 20 cm, count
	Ferns (EG)	—		Ferns (EG)	—	10 – 19 cm	—	Count (best practice)/tick
	Other (OG)	—		Other (OG)	—	5 – 9 cm	—	Count (best practice)/tick
						⁴Tree regeneration <5 cm	Tick	
			Total high threat weed cover		0.2 %	⁵Length of fallen logs	Tally space ✓	Total 65 m
						⁶Hollow bearing trees	Tick ✓	

Vegetation Integrity - function cont. (five 1 m² plots)	⁷Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	75 90 85 30 5	0 0 0 5 0	0 0 0 2 0	0 0 0 0.1 0
Average of the 5 subplots	57	1	0.4	0.02

These attributes require consideration of site observations and may be completed after field work:

Vegetation class		⁸Large tree benchmark size	20/ 30/ 50/ 80 DBH	Confidence	H/ M/ L
Plant community type (PCT)		EEC	Tick	Confidence	H/ M/ L

Physiography and site features that may help in determining PCT and management zone (optional) or for BioNet systematic flora survey purposes:

Morphological type		Landform element		Landform pattern		Microrelief	
Lithology		Soil surface texture		Soil colour		Soil depth	
Slope		Aspect		Site drainage		Distance to nearest water and type	

Disturbance	Severity code	Age code	Brief site description or other notes
Clearing (inc. logging)			
Cultivation (inc. pasture)			
Soil erosion			
Firewood / CWD removal			
Grazing (id. native/stock)			
Fire damage			
Storm damage			
Weediness			
Other			

		Emergents heights			Upper stratum heights			Middle stratum heights			Lower stratum heights		
		Top	Mid	Bottom	Top	Mid	Bottom	Top	Mid	Bottom	Top	Mid	Bottom
		m	m	m	m	m	m	m	m	m	m	m	m

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe   Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

400 m² floristics plot:	Survey name	Plot identifier	Recorders
Date 11 / 6 / 22	Dubbo Project Inland Grey Box Alkane	Inland Grey Box Plot	Phil Cameron Maddie Glove

GF code	Species name — Full species name, or a unique means of identifying separate taxa within a survey is mandatory. Data from here will be used to assign growth form richness and cover.		N, HTW or non-HTW	Foliage cover	Abund-ance	Voucher
T4	1	Eucalyptus microcarpa Inland Grey Box	N	30	6	—
G	3	Austrostipa verticillata	N	80	75k	—
F	3	Einadia nutans	N	25	1400	—
F	4	Calotis lappulacea Yellow burr daisy	N	0.5	100	—
—	6	Marrubium vulgare White horehound	E	0.1	10	—
—	6	Bromus hordeum Barley Grass	E	0.8	1000	—
—	7	Taraxacum officinale Dandilion	E	0.8	500	—
—	8	Medicago sp	E	0.1	200	—
F	9	Vittadinia cuneata Fuzzweed	N	0.1	20	—
—	10	Bidens pilosa Cobblers Pegs	HTW	0.2	100	—
F	11	Sida corrugata	N	0.1	15	—
F	12	Einadina Saloop	N	0.1	5	—
F	13	Austrostipa nodosa	N	0.1	5	—
F	14	Oxalis chnoodes	N	0.1	15	—
F	15	Dianella revoluta	N	0.1	1	—
F	16	Wahlenbergia communis	N	0.1	2	—
F	17	Austrostipa nodosa	N	0.1	15	—
F	18	Dichondra repens Kidney Weed	N	0.2	200	—
G	19	Rhytidosperman sp 4 Wallaby Grass	N	0.2	200	—
G	20	Chloris verticillata Tall Chloris	N	0.1	100	—

Print more copies of this page to allow for higher species counts at a plot. All vascular plant species in a plot need to be recorded.

GF Code: see growth form definitions in BAM 2020 Appendix F. **N:** native, **HTW:** high threat weed.

[2] **Foliage cover:** 0.1, 0.2, 0.3, …, 1, 2, 3, 4, 5, 10, 15, 20, 25, …100%; Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m. Note the top 3 dominant native species within each GF group.

Abundance: Count 1, 2, 3 …, when ≤10, estimate when >10, 20, 30 … 100, 200, 300 …, 1000, 2000, 3000 … (as integer values).

Site sheet #	1 of	Date	11/6/22	Survey name	Dubbo Project		Plot identifier	5 Ligothery

Recorders	Phil Cameron Michelle Chopin	IBRA region	SE Highlands		Veg zone ID	

Datum	GDA	Coordinate system	□ Projected □ Geographic	MGA zone	55	X coordinate		Y coordinate	

Location description   descriptive notes to locate site without grid reference

Plot dimensions	For composition & structure (400m²): 20 m x 20 m For function (1000m²): 20 m x 50 m	Orientation of midline from 0 m point	Magnetic °	Photo #

Datum: AGD66, WGS84, GDA94, GDA2020 or Other (specify). MGA Zone (for Projected coordinate system only): 56 (Coastal NSW), 55 (Central NSW or 54 (Western NSW). X/Y coordinate: Long/Lat (for Projected coordinate. system), Easting/Northing (for geographic coordinate. system)

Vegetation Integrity

Composition and structure sum values may be completed after entering data into available tools. It is not required while in the field

Composition (400 m² plot)		Sum values	Structure (400 m² plot)		Sum values (%) (may sum to >100%)	Function (1000 m² plot) Tree stem size class (DBH)	If data are to be used as more appropriate local data i.e. to generate local benchmarks, stems must be counted
Total count of native plant species (richness) in each growth form group (not individual plants within each growth form)	Trees (TG)	4	Sum of foliage cover of native plant species by growth form group	Trees (TG)	8.1	80 + cm	Count
	Shrubs (SG)	1		Shrubs (SG)	0.1	50 – 79 cm	Count (best practice)/tick. If large tree benchmark size ≥50 cm, count
	Grasses etc. (GG)	4		Grasses etc. (GG)	55.3	30 – 49 cm	Count (best practice)/tick. If large tree benchmark size ≥ 30 cm count
	Forbs (FG)	14		Forbs (FG)	19.1	20 – 29 cm	Count (best practice)/tick. If large tree benchmark size ≥ 20 cm, count
	Ferns (EG)	1		Ferns (EG)	15	10 – 19 cm	HHT II
	Other (OG)	—		Other (OG)	—	5 – 9 cm	HHT HHT III ✓
			Total high threat weed cover	— %		Tree regeneration <5 cm	Tick ✓
						Length of fallen logs	Tally space Total 23 m
						Hollow bearing trees	Tick ✓ 2

Vegetation Integrity - function cont. (five 1 m²) plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	2 35 25 2 1	1 0 3 1 1	3 0 30 2 3	85 2 16 3 10
Average of the 5 subplots	13	1.2	7.6	23.2

These attributes require consideration of site observations and may be completed after field work.

Vegetation class		Large tree benchmark size	20/ 30/ 50/ 80 DBH	Confidence	H/ M/ L

Plant community type (PCT)			EEC	Tick	Confidence	H/ M/ L

Physiography and site features that may help in determining PCT and management zone (optional) or for BioNet systematic flora survey purposes:

Morphological type		Landform element		Landform pattern		Microrelief	
Lithology		Soil surface texture		Soil colour		Soil depth	
Slope		Aspect		Site drainage		Distance to nearest water and type	

Disturbance	Severity code	Age code	Brief site description or other notes
Clearing (inc. logging)			Monitoring Plot.
Cultivation (inc. pasture)			
Soil erosion			
Firewood / CWD removal			
Grazing (id. native/stock)			
Fire damage			
Storm damage			

			Emergents heights			Upper stratum heights			Middle stratum heights			Lower stratum heights		
Weediness			Top	Mid	Bottom	Top	Mid	Bottom	Top	Mid	Bottom	Top	Mid	Bottom
Other			m	m	m	m	m	m	m	m	m	m	m	m

Severity: 0=no evidence, 1=light, 2=moderate. 3=severe   Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

400 m² floristics plot:	Survey name	Plot identifier	Recorders			
Date 11 6 22	Dubbo Project Alkane	Ugothery Hill	Phil Gwinn Isdella Glover			

GF code	Species name — Full species name, or a unique means of identifying separate taxa within a survey is mandatory. Data from here will be used to assign growth form richness and cover.	N, HTW or non-HTW	² Foliage cover	Abund-ance	Voucher
T	Casuarina luemenihii Bullock	W	5	9	
T	Eucalyptus dealbata	N	61	25	
T	Cypress glaucophylla	N	2	4	
F	Hibbertia obtusifolia	N	0.2	40	
G	Aristida ramosa	N	50	>5k	
F	Callotis lapulacea	H	5	1000	
G	Austrostipa nodosa	N	1	400	
F	Swainsona sp.	N	0.1	5	
F	Pterostylis sp1 Greenhood Orchid	N	0.1	50	
E G	Cheilanthes sieberi Poison Rock Fern	N	15	7000	
F	Pomax umbellis	N	5	2000	
F	Vittadinia cuneata	N	3	7000	
G	Panicum decompositum	N	2	800	
G	Austrostipa scabra Austrostipa juncifolia	N	2	400	
F	Callotis cuneifolia	N	0.1	100	
-	Fumaria muralis Wall Fumitory	E	0.1	10	
-	Bromus hordeum Barley Grass	E	0.1	50	
-	Taraxacum officinale Dandelion	E	0.3	200	
G	Rhytospermum sp. Wallaby Grass	N	0.1	10	
F	Drosera sp Sundew	N	0.1	1	
F	Chrysocephalum sp. Tiny daisy	N	0.1	25	
F	Rhagodia sp	N	0.1	1	
T	Brachychiton populneus Kurrajong	N	0.1	1	
-	Medicago sp	E	0.1	100	
F	Wahlenbergia communis	N	0.1	25	
F	Stephania glauca Nodding Blue lily	N	0.1	1	
G	Thyridolepis mitchelliana Mitchell Grass	N	0.2	50	
S	Solanum ferocissimum Spiny Potato bush	N	0.1	1	
F	Bulbine bulbosa	N	0.1	1	
F	Pimelea neo anglica	N	5	400	

Print more copies of this page to allow for higher species counts at a plot. All vascular plant species in a plot need to be recorded.

GF Code: see growth form definitions in BAM 2020 Appendix F. **N:** native, **HTW:** high threat weed.

² **Foliage cover:** 0.1, 0.2, 0.3, ..., 1, 2, 3, 4, 5, 10, 15, 20, 25, ...100%; Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m. Note the top 3 dominant native species within each GF group.

Abundance: Count 1, 2, 3 ..., when ≤10, estimate when >10, 20, 30 ... 100, 200, 300 ..., 1000, 2000, 3000 ... (as integer values).

Appendix B - Observed fauna

Common name	Scientific name
Eastern Rosella	*Platycercus eximius*
Magpie	*Cracticus tibicen*
Magpie Lark	*Grallina cyanoleuca*
Noisy Miner	*Manorina melanocephala*
Grey-crowned Babbler	*Pomatostomus temporalis*
Red-rumped Parrot	*Psephotus haematonotus*
Red-winged parrots	*Aprosmictus erythropterus*
Crested Pigeon	*Ocyphaps lophotes*
Galah	*Eolophus roseicapilla*
Australian Hobby	*Falco longipennis*
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
Richards Pipit	*Anthus richardi*
Wild Pig	*Sus scrofa*
Wallaroos	*Macropus robustus*
Eastern grey kangaroos	*Macropus giganteus*

Australian Strategic Materials, Dubbo Project

ASM
Australian Strategic Materials

Pink-tailed Worm-lizard Monitoring Report
Dubbo Regional LGA NSW
March 2022

IMAGE: Pink-tailed Worm-lizard monitoring DP 2022

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- ✓ Independent environmental auditors

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1 Introduction

Pink-tailed Worm-lizard (PTWL) *Aprasia parapulchella* is listed as vulnerable under the Commonwealth *Environment Protection Biodiversity & Conservation Act 1999* (EPBC Act) and the NSW *Biodiversity Conservation Act 2016* (BCA Act).

Tile (artificial habitat) monitoring and targeted searches of natural habitat was carried out on 29 March 2022. Monitoring has been occurring since 2013, the 2022 assessment team included Phil Cameron & Greg Kirk from AREA Environmental & Heritage Consultants.

This monitoring program is underpinned and implemented in accordance with the PTWL Plan of Management (Ozark 2016). The Dubbo Project (DP), operated by Australian Strategic Materials continues to oversee PWTL the monitoring program.

One PTWL was sighted during monitoring on 29 March 2022 under natural rock habitat adjacent to artificial habitat (roof tiles). This indicates natural habitat was preferred under the same environmental conditions.

Monitoring of the PWTL is scheduled to occur towards the end of Spring and Autumn each year when weather conditions are suitable. Monitoring did not occur in Autumn 2021 due to wet weather (188.2 millimetres of rain in March and 119.2 millimetres of rain in June). Spring monitoring did also not occur due to covid restrictions and wet weather (180.8 millimetres of rain in November).

The weather and ambient temperatures for the March 2022 monitoring program was ideal being overcast, warm with slight rain. The March 2022 monitoring event was timed to fall after good rainfall and when air temperature was above 20 °Celsius. The conditions were chosen to increase the likelihood of PTWL detection.

The project usually involves monitoring at seven locations: Glen Idol, Ugothery North, Ugothery East Lower, Ugothery East Upper, Ugothery Dowds Hill, Grandale and Ugothery Dam Site (Figure 1-1). Due to heavy rain on 29 March 2022 the Grandale, Ugothery Dam site were not accessible. The rain also reduced ambient air temperature to below 20 °Celsius. This reduced the change of PTWL detection because they would most likely be resting in sheltered parts of the ant burrow.

Figure 1 shows the location of previous PTWL sightings and the monitoring locations surveyed

Figure 1-1: PTWL monitoring and detection locations

Legend

·   Locations surveyed

●   Locations not surveyed

●   PTWL Sighting 2022

●   PTWL Sighting 2019
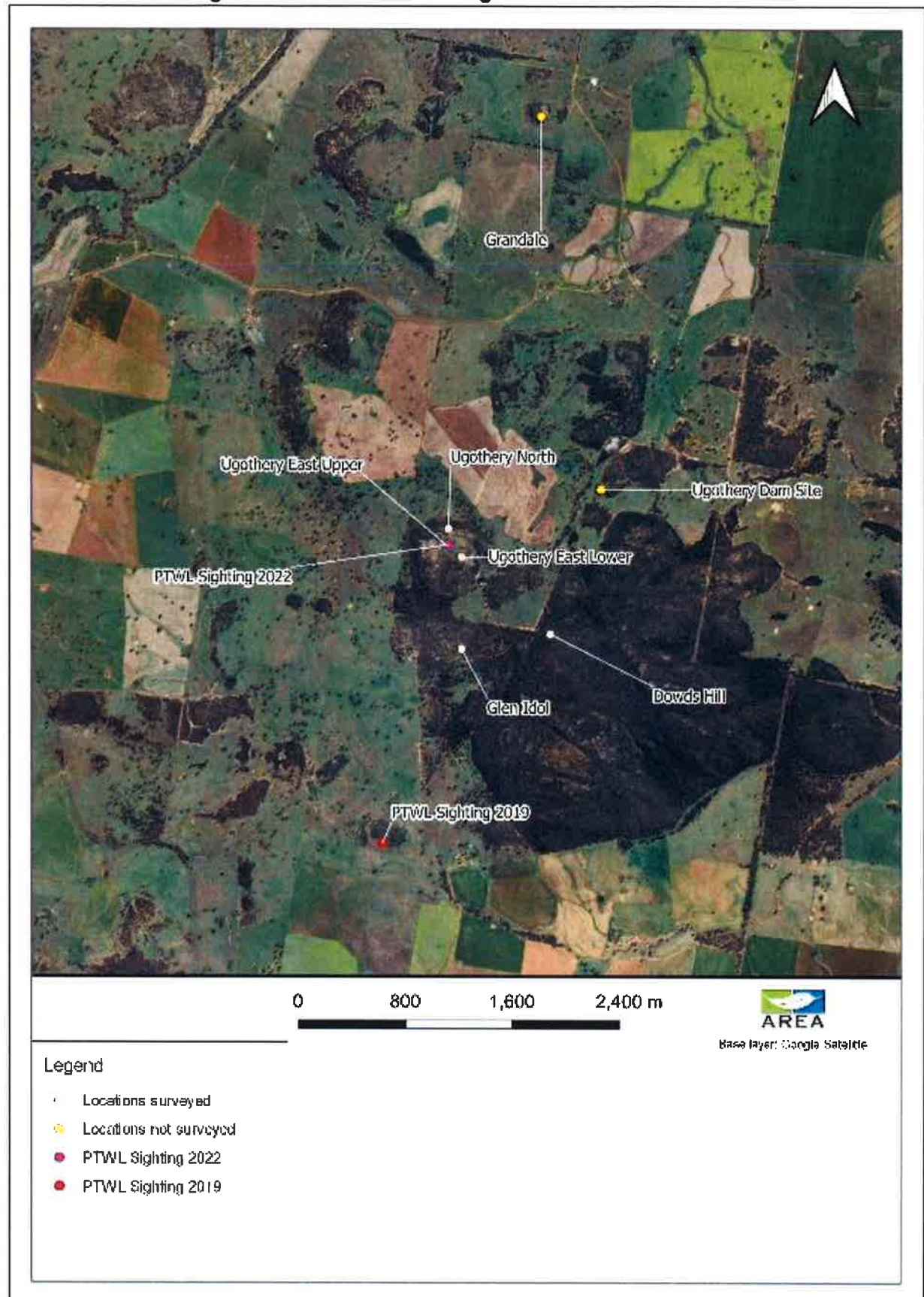
2 PTWL monitoring

2.1 Background

They PTWL monitoring program measures habitat values of artificial habitat (roof tile) for the species. The program aims to determine what key habitat features are present, how often the species uses the artificial habitat (roof tile) and if the method is suitable for monitoring PTWL populations. The overall research question is 'Are artificial tiles suitable to use as a land bridge to connect otherwise isolated populations of PTWL or to increase their area of occupancy within suitable habitat?'

Monitoring of PTWL is challenging due to its cryptic nature as it resides in ant burrows. The PTWL can be found throughout the year by searching under rocks, however, it appears to be more difficult to detect during hot dry periods (Osborne et al. 1991). If conditions are too hot or too cold the PTWL is likely to below the ground surface taking refuge in ant burrows beneath rocks. Temperatures between 20 °Celsius and 35 °Celsius are considered to increase the likelihood of detection for the species (P. Cameron pers comm 2017.).

While the ecology of the species is data deficient (poorly understood), peak activity is likely to be in late spring and early summer under warm, but not overly dry, conditions. During these months the lizards move to the upper edges of ant burrows, allowing them to regulate their body temperature by basking against the warm underside of rocks (Osborne et al. 1991, Jones 1999). It is not active on the ground surface by day and would only be active between sheltering sites at night.

Weather conditions, and the natural boom/bust population dynamics of the species plays a role in detection of the PTWL. The species is expected to boom after inundating rains and to bust when dryer, hotter seasons occur (Swan pers comm 2020). Dry and hot conditions are attributed to low detection rates. Strong winds, rain or overcast skies may also attribute to low detection rates (DSEWPC, 2011). Time of day also has an effect; diurnal surveys are best conducted between 10 am to 4 pm (DSEWPC, 2011).

Furthermore, the noted window of opportunity for species detection is also limited to seasonal overlap periods of March and October / November. Given the constraints on detection posed by these factors, a true reflection of population density and distribution will be provided when monitoring occurs when favourable climatic conditions (preceding inundating rains and mild temperatures) overlap with the known periods of detection. The timing, frequency and number of locations surveyed needs to flexible to ensure appropriate weather conditions exist.

Cameron (pers comm 2022) states all of the above is mostly true but adds in Toongi, the species has also been recorded early morning in late summer during a severe drought indicating the minutia of soil and rock temperature suitability irrespective of season may play more of a likelihood of detectability factor than previously considered.

2.2 Methods

The monitoring program was conducted on 29 March 2022 between 10 am and 2 pm with ideal weather on an overcast day at inception with slight rainfall throughput monitoring. Monitoring ceased with heavier rain and lower ambient soil and air temperatures. The survey method follows the accepted Clearing Procedure: Pink-tailed Worm Lizard issued by OzArk (2013). This involves 'flipping' either natural rocks or artificial habitat (roof tiles) to ascertain what lies beneath.

The March 2022 survey involved flipping natural rocks and artificial habitat (roof tiles) in the same area at the same time by subject matter specialists. Natural rocks were flipped to compare the effectiveness of the artificial habitat when compared to that under a natural suitable rock nearby. An estimated 500 to 700 suitable natural rocks were flipped, and five monitoring locations were surveyed. More than 300 PTWL habitat rocks were surveyed meeting the recommended Commonwealth survey effort.

The artificial tile habitats were created in 2013. The locations consist of 50 roof tiles in 10 separate sets. A set consists of a group of four tiles and a single tile to determine if group of tiles has more likelihood to provide habitat for a PTWL than a single tile. The configuration of the set is shown in Plate 2-1. The monitoring locations shown on Figure 1-1 were at:

- Dowds Hill
- Ugothery North
- Ugothery East Upper
- Ugothery East Lower
- Glen Idol.

Data collected for each set consisted of:

- Date and time of assessment
- Ambient air measured with a handheld kestrel weather station
- Soil temperature measured with a handheld laser device
- Number of ant species and burrows present
- Other insects (type/abundance)
- Other reptiles (species / abundance)
- General comments
- Photos were also taken where appropriate.

Plate 2-1: Tile set configuration

3 Weather

3.1 Preceding weather conditions

The nearest weather monitoring station recorded on the Bureau of Meteorology (BoM) website is at Dubbo Regional Airport which lies about 25 kilometres north of DP location (Toongi).

Average annual rainfall for Dubbo is 569.6 millimetres (Bureau of Meteorology, 2022). The year prior to the survey Dubbo recorded 924.4 millimetres, the highest annual rainfall on record. The high amount of rainfall did not lead to waterlogged burrows. Waterlogged burrows were previously observed in April 2017 where the 2016 rainfall was 916.4 millimetres.

This monitoring event was undertaken following 4.4 millimetres of rainfall falling the previous day. February rainfall was just below average with 41 millimetres and January was well above average with 130 millimetres. Figure 3-1 depicts the total amount of rainfall for the months preceding the monitoring event and compares them to the monthly average.

Figure 3-1: Dubbo Regional Airport rainfall averages and 2021/22 rainfall totals (BoM)
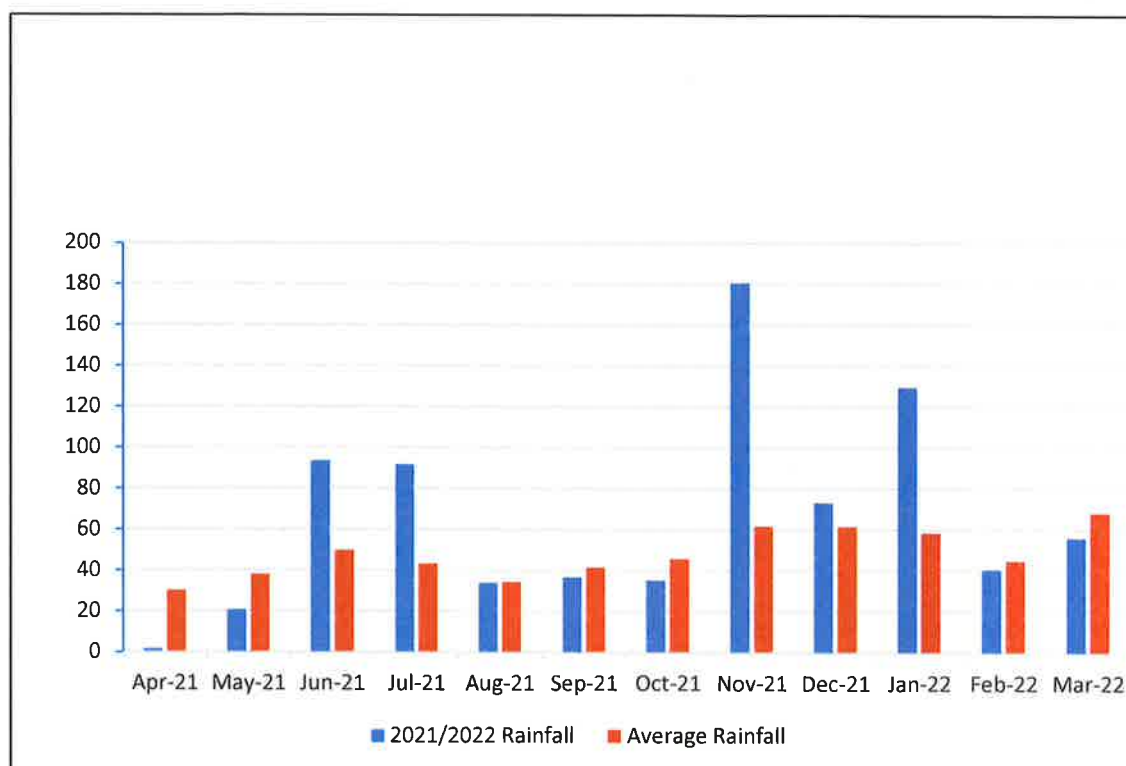
By comparison, the last 'boom' event recorded by monitoring in 2012 and 2013, where 30 PTWLs (in total) were recorded under naturally occurring rock. Followed years of higher-than-average rainfall (577.2 millimetres in 2011 and 608.6 millimetres in 2012). In 2021 rainfall well exceeded the totals for 2011 and 2012.

Table 3-1 shows Dubbo Airport weather station rainfall statistics from the BoM website. The recent post severe drought inundating rains increased the likelihood of PTWL detection (P. Cameron pers comms.).

Table 3-1: Dubbo Regional Airport weather rainfall statistics (BoM)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1994						4.0	51.0	15.0	8.8	20.0	46.8	20.2	
1995	191.0	7.0		0.6	102.2	13.0	31.2	0.4	52.0	24.4	94.8	58.0	
1996	97.2	30.2	20.6	0.2	74.2								
1997						17.2	23.2	13.8	78.2	30.8	11.4	37.2	
1998	48.0	31.0	10.0	84.4	75.4	82.4	138.0	151.6	111.6	46.4	66.6	5.6	**851.0**
1999	7.4	9.0	142.2	38.6	8.6	36.6	45.0	75.6	40.2	109.2	68.8	77.2	**658.4**
2000	35.0	25.6	173.8	105.8	86.8	18.4	28.4	29.4	11.6	77.4	181.8	35.0	**809.0**
2001	60.2	14.6	77.8	44.8	43.4	59.4	92.0	19.6	31.0	69.0	74.4	25.0	**611.2**
2002	13.2	218.2	27.0	17.4	17.2	14.6	4.0	2.8	42.8	3.0	0.0	21.6	**381.8**
2003	41.2	77.4	18.8	60.0	4.2	52.2	37.0	115.4	8.6	67.0	35.8	26.2	**543.8**
2004	23.6	45.6	13.2	22.0	46.8	44.4	38.2	30.4	10.2	50.6	79.4	65.0	**469.4**
2005	36.0	25.6	15.0	9.6	5.0	91.0	29.4	18.8	81.8	112.0	92.6	15.2	**532.0**
2006	37.4	29.0	24.0	10.8	0.6	35.0	39.2	14.4	9.2	1.2	10.6	17.2	**228.6**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2007	11.6	24.6	48.2	26.6	61.6	122.0	11.2	20.2	0.6	2.6	67.4	169.4	**566.0**
2008	153.2	43.2	27.4	1.4	7.2	32.0	31.0	33.6	63.8	58.6	110.0	49.2	**610.6**
2009	3.8	59.0	16.2	57.2	10.0	67.4	25.0	10.0	35.2	54.0	12.8	188.8	**539.4**
2010	25.6		69.6	62.2	54.6	34.2	64.4	58.4	51.8	54.0	144.0	167.6	
2011	8.6	37.8	49.4	28.4	60.0	11.2	8.4	59.8	81.8	55.4	101.6	74.8	**577.2**
2012	98.0	118.0	125.0	1.6	85.4	41.6	44.6	9.8	31.6	9.4	38.2	5.4	**608.6**
2013	63.4	27.8	80.8	0.4	27.0	126.0	23.2	5.4	83.2	5.2	3.0	47.6	**493.0**
2014	49.8	50.8	142.4	57.8	26.8	57.6	55.6	15.4	15.6	11.6	11.2	77.0	**571.6**
2015	130.6	31.8	8.4	81.8	47.8	72.2	60.2	39.4	6.8	46.4	66.6	59.6	**651.6**
2016	122.8	3.2	16.2	25.0	55.4	151.6	105.2	50.4	157.8	56.2	34.0	138.6	**916.4**
2017	14.8	1.6	223.0	9.4	5.2	9.2	3.0	20.6	5.0	84.6	34.8	54.2	**465.4**
2018	28.6	2.4	4.0	6.8	13.0	18.6	1.6	36.4	6.8	90.4	68.6	34.4	**311.6**
2019	64.4	18.4	46.8	0.0	23.4	10.4	6.4	6.8	11.0	1.6	19.4	2.6	**211.2**
2020	36.0	81.8	145.0		28.8	32.6	82.2	39.0	47.6	60.6	12.6	120.6	
2021	54.0	114.4	187.2	1.8	21.0	93.8	91.8	34.0	36.8	35.4	180.8	73.4	**924.4**
2022	*130.0*	*41.0*	*56.4*										

All days prior to monitoring exceeded 20 °Celsius and were below 35 °Celsius. Maximum temperatures were relatively stable through March 2022. Temperatures began to decrease four days prior to the 29 March 2022 monitoring event.
Figure 3-2 depicts the minimum and maximum temperatures for March 2022.

Figure 3-2: Dubbo Regional Airport maximum and minimum temperatures for March 2022
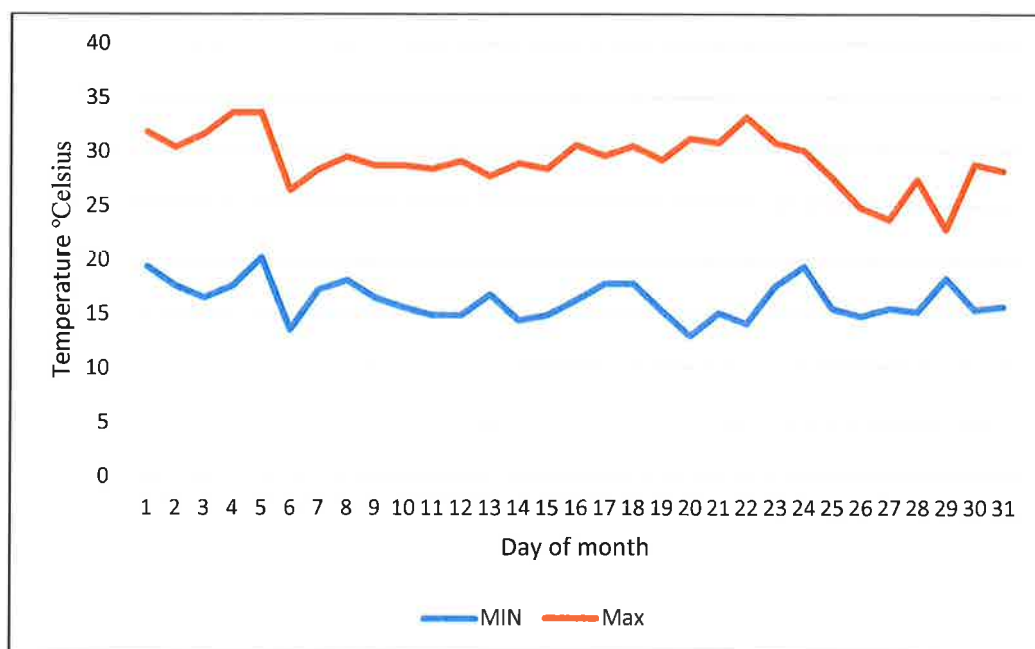
3.2 Weather conditions on day of monitoring

Weather on 29 March 2022 was ideal, overcast, warm with slight rain. One millimetre of rain was recorded at Dubbo Airport which lies about 25 kilometres north of DP location during the day of the survey (Toongi) (BoM, 2022). Heavier rain was experienced at the survey site with an estimated five millimetres falling.

The average ambient air temperature on site was 19.3 °Celsius, just below the ideal 20 °Celsius. The survey began when temperatures were above 20 °Celsius. The highest air temperature recorded in the field was 23 °Celsius, experienced at 1120 am. The lowest temperature recorded was 14.9 ° Celsius at 1214pm. Temperatures began to drop once rain started to fall decreasing the likelihood of PTWL detection.

The highest temperature recorded at Dubbo Airport was 22.8 °Celsius. The temperature was below the maximum average of 32.6 °Celsius. Maximum monthly averages for the previous months preceding the monitoring were also below the average (Figure 3-3)

Air temperature was recorded at each tile set and is compared with soil temperature under each tile set in Section 4.

Figure 3-3: Dubbo Regional Airport 2021/2022 maximum averages & monthly maximum temperature averages.
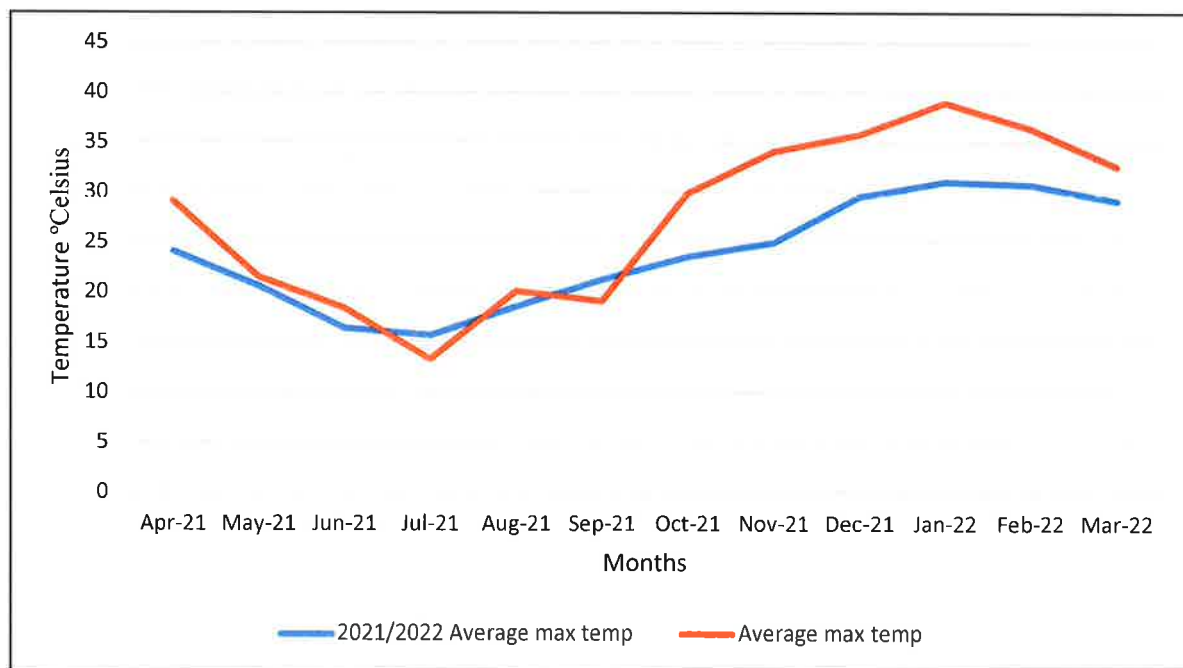
4 Soil parameters

4.1 Soil type and geology

No further data was collected in this area. Soil type and underlying geology have previously been determined. Soil and geology data may be refined through investigation during future monitoring events to further ascertain more information in the link between these factors and PTWL habitat selection.

4.2 Soil temperature

Air temperature was recorded at each tile set as well as soil surface temperature under each set of tiles.

The soil temperature ranged from 17.9° Celsius to 25.5° Celsius (Figure 4-1). The lowest temperature occurred when ambient air temperature was 14.9° Celsius at 1241 pm. The maximum soil temperature occurred when ambient air was 22.5° Celsius at 1030 am.

March 2022 monitoring saw a reduction in variation between soil and air temperature (Figure 4-1). The April 2020 monitoring program consisted of many soil temperatures lower than the ambient air temperature (Figure 4-2). Most locations for the March 2022 had soil temperature higher than the ambient air. Soil temperature was mostly in the ideal range for the PTWL with an average of 21.5° Celsius.

The location of where the PTWL was found had a soil temperature of 21° Celsius when the ambient temperate was below that (about 15° Celsius).

Figure 4-1: Air and soil temperature recorded at each tile location March 2022
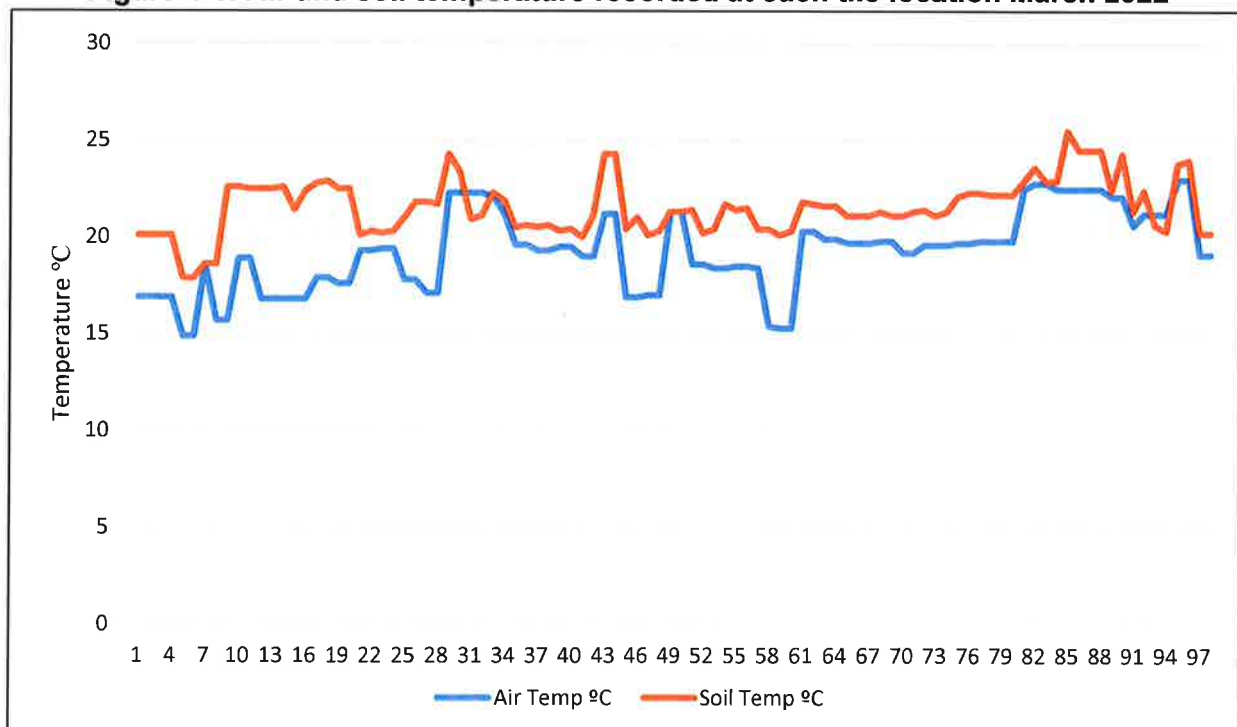
Figure 4-2: Air and soil temperature recorded at each tile location 2020
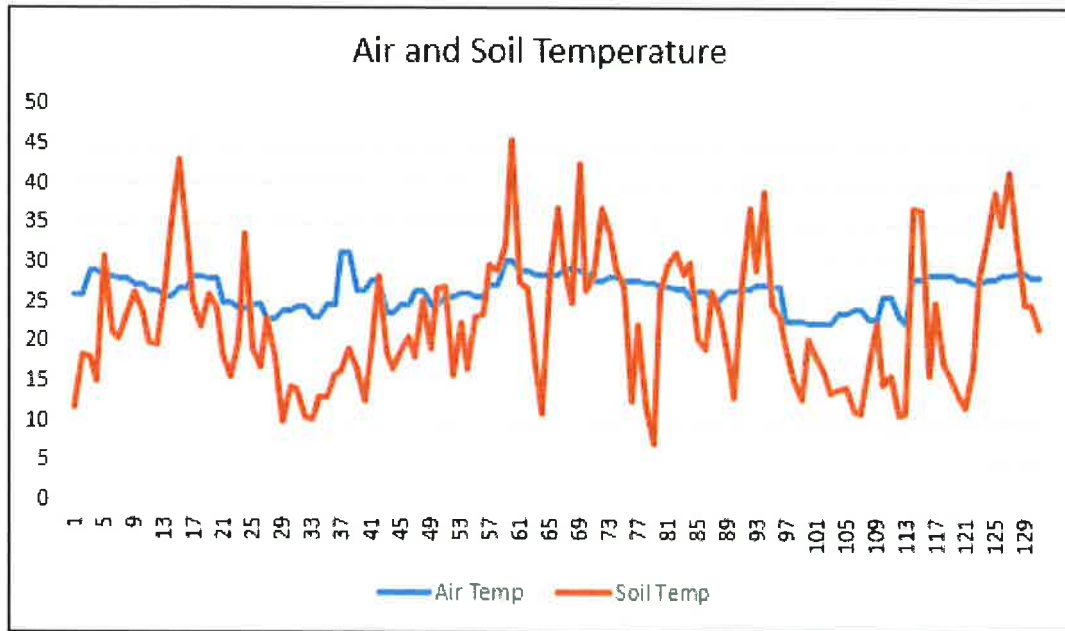
4.3 Moisture

Moisture was assessed by visual inspection only. One configuration of four tiles was considered moist, the others were all dry.

The week before the monitoring event saw a total of 5.5 millimetres of rain with 4.4 millimetres falling the day preceding the monitoring. The weather was overcast with slight rain. The month of March and February saw below average falls.

4.4 Sun exposure

The amount of sun on the tile/tile group at the time of checking was not recorded. Monitoring took place between 10am to 2pm when the ambient temperature was between 14.9 °Celsius and 23 °Celsius. The overcast day inhibited full sun exposure.

5   Flora

Flora was not surveyed during the March 2022 monitoring program.

In 2020 flora diversity and overall habitat improved due to livestock removal and fencing of the biodiversity offset area. Natural regeneration was exceptional across grasslands, although a number of trees have died since 2016 in woodlands due to severe drought conditions until late Summer 2020.

The following photos taken by P. Cameron and M. Sutherland in April 2020 illustrate drought impacts and regeneration.

Plate 5-1: Regenerating Eucalypt on northern offset area Photo taken 1 April 2020

Plate 5-2: *Swainson monicola* plants were prolific across the northern offset area 1 April 2020.

Plate 5-3: Extensive dieback of *Callitris* and *Allocasuarina sp.* 1 April 2020.

6 Fauna

6.1 Ants

Ants were assessed by number of burrows and species. Individual ant or species identification did not occur.

Ant burrow density was grouped into three categories. Low = less than five burrows, med = five to eight burrows, high = greater than eight burrows. **Error! Reference source not found.** depicts the relationship between ant burrow density and number of ant species.

Figure 6-1: Ant burrow density in relation to number of species
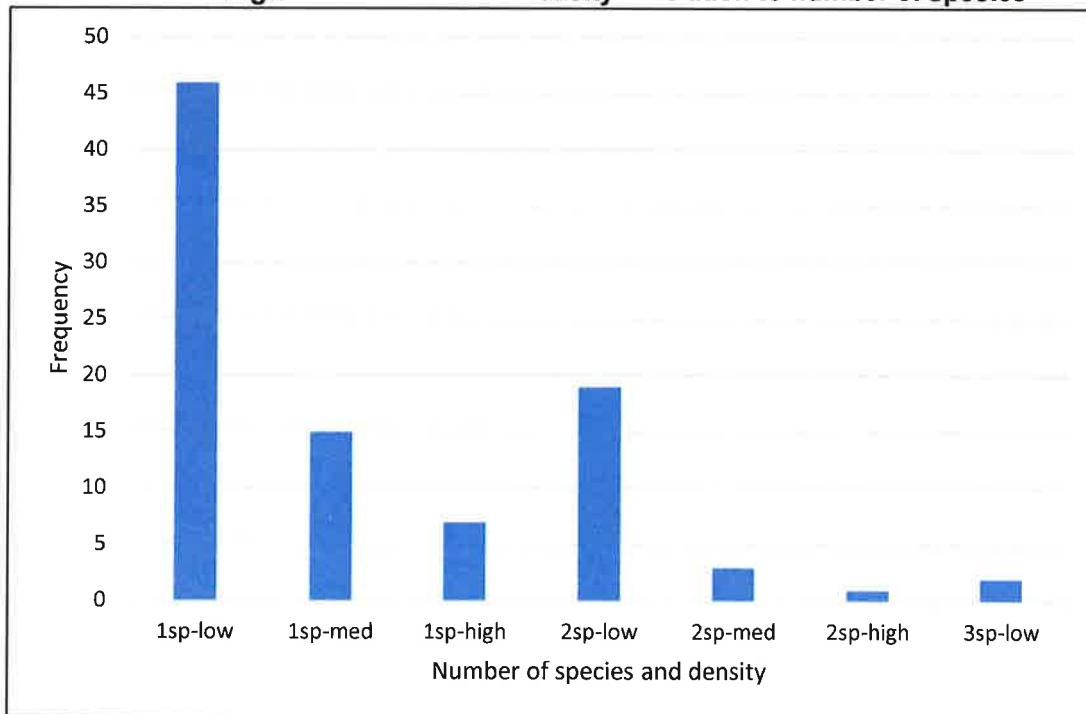
Ants were present under 92 per cent of tiles. Four sets of tiles were disturbed by pigs and two were solely occupied by termites' underneath. Ant nests/ burrows were present under all tiles with ants.

This is an increase from 2020 where 54 per cent of tiles were found with ants and 22 percent with burrows. Ant populations have been increasing since the cessation of drought.

During periods of low rainfall ant numbers were low. Ants were found under 34 per cent in 2018 (2018 annual rainfall was 311.6 millimeters).

Previous years with above average rainfall have seen large increases in populations. In 2016 ants were present under 90 per cent of tiles and 94 per cent in 2014.

The large presence of ants under tiles is an indication of food being readily available for the PTWL. Plate 6-1: Ant burrows and eggs underneath artificial habitatPlate 6-1 displays ant burrows and eggs under a surveyed tile.

Ants were not present under the natural habitat where the PTWL was found.

Plate 6-1: Ant burrows and eggs underneath artificial habitat

6.2 Other invertebrates

Other invertebrates were recorded under 55 percent of the tiles an increase from 36 per cent in 2020. Majority of the time they occurred in conjunction with ants. Spiders were the most common other invertebrate recorded. Termites, beetles, centipedes, weevils, cockroaches, millipedes, and crickets were also present. No invertebrates were found under tiles disturbed by pigs.

Centipedes, millipedes and spiders were also observed in the broader area.

6.3 Reptiles and other vertebrates

Other reptiles were found under seven per cent of tile sets. A decrease from nine per cent in 2020 and 18 per cent in 2018. Pig disturbance could have attributed to the low reptile count as pigs disturbed 12 sets of tiles (Plate 6-2).

Ctenotus robustus or striped skink was the only reptile found multiple times under five tile sets. Other species were recorded were:

- *Pseudonaja textilis* or Eastern Brown Snake
- *Litoria caerula* or Green Tree Frog
- *Litoria rubella* or Desert Tree Frog
- *Litoria latopalmata* or Broad-palmed Frog.

There were no clear indications of reptiles preferring a certain soil temperature or if they prefer single or grouped tiles.

Several species were sighted in the broader area under natural rock habitat. These included:

- *Lerista timida* or Wood-mulch Slider was sighted four times
- *Ctenotus robustus* or striped skink was sighted once
- *Pseudonaja textilis* or Eastern Brown Snake was sighted once.

Plate 6-2: Tiles disturbed by pigs

Plate 6-3: Eastern Brown Snake

Plate 6-4:Striped skink

Plate 6-5: Green tree frog

Plate 6-6: Desert tree frog

7 Pink-tail Worm-lizard sighting

No PTWL, or signs thereof, were found at the tile monitoring locations.

One PTWL was sighted on 29 March 2022 under a naturally occurring rock GDA2020/ MGA Zone 55 652825E 6407665N (Figure 1-1) where soil temperature was 21 °Celsius. Its recorded location was within five metres from a set of tiles being assessed at the same time. No insects or ants were present under the natural rock habitat.

8 Issues and suggestions for future monitoring efforts

8.1 Climate considerations

The DP PTWL Management Plan (Ozark 2016) states the following:

'The PTWL appears to mimic the same 'boom and bust' detection rates as seen in many western area species of fauna (P. Cameron, pers. comm.). This observation was supported by Gerry Swan (reptile expert) who also has experience with the species (pers. comm.). In favorable seasons, i.e. not long after inundating repetitive rains, 'many' (in context with the population) PTWL will be recorded with the recommended survey effort (P. Cameron pers. comm). This may be followed by subsequent hotter and dryer seasons when few or no PTWL recorded. Evidence available suggests this pattern follows a ten-year cycle related to approximately 10-year interval high rainfall events (P. Cameron and Gerry Swan pers. comm)'.

The last 'boom' was recorded when targeted surveys were undertaken in 2012 and 2013 by Biosphere Environmental Consultants Pty Ltd (Biosphere) and 30 PTWLs (in total) were found in sites within a five kilometre radius of the DP impact footprint. All records were associated with natural rock.

Since then, the area has been through a severe hot and dry 'bust' cycle and few PTWL have been detected. The large rainfall event of 2016 could have inhibited a boom from occurring due to burrow inundation. Since 2020 larger than average annual rainfalls have been occurring. The highest annual rainfall total was recorded in 2021. A similar annual rainfall total was observed in 2016 where burrow inundation occurred. The 2022 March survey did not detect inundated burrows.

The repetitive nature of the current inundating rains may facility a boom for the PTWL population. The climate has allowed for native grasses and food (ants) to become abundant. This fits in well with the hypothesised 10-year cycle as the last boom occurred in 2012-2013.

March 2022 monitoring conditions were ideal with soil temperatures in the suitable range PTWL. Conditions did deteriorate in the afternoon reducing temperatures to a level unsuitable for PTWL monitoring. Preventing two of the survey points from being reached (Grandale and Ugothery Dam). A full dataset was not formed but the recommended survey effort for PTWL was reached. Temperature was also lower than the average for March on the chosen survey day.

8.2 Artificial habitat considerations

Previous research suggests preferences for artificial reptile habitat may vary among species and between different designs. Reptiles appear to be highly selective when choosing retreat sites, evaluating multiple aspects of their habitat and making relatively subtle choices among available retreat sites based on their structural and thermal features, the presence of conspecifics and/or competitors, and the perceived risk of predation (Thierry *et al.* 2019).

The March 2022 survey saw a reduction in temperature variation under the artificial tiles. Previous surveys have had large variations indicating tiles may only provide short windows of habitat suitability for PTWL – they heat quicker and cool quicker than natural rock. This year

temperatures were not as high as previous years possibly leading to less variation in soil temperatures.

Since establishment of the roof tiles in 2013, two PTWL's have been recorded under an artificial habitat tile at DP. This may indicate tiles as a habitat option have very short windows of suitability, although it may also be the cryptic nature of the species.

Common sense suggests PTWL are always going to prefer natural habitat over artificial habitat where available, and there may be no suitable substitute to natural rock. As per the PTWL Plan of Management, prior to construction DP impact footprint, loose surface rocks suitable for PTWL habitat will be collected and moved to offset areas. In the meantime, the focus of management is on passive translocation though habitat quality improvement.

8.3 Native vegetation habitat

The DP PTWL Management Plan (Ozark 2016) states the following:

'The overarching performance target is to increase the area of occupancy for PTWL by restoring native vegetation, connecting adjoining populations though rehabilitated corridors) and providing natural or artificial rock/tile habitat.

The quality of PTWL habitat in DP was assessed on the EPBC Offset Calculator as:
* *30ha of low condition habitat (quality score = 4/10).*
* *113.6ha of moderate condition habitat (quality score = 7/10).*
* *80.9ha of good condition habitat (quality score = 9/10).*

In practical terms the goal will be to achieve a quality score of 8 or higher in all PTWL HA's within 5 years'.

Since conception of the PTWL Management Plan in 2016, the region has been through three significant events impacting the quality of habitat within DP:

1. Exclusion of grazing and fencing of the biodiversity offset area (positive)

2. An extreme drought (negative).

3. Reprieve from drought because of well above average rainfalls (positive)

Habitat re-assessment would be extremely valuable to how consider how habitat quality is trending in relation to these two significant events.

9 Conclusions

The targeted survey for the PTWL occurred during mostly ideal conditions in terms of temperature, season and proceeding rainfall. The survey was ceased before all survey points were reached due to rain leading to an incomplete data set.

No PTWL and few reptiles were observed using the artificial habitat. One PTWL was found in a natural habitat. The sighting confirms PTWL are still present in the area. The sighting also highlights that air temperatures below 20°Celsius are suitable for monitoring.as long as ground temperatures are above 21 °Celsius.

Artificial habitat as a place of refuge only provides short windows of suitability for PTWL as only two have been observed under a tile since the survey program began in 2013. The sighting of a PTWL under natural habitat also adds evidence to them preferring natural habitat. The artificial habitat did provide the advantage of maintaining soil temperature suitable for PTWL. This maintained soil temperature beneath the tiles may have occurred due to the below average air temperature occurring at the time of survey.

Ant populations and climate data are also positive signs for a population boom to occur. Ant populations are getting close to similar levels when the last boom occurred. Consistent inundating rains have also been occurring, increasing native grass levels. Grass levels have also increased due to livestock being excluded from the biodiversity offset area.

Many factors are combining to favour the PTWL. If a population is to boom it adds further evidence to the boom-and-bust cycle of PTWL being related to approximately 10-year interval high rainfall events.

Continued targeted surveys for this species is recommended. Given the recent climatic conditions leading to well above rainfall. The future surveys will also lead to an insight on how rainfalls well above affect PTWL population. The surveys will also give insight to other reptile populations in the area.

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Appendix A – Field Data

Table 0-1:

Area	Tile No	GDAz55 Easting	GDAz55 Northing	Time	Air Temp	Soil Temp	Soil Moisture	Ant Nests / Burrows Present?	Ants present?	Other insects (Type / abundance)	Other reptiles (Species / abundance)	Comment
Ugothery North	1	652845	6407800	1245	16.9	20.1		Y	Y	Y		
Ugothery North	1ABCD			1243	16.9	20.1		Y	Y	Y		
Ugothery North	2	652837	6407796	1244	16.9	20.1		Y	Y	Y	Ctenotus Ctenotus robusta	
Ugothery North	2ABCD			1244	16.9	20.1		Y	Y	Y		
Ugothery North	3	652829	6407792	1241	14.9	17.9		Y	Y			
Ugothery North	3ABCD			1241	14.9	17.9		Y	Y			
Ugothery North	4	652816	6407792	1240	18.6	18.6		Y	Y			
Ugothery North	4ABCD			1240	15.7	18.6		Y	Y			
Ugothery North	5	652809	6407780	1246	15.7	22.6		Y	Y	Y		
Ugothery North	5ABCD			1246	18.9	22.6		Y	Y	Y		
Ugothery North	6	652823	6407772	1246	18.9	22.5		Y	Y	Y		
Ugothery North	6ABCD			1246	16.8	22.5		Y	Y	Y		
Ugothery North	7	652830	6407773	1246	16.8	22.5		Y	Y	Y		
Ugothery North	7ABCD			1246	16.8	22.6		Y	Y	Y		
Ugothery North	8	652845	6407770	1246	16.8	21.4		Y	Y	Y		
Ugothery North	8ABCD			1246	16.8	22.4		Y	Y	Y		
Ugothery North	9	652845	6407778	1250	17.9	22.8		Y	Y	Y		
Ugothery North	9ABCD			1250	17.9	22.9		Y	Y	Y		
Ugothery North	10	652833	6407776	1248	17.6	22.5		Y	Y	Y		
Ugothery North	10ABCD			1248	17.6	22.5		Y	Y	Y		
Ugothery East Lower	1	652929	6407563	1137	19.3	20.1		Y	Y	Y		
Ugothery East Lower	1ABCD			1158	19.3	20.3		Y	Y	Y	Litoria latopalmata	
Ugothery East Lower	2	652912	6407571	1200	19.4	20.2		Y	Y	Y		
Ugothery East Lower	2ABCD			1200	19.4	20.3		Y	Y	Y		
Ugothery East Lower	3	652905	6407583	1204	17.8	21		Y	Y	Y		
Ugothery East Lower	3ABCD			1205	17.8	21.8		Y	Y	Y		
Ugothery East Lower	4	652915	6407589	1207	17.1	21.8		Y	Y	Y	Litoria rubella	

Area	Tile No	GDAz55 Easting	GDAz55 Northing	Time	Air Temp	Soil Temp	Soil Moisture	Ant Nests / Burrows Present?	Ants present?	Other insects (Type / abundance)	Other reptiles (Species / abundance)	Comment
Ugothery East Lower	4ABCD			1210	17.1	21.7		Y	Y	Y		
Ugothery East Lower	5	652929	6407583	1140	22.3	24.3		Y	Y			
Ugothery East Lower	5ABCD			1140	22.3	23.4		Y	Y	Y		
Ugothery East Lower	6	652928	6407574	1145	22.3	20.9		Y	Y	Y		
Ugothery East Lower	6ABCD			1145	22.3	21.1		Y	Y	Y		
Ugothery East Lower	7	652935	6407562	1148	22.1	22.3		Y	Y	Y		
Ugothery East Lower	7ABCD			1148	21.2	21.9		Y	Y	Y		
Ugothery East Lower	8	652946	6407541	1150	19.6	20.5		Y	Y	Y		
Ugothery East Lower	8ABCD			1153	19.6	20.6		Y	Y	Y		
Ugothery East Lower	9	652947	6407575	1154	19.3	20.5		Y	Y	Y		
Ugothery East Lower	9ABCD			133	19.3	20.6		Y	Y	Y		
Ugothery East Lower	10	652943	6407585	1200	19.5	20.3		Y	Y	Y		
Ugothery East Lower	10ABCD			1210	19.5	20.4		Y	Y	Y		
Ugothery East Upper	1	652836	6407637	1232	19	20		Y	Y	Y		
Ugothery East Upper	1ABCD			1232	19	21.1		Y	Y	Y		
Ugothery East Upper	2	652841	6407649	1225	21.2	24.3		Y	Y			
Ugothery East Upper	2ABCD			1225	21.2	24.3		Y	Y			
Ugothery East Upper	3	652835	6407657	1220	16.9	20.4		Y	Y			
Ugothery East Upper	3ABCD			122	16.9	21		Y	Y			

Area	Tile No	GDAz55 Easting	GDAz55 Northing	Time	Air Temp	Soil Temp	Soil Moisture	Ant Nests / Burrows Present?	Ants present?	Other insects (Type / abundance)	Other reptiles (Species / abundance)	Comment
Ugothery East Upper	4	652846	6407659	1223	17	20.1		Y	Y			
Ugothery East Upper	4ABCD			1223	17	20.3		Y	Y			
Ugothery East Upper	5	652841	6407664	1227	21.3	21.3		Y	Y	Y		
Ugothery East Upper	5ABCD			1227	21.3	21.3		Y	Y	Y		
Ugothery East Upper	6	652818	6407649	1214	18.6	21.4		Y	Y	Y		
Ugothery East Upper	6ABCD			1214	18.6	20.2		Y	Y	Y		
Ugothery East Upper	7	652811	6407639	1218	18.4	20.4		Y	Y	Y		
Ugothery East Upper	7ABCD			1218	18.4	21.7		Y	Y	Y		
Ugothery East Upper	8	652811	6407663	1229	18.5	21.4		Y	Y	Y		
Ugothery East Upper	8ABCD			1230	18.5	21.5		Y	Y	Y		
Ugothery East Upper	9	652819	6407665	1210	18.4	20.4						Pig disturbance
Ugothery East Upper	9ABCD			1210	15.4	20.4						Pig disturbance
Ugothery East Upper	10	652803	6407676	1207	15.3	20.1						Pig disturbance
Ugothery East Upper	10ABCD			1207	15.3	20.3						Pig disturbance
Grandale	1	653547	6410880									
Grandale	1ABCD											
Grandale	2	653541	6410870									
Grandale	2ABCD											
Grandale	3	653549	6410852									
Grandale	3ABCD											
Grandale	4	653541	6410831									
Grandale	4ABCD											
Grandale	5	653537	6410851									

AREA

Area	Tile No	GDAz55 Easting	GDAz55 Northing	Time	Air Temp.	Soil Temp.	Soil Moisture	Ant Nests / Burrows Present?	Ants present?	Other insects (Type / abundance)	Other reptiles (Species / abundance)	Comment
Grandale	5ABCD											
Grandale	6	653525	6410856									
Grandale	6ABCD											
Grandale	7	653518	6410846									
Grandale	7ABCD											
Grandale	8	653507	6410862									
Grandale	8ABCD											
Grandale	9	653499	6410870									
Grandale	9ABCD											
Grandale	10	653504	6410848									
Grandale	10ABCD											
Ugothery Dowds Hill	1	653525	6406962	1320	20.3	21.8		Y	Y	Y		
Ugothery Dowds Hill	1ABCD			1320	20.3	21.7		Y	Y	Y		
Ugothery Dowds Hill	2	653544	6406972	1322	19.9	21.6		Y	Y	Y		Pig disturbance
Ugothery Dowds Hill	2ABCD			1322	19.9	21.6		Y	Y	Y		Pig disturbance
Ugothery Dowds Hill	3	653561	6406985	1325	19.7	21.1		Y	Y	Y		
Ugothery Dowds Hill	3ABCD			1325	19.7	21.1		Y	Y	Y		
Ugothery Dowds Hill	4	653575	6406991	1326	19.7	21.1		Y	Y	Y		Pig disturbance
Ugothery Dowds Hill	4ABCD			1327	19.8	21.3		Y	Y	Y		Pig disturbance
Ugothery Dowds Hill	5	653589	6406998	1329	19.8	21.1		Y	Y	Y		
Ugothery Dowds Hill	5ABCD			1329	19.2	21.1		Y	Y	Y		
Ugothery Dowds Hill	6	653603	6407004	1331	19.2	21.3				Y		
Ugothery Dowds Hill	6ABCD			1331	19.6	21.4				Y		
Ugothery Dowds Hill	7	653618	6407007	1333	19.6	21.1		Y	Y	-		
Ugothery Dowds Hill	7ABCD			1333	19.6	21.3		Y	Y	Y		
Ugothery Dowds Hill	8	653633	6407009	1335	19.7	22.1				Y		

AREA

Area	Tile No	GDAz55 Easting	GDAz55 Northing	Time	Air Temp	Soil Temp	Soil Moisture	Ant Nests / Burrows Present?	Ants present?	Other insects (Type / abundance)	Other reptiles (Species / abundance)	Comment
Ugothery Dowds Hill	8ABCD			1335	19.7	22.3		Y	Y	Y	*Ctenotus robusta*	
	9	653646	6407011	1337	19.8	22.3		Y	Y	Y	*Ctenotus robusta*	
	9ABCD			1337	19.8	22.2		Y	Y	Y		Pig disturbance
Ugothery Dowds Hill	10	653660	6407011	1339	19.8	22.2		Y	Y			Pig disturbance
	10ABCD			1339	19.8	22.2		Y	Y			Pig disturbance
Glen Idol	1	652877	6406944	1023	22.5	22.9		Y	Y	Y		Pig disturbance
Glen Idol	1ABCD			1019	22.8	23.6		Y	Y	Y	*Ctenotus robusta*	
Glen Idol	2	652903	6406954	-	22.8	22.9		Y	Y	Y		
Glen Idol	2ABCD			1025	22.5	22.9		Y	Y	Y		
Glen Idol	3	652896	6406929	1030	22.5	25.5		Y	Y			
Glen Idol	3ABCD			1030	22.5	24.5		Y	Y			
Glen Idol	4	652888	6406885	1035	22.5	24.5		Y	Y			
Glen Idol	4ABCD			1037	22.5	24.5		Y	Y	Y		pig disturbance
Glen Idol	5	652909	6406873	1041	22.1	22.4		Y	Y	Y		
Glen Idol	5ABCD			1100	22.1	24.3		Y	Y	Y		
Glen Idol	6	652923	6406847	1102	20.6	21.3	Y	Y	Y	Y	*Furina diadema*	
Glen Idol	6ABCD			1109	21.2	22.4		Y	Y	Y		
Glen Idol	7	652946	6406871	1104	21.2	20.6		Y	Y	Y		
Glen Idol	7ABCD			1105	21.2	20.3		Y	Y	Y		
Glen Idol	8	652961	6406896	1120	23	23.8		Y	Y	Y	*Litoria caenula*	
Glen Idol	8ABCD			1120	23	23.98		Y	Y	Y		
Glen Idol	9	652953	6406846	1115	19.1	20.2		Y	Y	Y		
Glen Idol	9ABCD			1116	19.1	20.2		Y	Y	Y		
Glen Idol	10	652998	6406853	Under Fallen Tree								
Glen Idol	10ABCD											
Ugothery Dam Site	1	653894	6407990									
	1ABCD											
Ugothery Dam Site	2	653931	6408018									

Area	Tile No	GDAz55 Easting	GDAz55 Northing	Time	Air Temp	Soil Temp	Soil Moisture	Ant Nests / Burrows Present?	Ants present?	Other insects (Type / abundance)	Other reptiles (Species / abundance)	Comment
	2ABCD											
Ugothery Dam Site	3	653963	6408042									
	3ABCD											
Ugothery Dam Site	4	653964	6408060									
	4ABCD											
Ugothery Dam Site	5	654014	6408118									
	5ABCD											
Ugothery Dam Site	6	653997	6408121									
	6ABCD											
Ugothery Dam Site	7	653998	6408134									
	7ABCD											
Ugothery Dam Site	8	654014	6408123									
	8ABCD											
Ugothery Dam Site	9	654030	6408142									
	9ABCD											
Ugothery Dam Site	10	654035	6408158									
	10ABCD											

AREA

APPENDIX B - Rainfall Data July 2020 - June 2021

ASM – Toongi — Rainfall FY2022

Raingauge situated TA3   -32.458875, 148.609846

Date	Jul mm	Aug mm	Sep mm	Oct mm	Nov mm	Dec mm	Jan mm	Feb mm	Mar mm	Apr mm	May mm	Jun mm	Date
1	25.8							0.6	7.4			0.4	1
2	0.4	1.4		2.0					4.2				2
3	2.6	3.0		0.2								5.0	3
4			22.6		18.8		5.8				3.2	0.6	4
5			1.0		1.4				11.6		9.4		5
6						17.2	18.2		7.8	8.8		1.4	6
7						2.8	53.0			52.0			7
8						0.2	13.6		11.2	46.6		0.2	8
9	27.8									4.4			9
10				5.6	20.0		29.6	4.2			5.4		10
11		0.4		0.2	22.6		7.4				36.8		11
12		1.4		11.2	19.0						1.2		12
13				1.8	4.0						0.2		13
14	1.6			5.6									14
15	0.2			9.4			0.2						15
16	3.8												16
17	2.4							3.0					17
18						1.0	2.4			11.4			18
19	0.4		0.2		0.6	15.8				0.6			19
20	3.0		2.4		11.2								20
21		1.2		0.8									21
22						1.8		0.4					22
23	3.0	23.8			1.4								23
24	2.2	5.4				0.6			0.2				24
25	0.8				35.6	3.4			3.2		0.6		25
26					30.2								26
27					7.2					34.2	0.8		27
28	2.4						4.8			9.0	2.8		28
29			13.0						0.4		8.0		29
30					1.8		6.8			22.4	7.6		30
31													31
Month Total	82.4	36.6	39.2	36.8	173.8	42.8	141.8	8.2	46.0	189.4	76.0	7.6	**TOTAL**
No. of days	14	7	5	9	13	8	10	4	8	9	11	5	103
Cum. total	82.4	119.0	158.2	195.0	368.8	411.6	553.4	561.6	607.6	797.0	873.0	880.6	880.6

Bold data = cumulative total
^ 0.2mm readings may be dew
^^^ Raingauge situated TA3   -32.458875, 148.609846
~~~~ Highlighted split Green > 10mm / day effective rainfall

APPENDIX C – Correspondence between Regulators and Australian Strategic Materials (Holdings) Ltd

Mike Sutherland

Dear Mike Sutherland,

ML 1724 (1992), Annual Environmental Management Report

The Resources Regulator has received the above report lodged in accordance with the annual reporting condition of your mining authorisation(s).

Please note that the annual report may be the subject of a detailed review to ensure compliance with the conditions of your mining authorisation and the provisions of the *Mining Act 1992*.

This may include an inspection of the mining operation by Inspectors from the Resources Regulator.

Regards

Compliance Coordination

Resources Regulator

516 High Street | Maitland NSW 2320

PO Box 344 HRMC NSW 2310

The Department of Regional New South Wales acknowledges that it stands on Country which always was and always will be Aboriginal land. We acknowledge the Traditional Custodians of the land and waters, and we show our respect for Elders past, present and emerging. We are committed to providing places in which Aboriginal people are included socially, culturally and economically through thoughtful and collaborative approaches to our work.

Ref:MSG0535333_eSlhoPgWbFiDNxmuPChR

Mr Michael Sutherland
Australian Strategic Materials (Holdings) Ltd
Second Floor, 21 Church Street
Dubbo New South Wales 2830

02/11/2021

Dear Mr Sutherland

**Dubbo Project (formerly known as the Dubbo Zirconia Mine) - (SSD-5251)
Annual Review 2020-2021**

Reference is made to the Annual Review for the period 1 July 2020 to 30 June 2021, submitted to the Department of Planning, Industry and Environment (the Department) on 21 September 2021 as required under Schedule 5 Condition 4 of SSD-5251, as modified (the consent).

The Department has reviewed the Annual Review and considers it to satisfy the reporting requirements of the consent [and the Department's *Annual Review Guideline* (October 2015)]. Please note that the Department's acceptance of this Annual Review is not endorsement of the compliance status of the project.

Please make publicly available a copy of the 2020/21 Annual Review on the company website.

Should you need to discuss the above, please contact Michael Wood at Michael.Wood@environment.nsw.gov.au or on 0459890661.

Yours sincerely

Katrina O'Reilly
Team Leader - Compliance
Compliance
As nominee of the Planning Secretary