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Appin No. 6 Ventilation Shaft Offset Area

Offset Site Monitoring Report 2019

Prepared for South 32 Illawarra Coal | 16 December 2019



Document control

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Executive summary

As part of the project approval (MP 10_0079) and EPBC Approval (2010/5722) for the Appin Ventilation Shaft Site No.6, South 32 Illawarra Coal is required to implement a formal monitoring program of the management actions that were approved for the associated offset site at the Mountbatten Stud property at Douglas Park, NSW. This report is the eighth annual report for the monitoring program, conducted by Niche Environment and Heritage (Niche) in November 2019.

The aim of the monitoring program is to demonstrate the success of the management actions through the collection of empirical data, mapping and photographic record for the offset site. The monitoring methodology employs fixed floristic plots to collect vegetation condition data, population estimates of the threatened plant species *Pimelea spicata* (conducted every five years), strategic photo-point monitoring and vegetation distribution mapping.

The 2019 monitoring results in relation to the floristic composition and improvement through the site, indicate that, on average, the bushland on the site is outside of benchmark attribute values for the Cumberland Plain Woodland but is showing trends towards benchmark values. An increase in exotic species may be due to the lack of bush regeneration works within 2017 and 2018, although after works during 2019 this should decrease again with time after follow up treatments.

An assessment of the change in size and distribution of the threatened plant population of *Pimelea spicata* (Spiked rice-flower) was undertaken as part of the 2016/17 monitoring program and was not repeated this year. The next scheduled census of the *Pimelea spicata* population is in 2021/22.

Recommendations in relation to the on-going management of the site include continued treatment of African Olive and African Boxthorn, seasonal spraying of Blackberry, continued treatment of exotic vines and exotic perennial grasses.

Glossary and list of abbreviations

Term or abbreviation	Definition
BAM	Biodiversity Assessment Methodology
BC Act	<i>Biodiversity Conservation Act 2016</i> (NSW)
CEEC	Critically Endangered Ecological Community
DPIE	NSW Department of Planning, Industry and Environment was NSW Department of Planning and Environment (DP&E)
EEC	Endangered Ecological Community
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth)
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i> (NSW)
FM Act	<i>Fisheries Management Act 1994</i> (NSW)
ha	Hectare/s
IBRA	Interim Biogeographic Regionalisation for Australia
LEP	Local Environmental Plan
Locality	The Work Zone and surrounds, nominally a 10 km radius from the Work Zone.
MNES	Matters of National Environmental Significance (from the Commonwealth Environment Protection and Biodiversity Conservation Act 1999).
m	Metre/s
m ²	Metres square
NPW Act	<i>National Parks and Wildlife Act 1974</i> (NSW)
OEH	Office of Environment and Heritage (formerly DECCW, DECC, DEC)
Study area	Means the Work Zone and surrounding land where surveys were conducted.
PCT	Plant Community Type
TEC	Threatened Ecological Community

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1. Introduction

1.1 Background

The Appin No. 6 Ventilation Shaft Site project approval requires South 32 Illawarra Coal to secure, manage and monitor an 8.7 hectare offset of Cumberland Plain Woodland (CPW) such that an improve or maintain outcome would be achieved for threatened biodiversity.

The offset area is known as MZ5 and is located to the north of the Appin No. 6 Ventilation Shaft site on the property known as Mountbatten Stud at Douglas Park NSW (Figure 1). An initial assessment of the proposed offset area was conducted by Niche in December 2010 to assess the suitability of the site to be used as an offset for the unavoidable impacts associated with the development site. Niche determined that the site was indeed CPW and, under management, would improve to benchmark condition over time. The initial inspection of MZ5 also resulted in the discovery of a population of the threatened plant, *Pimelea spicata*, adding significant conservation value to the offset area.

In accepting the offset proposal, the Department of Planning and Environment (DPE) and Department of Environment and Energy (DoEE) provided a number of approval conditions relating to the reservation, management and monitoring of management actions within MZ5. One of the conditions required Illawarra Coal to implement a formal monitoring program for both the management of the native vegetation on the site and the extent and health of the *Pimelea spicata* population.

Conditions 2(c) (v – vii) of the NSW project approval (MP10_0079) and condition 3(d) of the EPBC Approval (2010/5722) are the conditions that require a monitoring and performance evaluation program to be implemented (Table 1).

Table 1: Conditions of approval requiring a monitoring program

Approval	Condition of Approval
NSW approval	2(c)(v) – A program to monitor the effectiveness of these measures, and progress against the performance and completion criteria
	2(c)(vi) – A description of the potential risks to re-vegetation, and a description of the contingency measures that would be implemented to mitigate these risks
	2(c)(viii) – Details of who would be responsible for monitoring, reviewing and implementing the plan
Commonwealth approval	3(d) The plan must include key milestones, performance indicators, corrective actions and timeframes for the completion of all actions outlined in the plan for the life of the project

1.2 Purpose and objectives

The aim of the monitoring program is to demonstrate the success of the management actions through the collection of empirical data, mapping and establishment of a photographic record for the offset site. The specific objectives of this report are:

1. To describe and evaluate the re-vegetation and bush regeneration works undertaken to date against the key performance criteria as detailed in the Biodiversity Management Plan (BMP) for the site (South 32 Illawarra Coal 2017);
2. To outline any problems encountered during works and how these were managed;
3. To recommend alterations or additions to management actions as required; and

4. To provide an analysis of vegetation monitoring results, including;
 - Comparison of data from Monitoring plots to benchmark condition levels for CPW,
 - Visual comparative analysis of photo point monitoring locations,
 - Vegetation and condition mapping at a scale deemed appropriate to inform management decisions.

Mapping will include:

1. Location of vegetation monitoring plots
2. Photo point monitoring locations
3. Baseline mapping of native vegetation and condition within MZ5.

The 2016 monitoring report included the details regarding the latest results of the *Pimelea spicata* population census, along with associated mapping. The 2021/2022 monitoring report will contain the next *Pimelea spicata* population census.

2. Management Actions

2.1 Management actions undertaken

Since 2011, management actions have been conducted at both the offset site (MZ5) and the voluntary management area (MZ6) to enhance and maintain native biodiversity. Stock has been excluded from the offset area by the installation of a fence around the site boundary, which was installed in 2011.

Toolijooa Bushland Restoration Pty Ltd (Toolijooa) has been conducting the bushland restoration works at both M5 and M6 sites between 2011 and 2016. Bush regeneration works were undertaken by Landcare Australia in 2019, with no works undertaken in the 2017 to 2018 monitoring period. The Landcare Australia (2019) monitoring report details the most recent bush regeneration works undertaken at MZ5 and MZ6. Planned bush regeneration works to be undertaken in 2020 include quarterly maintenance visits by a team of bush regenerators, as recommended by Landcare Australia (2019).

Weeds treated across the site since 2011 include:

- Herbaceous species: *Bidens pilosa* Cobbler's Peg, *Brassica* sp., *Cirsium vulgare* Spear Thistle, *Conyza* spp. Fleabane, *Echium plantagineum* Paterson's Curse, *Ehrharta erecta* Panic Veldt Grass, *Modiola caroliniana* Modiola, *Onopordum acanthium* Scotch Thistle, *Paspalum dilatatum* Paspalum, *Pennisetum clandestinum* Kikuyu, *Plantago lanceolata* Ribwort Plantain, *Senecio madagascariensis* Fireweed, *Solanum nigrum* Blackberry Nightshade, *Sonchus oleraceus* Common sowthistle, *Verbena bonariensis* Purpletop, *Xanthium* sp Noogoora Burr;
- Woody weeds: *Lycium ferocissimum* African Boxthorn, *Olea europaea* subsp. *cuspidata* African olive) and
- Vines (*Araujia sericifera* Moth Vine, *Delairea odorata* Cape Ivy and *Rubus* sp. Blackberry).

2.2 Management actions compared to BMP

The current management actions have addressed the recommended actions proposed in the BMP (South 32 Illawarra Coal 2017) for the site. These have been compared in Table 2. It should be noted that the actions are on-going.

Table 2: Proposed and current management actions in the BMP

Action	Description	Performance Target (Milestones)	Completion Status
MZ5 Fencing	<ul style="list-style-type: none"> ▪ The first action within the offset area will be to exclude stock. Existing four-strand post-and-wire fence will be utilised and additional fencing installed where required. No barbed-wire will be used and the bottom strand will have a clearance of 400mm above the ground to allow the movement of native fauna. Stock will be herded out of the area prior to fencing taking place. 	Four-strand post-and-wire fence installed, no strands barbed and 400 mm separation from ground to lowest strand.	Fence installed. On-going monitoring.

Action	Description	Performance Target (Milestones)	Completion Status
Bush Regeneration in MZ5	<ul style="list-style-type: none"> Primary, secondary and maintenance weed management within MZ5 will target the treatment of Blackberry, African Olive, Lantana, African boxthorn, privet, Cape ivy and a variety of exotic perennial grasses such as African Lovegrass, Rhodes Grass, Kikuyu and Couch. All weed management works will be supervised by a suitably qualified bush regenerator. A team of four bush regenerators will be engaged for five days for the primary weeding and then a team of two for one day every four months thereafter for secondary and maintenance weed management as required. 	<p>Engagement of suitably qualified bush regeneration contractor to implement primary, secondary and maintenance weed management program.</p> <p>Annual vegetation condition assessment</p> <p>Improvement in condition of offset bushland to within, or as near as possible to, benchmark condition levels.</p>	<p>Currently being conducted. On-going.</p> <p>Section 4 of this report regarding vegetation condition to benchmarks.</p>
<i>Pimelea spicata</i> Monitoring program	<ul style="list-style-type: none"> Design a program to determine the success of management or the need for intervention. Annual population counts within permanent plots. 5 yearly population census. Condition of individual plants from mixed cohorts. Condition of habitat. Annual inspections of fencing to ensure maintenance and up-keep. Regular site visits the potential presence of stock and/or feral herbivores that have breached fencing to ensure that such impact is eliminated by fencing and that trapped stock or feral herbivores are freed. Monitoring against stochastic events. 	<p>Sustainable <i>Pimelea spicata</i> population with population numbers staying level with or exceeding current numbers.</p>	<p>Census proposed to occur every five years. Most recent census undertaken in early 2017 and reported on in the 2016 monitoring report. Details regarding the <i>Pimelea spicata</i> population will be provided in the 2021 monitoring report. This report provides general observations for the species and presence within plots.</p>
MZ6 Fencing	<ul style="list-style-type: none"> The first action within the native vegetation area will be to exclude stock. Existing four-strand post-and-wire fence will be utilised and additional fencing installed where required. No barbed-wire will be used and the bottom strand will have a clearance of 400mm above the ground to allow the movement of native fauna. Stock will be herded out of the area prior to fencing taking place. 	<p>Four-strand post-and-wire fence installed, no strands barbed and 400 mm separation from ground to lowest strand.</p>	<p>Fence erected.</p> <p>On-going monitoring.</p>
Bush Regeneration in MZ6	<ul style="list-style-type: none"> Weed management within MZ6 will target the treatment of Blackberry, African Olive, lantana, African Boxthorn, privet, Cape ivy and a variety of exotic perennial grasses such as African lovegrass, Rhodes grass, Kikuyu and couch. All weed management works will be supervised by a suitably qualified bush regenerator. 	<p>Engagement of suitably qualified bush regeneration contractor to implement weed management program.</p> <p>Improvement in condition of offset bushland to within, or as near as possible to, benchmark condition levels.</p>	<p>Currently being conducted. On-going.</p> <p>Section 4 of this report regarding vegetation condition to benchmarks.</p>

3. Methodology

3.1 Key performance criteria

The priority management actions, performance criteria and timeframes for the works in MZ5, as described in the BMP, are provided in Appendix A. The key elements include:

- Engagement of suitably qualified bush regeneration contractor to implement a primary, secondary and maintenance weed management program.
- Annual vegetation condition assessment.
- Improvement in condition of offset bushland to within, or as near as possible to, benchmark condition levels.
- Sustainable *Pimelea spicata* population with population numbers staying level with or exceeding current numbers.

Utilising these elements, Niche developed the monitoring methodology described in Section 3.2.

3.2 Monitoring methodology

The monitoring methodology will follow that outlined in the BMP.

Fixed plot vegetation monitoring for 2019 was conducted on 13 and 15 November 2019 by three Niche employees: Sian Griffiths (Senior Botanist and Accredited BAM Assessor), Yogesh Nair (Botanist and Accredited BAM Assessor) and Sarah Hart (Ecologist).

3.2.1 Fixed plot vegetation monitoring

The plot monitoring incorporated the following (Figure 2):

1. Five fixed BAM (Biodiversity Assessment Method) plots within MZ5, monitored annually.
2. Five fixed BAM plots within MZ6, monitored annually.
3. Comparison of site collected attribute data with the benchmarks for the PCT 850 Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain (CPW) from the PCTs Benchmarks Database. The BAM site attributes and their methods of measurement are provided in Appendix C.

Historically, the fixed plot vegetation monitoring has used the BioBanking Plot methodology. However, in 2017 a new industry standard was developed in association with the *Biodiversity Conservation Act 2016* (BC Act). Biodiversity Assessment Method (BAM) Plots have replaced BioBanking Plots as the standard method of collecting attribute data. As such, BAM plots were utilised in the 2017 and 2018 monitoring instead of BioBanking Plots in order to collect data consistent with updated methodologies, PCTs and benchmarks.

3.2.2 *Pimelea spicata* population Census

Monitoring of the *Pimelea spicata* population takes place annually as part of the fixed plot vegetation monitoring, with counts of *P.spicata* stems occurring within the BioBanking Plots. *P.spicata* occurs within BAM plots MZ5-001, MZ5-003, MZ5-004. These plots coincide to some extent with the monitoring plots used to count *P.spicata* during the population census, as detailed below. Annual observations within the BAM plots can monitor the extent of the population throughout zone MZ5 within areas monitored by Niche. General observations of the population outside of the plots are also undertaken annually to **highlight identify** any obvious declines in population health.

A population census of the *P.spicata* population in the study area occurs once every five years to estimate the population size and determine the health of the population. With monitoring of the presence of the species undertaken annually, it is determined that a full population census undertaken every five years is

adequate. If the species was determined not to be present in plots where it is known to previously occur during the annual monitoring, this would trigger a full population census regardless of its scheduled timeframe.

The original census of the *Pimelea spicata* population was undertaken in October 2012 and a second census was undertaken in February 2017. The next *Pimelea spicata* census is due in 2021/2022.

3.2.3 Photo-point monitoring

The photo-point monitoring was planned as follows:

1. Five fixed photo-points were sited within MZ5, coincident with the BAM plots.
2. Five fixed photo-points were sited within MZ6, coincident with the BAM plots.
3. An additional five photo-points were located within 200 metres of the external boundary of MZ5 to enable a visual assessment of the health of the vegetation in that area. Opportunistically favourable locations for photo-points were also recorded.

The photo-point locations are those shown in Figure 2.

3.2.4 Vegetation distribution monitoring

1. The boundary of the native vegetation within MZ5 and MZ6 will be mapped annually using a hand held GPS and interpretation of the available aerial imagery.
2. The mapped vegetation boundary will be compared each year, with the expectation that the extent of native vegetation within the offset area will increase with management.

3.3 Survey stratification

Stratification of the monitoring sites within the offset area was determined on-site whilst conducting the first round of monitoring surveys in spring 2012. Stratification was based on condition such that an accurate comparison of the improvement in that condition could be gained over time. Three broad condition categories existed on the site:

1. Woodland (Section 4.2.1).
2. Blackthorn (*Bursaria spinosa*) thicket (Section 4.2.2).
3. Pasture (Section 4.2.3).

Five BAM plots were conducted in each of MZ5 and MZ6 (ten in total) and distributed over the three condition types as shown in Table 3 and Figure 2.

Table 3: Location of monitoring sites

Management Zone	Area (ha)	Monitoring Site	Easting	Northing	Condition Class
MZ5	8.7	MZ5-001	290285	6216759	Woodland
		MZ5-002	290360	6216591	Woodland
		MZ5-003	290365	6216665	Woodland
		MZ5-004	290195	6216725	Blackthorn thicket
		MZ5-005	290017	6216883	Pasture
MZ6	12.43	MZ6-006	289842	6216418	Woodland
		MZ6-007	289990	6216474	Woodland
		MZ6-008	289852	6216665	Woodland
		MZ6-009	289925	6216342	Pasture
		MZ6-010	289974	6216678	Blackthorn thicket

* Easting and Northing provided in GDA94, MGA Zone 56.

3.4 Data analysis and interpretation

A series of key attributes were identified for assessing the current condition of the vegetation and habitats at the Offset Area, the restoration pathways and progress towards attaining the conservation objectives. These attributes relate to species richness and percent cover of native plants in vegetation layers, as well as fauna habitat features and canopy regeneration. This monitoring report presents the 2019 monitoring data according to these key attributes.

Basic statistical analyses have been conducted incorporating temporal variation (i.e. changes over time) in vegetation condition to assess the magnitude and direction of change in vegetation communities. Statistical analysis conducted involved temporal comparisons of means and standard errors (variability in data between quadrats) between the average survey data from 2012 to 2019. Key attributes which would be most informative for management input were selected for comparison, such as native species diversity, percent cover of exotics and native canopy cover. Calculations of mean and standard error were not conducted where less than three plots were undertaken within a plant community type as this is not enough data to provide meaningful or statistically robust analysis. Therefore, analysis was limited to the woodland plots in MZ5 and MZ6.

Benchmark values based on the Plant Community Type (PCT) accessed from the Vegetation Information System (VIS) database were used to provide an indication of the condition of the vegetation in a broader context. It should be noted that these benchmark values are not site specific and therefore are not intended to represent a target for measuring restoration success. Comparison of site values with benchmark values is intended to provide a broader context for interpreting the restoration pathway and the trajectory of change as management measures are implemented (direction of change).

3.5 Limitations

Some plant species are cryptic and can only be detected when flowering at certain times of the year. For example some orchids flower within certain seasons and cannot be detected at other times of the year.

The density of blackthorn at plots 004 and 010 prevented the placement of the 50 metre transect tape. An estimate of the BAM composition, structure and function attributes were therefore used for the plot. Different staff to previous monitoring events were used and this may introduce observer bias in the results. Analysis of results should be undertaken with these limitations in mind.

4. Results

4.1 Flora recorded

A total of 74 species were recorded across ten floristic plots within the study area during the 2019 monitoring event. The number of species recorded varies slightly with each monitoring event, with 82 species recorded in 2018, 81 species recorded in 2017, 83 species recorded in 2016, 96 species recorded in 2015 and 2014, 85 species recorded in 2013 and 90 species recorded in 2012. The observed differences are likely attributed to seasonal variation.

During the current monitoring, 14 species were exotic which accounts for five percent of species recorded. This is a decrease in percent of exotic species recorded when compared to 2018 (37 percent), and a decrease to that recorded in 2016 (46 percent of species exotic), 2015 monitoring (45 percent of species were exotic), and 2014 monitoring (55 percent of species were exotic).

4.2 Assessment of site attribute data

4.2.1 Woodland



Plate 1. Woodland during 2019 at monitoring plot MZ5-003

4.2.1.1 Plot Data

BAM site attribute data was collected at six sites that corresponded to a woodland structure. Three of the sites were collected from MZ5 and three were collected from MZ6. The data collected is contained in Table 4 (2019, 2018 and 2017 data) and Table 5 (2012-2016 data), which also includes the benchmarks for each

of the site attributes for the relevant PCT. The relevant PCT is 850 Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain. Benchmarks for 2012-2016 data are for BVT HN529.

Graph 1 and Graph 2 show the temporal change for key attributes for woodland plots in MZ5 and MZ6 respectively and compare the average values to benchmarks (shown as line graphs).

MZ5 offset site and MZ6 voluntary management site woodland plot comparison

Table 4. Comparison of woodland plots to PCT benchmarks (2017, 2018 and 2019)

Plot	Composition (Richness)						Structure (Cover)						Function			
	T	S	G	F	Fe	O	T	S	G	F	Fe	O	NLT	LC	FL	HTW
Benchmark	5	8	12	15	2	5	52	18	61	10	1	5	3	35	40	
MZ5																
M5_001 (2019)	2	2	4	8	0	3	37	45.1	7.1	2.8	0	1.2	1	52	8	8.6
M5_002 (2019)	1	1	5	3	0	1	10	15	21	0.4	0	0.1	0	43	0	5
M5_003 (2019)	2	1	3	6	0	2	25	20	20	5.7	0	0.2	2	36	3	5.7
2019 Average	1.6	1.3	4	5.6	0	2	24	26.7	16	2.9	0	0.5	1	43.6	3.6	6.4
M5_001 (2018)	1	2	4	12	0	4	20	45.1	10.6	4.1	0	1.3	1	87	36	10.1
M5_002 (2018)	2	1	5	8	0	4	15	15	46.5	1.4	0	0.4	0	37	2	1
M5_003 (2018)	2	2	2	10	0	5	23	15.1	15	6.1	0	0.9	1	38	0	3
2018 Average	1.7	1.7	3.7	10.0	0.0	4.3	19.3	25.1	24.0	3.9	0.0	0.9	0.7	54.0	12.7	4.7
M5_001 (2017)	2	2	6	9	0	4	20	40.1	25.6	4.1	0	0.5	1	56	8	5.2
M5_002 (2017)	2	1	5	8	0	3	16	10	27.1	1.2	0	0.3	0	22	1	17
M5_003 (2017)	2	2	2	8	0	4	17	9.1	20.5	7.3	0	0.8	1	64	3	4.5
2017 Average	2.0	1.7	4.3	8.3	0.0	3.7	17.7	19.7	24.4	4.2	0.0	0.5	0.7	47.3	4.0	8.9
MZ6																
M6_006 (2019)	2	1	4	8	0	0	25	50	55.1	4.1	0	0	2	39	7	1
M6_007 (2019)	1	1	4	4	0	0	50	10	12.5	6.2	0	0	2	97.4	0	75
M6_008 (2019)	1	2	6	3	0	1	15	30	45.8	5.6	0	0.1	1	62	0	19.4
2019 Average	1.3	1.3	4.6	5	0	0.3	30	30	37.8	5.3	0	0.1	1.6	66.1	2.3	31.8
M6_006 (2018)	4	1	5	11	0	3	23	20	12.6	5.7	0	0.3	2	71	24	6
M6_007 (2018)	1	1	2	7	0	2	20	12	9	2.8	0	0.2	3	77	50	20.4
M6_008 (2018)	1	2	5	11	0	5	10	53	18.6	4.7	0	0.9	1	75	8	2.6

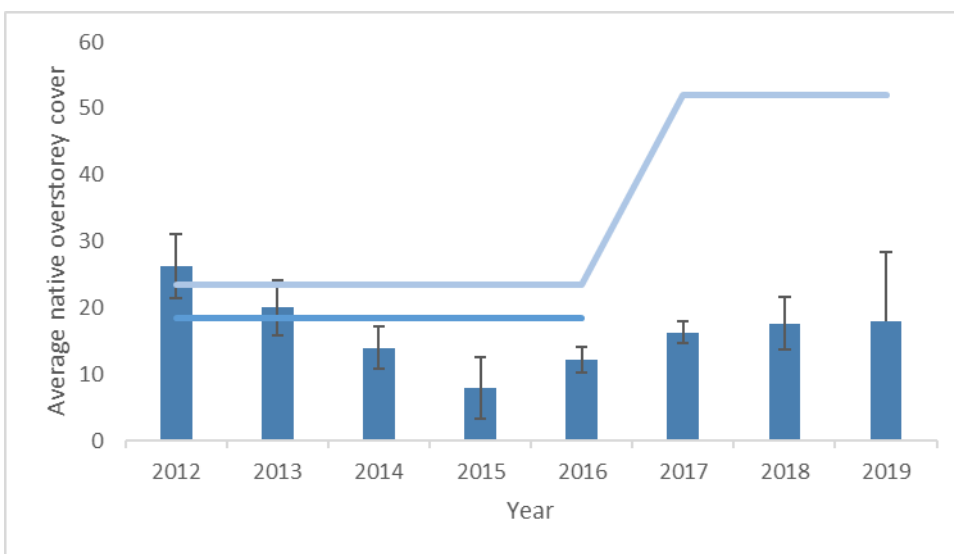
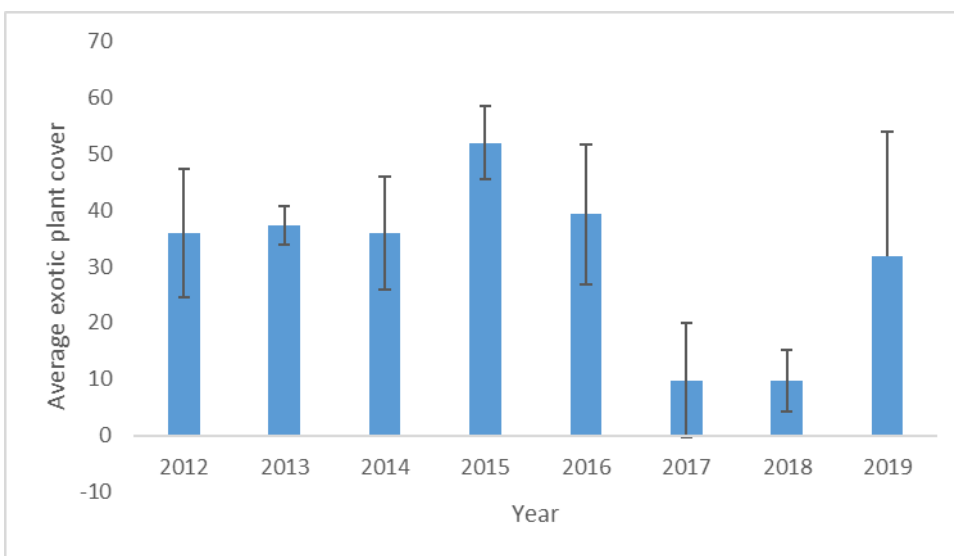
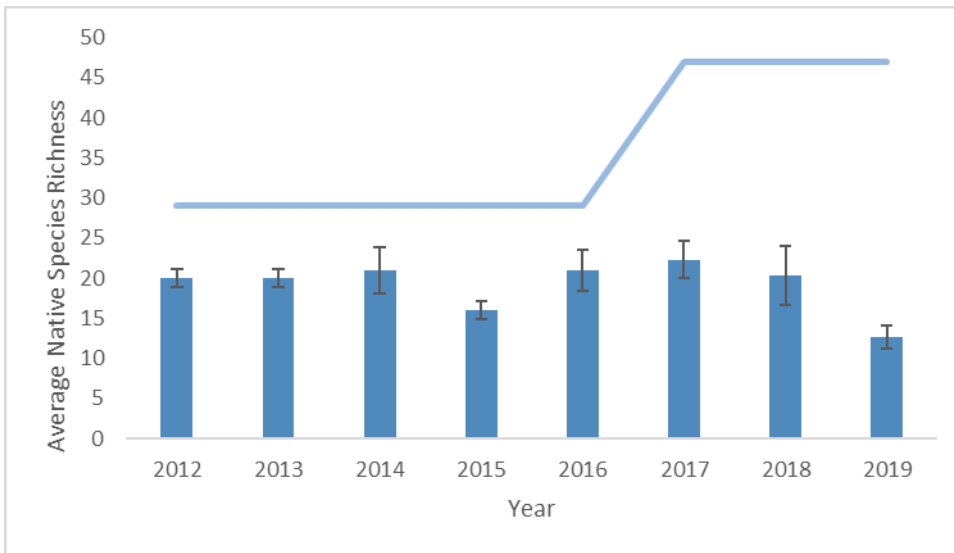
Plot	Composition (Richness)						Structure (Cover)						Function			
	T	S	G	F	Fe	O	T	S	G	F	Fe	O	NLT	LC	FL	HTW
2018 Average	2.0	1.3	4.0	9.7	0.0	3.3	17.7	28.3	13.4	4.4	0.0	0.5	2.0	74.3	27.3	9.7
M6_006 (2017)	3	1	6	10	0	2	19	15	24.1	4.2	0	0.3	2	52	18	7.2
M6_007 (2017)	1	1	7	6	0	4	20	25	18.3	7.4	0	0.4	6	48	51	15.9
M6_008 (2017)	1	2	8	11	0	4	10	50	21.4	4.2	0	0.5	1	61	4	4.2
2017 Average	1.7	1.3	7.0	9.0	0.0	3.3	16.3	30.0	21.3	5.3	0.0	0.4	3.0	53.7	24.3	9.1

Table 5. Comparison of woodland plots to PCT benchmarks (2012-2016)

Plot	NPS	NOS		NMS		NGCG		NGCS		NGCO		EPC	NTH	OR	FL
		L	U	L	U	L	U	L	U	L	U				
Benchmark	29	18.5	23.5	20	30	23	31	0	5	11.75	19.75	0	0	1	0
MZ5															
M5_001 (2016)	22		3.5		26		44		28		22	24	1	1	37
M5_002 (2016)	17		6		1.2		94		8		8	24	1	1	2
M5_003 (2016)	23		0.5		17.5		76		4		8	16	1	1	10
Average 2016	21		3.3		14.9		71.3		13.3		12.7	21.3	1	1	16.3
M5_001 (2015)	24		1		41.5		92		10		4	56	1	1	15
M5_002 (2015)	20		4.5		1.5		86		2		18	36	1	1	0
M5_003 (2015)	23		0.5		22.5		68		16		6	64	1	1	8
Average 2015	22		2.0		21.8		82.0		9.3		9.3	52.0	1.	1	7.7
M5_001 (2014)	21		0		62.5		26		26		6	10	1	1	12
M5_002 (2014)	17		7.5		0		78		2		0	12	1	1	3
M5_003 (2014)	16		30		53		22		28		9	14	2	1	0
Average 2014	18		12.5		38.5		42		18.5		5	12	1	1	5
M5_001 (2013)	12		9		20.5		58		10		42	39	1	1	12
M5_002 (2013)	18		2		1.5		82		0		30	44	1	1	6
M5_003 (2013)	17		24		3		6		2		16	23	2	1	0
Average 2013	16		11.6		8.3		48		4		29	35	1	1	6
M5_001 (2012)	17		5.5		24		66		8		50	24	1	1	8
M5_002 (2012)	18		6.5		3		92		2		18	50	1	1	6

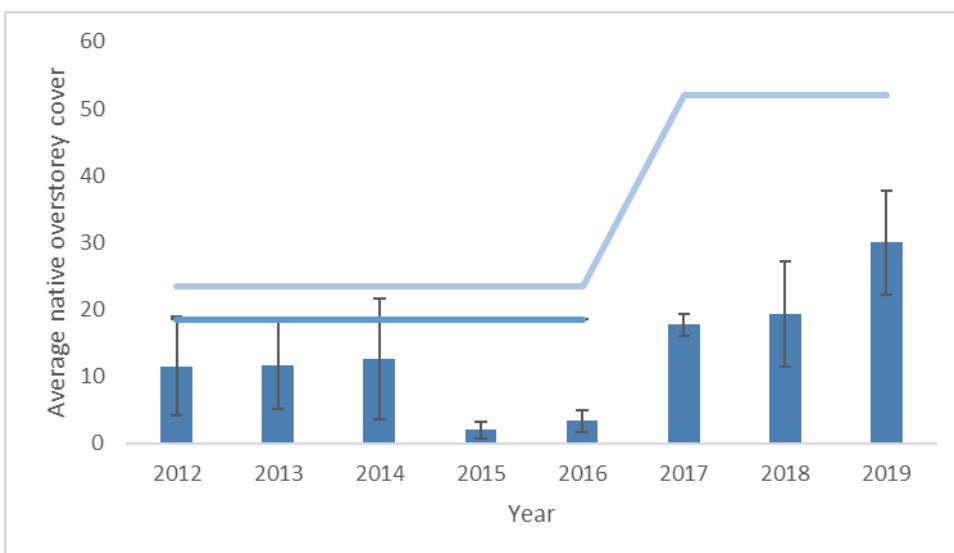
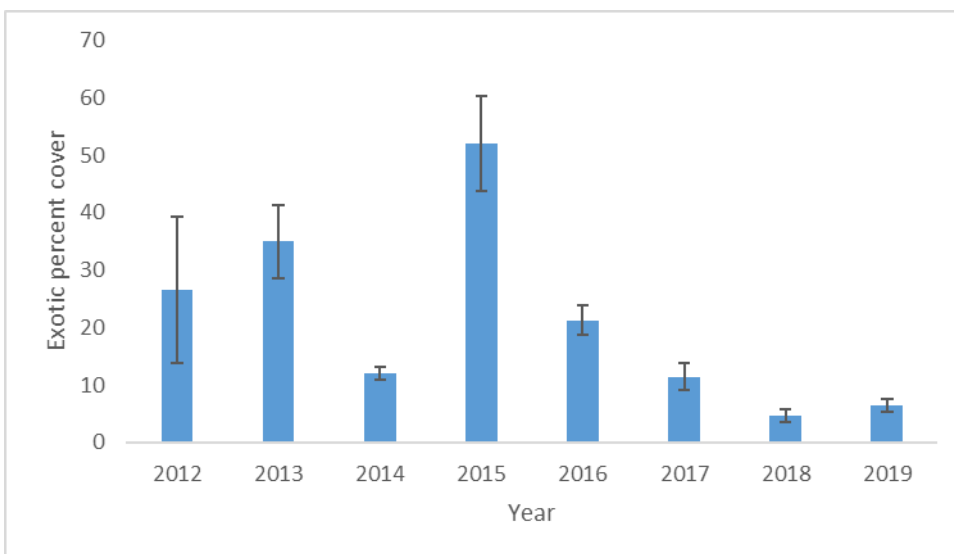
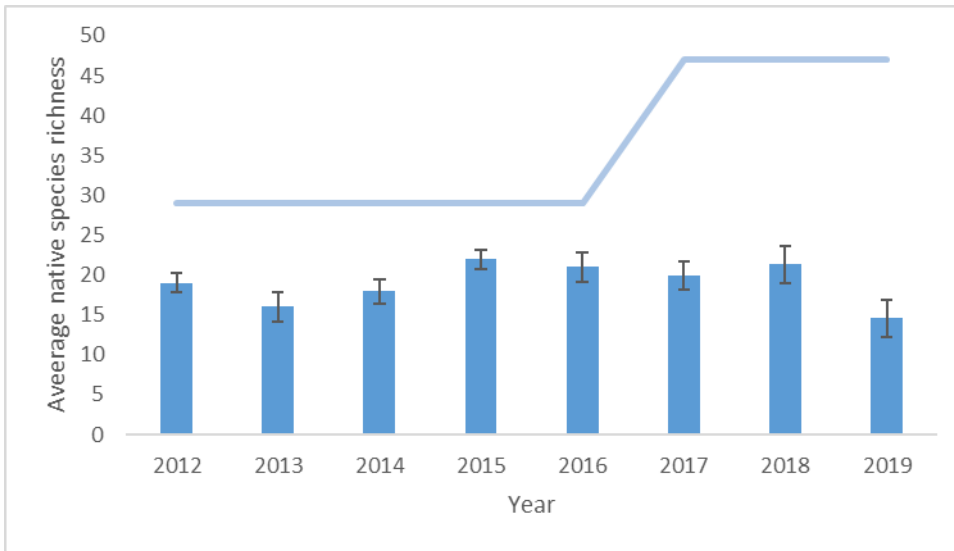
Plot	NPS	NOS		NMS		NGCG		NGCS		NGCO		EPC	NTH	OR	FL
		L	U	L	U	L	U	L	U	L	U				
M5_003 (2012)	21		22.5		1		3.8		3.4		12	6	2	1	0
Average 2012	19		11.5		9.3		53.9		4.5		26.6	26.6	1	4.6	4.6
MZ6															
M6_006 (2016)	23		10		15		88		16		20	24	6	1	32
M6_007 (2016)	16		16		10		36		20		4	64	8	1	70
M6_008 (2016)	24		10.5		30		70		14		16	30	1	1	10
Average (2016)	21		12.2		18.3		64.7		16.7		13.3	39.3	5	1	37.3
M6_006 (2015)	16		0		60		85		0		6	50	1	0	0
M6_007 (2015)	18		16		7.5		26		16		10	42	4	1	40
M6_008 (2015)	14		8.5		13.5		76		12		6	64	1	1	8
Average (2015)	16		8		27		62		9		7	52	2	1	16
M6_006 (2014)	27		18		8		60		6		30	48	2	1	16
M6_007 (2014)	21		17		0		26		16		24	16	4	1	10
M6_008 (2014)	17		8		16		50		0		16	44	1	1	8
Average 2014	21		14		8		45		7		23	36	2	1	11
M6_006 (2013)	22		26		16		90		2		30	34	2	1	22
M6_007 (2013)	20		22		0		22		12		16	44	4	1	20
M6_008 (2013)	18		12		12		60		12		18	34	1	1	10
Average (2012)	20		20		9.3		57.3		8.6		21.3	37.3	2.3	1	17.3
M6_006 (2012)	20		26.5		10.5		82		4		44	42	2	1	22
M6_007 (2012)	18		34.5		0		8		18		6	14	4	1	14
M6_008 (2012)	22		18		10		72		0		22	52	1	1	8
Average (2012)	20		26.3		6.8		54.0		7.3		24	36	2.3	1	14.6

NPS – Native Plant Species richness, NOS – Native Over-storey cover, NMS – Native Mid-storey cover, NGCG – Native Ground-cover (grasses), Native Ground-cover (shrubs), Native Ground-cover (other), EPC – Exotic Plant Cover, NTH – Number of Trees with Hollows, OR – Over-storey regeneration, FL – Length of Fallen Logs. L – Lower Benchmark, U – Upper Benchmark



Graph 1: Comparison of key attributes for woodland plots in MZ5 (HN529/PCT850) (Note only High Threat Weeds (HTW) measured in 2017, 2018 and 2019, as per BAM methodology)

Mean (±SE) 2012-2019 quadrat data ($n = 3$). Benchmark values/ranges shown as line graphs.



Graph 2: Comparison of key attributes for woodland plots in MZ6 (HN529/PCT850)

Mean (±SE) 2012-2019 quadrat data ($n = 3$). Benchmark values/ranges shown as line graphs

4.2.1.2 Discussion

Compositionally, the data 2019 shows the woodland plots remaining below benchmark values for all growth forms, as was the case in 2017 and 2018. The average native species richness for 2018 was 15 in MZ5 (a slight decrease to previous monitoring data of 21 native species recorded in 2018, 20 native species recorded in 2017, 21 native species recorded on average in 2016, 22 native species recorded on average in 2015, and 18 native species recorded on average in 2014). The average native species richness for 2019 in MZ6 was 13 (a decrease from 2018 data of 20, and 2017 data of 22 native species on average). Values of native species richness remains below benchmark in both MZ5 and MZ6 (Graph 1 and 2). Reduction in native species diversity within woodland areas is likely attributable to ongoing drought conditions. It is likely over time with the continual management of the site that the offset is likely to reach benchmark condition.

Structurally, the percent cover of all growth forms remained below benchmark in 2019 for the woodland plots, with the exception of shrub cover, which was above benchmark, as was the case in 2017 and 2018. The average native overstorey cover (tree cover) for 2019 was below benchmark, but slightly higher than 2018 (see Graph 1 and 2). Given the current management of the site and the fact that five of the six plots had regenerating overstorey species (stem size class <5 cm and 5-9cm DBH present), it is considered that MZ5 and MZ6 is likely to maintain a healthy overstorey canopy in future years. Regeneration of eucalypts were observed throughout the site.

Native ground-cover grasses (grass cover/NGCG) averaged lower than benchmark in 2019, 2018 and 2017 and higher than the benchmark range during all previous monitoring years, though it should be noted that the benchmark values have increased using the BAM benchmarks. The 2019, 2018 and 2017 monitoring data shows a substantial decrease in native ground-cover grasses compared with 2016, however again it should be noted that the method for collecting cover data has changed with BAM.

Native ground-cover shrubs (shrub cover/NGCS) was above benchmark in 2019, 2018, 2017 and 2016. As mentioned in the previous monitoring report this is likely attributed to the regeneration of blackthorn which have increased over the monitoring years. The score is likely to increase with management of the site and recruitment growth. Native ground-cover other (NGCO) remained below benchmark in 2019, 2018 and 2017, which was a decrease from 2016 where this attribute was within benchmark for the first time since monitoring commenced and had increased compared with 2015 on average. Again, the change in methodology could be attributed to this change.

Functionally, average litter cover was again above benchmark values in 2019 and all other attributes were below benchmark (as was the case in 2018 and 2017).

Trees with hollows (NTH) were present in three of the six plots in 2019 (down from being present in four of the six plots in 2017).

The length of fallen logs (FL) remained well below the benchmark of 40 m in all of the woodland plots, but had not changed in 2019 compared with 2018 data.

Exotic plant cover (EPC) during 2019 was slightly higher in MZ5 compared with 2018 data (6% in 2019, 5% in 2018 down from 11% in 2017), but much higher in MZ6 from 2019 (31.8%) compared to 2018 (9.6%) and 2017 (9.8%). Exotic cover in 2019 was much higher than previous years at MZ6, but similar for MZ5 (see Chart 1 and Chart 2). This reflects the historic bush restoration works, which have involved woody weed control as well as management of other weeds. However, again the different methodology for collecting data could also be attributed to this change. Woody weeds such as African Olive and African Boxthorn are

persisting in the woodland area throughout MZ5 and MZ6 and it is recommended that woody weed control be undertaken again in this area in 2019.

4.2.2 Blackthorn thicket



Plate 2. Blackthorn thicket in plot MZ5-004

4.2.2.1 Plot Data

BAM site attribute data was collected at two sites within patches of Blackthorn thicket. One site was located within the M5 offset site, and the other in the M6 voluntary management site. The data collected are contained in Table 6 (2019, 2018 and 2017 data) and Table 7 (2012-2016 data), which also includes the benchmarks for each of the site attributes for the relevant PCT. The relevant PCT is 850 Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain. Benchmarks for 2012-2016 data are for BVT HN529.

MZ5 offset site and MZ6 voluntary management site blackthorn thicket plot comparison

Table 6. Comparison of blackthorn thicket plots to PCT benchmarks (2017-2019)

Plot	Composition (Richness)						Structure (Cover)						Function			
	T	S	G	F	Fe	O	T	S	G	F	Fe	O	NLT	LC	FL	HTW
Benchmark	5	8	12	15	2	5	52	18	61	10	1	5	3	35	40	0
M5_004 (2019)	0	3	4	5	0	3	0	70.2	20.3	1	0	0.3	0	45	0	30.1

Plot	Composition (Richness)						Structure (Cover)						Function			
	T	S	G	F	Fe	O	T	S	G	F	Fe	O	NLT	LC	FL	HTW
M5_004 (2018)	0	2	6	7	0	5	0	66	31	0.9	0	0.5	0	52	0	26.1
M5_004 (2017)	0	2	6	7	0	4	0	42	29.1	2.7	0	0.4	0	40	0	10.1
M6_010 (2019)	0	1	7	3	0	3	0	60	65.2	0.6	0	0.3	0	68	0	30.2
M6_010 (2018)	0	1	4	6	0	4	0	60	11.2	1.9	0	0.4	0	50	0	15.2
M6_010 (2017)	0	1	3	5	0	5	0	45	19.1	7.3	0	0.6	0	39	0	10.1

T – Tree, S – Shrub, G – Grass, F – Forb, Fe – Fern, O – Other; NLT – Number of Large Trees, LC – Litter cover, FL – Length of Fallen Logs. HTW – High Threat Weeds

Table 7. Comparison of blackthorn thicket plots to PCT benchmarks (2012-2016)

	NPS	NOS		NMS		NGCG		NGCS		NGCO		EPC	NTH	OR	FL
		L	U	L	U	L	U	L	U	L	U				
Benchmark	29	18.5	23.5	20	30	23	31	0	5	11.75	19.75	0	0	1	0
M5_004 (2016)	16		0		37.5		80		4		24	18	0	0	0
M5_004 (2015)	16		0		45		75		5		20	25	0	0	0
M5_004 (2014)	18		0		20		70		28		22	55	0	0	0
M5_004 (2013)	15		0		18		84		22		24	55	0	0	0
M5_004 (2012)	18		0		11		82		26		32	67	0	0	0
M6_010 (2016)	18		0		60		65		10		8	60	0	1	0
M6_010 (2015)	10		12		10.5		74		20		2	38	3	1	15
M6_010 (2014)	18		0		50		54		2		32	28	0	0	0
M6_010 (2013)	20		0		60		62		12		20	10	0	0	0
M6_010 (2012)	20		0		53		56		14		18	10	0	0	0

NPS – Native Plant Species richness, NOS – Native Over-storey cover, NMS – Native Mid-storey cover, NGCG – Native Ground-cover (grasses), Native Ground-cover (shrubs), Native Ground-cover (other), EPC – Exotic Plant Cover, NTH – Number of Trees with Hollows, OR – Over-storey regeneration, FL – Length of Fallen Logs. L – Lower Benchmark, U – Upper Benchmark

4.2.2.2 Discussion

The results for blackthorn thicket during 2019 were relatively similar to the previous monitoring years, through shrub cover had increased in 2019. Results for the plots within the blackthorn thicket should be interpreted with caution, as the thicket both MZ5 and MZ6 were so dense that it prevented access to much of the plot and it was not possible to run the 50 m transect out. As such, estimates were used to gather the data in 2015, 2016, 2017, 2018 and 2019.

Compositionally, blackthorn thickets plots scored below benchmark for all growth form groups in 2019 (with the exception of other growth form for MZ5-004), but was fairly consistent with previous years.

Native plant species richness (NPS) has scored below the benchmark in all monitoring years, including 2019. However, this was to be expected given the thicket of Blackthorn.

Structurally, the percent cover of all growth forms remained below benchmark for the woodland plots in 2019, 2018 and 2017, with the exception of shrub cover, which was above benchmark in all years. No canopy species were recorded within the thicket, therefore native overstorey cover (tree cover/NOS) and overstorey regeneration (presence of stem size class <5 cm DBH/OR) were zero, as expected. Shrub cover was given a score higher than benchmark during 2019, 2018 and 2017, which is relatively consistent with previous years data (native mid-storey cover). It has been raised previously in the Niche (2018, 2017, 2016, 2015, 2014 and 2012) monitoring reports that, given the density of these thickets, there would be some ecological benefit to thinning the blackthorn within the woodland areas to diversify the habitat structure. One such ecological benefit may be in controlling the Bell Bird population, as discussed below. As previously stated, the density of blackthorn in these areas is considered unnaturally high.

Native ground-cover grasses (NGCG) was below benchmark in 2019, 2018 and 2017 and was lower than previous years. Native ground-cover other (NGCO) was also well below previous monitoring years in 2019 and 2018. The lower cover values could be attributed to the long period of dry weather preceding the surveys in 2019, 2018 and 2017 and also partly due to the change in method of estimating percent cover.

EPC has been given a score of 30 percent in 2019 (down from 5-10 percent in 2018 and 10-11 percent in 2017), again higher than previous years. Exotic cover is relatively high throughout the blackthorn thicket due to the presence of exotic perennial grasses, Blackberry (*Rubus fruticosus*), African Boxthorn (*Lycium ferrocissimum*) and African Olive (*Olea europea* subsp. *cuspidata*). The presence of African Olive in the midstorey and groundlayer is of concern, with numerous seedlings developing underneath the larger specimens. *Lantana camara* (Lantana) was also recorded in the groundlayer of MZ6-010 plot. Weed maintenance should be undertaken in this area to prevent African Olive and Lantana dominating.

Trees with hollows (NTH) and the length of fallen logs (FL) were zero in 2019, 2018 and 2017 within the blackthorn thickets, as expected in the absence of native overstorey cover.

As recommended in previous monitoring reports, bush regeneration works should continue and focus on the removal of African Olive and Blackberry within the vicinity of plot MZ5-004, due to the presence of the threatened plant, *Pimelea spicata*. Any management in this area should be conducted with care so as to minimise any impact to *Pimelea spicata* individuals. It is significant in this area as the population of *Pimelea spicata* is largely associated with the Blackthorn thicket.

During the monitoring surveys in 2019, 2018 and 2017, it was noted that Bell Miners were abundant in the MZ5 area. Management actions to reduce the Bell Miner colony should be considered as the birds seem to be having an impact on mature overstorey in woodland areas in MZ5. Eucalypt dieback in association with Bell Miners is listed as a Key Threatening Process on the NSW *Biodiversity Conservation Act 2016* (Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners).

An independent review of bell miner associated dieback was commissioned by Office of Environment and Heritage, which details management recommendations for bell miner associated dieback (Silver and Carnegie 2017):

- Prevention:
 - Disturbance of the canopy should be minimised where possible.
 - Where the canopy is disturbed, rehabilitation should focus on re-establishment of a canopy as soon as possible to limit unnatural understorey density.

- Site rehabilitation should include ongoing management of invasive weeds, particularly those that minimise natural regeneration and can act as superior nesting sites for Bell miners.
- Exclusion of fire is an artificial disturbance activity that can lead to woody weed invasion. Appropriate fire regimes should be designed and implemented.
- Treatment
 - A site assessment should be undertaken to ensure that Bell miners are present and psyllid attack is the primary cause of dieback.
 - If the prevailing vegetation community is naturally dense in the understorey or midstorey then consideration should be given to not intervening in the site as Bell Miner associated dieback (BMAD) may be a natural process there.
 - At sites with an unnatural level of understorey and/or midstorey density the viability of the seed bank for rehabilitation without planting should be assessed.
 - In sites with high value assets being impacted by BMAD (e.g. threatened flora or fauna) consideration should be given to culling of Bell miners followed by site rehabilitation. This has been shown to have an immediate reduction on exclusion of other bird species for example.
 - The primary aim of site treatment should be to reduce the occurrence of superior nesting sites for the Bell miner. The method best to use to achieve this will depend on site-specific characteristics.

Management at the offset site would involve undertaking primary weed management works surrounding areas of woodland. Weed management would involve removing all woody weeds, including African Olive and African Boxthorn.

4.2.3 Pasture



Plate 3. Plot (MZ5-005) within pasture land during 2019

4.2.3.1 Plot Data

BAM site attribute data was collected at two sites dominated by pasture. One site was located within the MZ5 offset area and the other in the M6 voluntary management area. The data collected are contained in Table 8 (2019, 2018 and 2017 data) and Table 9 (2012-2016 data), which also include the benchmarks for

each of the site attributes for the relevant PCT. The relevant PCT is 850 Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain. Benchmarks for 2012-2016 data are for BVT HN529.

Table 8. Comparison of pasture plots to PCT benchmarks (2019, 2018 and 2017)

Plot	Composition (Richness)						Structure (Cover)						Function			
	T	S	G	F	Fe	O	T	S	G	F	Fe	O	NLT	LC	FL	HTW
Benchmarks	5	8	12	15	2	5	52	18	61	10	1	5	3	35	40	0
M5_005 (2019)	0	1	4	1	0	2	0	2	17	0.5	0	0.2	0	20	0	2.2
M5_005 (2018)	0	2	4	4	0	3	0	2.1	28	20.7	0	0.3	0	24	0	6.5
M5_005 (2017)	0	1	6	3	0	1	0	1	22.1	2.1	0	0.1	0	28	0	11.1
MZ6_009 (2019)	0	1	6	3	0	1	0	5	83	0.3	0	0.1	0	33	0	3.5
MZ6_009 (2018)	0	1	4	8	0	2	0	5	13.2	0.8	0	1.1	0	24	0	5
MZ6_009 (2017)	0	1	5	5	0	2	0	4	18.1	0.5	0	0.2	0	14	0	23.5

T – Tree, S – Shrub, G – Grass, F – Forb, Fe – Fern, O – Other; NLT – Number of Large Trees, LC – Litter cover, FL – Length of Fallen Logs. HTW – High Threat Weeds

Table 9. Comparison of the pasture plots to PCT benchmarks (2012-2016)

	NPS	NOS		NMS		NGCG		NGCS		NGCO		EPC	NTH	OR	FL
		L	U	L	U	L	U	L	U	L	U				
Benchmark values	29	18.5	23.5	20	30	23	31	0	5	11.75	19.75	0	0	1	0
M5_005 (2016)	10		0		0		90		0		8	56	0	0	0
M5_005 (2015)	12		0		0		94		0		4	72	0	0	0
M5_005 (2014)	14		0		0		76		0		2	50	0	0	0
M5_005 (2013)	10		0		0		86		0		0	64	0	0	0
M5_005 (2012)	12		0		0		78		0		0	74	0	0	0
M6_009 (2016)	13		0		1.2		88		0		10	52	0	1	0
M6_009 (2015)	18		0		44		2		0		0	99	0	1	0
M6_009 (2014)	13		0		0		38		6		12	76	0	0	0
M6_009 (2013)	14		0		0		50		0		0	68	0	0	0
M6_009 (2012)	16		0		0		58		0		0	70	0	0	0

NPS – Native Plant Species richness, NOS – Native Over-storey cover, NMS – Native Mid-storey cover, NGCG – Native Ground-cover (grasses), Native Ground-cover (shrubs), Native Ground-cover (other), EPC – Exotic Plant Cover, NTH – Number of Trees with Hollows, OR – Over-storey regeneration, FL – Length of Fallen Logs. L – Lower Benchmark, U – Upper Benchmark

4.2.3.2 Discussion

Compositionally, pasture plots scored below benchmark for all growth form groups, but was fairly consistent in 2019 with previous years. Total native plant species richness (NPS) was lower than each of the woodland and blackthorn thicket condition classes for both MZ5 and MZ6. As stated in the previous monitoring reports this is an indication of the poor condition in these areas, the high percentage cover of

exotic pasture grasses and few key native grasses (NGCG) such as Weeping Grass (*Microlaena stipoides*), Kangaroo Grass (*Themeda australis*) and Wallaby Grass (*Rytidosperma racemosum*).

As discussed in previous monitoring reports (Niche 2012, 2013, 2015, 2016, 2017 and 2018), effective regeneration of these areas would be difficult without some re-vegetation of overstorey species, though in time blackthorn is likely to establish. As discussed in Niche (2014) better patches of pasture that are dominated by native grasses should be prioritised if any weed management work is conducted in these pastures. Chilean Needle Grass (*Nassella neesiana*) was recorded in the pasture plot in MZ6 in 2019, 2018 and 2017 and is observed to be dominant in parts of pasture surrounding the woodland areas. This exotic grass is very invasive and should be appropriately controlled as part of the bush regeneration program.

4.3 *Pimelea spicata* annual counts

Annual counts of *Pimelea spicata* where they occur within the fixed monitoring BAM plots are required. *Pimelea spicata* is known to occur in plots MZ5-001, MZ5-003, and MZ5-004. The annual count trigger for intervention is significant loss of population (>20% decline from one year to the next in population across biobanking plots), which would trigger full scale census.

At the time of the 2019 survey, there were no flowers present (likely due to the lack of rain), therefore the results are likely an underestimate of the *Pimelea spicata* stem count within the plots. Please note, previously only percent cover was estimated for *Pimelea spicata* within plots (not stem count), so stem count data is restricted to the years that the annual census was undertaken and the current survey (2019).

Table 10. Stem count of *Pimelea spicata* within fixed monitoring plots

Plot code	2012	2013	2014	2016	2019
MZ5-001	12	0	20	47	14
MZ5-003	5	0	4	4	0 (2 plants at 30 m mark of transect)
MZ5-004	52	218	61	7	47
Total count within BAM plots	69	218	85	58	61

Though some BAM plots have experienced a drop in stem count of *Pimelea spicata*, other BAM plots have experienced an increase in stem count. Overall, when accounting for all plots, there has been an increase in stem counts within the plots from 2016 to 2019 from 58 to 61. Across all BAM plots, there has not been a decrease in *Pimelea spicata* population, therefore a full scale census is not triggered.

Differences in population counts between years are likely due to dry conditions around the time of monitoring resulting in the species not occurring above ground. This is supported by Recovery Plan for *Pimelea spicata* (DEC 2005) which states:

‘It is difficult to accurately estimate population size and extent of occurrence for *P. spicata* given that the species is cryptic and difficult to detect, particularly when not in flower, and may not be apparent aboveground during drought conditions’.

4.4 Photo-points

Photo-point monitoring was conducted at each of the locations shown in Figure 2. A selection of the photo points has been provided in Appendix D. Changes evident include increased cover of ground and shrub layer over the monitoring period (2012 to present). Continued woody weed control is required in 2020, evident by the increase in woody weeds in the photo point monitoring.

4.5 Vegetation distribution monitoring

The extent of the wooded native vegetation of the site was mapped using aerial photography from NearMap (latest imagery December 2019) and data from the field surveys. The results were then compared with previous monitoring years.

Based on the results, no detectable increase in woody native vegetation cover was detected since the 2017 monitoring event. The increases in woody vegetation cover since the monitoring has been undertaken is shown in Table 11. The extent is illustrated in Figure 3 and Table 11.

Table 11. Woody native vegetation increases per monitoring year

Management zone	2011 (NPWS 2003)	2012	2013	2014	2015	2016	2017	2018	2019
M5 Woody vegetation	5.28 ha	6.58 ha (1.3 ha increase)	6.73 ha (0.15 ha increase)	7.19 ha (0.46 ha increase)	7.19 ha (no detectable increase since 2014)	7.19 ha (no detectable increase since 2014)	7.27 ha (0.08 ha increase)	7.27 ha (no detectable increase since 2017)	7.27 ha (no detectable increase since 2017)
M6 Woody vegetation	4.49 ha	7.99 ha (3.5 ha increase)	8.34 ha (0.35 ha increase)	8.79 ha (0.45 ha increase)	8.79 ha (no detectable increase since 2014)	8.79 ha (no detectable increase since 2014)	8.91 ha (0.12 ha increase)	8.91 ha no detectable increase since 2017)	8.91 ha no detectable increase since 2017)
Total native woody vegetation	9.77 ha	14.57 ha	15.07 ha	15.98 ha	15.98 ha	15.98 ha	16.18 ha	16.18 ha	16.18 ha

5. Recommendations

The management actions recommended in the BMP are provided in Appendix A. A summary of the management actions implemented throughout 2018-19, and a qualitative assessment of the outcomes and recommendations for 2019-20 are each described below.

5.1 Fencing and stock management

Description/Requirement – Stock exclusion through the upgrading of existing fences and installation of new fences where required. Stock excluded from offset area (MZ5).

Enacted management – New four-strand post and wire fencing was installed in 2011 and stock removed from the offset area.

Outcome (spring 2019) – Fencing was intact. No recent evidence of stock in offset areas during field survey.

Recommendations for 2020

1. Continue to ensure integrity of fencing through regular inspections of the site;
2. Continue to exclude stock from MZ5.

5.2 Bush regeneration

Description/Requirement – Primary, secondary and maintenance weed management by Toolijooa has been conducted since 2011 in the MZ5 offset area, and the MZ6 voluntary management area. This year Landcare Australia (2019) has undertaken the primary, secondary and maintenance weed management.

Previous weed species targeted include: Blackberry (*Rubus fruticosus*), African Olive (*Olea europaea* subsp. *cuspidata*), Lantana (*Lantana camara*), African Boxthorn (*Lycium ferocissimum*), Privet (*Ligustrum* spp.), Cape Ivy (*Delairea odorata*) and a variety of exotic perennial grasses such as African lovegrass (*Eragrostis curvula*), Rhodes grass (*Chloris gayana*), Chilean needle grass and Kikuyu (*Pennisetum clandestinum*).

The weed species identified and targeted in 2019 are: Brassica (*Brassica* spp), Spear thistle (*Cirsium vulgare*), Fleabane (*Conyza* spp.), Paterson's curse (*Echium plantagineum*), Purpletop (*Verbena bonariensis*), Blackberry (*Rubus fruticosus*), African Olive (*Olea europaea* subsp. *cuspidata*) and African Boxthorn (*Lycium ferocissimum*).

Enacted management – Landcare Australia was engaged to undertake bush regeneration in 2019. Landcare Australia has completed three quarterly site visits on the following dates: 9 May 2019, 30 July 2019 and 21 October 2019. A further quarterly site visit is planned for December 2019 or January 2020.

Outcome (spring 2019) – Evidence of weed control shows in the data, with a reduction in EPC in MZ5. However, the dramatic reduction in exotic plant cover during 2018 and 2017 may be a consequence of the different method of data collection, given that no bush regeneration works were undertaken in 2017 or 2018. Weeds, particularly woody weeds, continue to be an issue that requires attention in both the MZ5 and MZ6 zones.

Recommendations for 2020

1. Continue the bush regeneration works, and target woody and vine weeds within better condition areas and drip-lines of large trees and adjacent to regenerating overstorey plants.
2. Ensure that herbaceous weeds and introduced grasses are targeted within woodland areas.

3. Areas which have had large woody weed removal should be followed up to ensure herbaceous weeds do not dominate and promote native regeneration.
4. Targeted spraying of Blackberry (or otherwise recommended treatment) throughout site. Ensure that those areas previously treated are re-inspected and follow up conducted where required.
5. Targeted removal of Chilean Needle Grass, which is beginning to dominate in parts of the pasture areas surrounding the woodland.
6. Ensure staff of the bush regeneration company are familiar with *Pimelea spicata* so as to identify it and avoid it during bush regeneration activities and especially weed spraying.
7. Selectively remove/trim areas of blackthorn thicket surrounding eucalypts. This will help reduce Bell Birds from occupying the site.

5.3 Monitoring of native vegetation and *Pimelea spicata*

Description/Requirement – Design a program to determine the success of management or the need for intervention including assessment of improvement in the condition of native vegetation, annual *Pimelea spicata* population counts, assessment of species and habitat condition and monitoring against stochastic environmental events.

Enacted management – Niche was engaged to develop and implement a monitoring strategy. The methodology is based on the BioBanking Assessment Methodology (DECCW 2014) (now modified to be consistent with the Biodiversity Assessment Method (OEH 2017)), photographic records and formalised *Pimelea spicata* population counts.

Outcome (spring 2019) – Monitoring of native vegetation was undertaken in November 2019, using five fixed BAM plots in MZ5, five fixed BAM plot in MZ6 and a number of photo points. Reduction in species diversity across management zones may be attributable to ongoing drought conditions. Weed control required in 2020 to reduce exotic species cover.

Monitoring of *Pimelea spicata* was conducted via stem counts within the BAM plots in 2019. An increase in number of *Pimelea spicata* stems across all BAM plots combined was observed, comparing latest two years of data (2016 and 2019 data)...

Recommendation for future monitoring

1. Conduct the next monitoring of native vegetation in spring 2019.
2. Conduct the next monitoring of *Pimelea spicata* during its correct flowering period (October-November) in 2021.
3. Maintain annual presence/absence and stem count monitoring for *Pimelea spicata* within BAM plots, and continue opportunistic observations of the presence and spread of the species throughout the offset area.
4. Ensure staff of the bush regeneration company are familiar with *Pimelea spicata* so as to identify it and avoid it during bush regeneration activities and especially weed spraying.

6. Conclusions

The aim of this report was to demonstrate the results of the on-going management actions at the offset and voluntary management areas associated with the Appin Ventilation Shaft Site No.6 site. The on-going management actions at these sites has resulted in improved vegetation condition overall measured by the collection of empirical data, through undertaking annual mapping of the vegetation extent on the site and through a photographic record.

For the most part, the site requires an on-going commitment to weed management and ecological restoration in order to reach a benchmark state and successfully achieve and improve or maintain outcome for biodiversity.

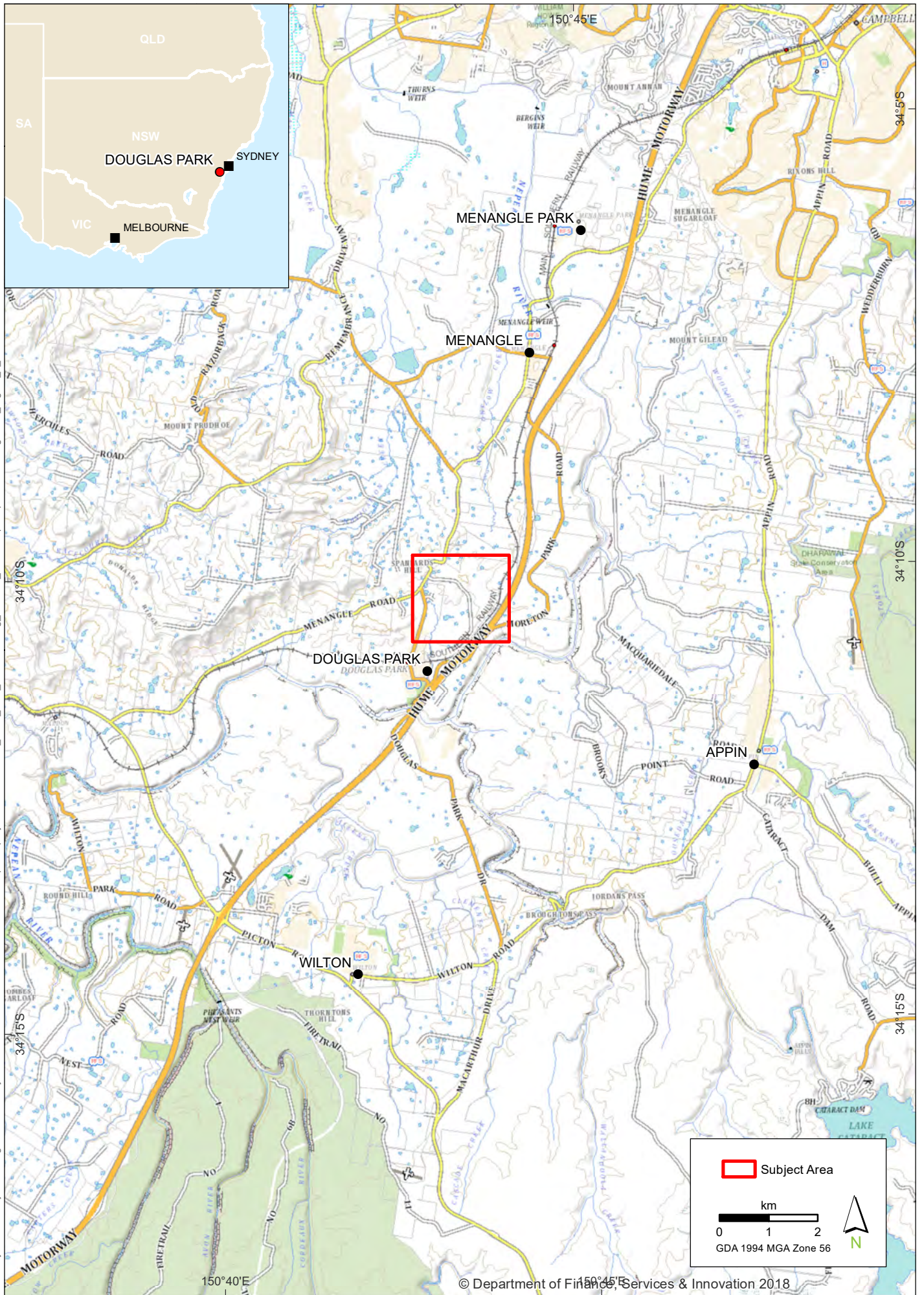
Recommendations for future adaptive management and monitoring of the management zones include:

1. Continue to ensure integrity of fencing through regular inspections.
2. Continue to ensure stock remains excluded from MZ5 in order to ensure the recovery and conservation of the *Pimelea spicata* population.
3. Continue to target woody and vine weeds within better condition areas and drip-lines of large trees and adjacent to regenerating overstorey plants.
4. Conduct herbaceous weed management and introduced grass management within areas of woodland and immediate surrounds.
5. Continue targeted spraying of Blackberry (or otherwise recommended treatment) throughout site. This includes re-visiting areas that have been previously treated to ensure treatment has been effective.
6. Consider feral herbivore control (rabbits), as evidence of rabbit occupation within *Pimelea spicata* habitat was observed in 2016.
7. Ensure bush regeneration staff are familiar with the identification of *Pimelea spicata*.
8. Maintain the timing of annual vegetation monitoring surveys to late October to beginning of December such that the data collected for the species richness and native ground-cover attributes are optimised.

References

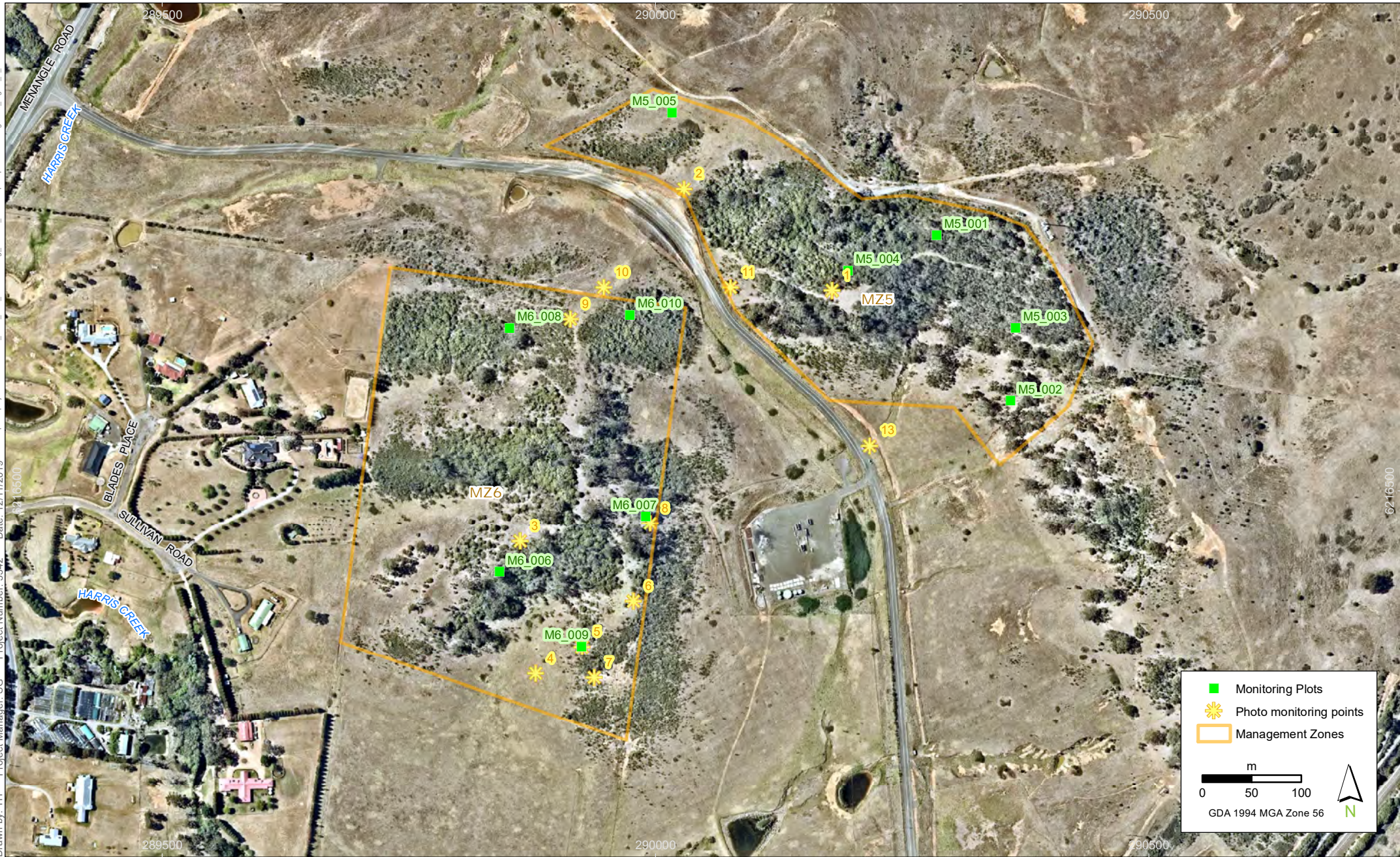
- DECC (2014) BioBanking Assessment Methodology 2014. Office of Environment and Heritage. Dated September (2014).
- Landcare Australia (2019) Appin Vent Shaft 6 Bush Regeneration Report for South32 2019, prepared for South 32 Illawarra Coal.
- OEH (2009) *BioBanking Assessment Methodology and Credit Calculator Operational Manual*, Sydney, NSW.
- OEH (2017) Biodiversity Assessment Method. NW Office of Environment and Heritage. Dated August 2017.
- Niche (2011) *Appin Mine Ventilation Shaft No.6 Project - Biodiversity Management Plan*, prepared for Illawarra Coal.
- Niche (2012) *Appin Ventilation Shaft No. 6 Offset Area Monitoring Report 2012*, prepared for Illawarra Coal.
- Niche (2013) *Appin Ventilation Shaft No. 6 Offset Area Monitoring Report 2013*, prepared for Illawarra Coal.
- Niche (2014) *Appin Ventilation Shaft No. 6 Offset Area Monitoring Report 2014*, prepared for Illawarra Coal.
- Niche (2015) *Appin Ventilation Shaft No. 6 Offset Area Monitoring Report 2015*, prepared for Illawarra Coal.
- Niche (2016) *Appin Ventilation Shaft No. 6 Offset Area Monitoring Report 2016*, prepared for South 32 Illawarra Coal.
- Niche (2017) *Appin Ventilation Shaft No. 6 Offset Area Monitoring Report 2017*, prepared for South 32 Illawarra Coal.
- Niche (2018) *Appin Ventilation Shaft No. 6 Offset Area Monitoring Report 2018*, prepared for South 32 Illawarra Coal.
- Silver, MJ and Carnegie AJ (2017) An independent review of bell miner associated dieback. Final report prepared for the Project Steering Committee: systematic review of bell miner associated dieback.
- South 32 Illawarra Coal (2017) Appin VS#6 Biodiversity Management Plan Bulli Seam Operations. Version P5. Dated 30/01/2017.

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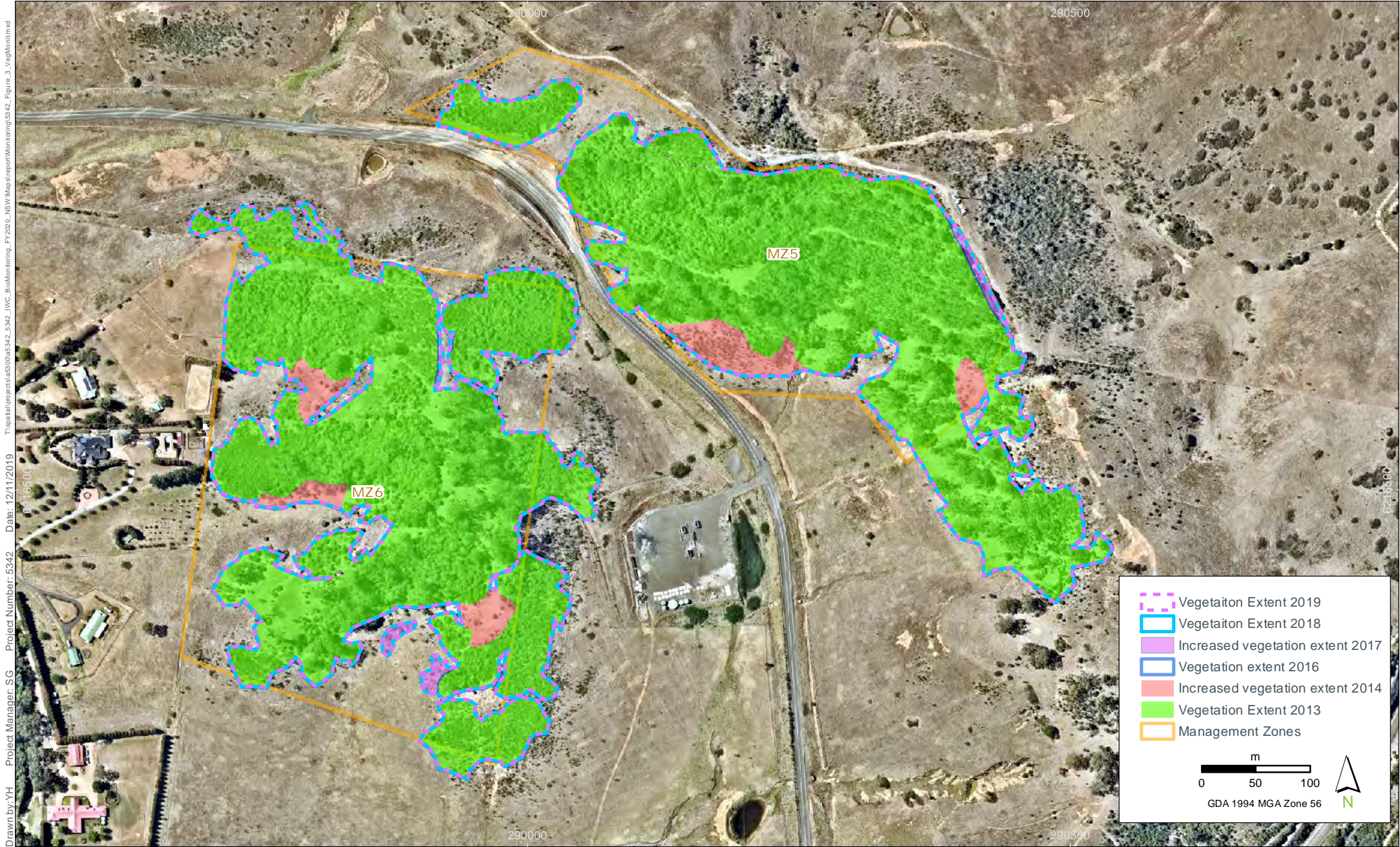


Monitoring plot and photo point monitoring locations

Appin Mine Ventilation Shaft No.6 – Biodiversity Offset Monitoring 2019

FIGURE 2

Imagery: (c) Nearmap 2019-11-13



Appendix A– Management actions, performance criteria, corrective actions and timeframes

Action	Description	Performance Target (Milestones)	Corrective Actions	Timeframe
MZ5 and MZ6 Fencing	The first action within the offset area will be to exclude stock. Existing four-strand post-and-wire fence will be utilised and additional fencing installed where required. No barbed-wire will be used and the bottom strand will have a clearance of 400mm above the ground to allow the movement of native fauna. Stock will be herded out of the area prior to fencing taking place.	Four-strand post-and-wire fence has been installed, no strands barbed and 400 mm separation from ground to lowest strand.	Maintenance of fencing – fencing to be inspected at regular intervals and repairs made as required.	Every 3 months
Bush Regeneration in MZ5	<p>Primary, secondary and maintenance weed management within MZ5 will target the treatment of Blackberry, African Olive, Lantana, African Boxthorn, Privet, Cape Ivy and a variety of exotic perennial grasses such as African lovegrass, Rhodes Grass, Kikuyu and Couch.</p> <p>All weed management works will be supervised by a suitably qualified bush regenerator. A team of four bush regenerators will be engaged for five days for the primary weeding and then a team of two for one day every four months thereafter for secondary and maintenance weed management as required.</p>	<p>Engagement of a suitably qualified bush regeneration contractor to implement primary, secondary and maintenance weed management program has occurred.</p> <p>Annual vegetation condition assessment has commenced.</p> <p>Improvement in condition of offset bushland to within, or as near as possible to, benchmark condition levels – on-going.</p>	<p>On-ground weed management regime to be adaptable and able to respond to changing conditions and weed problems. Given that the Offset Area has an intact soil profile and moderate resilience, sound bush regeneration methods and observance of integrated pest management should minimise the need for corrective actions.</p> <p>Weed management program in Offset Area to be annually reviewed and altered actions documented and implemented.</p> <p>Revegetation with locally collected native vegetation of local genetic stock as recommended by an appropriately qualified expert.</p>	Annually
<i>Pimelea spicata</i> Monitoring program	<p>Design a program to determine the success of management or the need for intervention.</p> <p>Annual population counts within permanent plots.</p> <p>5 yearly population census.</p>	Sustainable <i>Pimelea spicata</i> population with population numbers staying level with or exceeding current numbers.	<p>Annual count trigger for intervention is significant loss of population (>20% of monitored population within BioBanking Plots). Response: undertake full scale census.</p> <p>Stochastic events such as one off fire events will reset the baseline population size which will be determined after a population census immediately after the event</p>	Annually as part of the fixed plot vegetation monitoring and

	<p>Condition of individual plants from mixed cohorts.</p> <p>Condition of habitat.</p> <p>Annual inspections of fencing to ensure maintenance and up-keep.</p> <p>Regular site visits the potential presence of stock and/or feral herbivores that have breached fencing to ensure that such impact is eliminated by fencing and that trapped stock or feral herbivores are freed.</p> <p>Monitoring against stochastic events.</p>		<p>and then again at six, twelve, eighteen and twenty four months post disturbance.</p> <p>5 yearly population census trigger for intervention is: >35% decline in population from preceding census; or Two consecutive (over two census') declines of >20%; or</p> <p>Area of occupancy is mapped to decrease to 50% or lower than originally mapped.</p> <p>Intervention Actions:</p> <p>Stop regeneration works;</p> <p>Consult with experts (RBG Mt Annan);</p> <p>Implement actions as recommended by experts; additional actions may include slashing of competing native grasses, thinning of competing native shrubs or trees (e.g., <i>Bursaria spinosa</i>), ecological burning or resting of weed management until the population stabilises.. Crash grazing should only be utilised as a last resort. In emergency situations, plant rescue and re-introduction may be required.</p>	<p>population census undertaken every five years</p>
<p>Bush Regeneration in MZ6</p>	<p>Weed management within MZ6 will target the treatment of Blackberry, African Olive, Lantana, African Boxthorn, Privet, Cape Ivy and a variety of exotic perennial grasses such as African Lovegrass, Rhodes Grass, Kikuyu and Couch.</p> <p>All weed management works will be supervised by a suitably qualified bush regenerator.</p>	<p>Engagement of a suitably qualified bush regeneration contractor to implement weed management program has occurred</p> <p>Improvement in condition of offset bushland to within, or as near as possible to, benchmark condition levels – on-going.</p>	<p>On-ground weed management regime to be adaptable and able to respond to changing conditions and weed problems. Given that the native vegetation areas have an intact soil profile and moderate resilience, sound bush regeneration methods and observance of integrated pest management should minimise the need for corrective actions.</p> <p>Weed management program in native vegetation area to be annually reviewed and altered actions documented and implemented.</p>	<p>Annually</p>

Appendix B. Plant species list (2019)

Scientific Name	MZ5_01	MZ5_02	MZ5_03	MZ05_04	MZ05_05	MZ06_06	MZ06_07	MZ06_08	MZ06_09	MZ06_10
<i>Acacia implexa</i>								5		
<i>Amyema pendula</i>							0.1			
<i>Anagallis arvensis</i>								0.1		
<i>Araujia hortorum</i>	0.1	0.1	0.2							
<i>Araujia sericifera</i>								0.1		0.1
<i>Aristida ramosa</i>	1	5	5		5	5	10	20		5
<i>Arthropodium milleflorum</i>						0.1				
<i>Asparagus asparagoides</i>	0.1									
<i>Asperula conferta</i>			0.1	0.1	0.5					
<i>Bromus catharticus</i>								0.1		
<i>Bromus hordeaceus</i>									5	
<i>Brunoniella australis</i>	2	0.1	2	0.5		0.5	0.5		0.1	0.2
<i>Bursaria spinosa</i>					2		10			
<i>Bursaria spinosa spinosa</i>	45	15	20	70		50		25	5	60
<i>Calotis cuneata</i>						0.1	0.5	0.5	0.1	
<i>Calotis lappulacea</i>						0.1				
<i>Capsella bursa-pastoris</i>							0.1			
<i>Carex inversa</i>										0.1
<i>Chloris truncata</i>		0.5	5		5	10		10	5	
<i>Clematis aristata</i>				0.1						
<i>Convolvulus erubescens</i>					0.1				0.1	0.1
<i>Crassula sieberiana</i>						0.1				
<i>Cynodon dactylon dactylon</i>									15	
<i>Cyperus laevis</i>								0.2		
<i>Delairea odorata</i>	0.5		0.2	0.1						
<i>Desmodium varians</i>	0.1	0.1	0.1	0.1						0.1

Scientific Name	MZ5_01	MZ5_02	MZ5_03	MZ05_04	MZ05_05	MZ06_06	MZ06_07	MZ06_08	MZ06_09	MZ06_10
<i>Dianella longifolia longifolia</i>								0.1		
<i>Dichondra repens</i>	0.1	0.2	0.2	0.2		0.1	0.2			0.3
<i>Echinopogon ovatus</i>				0.2						
<i>Einadia hastata</i>	0.2		3							
<i>Einadia nutans</i>						3				
<i>Einadia nutans nutans</i>							5	5		
<i>Einadia polygonoides</i>			0.2							
<i>Einadia trigonos</i>	0.1									
<i>Elymus scaber</i>									3	
<i>Eragrostis leptostachya</i>								0.1		
<i>Eucalyptus crebra</i>						20		15		
<i>Eucalyptus moluccana</i>	2		5			5	50			
<i>Eucalyptus tereticornis</i>	35	10	20							
<i>Galium spp.</i>	0.1									
<i>Glycine tabacina</i>	0.1		0.1	0.1	0.1			0.1		0.1
<i>Lantana camara</i>								10		0.1
<i>Lolium perenne</i>									0.5	
<i>Lomandra filiformis coriacea</i>						0.1		0.5		
<i>Lycium ferocissimum</i>			0.5				5	1		
<i>Microlaena stipoides</i>					5					
<i>Microlaena stipoides stipoides</i>	5	5	10	10		40	0.5		50	5
<i>Nassella neesiana</i>							5		3	
<i>Olea europaea africana</i>		5								
<i>Olea europaea cuspidata</i>							65	8	0.5	30
<i>Olea europaea europaea</i>	8		5	30	0.2					
<i>Oplismenus aemulus</i>	0.1			0.1						
<i>Oplismenus spp.</i>										0.1
<i>Opuntia stricta</i>	0.1		0.1							
<i>Oxalis perennans</i>	0.1			0.1						

Scientific Name	MZ5_01	MZ5_02	MZ5_03	MZ05_04	MZ05_05	MZ06_06	MZ06_07	MZ06_08	MZ06_09	MZ06_10
<i>Panicum simile</i>		0.5								
<i>Paspalum dilatatum</i>					2			0.3		
<i>Pennisetum clandestinum</i>					35					
<i>Pimelea spicata</i>	0.1			0.1						
<i>Plantago gaudichaudii</i>										0.1
<i>Plantago lanceolata</i>		0.1		0.1	0.5	0.5		0.1	2	0.1
<i>Poa labillardierei labillardierei</i>	0.5		2		0.5					
<i>Poa sieberiana sieberiana</i>										10
<i>Rubus fruticosus</i>		0.1		0.2	0.1					
<i>Rubus parvifolius</i>				0.1						
<i>Rytidosperma spp.</i>					2				5	15
<i>Senecio madagascariensis</i>					0.1	0.1	0.1			0.1
<i>Sida corrugata</i>						0.1			0.1	
<i>Sida rhombifolia</i>		0.1	0.1	0.1	0.2		0.5	0.1		
<i>Smilax glycyphylla</i>	1									
<i>Solanum prinophyllum</i>	0.1		0.2							
<i>Sporobolus spp.</i>									5	
<i>Themeda triandra</i>	1	10		10			2	15		30
<i>Verbena bonariensis</i>		0.1			0.2					
<i>Verbena rigida</i>									5	
<i>Veronica plebeia</i>	0.1	0.1		0.1						

Appendix C. Biodiversity Assessment Method: measuring vegetation integrity attributes (OEH 2017)

Composition

- Assessment of composition is based on the number of native plant species (richness) observed and recorded by the assessor within a plot for each growth form group shown in Table 3 of the BAM (OEH 2017).
- The assessor must assign a native plant species to a growth form group according to the definitions set out in Appendix 4 of the BAM. An assessor must allocate a species to one growth form group based on the adult/mature growth form of the species.
- The minimum vegetation survey data required to be recorded by the assessor for composition at each 20m x 20m condition plot are:
 - (a) full species name (*Genus species*) 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, and
 - (b) genus name or the full species name where practicable for all other species. Practicable means that sufficient plant material is present to make a species level identification and the assessor has sufficient skills and knowledge to make the identification in the field
 - (c) whether each species is native, exotic, or high threat exotic
 - (d) the growth form group to which each native species has been allocated.
- The composition of each growth form group is assessed by counting the number of different native plant species recorded within each growth form group within each 20m × 20m condition plot.

Structure

- Structure is the assessment of foliage cover for each growth form group within the 20m x 20m plot boundary. 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 must record 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 must draw from the following number series: 0.1, 0.2, 0.3,.....1, 2, 3,.....10, 15, 20, 25,.....100%.
- The assessor must not use methods such as Braun-Blanquet (or other) classes, or a transect point intercept method to record the foliage cover score for a growth form group.
- The structure of each growth form group for the 20m x 20m plot is 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 must assign each non-native (exotic) plant species a foliage cover estimate and either E (exotic) or HTE (high threat exotic).

Function

- The number of large trees, tree stem size class, tree regeneration and length of fallen logs is recorded within a 1000m² plot.
- Tree stem size classes should be 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 contribute to counts for determination of presence and for a multi-stemmed tree, only the largest living stem is included in the count.

- 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 must be equal to or greater than the large tree benchmark DBH size to count as a large tree.
- Stem size class is 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).
- For a multi-stemmed tree, only the largest living stem is counted for determining the presence or absence of stems within each size class.
- Regeneration is 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 must only record 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. Litter cover includes leaves, seeds, twigs, branchlets and branches (<10cm in diameter). The assessment of litter cover must include all plant material that is 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 should be considered as the two-dimensional litter layer and includes litter under the canopies of erect plants.
- The number of trees with hollows is 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 can include native species allocated to the shrub growth form group. It must include both living and dead trees.
- The number of trees with hollows does 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 and for identifying the credit class for biodiversity credits in Chapter 11 of the BAM.

Appendix D. Photo point monitoring



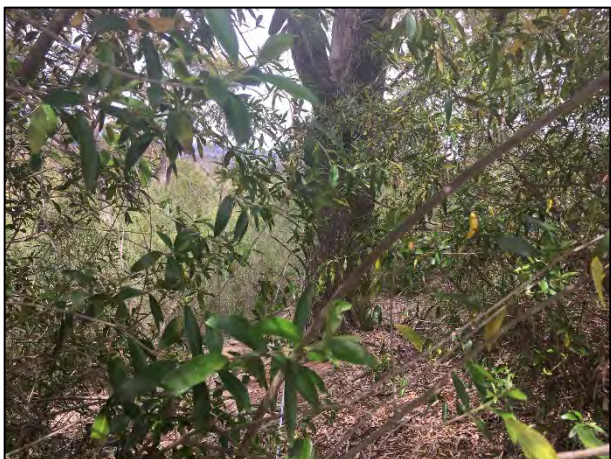
Derived grassland and area of woodland from MZ6-009 (photo point 5) during 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 2019



Derived grassland from photo point 4 during 2012, 2013, 2014 2015, 2016, 2017, 2018 and 2019.



Area of erosion from photo point 7 during 2012, 2013, 2014, 2015, 2017, 2018 and 2019.



MZ6_006 during 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 2019. Note the obvious cover differences between the years. Woody weed control required in 2020.



MZ6_007 during 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 2019. Note the ground cover since 2012. Woody weed control required in 2020.



Regenerating woodland from MZ5_002 during 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 2019. Note the increase in the regeneration of *Bursaria spinosa* within the woodland understorey.



Derived grassland from M5_005 during 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 2019.

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Wildlife Schools and training

Heritage management

Aboriginal heritage
Historical heritage
Conservation management
Community consultation
Archaeological, built and landscape values

Environmental management and approvals

Impact assessments
Development and activity approvals
Rehabilitation
Stakeholder consultation and facilitation
Project management

Environmental offsetting

Offset strategy and assessment (NSW, QLD, Commonwealth)
Accredited BAM assessors (NSW)
Biodiversity Stewardship Site Agreements (NSW)
Offset site establishment and management
Offset brokerage
Advanced Offset establishment (QLD)