



Byerwen Coal Pty Ltd
EPBC 2010/5778 (Commonwealth)
EPML00595013 (State)

Offset Area Management Plan
Wollombi Station

November 2018

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Introduction

The purpose of this management plan is to identify the management objectives and outcomes, and the actions necessary to fulfil a statutory requirement for the provision of an offset under the *Queensland Biodiversity Offsets Policy* (2011) (QBOP) and the *Environment Protection & Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act).

The plan is composed of four components:

Part 1 – Summary information

This section must be completed by all offset proposals and lists all of the following information:

1. Departmental reference details
2. Legislative triggers and impacts requiring an offset
3. Offset area details
4. Ecological Equivalence Assessment
5. Description of the values in the stage 1 impact area and the values located on the offset area

Part 2 – Management plan

This section contains the management plan details that must be completed based on the offsets triggered and requires at a minimum the following information:

1. The offset area management objectives and outcomes
2. Any restrictions imposed on the use of the offset area
3. The activities that will be undertaken to achieve the objectives and outcomes
4. Monitoring requirements
5. An analysis of the risks to achieve the management objectives and outcomes
6. A map that shows spatially the areas subject to the management plan
7. A reporting program
8. Consent between the Landholder and the delegate

Part 3 – Attachment 1 baseline data

1. Ecological equivalence assessment of the offset area
2. Weed Fact Sheets
3. Flora and fauna present on the offset area or adjacent to offset area

Part 4 – Attachment 2 Land Manager's Monitoring Guide

1. The Land Manager's Monitoring Guide published by the State of Queensland (Department of Environment and Resource Management) 2010 (DERM)

1. Summary information

1.1 Departmental reference details

Departmental Reference Details for application that triggers offset	
Departmental Reference Number and Case Name:	DoE reference: 2010/5778 DEHP Environmental Authority EPML00595013 – Byerwen Coal Mine
Offset reference number (if applicable):	N/A
Tenure: GHPL 30/4120 (State Lease)	Primary Local Government Area: Isaac Regional Council

Offset Triggers and Values	
Offset Trigger	Values requiring to be offset
<input type="checkbox"/> Regional Vegetation Management Code <ul style="list-style-type: none"> <input type="checkbox"/> Part P <input type="checkbox"/> Part S <input type="checkbox"/> Part Xa <input type="checkbox"/> Part Xb <input type="checkbox"/> Material Change of Use / Reconfiguration of a lot Policies (Table F1) <input checked="" type="checkbox"/> <i>Environment Protection & Biodiversity Conservation Act 1999 (Cth)</i> <input checked="" type="checkbox"/> <i>Nature Conservation Act 1992 (Qld)/Environmental Protection Act 1994 (Qld)</i>	<input checked="" type="checkbox"/> EPBC TEC and/or Protected Spp. <input type="checkbox"/> Assessable vegetation adjacent to a wetland, significant wetland <input checked="" type="checkbox"/> Assessable vegetation adjacent to a watercourse <input checked="" type="checkbox"/> Connectivity <input type="checkbox"/> Endangered regional ecosystem <input checked="" type="checkbox"/> Of concern regional ecosystem <input type="checkbox"/> Threshold regional ecosystem <input type="checkbox"/> Critically limited regional ecosystem <input type="checkbox"/> Essential habitat <input type="checkbox"/> Essential habitat for koalas in SEQ <input type="checkbox"/> Values within a highly vegetated bioregion <input type="checkbox"/> Protected Plant under the <i>Nature Conservation Act 1992</i>

1.2 Offset area details

Landholder Details	
Registered Owner/s on Title: Christopher Ian Wallin	
Sub-lessee: NA	Trustee: NA
Business/Company name: NA	
ABN/ACN: NA	
Phone number: NA	Mobile phone: NA
Facsimile number: NA	Contact person (if required): Laif McLoughlin
Email: NA	
Postal Address: PO Box 10630, Brisbane QLD 4000	

Property Details			
Property name:	Wollombi Station	Real property description	Lot 1 on SP278043
Tenure:	GHPL 30/4120 (State Lease)	Primary Local Government Area:	Isaac Regional Council
Planning Scheme Zone:	Rural	Property area (ha):	9831.56 ha
		Offset Area (ha):	536.1 ha
Landzone / geology	<p>Landzone 3 - Recent Quaternary alluvial systems, including closed depressions, paleo-estuarine deposits currently under freshwater influence. Includes a diverse range of soils, predominantly Vertosols and Sodosols.</p> <p>Landzone 4 - Tertiary-early Quaternary clay deposits, usually forming level to gently undulating plains not related to recent Quaternary alluvial systems. Excludes clay plains formed in-situ on bedrock. Mainly Vertosols with gilgai microrelief, but includes thin sandy or loamy surfaced Sodosols and Chromosols with the same paleo-clay subsoil deposits.</p> <p>Landzone 5 - Tertiary-early Quaternary extensive, uniform near level or gently undulating plains with sandy or loamy soils. Includes dissected remnants of these surfaces. Also includes plains with sandy or loamy soils of uncertain origin, and plateau remnants with moderate to deep soils usually overlying duricrust. Excludes recent Quaternary alluvial systems (land zone 3), exposed duricrust (land zone 7), and soils derived from underlying bedrock (land zones 8 to 12). Soils are usually Tenosols and Kandosols, also minor deep sandy surfaced Sodosols and Chromosols. There may be a duricrust at depth.</p>		
Soils	Mainly Vertosols and Sodosols		
Pre-clear regional ecosystem	11.5.3, 11.3.27b, 11.4.11, 11.5.9, 11.4.4, 11.3.7, 11.3.2, 11.4.9		
Existing vegetation	<p>Remnant 11.4.9, 11.4.2, 11.3.2</p> <p>Non – remnant 11.4.9, 11.3.2, 11.5.3, 11.5.9</p> <p>Category X</p>		
Estimated age of vegetation	Remnant – minimum of 25 years, regrowth – minimum of 8 years		
Is there a PMAV currently over all or part of the property, Please detail	Yes – PMAV –2008/00679		
Legally Binding Mechanism			
<p><input checked="" type="checkbox"/> Voluntary Declaration (<i>Vegetation Management Act 1999</i>) <input type="checkbox"/> Covenant (<i>Land Act 1994/Land Title Act 1994</i>)</p> <p><input type="checkbox"/> Nature Refuge (<i>Nature Conservation Act 1992</i>) <input type="checkbox"/> Other</p> <p>Reference Number:</p>			

All existing easements relative to the offset site have been mapped and excluded from the offset area calculations. No other permanent access tracks are to be established within the offset area.

1.3 Description of State impact and offset values

Table 1 identifies the values impacted on and captured under the Queensland *Environmental Protection Act 1994* and Queensland *Nature Conservation Act 1992* (NCA) in the Byerwen Coal Project Stage 1 impact area for which an offset is provided for within the offset areas. The location of remnant regional ecosystems across the Stage 1 impact area is shown in **Figure 1**.

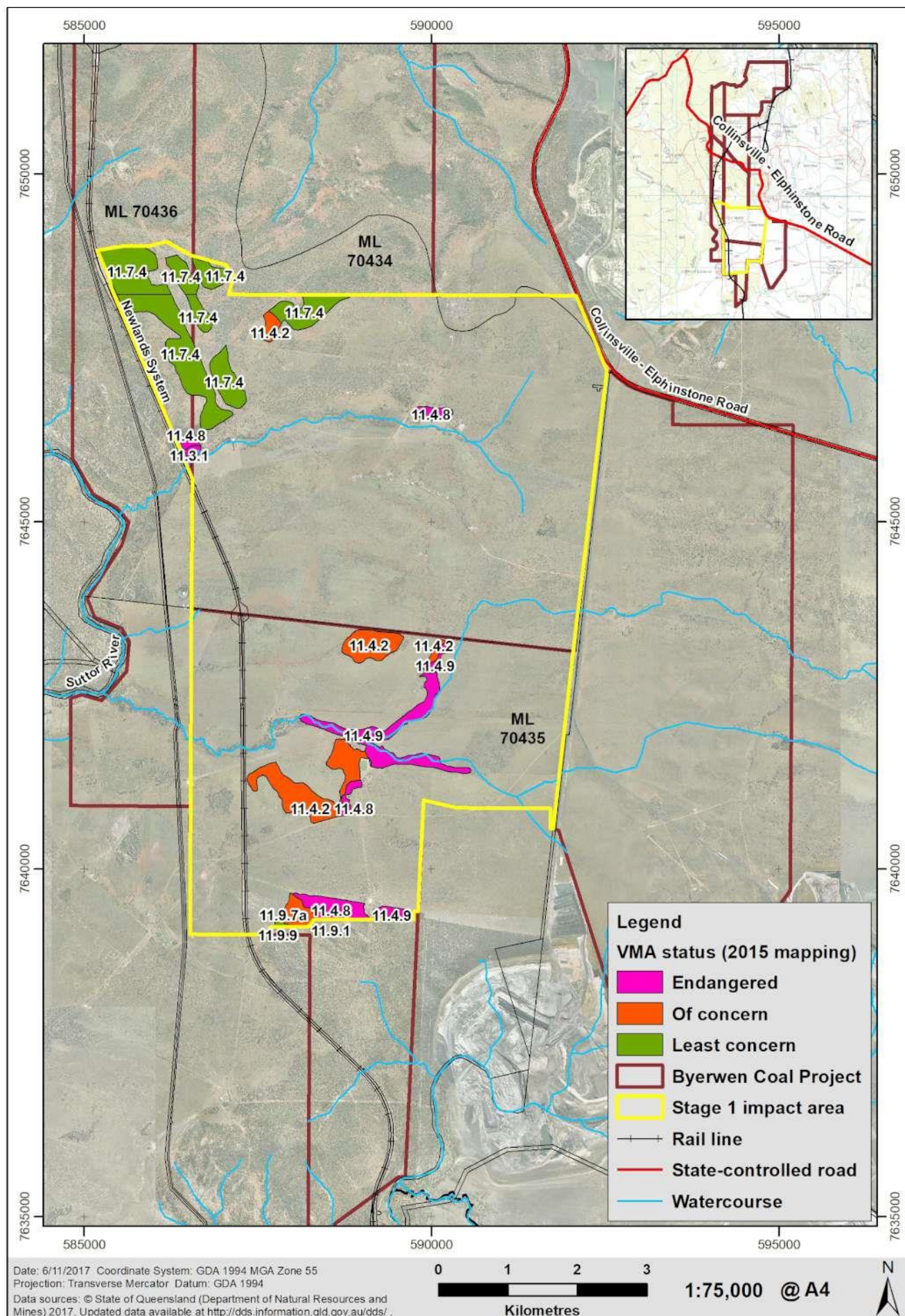
The offsets for impacts to of concern remnant vegetation, watercourse vegetation and connectivity will also benefit the Common Death Adder and Black-throated Finch (southern) which were assessed as likely to occur in the Project area.

Table 1: Impact area values

Impact Area			
Value (as identified in QBOP)	VMA* or NCA status	Regional ecosystem	Area (ha)
Of Concern remnant vegetation (known to occur)	OC	11.4.2 (BVG 17a)	107.2 ha
	OC	11.9.7a (BVG 17a)	15.0 ha
			Total: 122.2 ha
Common Death Adder (likely to occur)	Near Threatened	11.3.1 (BVG 25a)	4.5 ha
		11.7.4 (BVG 12a)	141.8 ha
			Total: 146.3 ha
Black-throated Finch (southern) (likely to occur)	Endangered	11.4.2 (BVG 25a)	8.7 ha
		11.9.7a (BVG 17a)	15.0 ha
		11.9.9 (BVG 13c)	1.8 ha
			Total: 25.8 ha
Watercourse vegetation (known to occur)	-	11.3.1 – SO1 (BVG 25a)	3.3 ha
		11.4.2 – SO2-3 (BVG 17a)	0.1 ha
		11.4.9 – SO2-3 (BVG 25a)	32.2 ha
			Total: 35.6 ha
Connectivity (known to occur)	-	Category B core areas	Total: 193.9 ha

* VMA status refers to the remnant vegetation's classification under the *Vegetation Management Act 1999* (Qld) (VMA)

Figure 1: Location of remnant regional ecosystems within the Byerwen Coal Project Stage 1 impact area



1.4 Ecological equivalence assessment for State Significant Biodiversity Values under QBOP

Ecological Equivalence Assessment	
Impact area	Offset area
Date of Assessment: 1 September 2015	Date of Assessment: September 2015
Ecological Condition assessment score:	Ecological Condition assessment score:
Special Features indicators 1-14:	Special Features indicators 1-14:
Undertaken using Ecological Equivalence Methodology V 1.1	Undertaken using Ecological Equivalence Methodology V 1.1
Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Score sheets/assessment attached Yes: <input checked="" type="checkbox"/> No <input type="checkbox"/>	Score sheets/assessment attached Yes: <input checked="" type="checkbox"/> No <input type="checkbox"/>
Other comments: Refer to Appendix A from Field Assessment Report (Ecological Condition Scoresheets) for assessment scores.	Other comments: Refer to Appendix A from Field Assessment Report (Ecological Condition Scoresheets) for assessment scores.

Table 2A: Offset values – BVG 17a of concern RE 11.4.2 and RE 11.9.7a

	Impact Area	Impact Area				Offset Area						
Assessment Unit:	AU6	AU2				O-AU1				O-AU2		
Assessment Unit Size (ha):	122.2					92.9				122.2		
Regional Ecosystem (RE)	11.9.7a	11.4.2				11.3.2 <i>remnant</i>				11.3.2 <i>non- remnant</i>		
VMA Status	OC	OC				OC						
BVG1M:	17a	17a				17a						
Polygon No.:	17	14	10	9	5	1	7	25	47, 50, 53, 54	8 (cat x)	31, 64	34
Sum of Score:	62.0	67.0	61.0	61.0	61.0	58.0	58.0	58.0	60.5	54.0	41.3	48.0
Polygon Size (ha):	15.3	66.4	3.5	29.8	7.6	17.7	57.4	8.5	9.3	28.2	52.1	41.9
Sum of scores x area / 100 = Ecological equivalence score for ecological condition	9.5	44.5	2.1	18.2	4.6	10.3	33.3	4.9	5.6	15.2	21.5	20.1
Site Context Score:	18.0	7.0	6.0	2.0	16.0	8.0	11.0	8.0	6.0	11.0	7.0	14.0
Polygon Size (ha):	15.3	66.4	3.5	29.8	7.6	17.7	57.4	8.5	9.3	28.2	52.1	42.0
Sum of scores x area / 100 = Ecological equivalence score for special features	2.8	4.6	0.2	0.6	1.2	1.4	6.3	0.7	0.6	3.1	3.6	5.9
Total Condition Score*	78.9					27.1*				56.9		
Total Site Context Score	9.4					4.5				12.6		

* adjusted value of 50% used to accommodate the use of remnant vegetation in the calculations

Table 2B: Offset values – watercourses, stream order 1–3

	Impact Area			Offset Area	
Assessment Unit:	Stream Order 1 AU1	Stream Order 2-3 AU 2	Stream Order 2-3 AU4	Stream Order 5 O-AU2	Stream Order 5 O-AU4
Assessment Unit Size (ha):	4.55	66.35	59.86	94.047	
Regional Ecosystem (RE)	11.3.1	11.4.2	11.4.9	11.3.2	
VMA Status	E	OC	E	OC	
BVG1M:	25a	17a	25a	17a	
Polygon No.:	8	14	12	34	31
Sum of Score:	47.5	67	59.9	48	41.3
Stream order impact Size (ha):	3.3	0.1	32.2	41.9	47.49
<i>Sum of scores x area / 100 = Ecological equivalence score for ecological condition</i>	1.56	0.067	19.28	20.11	19.61
Site Context Score:	12	7.0	7.0	14	7.0
Impact area within stream order buffer (ha):	3.3	0.1	32.2	41.9	47.49
<i>Sum of scores x area / 100 = Ecological equivalence score for special features</i>	0.396	0.007	2.25	5.86	3.32
<i>Total Condition Score</i>	20.9			39.72	
<i>Total Site Context Score</i>	2.65			9.18	

Table 2E: Offset values – connectivity

	Impact Area	Offset area
Size (ha)	193.9	275.4
Description	Polygons of remnant vegetation that are mapped as Category B areas in Stage 1 impact area.	Entirely co-located in 222.1 ha of non-remnant REs 11.3.2, 11.3.4, 11.5.3 and 11.5.9 with Squatter Pigeon (southern) and of concern vegetation offsets, and 58.0 ha of non-remnant RE11.4.9 +/- 11.4.2 with Ornamental Snake offsets, all of which are located within the BPA mapped regional ecological corridor.

1.5 Description of Commonwealth impacts and offset values

Table 3 summarises the impacts to Matters of National Environmental Significance (**MNES**) under the *Environment Protection & Biodiversity Conservation Act 1999* (Commonwealth) in the Byerwen Coal Project Stage 1 area for which an offset is provided. These values are illustrated in **Figure 2**.

Table 3: Summary Byerwen Coal Project impact and offset area values – *Environment Protection & Biodiversity Conservation Act 1999*

Protected Matter	Status	Impact area (ha)	Habitat Quality Score	Offset Area (ha)	Habitat Quality Score	Regional Ecosystem (RE)	Offset Property
Threatened Ecological Communities							
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)	Endangered	Polygon 8 (RE 11.3.1): 4.5 ha Polygon 6,7,13,18 (RE 11.4.8): 43.9ha Polygon 11,12,19 (RE 11.4.9): 74.32 ha Total: 122.8 ha	6	<i>Non-remnant</i> Polygons 30 and 32: 165.0 ha Total: 165.0 ha	6	11.4.9	Wollombi Station
Threatened Species							
Primary habitat for the <i>Denisonia maculata</i> (Ornamental Snake)	Vulnerable	Polygon 8 (RE 11.3.1): 4.5 ha Polygons 6, 7, 13, 18 (RE 11.4.8): 43.9ha Polygons 11, 12, 19 (RE 11.4.9): 74.32 ha Polygons 5, 9, 10, 14 (RE 11.4.2): 107.2 ha Total: 229.9 ha	6	<i>Non-remnant</i> Polygons 30 and 32: 165.0 ha <i>Remnant</i> Polygons 39 and 43: 64.9 ha Total: 229.9 ha	6 5	11.4.9 11.4.9±11.4.2	Wollombi Station

Protected Matter	Status	Impact area (ha)	Habitat Quality Score	Offset Area (ha)	Habitat Quality Score	Regional Ecosystem (RE)	Offset Property
Primary habitat for the <i>Geophaps scripta scripta</i> (Squatter pigeon (southern))	Vulnerable	Polygons 1, 2, 3, 4 (RE 11.7.4): 141.8ha Total: 214.8 ha	7	<i>Remnant</i> Polygons 47, 50, 53, 54: 9.3ha	7	11.3.2	Wollombi Station
				<i>Non-remnant</i> Polygon 31, 34: 89.4ha	6	11.3.2	
				Polygons 45, 46, 55: 96.4 ha	6	11.3.4	
				Polygon 66: 30.3 ha	6	11.4.8	
				Adjacent to Polygons 6 and 7: 47.1 ha	6	11.4.9	
				Polygons 58, 59, 60 (+ south of 60): 116.1ha	6	11.5.3	
				Polygons 41, 56, 57: 29.4ha	6	11.5.9	
				Total: 418.0 ha			

Figure 2: Location of Matters of National Environmental Significance within the Byerwen Coal Project disturbance footprint

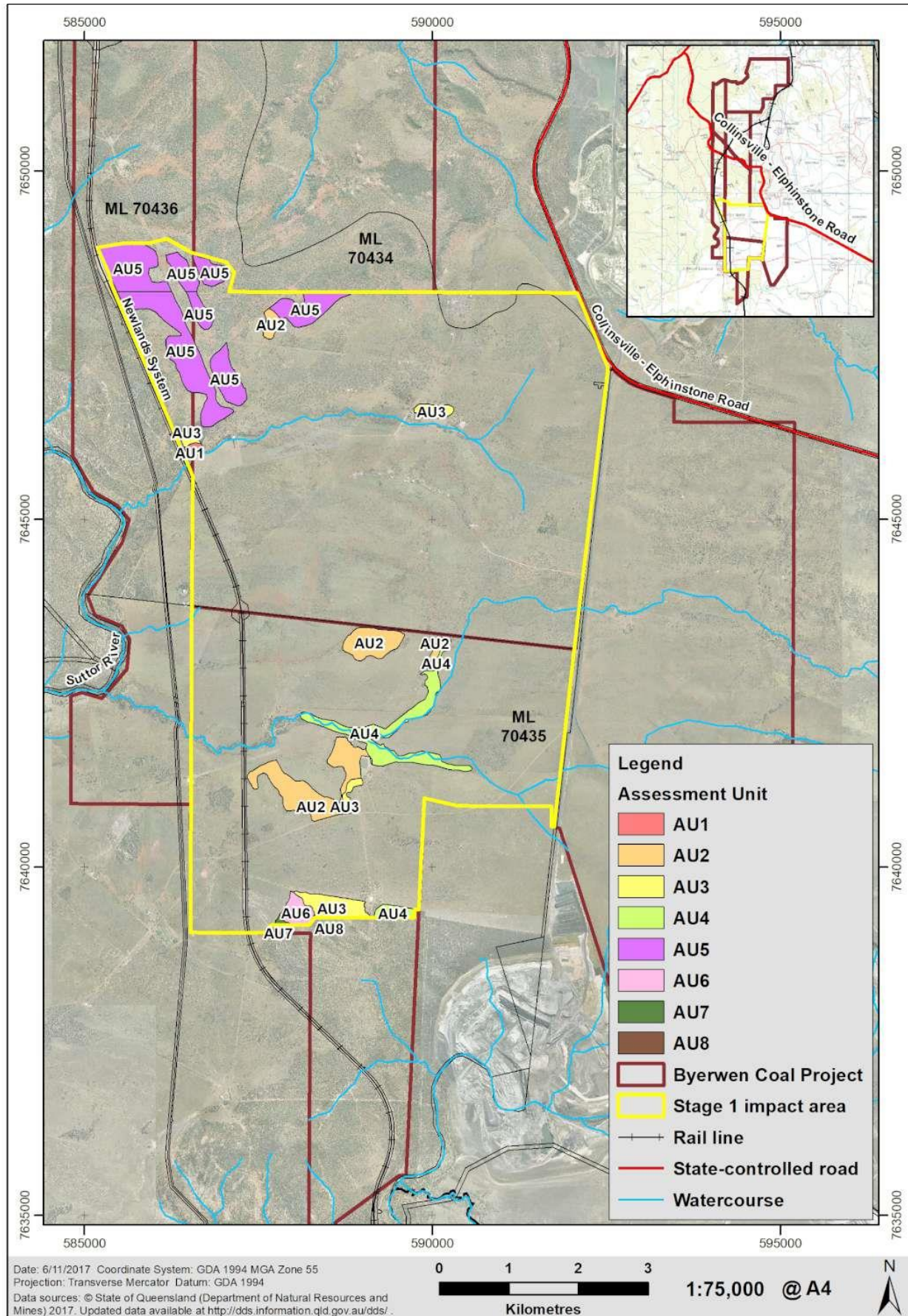


Table 4A: Impact assessment for Brigalow TEC

Attribute	Value	Rationale/assumption
Impact Area		
Description	122.8 ha	The TEC REs are 11.3.1, 11.4.8, 11.4.9 and 11.9.1 (Table 1) and are present across several polygons ranging in size from 3.1 ha to 59.9 ha.
Quality (REs 11.3.1 and 11.4.9 were assessed together as these areas of Brigalow TEC had similar characteristics and ecological equivalence score) (78.8 ha)	6/10	Site condition = 2 The overstorey of the vegetation communities is primarily comprised of Brigalow with Belah (<i>Casuarina cristata</i>) and Yellowwood occurring less commonly. The ground cover tended to be dominated by a mixture of exotic pasture grasses, particularly *Buffel Grass (<i>Pennisetum ciliare</i>) and to a lesser extent *Indian Bluegrass (<i>Bothriochloa pertusa</i>) with an average cover of 9.3%. Native grasses and herbs were less frequently encountered and had an average cover of 4.8%. The ground cover in many areas was moderately to heavily impacted through grazing by cattle.
		Site context = 2 A number of the polygons of Brigalow TEC are small and isolated or have a high edge to area ratio. This is particularly the case with the largest polygon that flanks the unnamed creek in the south of the Stage 1 impact area.
		Species stocking rate = 2 RE 11.4.9 comprises the largest polygon of Brigalow TEC at 59.9 ha. The remaining polygons are approximately 5 ha or greater. In total REs 11.3.1 and 11.4.9 account for 78.8 ha of the Brigalow TEC in the Stage 1 impact area.
Quality (REs 11.4.8 and 11.9.1 are considered to have a slightly higher ecological equivalence score) (44.0 ha)	7/10	Site condition = 3 The overstorey of the vegetation communities is comprised of Dawson River Gum (<i>Eucalyptus cambageana</i>), which represents the ecologically dominant layer (EDL). The ground cover tended to be dominated by a mixture of native grasses with an average cover of 12.6%, and exotic pasture grasses, particularly *Buffel Grass with an average cover of 4.0%. The ground cover in many areas was moderately to heavily impacted through grazing by cattle.
		Site context = 2 One large patch of RE 11.4.8 representing Brigalow TEC is connected with a larger tract of remnant vegetation to the south. Although vegetation clearing for grazing purposes is not a pressure acting on this TEC at this location, the risk of incidences of fire due to increased fuel load in the ground cover layer and continual degradation through cattle grazing are ongoing threats to this community.
		Species stocking rate = 2 A total of 44 ha of RE 11.4.8 and 11.9.1 will be impacted in the Stage 1 impact area.

Table 4B: Impact assessment for primary habitat for the Ornamental Snake

Attribute	Value	Rationale/assumption
Impact Area		
Description	229.9 ha	Field-validation of the Stage 1 impact area found that vegetation representing four remnant REs would be considered to provide habitat for the Ornamental Snake. These REs are 11.3.1, 11.4.2, 11.4.8 and 11.4.9 (Table 1). These REs are comprised of a range of polygons ranging in size from 3.1 ha to 66.4 ha. At present some of the polygons within the Stage 1 impact area comprise a ground layer with a perennial weed cover (i.e. exotic grasses) greater than 50%. Gilgai is present throughout most habitat areas, but ranges from low to moderate quality depending on the extent of thinning and cattle trampling present.
Quality	6/10	<p>Site condition = 2.5</p> <p>The overstorey of the vegetation communities is primarily comprised of Brigalow with Belah and Yellowwood occurring less commonly. The ground cover in many areas was moderately to heavily impacted as a result of grazing by cattle. The majority of RE 11.4.2 did not support gilgai, but in many cases was connected with areas that did, e.g. RE 11.4.9 and contained substantial coarse woody debris. Coarse woody debris in REs 11.3.1, 11.4.8 and 11.4.9 ranged from very low to moderately high.</p>
		<p>Site context = 2.5</p> <p>A number of the polygons of habitat are small and isolated or have a high edge to area ratio. This is particularly the case with the largest polygon that flanks the unnamed creek in the south of the Stage 1 impact area. Continual degradation through cattle grazing are ongoing threats to this habitat.</p>
		<p>Species stocking rate = 1</p> <p>The Stage 1 impact area is within the known distribution of the Ornamental Snake in Queensland, it is known to occur and has been previously recorded in the Stage 1 impact area (Environmental and Licensing Professionals, 2013). It is assumed to be present as potential habitat is available, however, it is not assumed to be present in high numbers.</p>
Risk of loss (%) with mitigation and management	5%	Unlikely, as habitat quality will be improved with cattle exclusion and legal protection of the non-remnant, non-regulated vegetation.
Future quality with mitigation and management (non-remnant RE 11.4.9, polygon 32 and part of polygon 30)	9/10	<p>Site condition = 3.5</p> <p>The existing values and quality of habitat in the offset area will be improved by preventing clearing and with active management of cattle grazing, fire regimes, weed invasion and feral animal (particularly pigs). As native vegetation is allowed to regenerate, microhabitat features such as fallen timber and leaf litter will develop to form the coarse woody debris that is required by Ornamental Snake.</p>
		<p>Site context = 3.5</p> <p>Removing clearing and grazing pressure will allow gradual recovery of the vegetation to remnant status and remove the process of trampling and compaction of gilgai. Water quality of gilgai will improve, which will likely improve quality of habitat for frogs, which are the preferred food of Ornamental Snake.</p>

Attribute	Value	Rationale/assumption
		<p>Species stocking rate = 2</p> <p>Protection and improvement of the quality of this vegetation will result in a large patch of this habitat that is well connected in the broader landscape and will likely support an important population at some point in the future, based on the current DotE definition of an important population (SEWPaC, 2011).</p>
Future quality with mitigation and management (non-remnant RE 11.4.9, polygons 39 and 43)	8/10	<p>Site condition = 3</p> <p>The existing values and quality of habitat in the offset area will be improved with active management of cattle grazing, fire regimes, weed invasion and feral animal (particularly pigs). As native vegetation is allowed to regenerate, microhabitat features such as fallen timber and leaf litter will develop to form the coarse woody debris that is required by Ornamental Snake</p>
		<p>Site context = 3.5</p> <p>Removing clearing and grazing pressure will allow gradual recovery of the vegetation to remnant status and remove the process of trampling and compaction of gilgai. Water quality of gilgai will improve, which will likely improve quality of habitat for frogs, which are the preferred food of Ornamental Snake. These polygons abut remnant areas and are relatively close to the Suttor River and form part of the riparian corridor.</p>
		<p>Species stocking rate = 1.5</p> <p>Protection and improvement of the quality of this vegetation will result in reasonably sized patches of this habitat that is well connected in the broader landscape and located within remnant areas. Therefore, this habitat will likely support an important population at some point in the future, based on the current DotE definition of an important population, although the gilgai may not match the qualities of polygons 30 and 32 (SEWPaC, 2011).</p>
Confidence in averted loss	80%	<p>There is reasonable confidence that loss will occur without intervention through gradual decline in habitat quality particularly through continued heavy grazing by cattle. This will affect recruitment of key species, inhibit natural regeneration of the community and degrade gilgai features.</p> <p>The management and mitigation measures are low risk measures and they are widely applied as standard techniques in the industry. The measures to be applied tend to result in small gains but the outcomes are positive and relatively certain.</p>
Confidence in change of habitat quality	80%	<p>The offset area and broad management strategies are in line with managing the key threats to Ornamental Snake habitat identified in the conservation advice, i.e. reducing vegetation clearing, managing fire risk and cattle grazing pressure (TSSC, 2013). Specifically, the offset will legally secure a large area of habitat and future land management will allow the vegetation to improve in structure and quality to meet remnant status and the condition thresholds for the Brigalow TEC and deep well formed gilgai will be maintained.</p>

Table 4C.1: Impact Area (141.8ha) EPBC Act Offset Assessment Guide Inputs – Squatter Pigeon (southern)

Attribute	Value	Rationale/assumption
Impact Area		
Description	141.8 ha	<p>The project BOS considered the distributions of all polygons of REs 11.3.2 and 11.7.4 (Figure 1) throughout the Stage 1 impact area as Squatter Pigeon (southern) habitat. Field-validation of these areas found that RE 11.3.2 was not present however a larger area of 11.7.4 was present (Figure 1).</p> <p>The field-validated area of impacted Squatter Pigeon (southern) habitat in the Stage 1 impact area is connected to larger tracts of remnant vegetation to the north and west. Connectivity of habitat immediately to the south and south-east is limited as these areas have been cleared of remnant vegetation. This cleared area is up to approximately 7 km in width in some areas between the Squatter Pigeon habitat and other remnant polygons to the south. The Squatter Pigeon habitat is directly connected by remnant vegetation with the Suttor River (fifth order watercourse) state and regional corridor, approximately 1.6 km to the west.</p>
Quality	7/10	<p>Site condition = 3</p> <p>The overstorey of the vegetation communities are dominated by a variety of <i>Eucalyptus</i> and <i>Corymbia</i> species including Narrow-leaved Ironbark (<i>Eucalyptus crebra</i>), Poplar Box (<i>Eucalyptus populnea</i>), Ironwood (<i>Acacia excelsa</i>), with <i>Erythroxylum</i> (<i>Erythroxylum australe</i>), Leichhardt Bean (<i>Cassia brewsteri</i>) and Quinine Tree (<i>Petalostigma pubescens</i>). The ground cover tended to be dominated by a mixture of exotic pasture grasses, particularly *Buffel Grass and *Indian Blue Grass. Native grasses include <i>Aristida</i> sp., Dark Wiregrass (<i>Aristida calycina</i>), Jericho Wiregrass (<i>Aristida jerichoensis</i>), Pitted Bluegrass (<i>Bothriochloa decipiens</i>). The ground cover in many areas was moderately impacted through grazing by cattle, which greatly reduces the amount of cover provided to the Squatter Pigeon (southern). However, these communities exhibited relatively low exotic grass cover and shrub cover was high in these polygons and they would provide suitable breeding and foraging habitat. A second order ephemeral stream and dam is located approximately 500 m to the south of RE 11.7.4 (Figure 1).</p> <p>Site context = 3</p> <p>Large tracts of remnant vegetation occur to the north and west of the Squatter Pigeon (southern) habitat. However, expanses of cleared land occur to the south and south-east The Stage 1 impacted area is within 500 m of permanent and seasonal drainage lines and within 3 km of the Suttor River to the west. Easement clearing for existing water and gas pipelines is also present, particularly in a north-south direction between parts of the habitat and the Suttor River, however, the extent of fragmentation in this</p>

Attribute	Value	Rationale/assumption
		northern area is not substantial and would not be an impediment to the species' movement across the larger remnant landscape.
		<p>Species stocking rate = 1</p> <p>The Squatter Pigeon (southern) was recorded regularly from the Stage 1 impact area during both the EIS surveys (Environmental and Licensing Professionals, 2013) and the recent assessment of habitat condition in September 2015. Seven records of the Squatter Pigeon (southern) were returned from a Wildlife Online search of the impact area and a surrounding 25 km area. Though no evidence of feral cat or fox were observed in the impact area, it is considered likely that they occur within the broader landscape. The feral dog, cat or fox is therefore likely to exert some predation pressure on the Squatter Pigeon (southern).</p>

Table 4C.2: Impact Area (73ha) EPBC Act Offset Assessment Guide Inputs – Squatter Pigeon (southern)

Attribute	Value	Rationale/assumption
Impact Area		
Description	73 ha	<p>The Squatter Pigeon (southern) habitat to be impacted by the extended waste rock dump is foraging habitat only, as indicated in the Ecological Report of September 2016. The impact area is 1.5km to 4.8km from the Suttor River and is Regional Ecosystem (RE) 11.7.4, a dry eucalypt open forest.</p> <p>The additional areas of 11.7.4 for the expansion of the waste rock dump, in the north-west portion of the Stage 1 impact areas, are included in (Figure 1).</p>
Quality	7/10	<p>Site condition = 3</p> <p>The overstorey of the vegetation communities is dominated by a variety of <i>Eucalyptus</i> and <i>Corymbia</i> species including Narrow-leaved Ironbark (<i>Eucalyptus crebra</i>), Poplar Box (<i>Eucalyptus populnea</i>), Ironwood (<i>Acacia excelsa</i>), with <i>Erythroxylum</i> (<i>Erythroxylum australe</i>), Leichhardt Bean (<i>Cassia brewsteri</i>) and Quinine Tree (<i>Petalostigma pubescens</i>). The ground cover tended to be dominated by a mixture of exotic pasture grasses, particularly *Buffel Grass and *Indian Blue Grass. Native grasses include <i>Aristida</i> sp., Dark Wiregrass (<i>Aristida calycina</i>), Jericho Wiregrass (<i>Aristida jerichoensis</i>), Pitted Bluegrass (<i>Bothriochloa decipiens</i>). The ground cover in many areas was moderately impacted by cattle grazing, which greatly reduces the amount of cover provided to the Squatter Pigeon (southern). However, these communities exhibited relatively low exotic grass cover and shrub cover was high in these polygons and they could provide suitable breeding and foraging habitat. A second order ephemeral stream and dam is located approximately 500 m to the south of RE 11.7.4 (Figure 1).</p> <p>Site context = 3</p> <p>Large tracts of remnant vegetation occur to the north and west of the Squatter Pigeon (southern) habitat. However, expanses of cleared land occur to the south and south-east. The Stage 1 impacted area is within 500 m of permanent and seasonal drainage</p>

Attribute	Value	Rationale/assumption
		<p>lines and within 3 km of the Suttor River to the west. Easement clearing for existing water and gas pipelines is also present, particularly in a north-south direction between parts of the habitat and the Suttor River, however, the extent of fragmentation in this northern area is not substantial and would not be an impediment to the species' movement across the larger remnant landscape.</p>
		<p>Species stocking rate = 1</p> <p>Squatter Pigeons (southern) have been recorded in pairs or small flocks.</p> <p>The Squatter Pigeon (southern) was recorded regularly from the Stage 1 impact area during both the EIS surveys (Environmental and Licensing Professionals, 2013) and the recent assessment of habitat condition in September 2015. Seven records of the Squatter Pigeon (southern) were returned from a Wildlife Online search of the impact area and a surrounding 25 km area. Though no evidence of feral cat or fox were observed in the impact area, it is considered likely that they occur within the broader landscape. Feral dogs, cats and/or foxes are therefore likely to exert some predation pressure on the Squatter Pigeon (southern).</p>

Table 5A: Offset area calculator inputs - Wollombi Station – Brigalow TEC

Attribute	Value	Rationale/assumption
Offset Area		
Description	165.0 ha (non-remnant RE 11.4.9)	<p>The offset area is situated adjacent to a 3.6 km stretch of the Suttor River riparian corridor. The offset area is approximately 4 km south-west of the Stage 1 impact area, and connected to other extensive tracts of remnant vegetation to the south, west and north-west and framed by the Suttor River to the north and Suttor Creek to the south. The offset area is connected to the Stage 1 impact area via vegetation along the Suttor River. The offset area also provides habitat for the Ornamental Snake as well as potential dispersal habitat for the Squatter pigeon.</p> <p>The characteristics of the offset area, particularly polygon 32, are considered to present opportunity for substantial improvement in condition of the Brigalow vegetation due to the low lying position of the vegetation in the landscape and moist condition of the ground layer.</p>
Time over which loss averted	20 years	A legally binding mechanism will be established for the offset area providing protection and management for the term of the management plan.
Time until ecological benefit	10 years	Ecological benefit will principally be achieved through the prevention of clearing, management of cattle grazing, appropriate management of fire regime, management of feral animals (particularly feral pigs) and control of weeds. These management actions will improve the cover of native grasses and/or sedges and other hydrophilic vegetation that is prevalent in the gilgai areas (e.g. <i>Eleocharis spp.</i>) through reduced soil compaction, trampling and predation that is associated with cattle grazing. These benefits are likely to be realised in approximately 5-10. Reduced grazing pressure will also have the benefit of reduced soil compaction and trampling, which will provide more favourable conditions for recruitment.
Start quality (non-remnant RE 11.4.9, polygon 32 and part of polygon 30)	5/10	<p>Site condition = 1.5</p> <p>The offset vegetation is represented by non-remnant RE 11.4.9 (polygon 32 and part of polygon 30, which is dominated by Brigalow. A high proportion of the ground cover layer is comprised of native sedges. In polygon 32, native ground cover accounted for 37.7% average vegetative cover, while exotic vegetative cover was 5.5%. *Buffel Grass is more prevalent in polygon 30 and in conjunction with *Indian Bluegrass has an average cover of 21.0% compared with the average cover of native grasses, which is 4.8%.</p> <p>The vegetation is non-remnant, although there is recruitment of key species, including Brigalow. Species richness is above average. There are large areas of low exotic grass cover, particularly in polygon 32. The moist condition of the ground layer across large sections of this offset area impede *Buffel Grass growth to the extent that it does not readily outcompete native cover.</p>
		<p>Site context = 1.5</p> <p>The offset area is connected with other large tracts of remnant and non-remnant vegetation including the Suttor River ecological corridor to the north-west. The Brigalow offset area is approximately 450 m from the Suttor River and the western portion is in the mapped biodiversity corridor. The offset area is generally well connected in the broader landscape and is within a broad distribution of largely contiguous remnant vegetation to the north, west and south. However, cattle grazing is intensive in the offset area and this inhibits recruitment and the growth of the community to remnant structure. Minimal fencing</p> <p>also allows cattle to significantly overgraze and over-utilise preferable areas.</p>
		Species stocking rate = 2

Attribute	Value	Rationale/assumption
		The offset area is part of larger non-remnant polygons of RE 11.4.9 greater than 1,200 ha. These areas have the potential to form remnant vegetation representative of the Brigalow TEC in the future.
Risk of loss (%) without offset	100%	<p>The Wollombi Station has been historically managed by an agistee for cattle grazing purposes. The vegetation in non-remnant (Category X) areas has been actively managed to suppress woody vegetation in order to increase livestock carrying capacity and ease of livestock management. Management actions have included removing juvenile trees and shrubs and managing fuel loads. It is understood that it is the intention of the agistee to continue these practices as routine management of the balance of the property once offsets have been finalised and set aside (Lane Infrastructure Pty Ltd pers. comms. 12 September 2016). Therefore, it is reasonable to expect that the offset area would otherwise become gradually degraded from its current state as a result of the on-going land management practices</p> <p>Due to the Category X non-regulated classification of this area under the VM Act, it is anticipated that the area of regrowth will be maintained in a suppressed or cleared state in the future without the need for permits.</p>
Future quality without offset	4/10	<p>Site condition = 1.5</p> <p>The condition of vegetation particularly the abundance of native sedges will potentially be adversely affected over the long term, particularly on the edge of soak areas where existing land management is maintained. Cattle grazing will further degrade the ground cover layer and shrub layer, particularly during times of extended drought, and the community will unlikely meet remnant and/or TEC status in the foreseeable future. Weed infiltration of other areas is a risk to this community.</p>
		<p>Site context = 1.5</p> <p>Connectivity is unlikely to be substantially affected as the offset area is connected with large tracts of remnant vegetation to the west.</p> <p>There is potential for this vegetation to become an area of refuge for cattle during particularly dry conditions and seasons due to the moist conditions of the ground layer.</p>
		<p>Species stocking rate = 1.0</p> <p>There is potential for broad scale clearing within the offset area and adjacent non-remnant areas. The offset area is currently non-remnant and mapped as non-regulated and therefore clearing associated with land management practices is possible and highly likely.</p>
Risk of loss (%) with mitigation and management	5%	Unlikely, as habitat quality will be improved with cattle management and legal protection of the non-regulated vegetation from clearing for pasture production.
Future quality with mitigation and management	8/10	<p>Site condition = 3.5</p> <p>The existing values and quality of habitat in the offset area will be improved with active management of cattle grazing, fire regimes and weed invasion.</p>
		<p>Site context = 2.0</p> <p>Removing constant grazing pressure will allow gradual recovery of the vegetation to remnant status.</p>
		<p>Species stocking rate = 2.5</p> <p>Protection and improvement of the quality of this vegetation will result in a large patch of this TEC that is well connected in the broader landscape.</p>

Attribute	Value	Rationale/assumption
Confidence in averted loss	80%	<p>There is a high level of confidence that loss will occur without protection and intervention through gradual decline in habitat quality particularly through continued heavy grazing by cattle and clearing for pasture production.</p> <p>The management and mitigation measures proposed are low risk measures and they are widely applied as standard techniques in the industry. The measures to be applied tend to result in incremental gains but the outcomes are positive and relatively certain.</p>
Confidence in change of habitat quality	80%	<p>The offset area and broad management strategies are in line with managing the key threats to Brigalow TEC identified in the conservation advice, i.e. reducing vegetation clearing, managing fire risk and cattle grazing pressure (TSSC, 2013). Specifically, the offset will legally secure a large area of vegetation and future land management will allow the vegetation to improve in structure and quality to meet remnant status and the condition thresholds for the Brigalow TEC.</p>

Table 5B – Offset area calculator inputs - Wollombi Station – Ornamental Snake

Attribute	Value	Rationale/assumption
Offset Area		
Description	<p>229.9 ha</p> <p>(165.0 ha of non-remnant RE 11.4.9 (polygons 30 and 32) and 64.9 ha of non-remnant RE 11.4.9 +/- 11.4.2 (polygons 39 and 43))</p>	<p>The offset area is situated adjacent to a stretch of the Suttor River riparian corridor. The offset area is approximately 4 km south-west of the Stage 1 impact area. The offset area is connected to other extensive tracts of remnant vegetation to the south, west and north-west and framed by the Suttor River to the west and north-west and Suttor Creek to the south. The Wollombi offset area is connected to the Stage 1 impact area via remnant vegetation along the Suttor River. The offset area also provides habitat for Brigalow TEC, and dispersal habitat for the Squatter Pigeon as well as other SSBV (see <i>Table 2</i>).</p> <p>The characteristics of the offset area, particularly polygon 32, are considered to present opportunity for substantial improvement in condition of the Brigalow vegetation and gilgai due to the low lying position of the vegetation in the landscape, underlying clay soils and moist condition of the ground layer.</p>
Time over which loss averted	20 years	A legally binding mechanism would be established for the offset area providing protection and management over the timeframe required to achieve the management plan outcomes.
Time until ecological benefit	5 years	Ecological benefit will principally be achieved through the prevention of clearing, management of cattle grazing, appropriate management of fire regime, management of feral animals (particularly pigs) and control of weeds. These management actions will improve the cover of native grasses and/or sedges and other hydrophilic vegetation that is prevalent in the gilgai areas (e.g. <i>Eleocharis spp.</i>) through reduced soil compaction, trampling and predation that is associated with cattle grazing. These benefits are likely to be realised in approximately 5-10. Reduced grazing pressure will also have the benefit of reduced soil compaction and trampling, which will provide more favourable conditions for recruitment and improve gilgai formation and water quality within gilgai.
Start quality (non-remnant RE 11.4.9, polygon 32 and part of polygon 30) (165.0 ha)	6/10	<p>Site condition = 2.5</p> <p>The offset vegetation is represented by non-remnant RE 11.4.9 (polygon 32, part of polygon 30, which is dominated by Brigalow and associated Yellowwood and Red-flowered Bauhinia and/or Belah. A high proportion of the ground cover layer was comprised of native sedges, and native grasses. In polygon 32, native ground cover accounted for 37.7% average vegetative cover, while exotic</p>

Attribute	Value	Rationale/assumption
		<p>vegetative cover was 5.5%. *Buffel Grass is more prevalent in polygon 30 and in conjunction with *Indian Bluegrass has an average cover of 21.0% compared with the average cover of native grasses, which is 4.8%. Gilgai formation is of good condition with clay cracks in excess of 2 m deep. There is limited coarse woody debris most likely due to the age of the vegetation and there was evidence of stick raking throughout this habitat.</p> <p>The vegetation is non-remnant, although there is recruitment of key species, including Brigalow. Species richness is above average. There are large areas of low weed cover compared with exotic grass cover. The moist condition of the ground layer across large sections of this offset area impede *Buffel Grass growth to the extent that it does not readily outcompete native cover. These conditions have also allowed persistence of native sedges in the ground layer, which further improves the quality of the gilgai for Ornamental Snake.</p>
		<p>Site context = 3</p> <p>The offset area is connected with other large tracts of remnant and non-remnant vegetation and these are connected to the Suttor River corridor only 0.4 km to the north-west. The offset area is generally well connected in the broader landscape and is within a broad distribution of largely contiguous remnant vegetation to the north, west and south.</p>
		<p>Species stocking rate = 0.5</p> <p>The offset area is well within the known distribution of the Ornamental Snake and there is good connectivity with expansive remnant areas to the north-west. It is considered highly likely to be present, particularly in areas such as Polygon 32, as gilgai formation is in good condition and numerous deep cracks are present.</p>
Start quality (non-remnant RE 11.4.9, polygons 39 and 43) (64.9 ha)	5/10	<p>Site condition = 2</p> <p>Regrowth vegetation was representative by non-remnant RE 11.4.9. A high proportion of the ground cover layer was comprised of *Buffel Grass +/- *Indian Bluegrass. Minor gilgai formation was also recorded, but it would appear that the historic structure and depth of these has been impacted through the frequency of clearing. There is limited coarse woody debris most likely due to the age of the vegetation and there was evidence of stick raking throughout this habitat.</p> <p>The vegetation is non-remnant, although there is recruitment of key species, including Brigalow. Species richness is moderate. There are large areas of low weed cover compared with exotic grass cover. The moist condition of the ground layer across large sections of this offset area impede *Buffel Grass growth to the extent that it does not readily outcompete native cover.</p>
		<p>Site context = 3</p> <p>The offset area is connected with other large tracts of remnant and non-remnant vegetation and these are connected to the Suttor River corridor only 0.4 km to the north-west. The offset area is generally well connected in the broader landscape and is within a broad distribution of largely contiguous remnant vegetation to the north, west and south. However, cattle grazing is intensive in the area in which the offset is located and this inhibits recruitment and the growth of the community to remnant structure. It also affects condition and suitability of the understorey and gulgais to support Ornamental Snake.</p>
		<p>Species stocking rate = 0.5</p> <p>The offset area is well within the known distribution of the Ornamental Snake and there is good connectivity with expansive remnant areas to the north-west. It</p>

Attribute	Value	Rationale/assumption
		is considered highly likely to be present, particularly in areas such as Polygon 32, although species abundance cannot be assumed.
Risk of loss (%) without offset	100%	<p>The Wollombi Station has been historically managed by an agistee for cattle grazing purposes. The vegetation in non-remnant (Category X) areas has been actively managed to suppress woody vegetation in order to increase livestock carrying capacity and ease of livestock management. Management actions have included removing juvenile trees and shrubs and managing fuel loads. It is understood that it is the intention of the agistee to continue these practices as routine management of the balance of the property once offsets have been finalised and set aside (Lane Infrastructure Pty Ltd pers. comms. 12 September 2016). Therefore, it is reasonable to expect that the offset area would otherwise become gradually degraded from its current state as a result of the on-going land management practices. Cattle grazing will cause further decline in the condition of the ground stratum through ground compaction, erosion of drainage lines and banks of watercourses, spread of existing and infiltration by new weed species. Inappropriate fire management and a lack of legitimate fire-breaks is also a significant on-going risk for this community.</p> <p>Due to the Category X non-regulated classification of this area under the VM Act, it is anticipated that the area of regrowth will be maintained in a suppressed or cleared state in the future without the need for permits.</p>
Future quality without offset	4/10	<p>Site condition = 1.5</p> <p>The condition of gilgai and ground layer vegetation particularly the abundance of native sedges will be affected over the long term, especially on the edge of soak areas where existing land management is maintained. Cattle grazing may further degrade the ground cover layer and shrub layer, particularly during times of extended drought, and the community will struggle to meet remnant status. Gilgai formation will likely be shallow, edges degraded and may potentially be lost altogether across large sections of the RE 11.4.9 community due to clearing.</p> <p>Site context = 2.5</p> <p>Connectivity is unlikely to be substantially affected as the offset area is connected with large tracts of remnant vegetation to the west.</p> <p>There is potential for this vegetation to become an area of refuge for cattle during particularly dry conditions and seasons due to the moist conditions of the ground layer.</p> <p>Species stocking rate = 0</p> <p>There is potential for broad scale clearing within the offset area and adjacent non-remnant areas. The offset area is currently non-remnant and mapped as non-regulated and therefore clearing associated with land management practices is possible. Cattle trampling of gilgai could continue to the extent that gilgai formation is no longer present.</p>
Risk of loss (%) with mitigation and management	5%	Unlikely, as habitat quality will be improved with cattle exclusion and legal protection of the non-remnant, non-regulated vegetation.
Future quality with mitigation and management (non-remnant RE 11.4.9, polygon 32 and part of polygon 30)	9/10	<p>Site condition = 3.5</p> <p>The existing values and quality of habitat in the offset area will be improved by preventing clearing and with active management of cattle grazing, fire regimes, weed invasion and feral animal (particularly pigs). As native vegetation is allowed to regenerate, microhabitat features such as fallen timber and leaf litter will develop to form the coarse woody debris that is required by Ornamental</p>

Attribute	Value	Rationale/assumption
		Snake. However, in some areas that are not as moist as polygon 32, it may take longer than 15 years to establish a canopy of Brigalow that will allow shading out of the Buffel Grass.
		Site context = 3.5 Removing clearing and grazing pressure will allow gradual recovery of the vegetation to remnant status and remove the process of trampling and compaction of gilgai. Water quality of gilgai will improve, which will likely improve quality of habitat for frogs, which are the preferred food of Ornamental Snake.
		Species stocking rate = 2 Protection and improvement of the quality of this vegetation will result in a large patch of this habitat that is well connected in the broader landscape and will likely support an important population at some point in the future, based on the current DotE definition of an important population (SEWPaC, 2011).
Future quality with mitigation and management (non-remnant RE 11.4.9, polygons 39 and 43)	8/10	Site condition = 3 The existing values and quality of habitat in the offset area will be improved with active management of cattle grazing, fire regimes, weed invasion and feral animal (particularly pigs). As native vegetation is allowed to regenerate, microhabitat features such as fallen timber and leaf litter will develop to form the coarse woody debris that is required by Ornamental Snake. However, in some areas that are not as moist as polygon 32 and which have been more heavily used by cattle as is the case for polygons 39 and 43, some exotic grass cover may persist and gilgai may not reform as well.
		Site context = 3.5 Removing clearing and grazing pressure will allow gradual recovery of the vegetation to remnant status and remove the process of trampling and compaction of gilgai. Water quality of gilgai will improve, which will likely improve quality of habitat for frogs, which are the preferred food of Ornamental Snake. These polygons abut remnant areas and are relatively close to the Suttor River and form part of the riparian corridor.
		Species stocking rate = 1.5 Protection and improvement of the quality of this vegetation will result in reasonably sized patches of this habitat that is well connected in the broader landscape and located within remnant areas. Therefore, this habitat will likely support an important population at some point in the future, based on the current DotE definition of an important population, although the gilgai may not match the qualities of polygons 30 and 32 (SEWPaC, 2011).
Confidence in averted loss	80%	There is reasonable confidence that loss will occur without intervention through gradual decline in habitat quality particularly through continued heavy grazing by cattle. This will affect recruitment of key species, inhibit natural regeneration of the community and degrade gilgai features. The management and mitigation measures are low risk measures and they are widely applied as standard techniques in the industry. The measures to be applied tend to result in small gains but the outcomes are positive and relatively certain.
Confidence in change of habitat quality	80%	The offset area and broad management strategies are in line with managing the key threats to Ornamental Snake habitat identified in the conservation advice, i.e. reducing vegetation clearing, managing fire risk and cattle grazing pressure (TSSC, 2013). Specifically, the offset will legally secure a large area of habitat and future land management will allow the vegetation to improve in structure

Attribute	Value	Rationale/assumption
		and quality to meet remnant status and the condition thresholds for the Brigalow TEC and deep well formed gilgai will be maintained.

Table 5C.1 – Offset area EPBC Act Offset Assessment Guide Inputs – Squatter Pigeon (southern)

Attribute	Value	Rationale/assumption
Offset Area		
Description	198.3 ha (9.3 ha of remnant RE 11.3.2 and 189.0 ha of non-remnant RE s 11.3.2, 11.3.4, 11.5.3 and 11.5.9)	<p>The offset area is situated adjacent to a 3.6 km stretch of the Suttor River riparian corridor. The offset area is approximately 4 km south-west of the Stage 1 impact area. The offset area is connected to other extensive tracts of remnant vegetation to the south, west and north-west and framed by the Suttor River to the north and Suttor Creek to the south. The Wollombi offset area is connected to the Stage 1 impact area via remnant vegetation along the Suttor River.</p> <p>Squatter Pigeon habitat in the form of RE 11.7.4 does not occur in the offset area, however, REs 11.5.3 and 11.5.9 are present and suitable as offset areas due to their grassy woodland assemblages and close proximity to Suttor Creek and Suttor River (i.e. <3 km). The Species Profile and Threats (SPRAT) Database for the Squatter Pigeon describes foraging habitat as being 'mostly dominated in the overstorey by <i>Eucalyptus</i>, <i>Corymbia</i>, <i>Acacia</i> or <i>Callitris</i> species, as part of remnant, regrowth or partly modified vegetation and within 3 km of waterbodies or watercourses (seasonal or permanent)'. REs on land zones 5 and 7 are specifically referred to as potential habitat for the Squatter Pigeon in Queensland (DotE, 2015b).</p> <p>Remnant and non-remnant REs 11.3.2 and 11.3.4 in the offset area are also considered to provide potential habitat for this species as although land zone 3 is not specifically referred to in the SPRAT profile for the Squatter Pigeon, this community provides a grassy woodland habitat dominated by eucalypt species (Poplar Box in RE 11.3.2, and mixed eucalypt species in RE 11.3.4) on well-draining, sandy and loosely consolidated soils and is within 3 km of seasonal watercourses being the Suttor River and Suttor Creek. Squatter Pigeon has previously been recorded on other sites on land zone 3 (Ecological Survey & Management, 2015).</p>
Time over which loss averted	20 years	A legally binding mechanism would be established for the offset area providing protection and management over the timeframe required to achieve the management plan outcomes.
Time until ecological benefit	5 years	Ecological benefit will principally be achieved through the management of cattle grazing, appropriate management of fire regimes, control of weeds and managing pest animal populations. These management actions will improve the cover of native grasses through reduced soil compaction, trampling and predation that is associated with cattle grazing. These benefits are likely to be realised in approximately 5 years when native grasses have had an opportunity to re-colonise areas currently dominated by exotic grasses.

Attribute	Value	Rationale/assumption
Start quality (remnant RE 11.3.2, polygons 47, 50, 53 & 54) (9.3 ha)	7/10	Site condition = 3 A large portion of this habitat is of remnant condition and species richness is high. The groundcover in many areas showed moderate grazing damage and an exotic grass cover averaging more than 43%. Native species were common.
		Site context = 3 The offset area flanks other remnant communities along Suttor River. Connectivity with the broader landscape is maintained along this riparian corridor joining the Suttor Creek to the south-west where large tracts of endangered and remnant vegetation adjoin the confluence of the two watercourses. These watercourses provide seasonal if not permanent (ponded) water sources.
		Species stocking rate = 1 Squatter Pigeon (southern) was recorded in the local area just outside the offset area during recent vegetation surveys (September 2015). It is considered to be widespread in central Queensland (Environmental and Licensing Professionals, 2013). The offset area is considered to provide foraging habitat for this species. Breeding habitat is more likely to be restricted to land zone 5 or 7, where sandy or gravelly conditions identified as important in the DotE SPRAT profile are more likely to occur.
Start Quality (non-remnant RE 11.3.2, polygon 34) (41.9 ha)	6/10	Site condition = 2 This habitat is of non-remnant condition and species richness is moderate. The overstorey of the vegetation community is generally comprised of isolated mature and mid-mature Poplar Box. The ecologically dominant layer is most commonly the shrub layer where recruitment of canopy species was prevalent and the distribution relatively consistent. The groundcover in many areas showed moderate to major grazing pressure and an exotic grass cover in excess of 50%.
		Site context = 3 The offset area flanks the Suttor Creek, which is a fifth order watercourse. Connectivity with the broader landscape is maintained along this riparian corridor where large tracts of endangered and remnant vegetation adjoin the confluence of this watercourse with Suttor River. These watercourses provide seasonal if not permanent (ponded) water sources, which are important for breeding habitat in the area.
		Species stocking rate = 1 A pair of Squatter Pigeon (southern) were recorded in non-remnant RE 11.3.2 to the north of the offset investigation area in September 2015.
Start Quality	6/10	Site condition = 1.5

Attribute	Value	Rationale/assumption
(non-remnant RE 11.3.4, polygons 45, 46 & 55) (96.4 ha)		This habitat is of non-remnant condition and species richness is moderate. The overstorey of the vegetation community is generally comprised of isolated mature and mid-mature Clarkson's Bloodwood, Carbeen, Queensland Blue Gum, Dallachy's Gum and/or Narrow-leaved Red Ironbark. The ecologically dominant layer is most commonly the shrub layer where recruitment of canopy species was prevalent but the distribution inconsistent. The groundcover in many areas showed moderate to major grazing pressure and an exotic grass cover in excess of 50%.
		Site context = 3 The offset area flanks the Suttor River, which is a fifth order watercourse. Connectivity with the broader landscape is maintained along this riparian corridor joining the Suttor Creek to the south-west where large tracts of endangered and remnant vegetation adjoin the confluence of the two watercourses. These watercourses provide seasonal if not permanent (ponded) water sources, which are important for breeding habitat in the area.
		Species stocking rate = 1.5 Nine specimens of Squatter Pigeon (southern) were recorded in polygon 45 in December 2015.
Start Quality (non-remnant RE 11.5.3, polygons 58, 59) (21.3 ha)	6/10	Site condition = 1.5 This habitat is of non-remnant condition and species richness is moderate. The overstorey of the vegetation community is generally comprised of isolated mature and mid-mature Poplar Box. The ecologically dominant layer is most commonly the shrub layer where recruitment of canopy species was prevalent and the distribution relatively consistent. The groundcover in many areas showed moderate to major grazing pressure and an exotic grass cover in excess of 50%.
		Site context = 3 The offset area flanks the Suttor River, a fifth order watercourse. Connectivity with the broader landscape is maintained along this riparian corridor joining the Suttor Creek to the south-west where large tracts of endangered and remnant vegetation adjoin the confluence of the two watercourses. These watercourses provide seasonal if not permanent (ponded) water sources, which are important for breeding habitat in the area.
		Species stocking rate = 1.5 Nine specimens of Squatter Pigeon (southern) were recorded adjacent to polygon 61 in December 2015.
Start Quality (non-remnant RE 11.5.9,	6/10	Site condition = 2 This habitat is of non-remnant condition and species richness is moderate. The overstorey of the vegetation community is generally

Attribute	Value	Rationale/assumption
polygons 41, 56 & 57) (29.4 ha)		comprised of isolated mature and mid-mature Clarkson's Bloodwood, Carbeen and/or Narrow-leaved Red Ironbark. The ecologically dominant layer is most commonly the shrub layer where recruitment of canopy species was prevalent but the distribution inconsistent. The groundcover in many areas showed moderate to major grazing pressure and an exotic grass cover in excess of 50%.
		<p>Site context = 3</p> <p>The offset area flanks the Suttor River, a fifth order watercourse. Connectivity with the broader landscape is maintained along this riparian corridor joining the Suttor Creek to the south-west where large tracts of endangered and remnant vegetation adjoin the confluence of the two watercourses. These watercourses provide seasonal if not permanent (ponded) water sources, which are important for breeding habitat in the area.</p>
		<p>Species stocking rate = 1</p> <p>Squatter Pigeon (southern) were recorded in adjacent polygons in December 2015.</p>
Risk of loss (%) without offset	30% (remnant areas) 100% (non-remnant areas)	<p>The Wollombi Station has been historically managed by an agistee for cattle grazing purposes. It is reasonable to expect that the offset area would become gradually degraded from its current state as a result of cattle grazing. Cattle grazing will cause further decline in the condition of the ground stratum through ground compaction, erosion of drainage lines, spread of existing and infiltration by new weed species.</p> <p>The vegetation in non-remnant (Category X) areas has been actively managed to suppress woody vegetation in order to increase livestock carrying capacity and ease of livestock management. Management actions have included removing juvenile trees and shrubs and managing fuel loads. It is understood that it is the intention of the agistee to continue these practices as routine management of the balance of the property once offsets have been finalised and set aside (Lane Infrastructure Pty Ltd pers. comms. 12 September 2016). Therefore, it is reasonable to expect that the offset area would otherwise become gradually degraded from its current state as a result of the on-going land management practices. Cattle grazing will cause further decline in the condition of the ground stratum through ground compaction, erosion of drainage lines and banks of watercourses, spread of existing and infiltration by new weed species. Inappropriate fire management and a lack of legitimate fire-breaks is also a significant on-going risk for this community.</p> <p>Due to the Category X non-regulated classification of portions of this habitat area under the VMA, it is anticipated that the area of regrowth will be maintained in a suppressed or cleared state in the future without the need for permits.</p>
	5/10	Site condition = 1.5

Attribute	Value	Rationale/assumption
Future quality without offset		The condition/quality of Squatter Pigeon (southern) habitat particularly the abundance of native grasses general diversity of habitat features in the ground cover layer will potentially be affected over the long term where active management is not provided for habitat areas. Cattle grazing and gradual invasion of improved pasture species, particularly *Buffel Grass, along with understorey management for exotic pasture improvement and minor clearing for cattle yards, fencing etc. will likely continue to some extent. Once improved grazing management practices are imposed, the area will be subject to minimal disturbance. Predation pressure from feral dogs, cats and foxes will be monitored and managed as required. All non-remnant areas within the offset area are at risk of being cleared without the security of the offset being put in place
		<p>Site context = 2.5</p> <p>Connectivity is unlikely to be substantially affected as all habitat proposed as offsets are within or adjacent to a riparian corridor. There is potential for all non-remnant areas of REs 11.3.2, 11.3.4, 11.5.3 and 11.5.9 to be cleared as these are Category X (unregulated) vegetation. Nonetheless, a conservative approach has been adopted whereby it is considered unlikely that connectivity will be substantially affected in the foreseeable future due to the presence of remnant regulated vegetation management areas.</p>
		<p>Species stocking rate = 1</p> <p>As a result of the reduced site condition there may be a reduction in the Squatter Pigeon (southern) stocking rate of the offset area. However, this is unlikely to be substantial as they are known to use degraded habitats and they are considered widespread in central Queensland (Environmental and Licensing Professionals, 2013).</p>
Risk of loss (%) with mitigation and management	5%	Unlikely, as habitat quality will be maintained and improved with periodic cattle exclusion and active management and monitoring and the prevention of clearing.
Future quality with mitigation and management	8/10	<p>Site condition = 3.5</p> <p>The existing values and quality of habitat in the offset area, particularly in the ground cover layer, will be improved with active management of cattle grazing, fire regimes and weed invasion. This will occur through establishment of greater diversity of micro-habitat features, cover and native foraging resources for the Squatter Pigeon (southern). Once improved grazing management practices are imposed, the area will be subject to minimal disturbance with the maintenance of fire breaks and weed management undertaken as required. Predation pressure from feral dogs, cats and foxes will be monitored and managed as required.</p>
		Site context = 3

Attribute	Value	Rationale/assumption
		This element is unlikely to change with management.
		Species stocking rate = 1.5 It is expected that where habitat quality is improved from its current state, use of these areas by the Squatter Pigeon (southern) will increase, particularly where breeding habitat is improved in REs 11.5.3 and 11.5.9.
Confidence in averted loss	80%	There is reasonable confidence that loss will occur without intervention through gradual decline in habitat quality particularly in native grass cover by being over sown with Buffel Grass and continued heavy grazing by cattle and prevention of clearing. The management and mitigation measures proposed are low risk measures and they are widely applied as standard techniques in the industry. The measures to be applied tend to result in small gains but the outcomes are positive and relatively certain.
Confidence in change of habitat quality	80%	The offset area and broad management strategies are in line with the threat abatement actions in the SPRAT profile for the Squatter Pigeon (southern) (DotE, 2015b). Specifically, the offset will legally secure a large area of foraging and breeding habitat close to a permanent water-point (the Suttor River and Suttor Creek). In addition, the proposed management actions will improve habitat quality in this area.

Table 5C.2 – Additional Offset area EPBC Act Offset Assessment Guide Inputs – Squatter Pigeon (southern)

Attribute	Value	Rationale/assumption
Offset Area		
Description	Polygon 60 – 55.77 ha RE 11.5.3 Polygon 31 – 47.49 ha RE 11.3.2 Polygon 66 – 30.3 ha RE 11.4.8 Additional area south of Polygon 60 – 39.0 ha RE 11.5.3 47.1 ha of RE 11.4.9 adjacent to	The additional offset areas are situated adjacent to the Suttor River and Suttor Creek riparian corridors, with the nearest offset area being approximately 4 km south-west of the Stage 1 impact area. A small portion of the offset area is located on ML 70436; however, the current proposed mine footprint is more than 1km from the offset area, and the vast majority of mining activities are undertaken east of the rail line. Squatter Pigeon habitat in the form of RE 11.7.4 does not occur in the offset area, however, REs 11.3.2, 11.4.8, 11.4.9, 11.5.3 and 11.5.9 are present and suitable as offset areas due to their grassy woodland assemblages and close proximity to Suttor Creek and Suttor River (i.e. <3 km). The Species Profile and Threats (SPRAT) Database for the Squatter Pigeon describes foraging habitat as being 'mostly dominated in the overstorey by <i>Eucalyptus</i> , <i>Corymbia</i> , <i>Acacia</i> or <i>Callitris</i> species, as part of remnant, regrowth or partly modified vegetation and within 3 km of waterbodies or watercourses (seasonal or permanent)'. REs on land zones 5 and 7

ⁱ http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64440

Attribute	Value	Rationale/assumption
	<p>Suttor Creek and buffering Polygon 6 and 7</p> <p>Total additional offset – 219.66</p>	<p>are specifically referred to as potential habitat for the Squatter Pigeon in Queensland (DotE, 2015b).</p> <p>The offset area is a combination of breeding (i.e. < 1km from water) and foraging habitat. The expanded offset areas are all regrowth vegetation.</p> <p>Polygon 60 (55.77 ha of RE 11.5.3), Polygon 66 (30.3 ha of RE 11.4.8), and Polygons 31 (47.49 ha of RE 11.3.2) are within 1 – 2 km of permanent water, and have been included as suitable breeding and foraging habitat. An additional 39.0 ha south of Polygon 60 has been confirmed as a continuation of RE 11.5.3 by the ecologists who undertook the initial survey, and would be suitable for foraging. Another 47.1 ha of RE 11.4.9 adjacent to Polygons 6 and 7 has also been included, and constitutes potential breeding and foraging. This has been confirmed as a continuation of Polygon 60 by the ecologists. See <i>Figure 4</i> in the OAMP and <i>Figure 5</i> in the Ecology Report (Appendix 1A).</p> <p>The offset area is connected to other extensive tracts of remnant vegetation to the south, west and north-west and framed by the Suttor River to the north and Suttor Creek to the south. The Wollombi offset area is connected to the Stage 1 impact area via remnant vegetation along the Suttor River.</p>
Time over which loss averted	20 years	A legally binding mechanism is to be established for the offset area providing protection and management over the timeframe required to achieve the management plan outcomes.
Time until ecological benefit	20 years	<p>Prevention of ongoing clearing regimes and management actions, including exclusion of cattle during breeding times, weed and feral pest monitoring and management are likely to improve site condition and species stocking rate.</p> <p>Although light cattle grazing can improve foraging habitat in isolated cases (i.e. within Land Zone 4, where dense woodland vegetation overlies non-alluvial clay soils), cattle grazing and vegetation clearing for agriculture remain the key threatening process for the Squatter Pigeon.</p> <p>A condition increase from 6 to 8 will principally be achieved through the removal of the ongoing risk of vegetation clearing and subsequent sowing with exotic pasture species, management of cattle grazing, appropriate management of fire regimes, control of weeds, and management of pest animal populations. These management actions will improve the cover of native grasses and reduce soil compaction and trampling that is associated with cattle grazing during the breeding season. These benefits are very likely to be realised within 20 years when the vegetation has regained structure (including understorey) and native grasses have had an opportunity to re-colonise areas currently dominated by exotic pasture species.</p>
Start Quality (non-remnant RE 11.3.2, Polygon 31) (47.49 ha)	6/10	<p>Site condition = 2</p> <p>This habitat is of non-remnant condition and species richness is moderate. The overstorey of the vegetation community generally comprises isolated mature and mid-mature Poplar Box. The ecologically dominant layer is most commonly the shrub layer where recruitment of canopy species was prevalent and the distribution relatively consistent. The groundcover in many areas showed</p>

Attribute	Value	Rationale/assumption
		<p>moderate to major grazing pressure and an exotic grass cover in excess of 50%. The impact of heavy grazing on native grasses resulted in between 0% and 2% native grass cover being recorded which then impacted the condition score.</p> <p>Site context = 3</p> <p>The offset area flanks the Suttor River, which is a fifth order watercourse. Connectivity with the broader landscape is maintained along this riparian corridor where large tracts of endangered and remnant vegetation adjoin the confluence of this watercourse with Suttor Creek. These watercourses provide seasonal if not permanent (ponded) water sources, which are important for breeding habitat in the area.</p> <p>Species stocking rate = 1</p> <p>A pair of Squatter Pigeon (southern) were recorded in non-remnant RE 11.3.2 to the north of the offset investigation area in September 2015.</p>
<p>Start Quality</p> <p>(non-remnant RE 11.4.8, polygon 66)</p> <p>(30.30 ha)</p>	6/10	<p>Site condition = 1.5</p> <p>RE 11.4.8 is described as <i>Eucalyptus cambageana</i> woodland to open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains. This polygon has no large trees, and therefore scored 0% for canopy cover. However, all canopy species are evidenced by good recruitment (75% species richness) in the shrub layer. The lack of a canopy cover has resulted in a high exotic grass cover of 95%. The combination of no canopy cover, no native grass species and a high exotic grass cover has resulted in an overall reduction in the condition score for this area. Reference Ecological Equivalence Methodology Sheets attached to the field report.</p> <p>Site context = 3</p> <p>The offset area flanks the Suttor River, a fifth order watercourse. Connectivity with the broader landscape is maintained along this riparian corridor joining the Suttor Creek to the south-west where large tracts of endangered and remnant vegetation adjoin the confluence of the two watercourses. These watercourses provide seasonal if not permanent (ponded) water sources, which are important for breeding habitat in the area.</p> <p>Species stocking rate = 1.5</p> <p>Nine specimens of Squatter Pigeon (southern) were recorded adjacent to polygon 61 in December 2015.</p>
<p>Start Quality</p> <p>Part of Polygon 30 (non-remnant RE 11.4.9, adjacent to Polygons 6 and 7 on Suttor Creek)</p> <p>(47.10 ha)</p>	6/10	<p>Site condition = 1.5</p> <p>This polygon consists of RE 11.4.9 which is described as <i>Acacia harpophylla</i> shrubby woodland with <i>Terminalia oblongata</i> on Cainozoic clay plains. This polygon has no large trees, and therefore scored 0% for canopy cover. This impacts the score as Squatter Pigeon will only move up to 200m from canopy cover because of predation from raptors. However, all canopy species are evidenced by good recruitment in the over developed shrub layer, which is 433% of the benchmark). The lack of a canopy cover has resulted in a high exotic grass cover that is 28.9% of the benchmark for this RE. This has resulted in an overall reduction in the condition score</p>

Attribute	Value	Rationale/assumption
		for this area. Reference Ecological Equivalence Methodology Sheets attached to the field report.
		<p>Site context = 3</p> <p>The offset area flanks the Suttor River, a fifth order watercourse. Connectivity with the broader landscape is maintained along this riparian corridor joining the Suttor Creek to the south-west where large tracts of endangered and remnant vegetation adjoin the confluence of the two watercourses. These watercourses provide seasonal if not permanent (ponded) water sources, which are important for breeding habitat in the area.</p>
		<p>Species stocking rate = 1.5</p> <p>Nine Squatter Pigeon (southern) were recorded adjacent to polygon 61 in December 2015 suggesting a moderate stocking rate.</p>
Start Quality (non-remnant RE 11.5.3, polygon 60 and area South) (94.77 ha)	6/10	<p>Site condition = 1.5</p> <p>This polygon consists of RE 11.5.3 which is composed of <i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces. This polygon has no large trees, and therefore scored 0% for canopy cover. However, all canopy species have good rates of recruitment and the shrub layer is well developed. The lack of a canopy cover has resulted in a high grass cover that is 266% of the benchmark for this RE. This has resulted in an overall reduction in the condition score for this area. Refer to the Ecological Equivalence Methodology Sheets attached to the field report.</p>
		<p>Site context = 3</p> <p>The offset area flanks the Suttor River, a fifth order watercourse. Connectivity with the broader landscape is maintained along this riparian corridor joining the Suttor Creek to the south-west where large tracts of endangered and remnant vegetation adjoin the confluence of the two watercourses. These watercourses provide seasonal if not permanent (ponded) water sources, which are important for breeding habitat in the area.</p>
		<p>Species stocking rate = 1.5</p> <p>Nine specimens of Squatter Pigeon (southern) were recorded adjacent to polygon 61 in December 2015.</p>
Risk of loss (%) without offset	0%	Based on advice and negotiation with the Department of Environment and Energy a 0% Risk of Loss has been adopted for the additional offset areas without offsets in place
Future quality without offset	5/10	<p>Site condition = 1</p> <p>The condition/quality of Squatter Pigeon (southern) habitat particularly the abundance of native grasses general diversity of habitat features in the ground cover layer will potentially be affected over the long term where active management is not provided for habitat areas. Cattle grazing and gradual invasion of improved pasture species, particularly *Buffel Grass, along with understorey management for exotic pasture improvement and minor clearing for cattle yards, fencing etc. will likely continue to some extent. Once improved grazing management practices are imposed, the area will be subject to minimal disturbance. Predation pressure from feral dogs, cats and foxes will be monitored and managed as required. All</p>

Attribute	Value	Rationale/assumption
		<p>non-remnant areas within the offset area are at risk of being cleared without the security of the offset being put in place</p> <p>Site context = 3</p> <p>Connectivity is unlikely to be substantially affected as all habitat proposed as offsets are within or adjacent to a riparian corridor which is remnant vegetation. The majority of Wollombi Station, to the east and south of the offset area is mapped as Category X and has no protection from re-clearing. Additionally, there is potential for all non-remnant areas of the offset site to be re-cleared resulting in a loss of some connectivity and patch size in the landscape</p> <p>Species stocking rate = 1</p> <p>As a result of the reduced site condition there may be a reduction in the Squatter Pigeon (southern) stocking rate of the offset area. However, this is unlikely to be substantial as they are known to use degraded habitats and they are considered widespread in central Queensland (Environmental and Licensing Professionals, 2013).</p>
Risk of loss (%) with mitigation and management	0%	Based on advise and negotiation with the Department of Environment and Energy a 0% Risk of Loss has been adopted for the additional offset areas with mitigation and management.
Future quality with risk mitigation and management Over the period of the offset area management plan, there will be a gradual increase in the following attributes that are directly relevant to the habitat condition for the Squatter Pigeon.		
(non-remnant RE 11.3.2, Polygon 31) (47.49 ha)	8/10	<p>Site condition = 3/4</p> <ul style="list-style-type: none"> Native plant species richness (grasses) increase in score from 2.5 to 3 Native perennial grass cover – increase in score from 0 to 3 (note: benchmark native grass cover for this RE is 35%) Non-native plant cover – increase score from 0 to 10 (<5%) <p>Site context = 3/4</p> <p>The offset area borders the Suttor River to the west with the area within 500m of the river. The Suttor River is a fifth order watercourse and provides connectivity along the riparian corridor where large tracts of endangered and remnant vegetation adjoin the confluence of this watercourse with Suttor Creek. These watercourses provide seasonal if not permanent (ponded) water sources, which are important for breeding habitat in the area.</p> <p>This attribute is unlikely to change due to the high context of the area selected for the offset from the outset. The return of regrowth vegetation to remnant will increase the canopy cover and protection from predatory birds which will add to the context of the landscape allowing the Squatter Pigeon access to larger areas for foraging and breeding habitat.</p> <p>Species stocking rate = 2/2</p> <p>A pair of Squatter Pigeon (southern) were recorded in non-remnant RE 11.3.2 to the north of the offset investigation area in September 2015.</p>

		It is anticipated that this score would increase from a score of 1 to 2 with a higher population as the condition of the habitat increased and with the added benefit of canopy cover from predatory birds.
(non-remnant RE 11.4.8, polygon 66) (30.30 ha) <i>Note – there is no benchmark for 11.4.8 so 11.4.9 was used as a surrogate</i>	8/10	<p>Site condition = 3/4</p> <ul style="list-style-type: none"> Native plant species richness (grasses) increase in score from 3 to 5 Native perennial grass cover – increase in score from 0 to 3 (note: benchmark native grass cover for this RE is 20%) Non-native plant cover – increase score from 0 to 10 (<5%) <p>Site context = 3/4</p> <p>The offset area adjoins polygon 31 (above) and is between 500m and 1km from the Suttor River. The eastern side of the polygon is along a small empirical stream that has water during the wet season. Due to its proximity to the river and remnant vegetation, the context will improve with canopy cover, however the overall context score is not expected to change.</p> <p>Species stocking rate = 2/2</p> <p>A pair of Squatter Pigeon (southern) were recorded in the non-remnant RE 11.3.2 (polygon 66 described above) to the north of the offset investigation area in September 2015.</p> <p>It is anticipated that this score would increase from a score of 1 to 2 with a higher population as the condition of the habitat increased and with the added benefit of canopy cover from predatory birds.</p>
Part of Polygon 30 (non-remnant RE 11.4.9, adjacent to Polygons 6 and 7 on Suttor Creek) (47.10 ha)	8/10	<p>Site condition = 3/4</p> <ul style="list-style-type: none"> Tree canopy cover increase score from 0 to 5 (>50%-<200%) Native plant species richness (grasses) increase in score from 3 to 5 Native perennial grass cover – increase in score from 3 to 5 (note: benchmark native grass cover for this RE is 20%) Non-native plant cover – increase score from 3 to 5 (<5-25%) <p>Site context = 3/4</p> <p>This polygon is entirely within 1.1km of Suttor Creek which forms the southern boundary of part of the polygon as well as the boundary of the property. Suttor Creek is a stream order 5 and has permanent ponded pools during the later dry season and permanent water during the wet season. The creek has a riparian corridor which consists of remnant vegetation RE 11.3.2. The polygon is considered breeding habitat. Due to the proximity to permanent water, this score is not considered to increase over time although there will be an increase in the connectivity to remnant vegetation over time.</p> <p>Species stocking rate = 2/2</p> <p>This area of the property only recorded low numbers at the survey in 2015 with only pairs sighted. It is anticipated that the stocking rate would increase over time and therefore the score is increased from 1.5 to 2.</p>
(non-remnant RE 11.5.3, polygon 60 and area South)	8/10	<p>Site condition = 3/4</p> <ul style="list-style-type: none"> Tree canopy cover increase score from 0 to 5 (>50%-<200%) Native plant species richness (grasses) increase in score from 2.5 to 3 Native perennial grass cover – increase in score from 3 to 5 (note: benchmark native grass cover for this RE is 20%) <p>Site context = 3/4</p>

(94.77 ha)		<p>This attribute is unlikely to change due to the high context of the area selected for the offset from the outset.</p> <p>Species stocking rate = 2/2</p> <p>This area of the property only recorded low numbers at the survey in 2015 with only pairs sighted., however a larger population was recorded in the adjacent polygon 61 during the 2015 survey. Therefore, it is anticipated that the stocking rate would increase with the improvement in the habitats condition and connectivity and therefore the score is increased from 1.5 to 2.</p>
Confidence in averted loss	90%	<p>The main threats to the Squatter Pigeon (southern) are the loss and fragmentation of habitat due to clearing for agricultural purposes, the degradation of habitat by overgrazing by domesticated herbivores, especially the sheep (<i>Ovis</i> species) and the cow (<i>Bos</i> species), the degradation of habitat by invasive weeds, such as buffel grass (<i>Cenchrus ciliaris</i>), and predation by numerous avian and terrestrial predators (EPA 2006; Frith 1982b; Le Souef 1923; North 1913-14; Squatter Pigeon Workshop 2011).</p> <p>The management strategies outlined in the BOMP directly address all of these key threats and are sufficient to provide an increase in in habitat quality of 6 to 8, within 20 years.</p> <p>There is reasonable confidence that loss will occur without intervention through gradual decline in habitat quality particularly in native grass cover by being over sown with Buffel Grass and continued heavy grazing by cattle and prevention of clearing.</p> <p>The management and mitigation measures proposed are low risk measures and they are widely applied as standard techniques in the industry. The measures to be applied tend to result in small gains but the outcomes are positive and relatively certain.</p>
Confidence in change of habitat quality	85%	<p>The offset area and broad management strategies are in line with the threat abatement actions in the SPRAT profile for the Squatter Pigeon (southern) (DotE, 2015b). ⁱⁱSpecifically, the offset will legally secure a large area of foraging and breeding habitat close to a permanent water-point (the Suttor River and Suttor Creek). In addition, the proposed management actions will improve habitat quality in this area.</p>

ⁱⁱ http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64440

2. Management plan

2.1 Management area objectives and outcomes

The management area objectives and outcomes identified below are estimated to be achieved within 20 years, or by 2044. It is recognised that the timeframes are subject to natural conditions and unexpected events, and the risks are identified in Section 4, Risk Analysis.

The management area objectives and outcomes for the offset area are to achieve the scores for each protected matter as detailed in Table 4 and for the enhancement of the condition of the Of Concern regional ecosystems 11.4.2 and 11.9.7, the Brigalow TEC, connectivity along the Suttor River, watercourse vegetation and habitat for the Squatter Pigeon (southern) and Ornamental Snake. The offset area may also provide habitat for the Black-throated Finch and Common Death Adder which were assessed as likely to occur in the impact area.

The habitat and regional ecosystems are currently in a degraded condition within the offset area (refer to Section 1).

2.1.1 Management area objectives

Environment Protection & Biodiversity Conservation Act 1999 (Commonwealth)

The management area objectives are to protect and to achieve the scores for each protected matter as detailed in Table 4 for the Brigalow TEC and the habitat conditions for listed threatened species *Denisonia maculata* (Ornamental Snake) and the *Geophaps scripta scripta* (Squatter Pigeon – (southern) under the EPBC Act approval. Management actions in the offset area will enable the natural regeneration of the habitat via the following:

- prevention of broad-scale clearing;
- weed management including control measures;
- fire management as per the guidelines provided in the Queensland Herbarium Regional Ecosystems Descriptions Database (REDD) for the respective regional ecosystems;
- livestock management in order to minimise grazing impacts;
- pest animal management including control measures; and
- restrictions on access.

A legally binding mechanism, in the form of a Voluntary Declaration under the VMA will protect this offset area from clearing and require the actions within the management plan to be implemented. The areas will be actively managed for the duration of the Voluntary Declaration, or until the outcomes of the management plan are achieved, whichever comes first.

If due to natural conditions and/or unexpected events the offset has not achieved the future quality as detailed in **Table 5**, then the actions detailed in **Table 6** and **Table 8** will be continued until the outcomes of the management plan are achieved. This is to be followed by a monitoring and maintenance period until the expiry of the EPBC approval in October 2044.

Environmental Protection Act 1994 (Queensland)

The offset area for impacts to of concern regional ecosystems 11.4.2 and 11.9.7a, watercourse vegetation and connectivity (and also Common Death Adder habitat and Black-throated Finch habitat which are likely to occur) are managed to maintain and enhance the condition of regional ecosystems 11.3.2, 11.3.4, 11.4.2, 11.4.9, 11.5.3, 11.5.9 and the associated habitat, specifically:

- the ecosystem attains and, or retains, remnant status as defined under the VMA and remains mapped on a Regulated Vegetation Management Map (**RVMP**), or a map published by the Queensland Government that supersedes the RVMP;
- prevention of broad-scale clearing;
- weed management including control measures;
- fire management as per the guidelines provided in the Queensland Herbarium Regional Ecosystems Descriptions Database (**REDD**) for the respective regional ecosystems;

- livestock management in order to minimise grazing impacts;
- pest animal management including control measures; and
- restrictions on access.

2.1.2 Offset area outcomes

- Site Condition:** The offset area is managed to improve the ecological condition of the vegetation through appropriate management actions as detailed in **Table 8**. These actions include the exclusion of any forestry and/or timber harvesting operations which will allow natural regeneration of canopy and sub-canopy species and protect large hollow bearing trees, weed control and fire management as per the guidelines provided in the Queensland Herbarium Regional Ecosystems Descriptions Database (REDD) for the respective regional ecosystems.
- Offset Start Condition** scores as shown in **Table 5** align with the scores recorded as the baseline at the monitoring and reporting locations as detailed in **Table 10: Monitoring Sites**. The baseline data is provided in **Attachment 1** of this management plan.
- Site Context:** the offset area is managed to enable the natural regeneration process of the vegetation and associated habitat to occur and to therefore achieve enhanced connectivity along the Suttor River and Suttor Creek corridors.

2.2 Detailed offset area mapping

The proximity of the offset area to the Byerwen Coal Project and within the region is illustrated in **Figure 3**. The explicit location of the offset area on Wollombi Station and the location of offsets under the EPBC Act and QBOP are shown on **Figure 4**.

Figure 3: Byerwen Coal Project, Wollombi Station and offset area location map

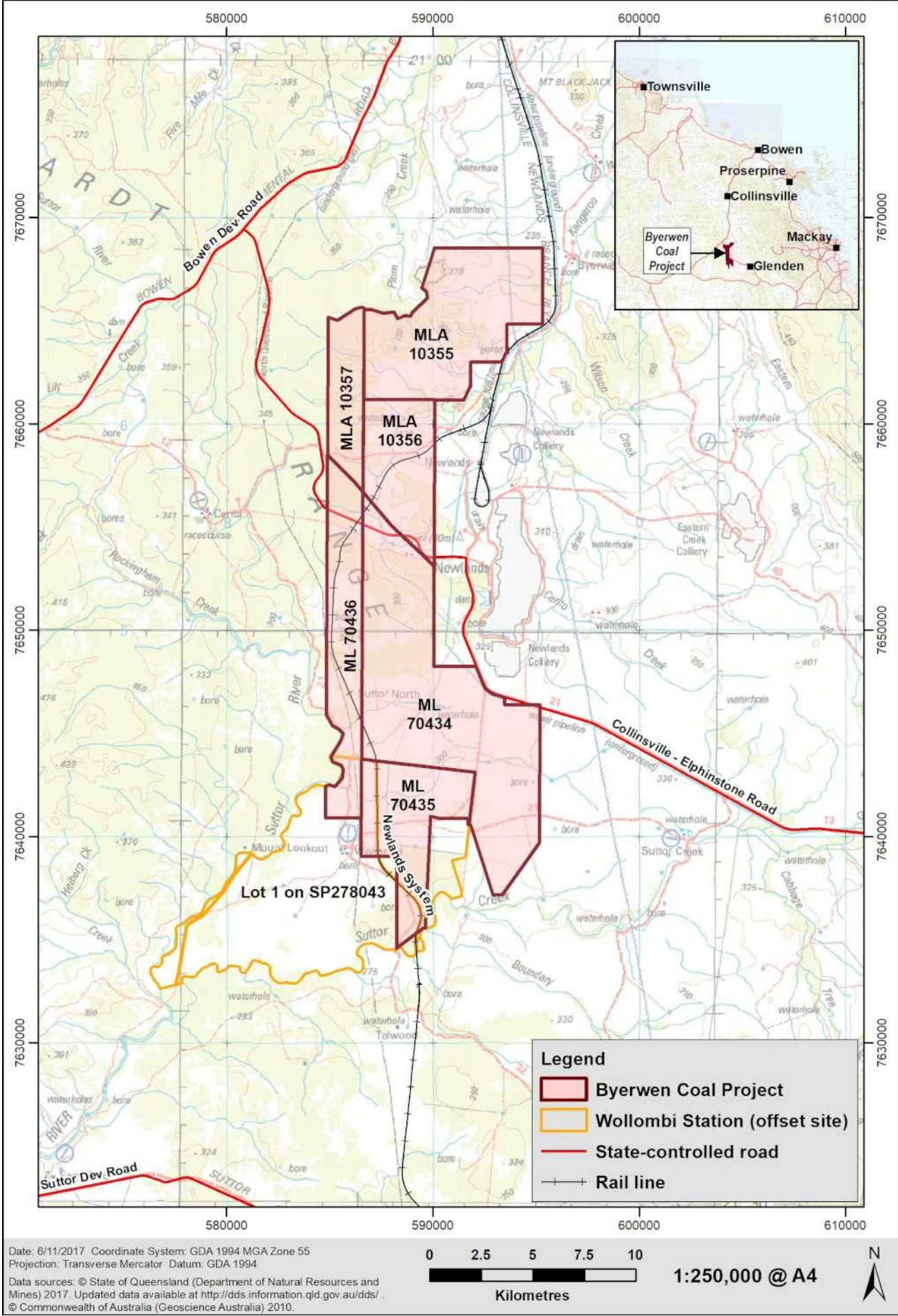
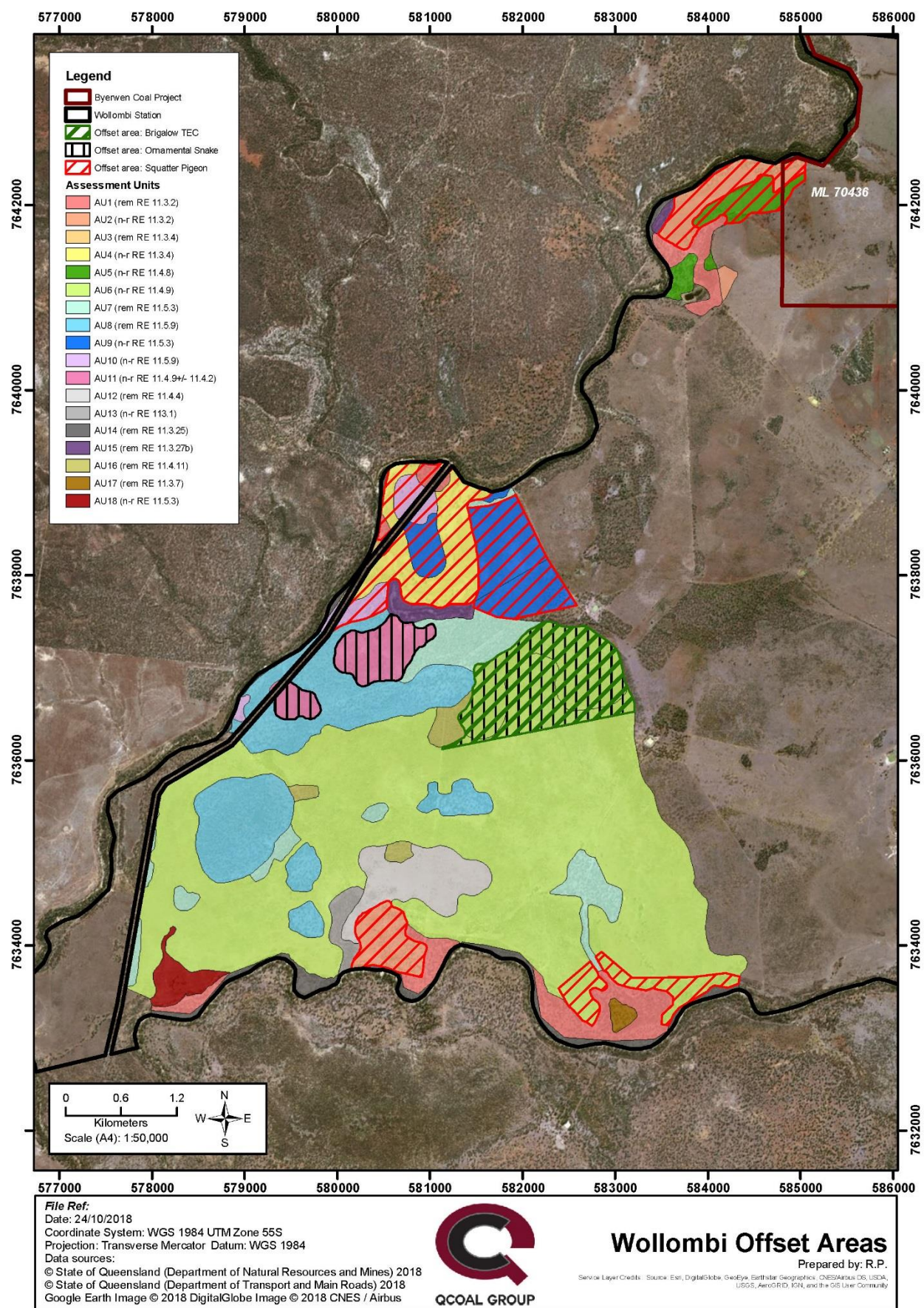


Figure 4: Offset area on Wollombi Station



3. Restrictions imposed on the use of the offset area

The restrictions below (**Table 6**) will be implemented within the Offset Area Management Plan (**OAMP**).

Table 6: Offset area restrictions

Restriction	Details
Vegetation clearing is restricted and to be undertaken only by the exemptions in the <i>Vegetation Management Act 1999</i> for point 1. No clearing for new infrastructure is to be undertaken within the offset area unless it is detailed in the Figure in Attachment 3	<ol style="list-style-type: none"> Vegetation clearing in the offset area is restricted to: <ol style="list-style-type: none"> that necessary for the removal of non-native weeds or declared pests ensure public safety maintenance of existing roads, fence lines, water pipelines and firebreaks; and that necessary to establish and maintain access to Ecological Equivalence assessment and photo point monitoring sites. <p>Where vegetation clearing is sought for any other purpose, the Landholder must contact the relevant department administering the <i>Vegetation Management Act 1999 (Qld)</i>.</p> <ol style="list-style-type: none"> Native forest practice (harvesting of timber for forestry purposes) <u>is not</u> allowed under this Offset Area Management Plan. Clearing for new fencing will be on the outside of the offset area boundary or along the property boundary. <p>Note: Any vegetation clearing must be undertaken in accordance with:</p> <ul style="list-style-type: none"> best practice management methods; and any applicable legislative requirements. For example, the clearing of endangered, vulnerable or near-threatened plant species or the tampering with animal breeding places under <i>Nature Conservation Act 1992 (Qld)</i> <p>Under the <i>Vegetation Management Act 1999</i>, clearing in Least Concern regional ecosystems for fences, roads or tracks is exempt clearing if it is less than 10 m in width. Any new fence lines, roads or tracks will be less than 10 m in width for each piece of infrastructure. Clearing to establish or maintain a necessary firebreak to protect infrastructure (other than fences, roads and tracks) to a maximum width of 20 m or 1.5 times the height of the tallest adjacent tree, whichever is the greater.</p>
Access	<ol style="list-style-type: none"> Installation of signage along the offset area perimeter to alert traffic of the offset area prior to the offset area being legally secured. Installation of slow speed signage at the main entry points to the offset area. Access is restricted to those authorised persons required to undertake actions described in this management plan, including the landholder, QCoal and Byerwen Coal staff and their contractors and assigns. Any other access is to be at the discretion of Byerwen Coal for specific purposes only. Public access to the offset area is prohibited. The offset area is not to be utilised for any other purpose including recreational activities or any other activities that deter from achieving the outcomes of this plan.
Grazing	<p>For the offset areas detailed in Table 5A, 5B, and 5C.1, grazing of domestic livestock (cattle) will occur in the Offset Area under the following arrangements:</p> <ol style="list-style-type: none"> for fuel reduction purposes only during the dry season; and noting that there are no set stocking rates or times throughout the year where stock are to be permitted to graze. The Landholder, at their discretion, is to graze stock at rates and times necessary to reduce the fuel load in the Offset Area without lowering the total grass cover to below: <ul style="list-style-type: none"> Remnant Brigalow communities 20% grass cover Non-remnant Brigalow communities 60% grass cover or 1500kg/ha pasture biomass Eucalypt Communities 60% grass cover or 1500kg/ha pasture biomass at the end of the dry season. The ground cover is to be determined as per <i>Attachment 2: Land Manager's Monitoring Guide</i>.

Restriction	Details
	<ol style="list-style-type: none"> the grazing regime should allow native grasses to flower and set seed at least every two years (6-8 week period during the wet/summer season). Cattle are excluded from the offset area during the wet season and during the early dry season which corresponds with the breeding and nesting season for the Squatter Pigeon (southern). Grazing will not be used in times of drought as this will lead to a high temperature burn and a reduction of the grasscover below that required in <i>Table 8</i>. <p>For Squatter Pigeon (southern) offset areas detailed in Table 5C.2, crash grazing may only be undertaken in December, when ground cover is greater than 60%.</p>
Fire	<ol style="list-style-type: none"> Fire is to be excluded from the offset area except for low intensity ecological burns at the end of the wet season by: <ol style="list-style-type: none"> maintaining firebreaks relative to the offset areas; using a low intensity fire >7 years interval; and firebreaks are to be co-located with roads and fence lines on the property where possible. <p>Note: Fire is not to be used as a tool for regrowth management on the offset areas.</p>
Pest animals and weeds	<p>Animal</p> <p>Minimise the introduction of pest animals and control of existing populations of pest animals within the Offset Areas in accordance with <i>the Land Protection (Pest and Stock Route Management) Act 2002</i>.</p> <ol style="list-style-type: none"> Monitor and manage pest animal populations quarterly as per Table 9 and subsequently adapt control effort with populations with regards to wild pigs, dogs, foxes and cats if more than 6 animals are seen during these inspections. <p>Weeds</p> <ol style="list-style-type: none"> Keep the introduction; establishment and spread of non-native weeds including Declared Pest Plants listed under the Land Protection (Pest and Stock Route Management) Act 2002 (Qld) to no more than 5% weed cover over the Offset Areas. Control any existing infestations of non-native weeds including Declared Pest Plants under the Land Protection (Pest and Stock Route Management) Act 2002 (Qld) to ensure that the non-native weeds do not cover more than 5% of the Offset Areas, e.g., Parthenium. Minimise the spread of any non-native pasture species within the Offset Areas in accordance with Table 8: Management Actions. <p>Note: Any weed control required will be undertaken as early as practicable within the natural regeneration process throughout the Offset Areas and then periodically as required to treat the weeds at the optimum time in their life cycles to control and minimise the spread of the existing weed species.</p>

4. Analysis of risks to achieving management objectives and outcomes

The following risk assessment (**Table 7**) has considered:

- any real or potential risks associated with achieving the management objectives and outcomes;
- the actions taken to minimise those risks;
- remedial action that will be undertaken if any of the risks occur; and
- residual risk with mitigation measures.

Table 7: Risk analysis

Number	Risk	Level of risk (extreme, high, moderate or low)	Proposed actions to minimise risk (i.e. mitigation measures)	Proposed remedial actions if risk occurs	Residual risk
1	Fire	Low The offset area contains both non-remnant (<8 years old) and remnant vegetation (>8 years old) although in a degraded condition with a ground layer of mixed native and exotic pasture grasses. Inappropriate fire events will delay the development of more mature trees and affect groundcover, but will not destroy the habitat.	Maintaining firebreaks at appropriate widths to enable fires in adjoining areas to be prevented from impacting on the offset area. Manage fuel loads through controlled grazing during the dry season. <i>Force Majeure</i> events are acknowledged as being separate from ecological burns and are beyond the control of the landholder. Fire control lines to be checked annually for condition and adequacy.	Fire to be excluded wherever possible from the offset areas, with low intensity fires allowed immediately after the wet season at a >7year intervals on the advice of an ecologist following ecological surveys as outlined in Table 9. Remedial action: Destock the offset area within 10 days and re-establish fire breaks and control lines within 30 days and, if appropriate, widen fire control lines and reassess fuel load reduction practices, that are advised by the monitoring of the groundcover as at Table 9.	Low
2	Forestry	Low Standard forestry and Native Timber Harvesting practices remove large trees that contain hollows and deadwood from the environment and are hence considered a potential threat to the quality of the vegetation community and to the accumulation of groundcover.	Forestry and Native Timber Harvesting are excluded from the offset area. Signs at entrance points to the area with regards that it is an offset area and that any harvesting of timber is prohibited.	No clearing of native trees is to occur within the offset area. Remedial action: Reassess access protocols for any lessees etc., signage and general access.	Low
3	Grazing	Low Low groundcover and shrubs provide habitat and	Grazing of domestic livestock will occur in the Offset Areas during the balance of the dry season	Grazing is determined by the amount of dry matter available and is used conservatively for	Low

Number	Risk	Level of risk (extreme, high, moderate or low)	Proposed actions to minimise risk (i.e. mitigation measures)	Proposed remedial actions if risk occurs	Residual risk
	Grazing animals are to be excluded from April to August, which is the Squatter Pigeon breeding season	cover for the squatter pigeon. High density grazing destroys shrubs and native grass cover and slows the regeneration of the habitat. The natural condition of the benchmark for the RE's varies between circa 20-30% native grass cover hence any grazing undertaken is to be at low stocking rates and for short periods of time.	(Sept to December inclusive) for fuel reduction purposes with a minimum grass cover to be present at the end of the dry season as follows: <ul style="list-style-type: none"> in Eucalypt communities and non-remnant Brigalow communities 60% grass cover or 1500kg/ha pasture biomass in remnant Brigalow Communities 20% grass cover. Offset area boundary fencing to be checked quarterly and maintained in a stock proof condition. See location of fencing in Figure 5	that necessary for fuel reduction purposes only Remedial action: Any entry points due to fencing breaks etc. to be repaired to a stock proof condition within a 10-day period during a non-grazing period and within 48 hours during an exclusion period. If cattle are evident in the offset area during an exclusion period, fencing is to be repaired to a stock proof condition within 48 hours and the cattle removed thereafter.	
4	Erosion	Low	Maintaining grass cover at levels specified in (3) above at the end of the dry season. This will ensure groundcover is even higher (due to the presence of fallen woody debris, organic matter etc.) thus minimising the risk of sheet erosion.	Remedial action: Further reduction of grazing levels and checking on the cause of any point source erosion (such as illegal vehicle access) and rectifying access if this is the cause.	Low
5	Drought	Low The risk incurred by drought would be an increase in the likelihood of fire due to the dry conditions and accumulated fuel loads.	Maintain fire control lines as detailed above and manage grazing levels according to the amount of pasture biomass available for grazing.	Remedial action: Allow Offset Areas to recover post drought/fire, particularly through the control of weeds. Maintaining grass cover at levels specified in (3) above at the end of the dry season.	Low
6	Feral herbivores	Low The risk associated with large numbers of Feral herbivores is a similar effect of reduced native grass cover as experienced from excessive cattle grazing pressure.	There were no sightings of feral herbivores noted during the ecological surveys where were undertaken during both wet and dry seasons over a number of years thus a low population is present if at all.	Remedial action: If the number of feral herbivores increases to more than 6 being noted at a time during quarterly surveys	Low

5. Management actions

The following tables (**Table 8**) identifies the actions which will be undertaken for the offset area, by whom, when and more specific information relating to the action. It is noted that all costs and responsibilities associated with the implementation, and monitoring and reporting of the management plan rests with Byerwen Coal Pty Ltd.

Table 8A: Schedule of management actions

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
<p>Forestry operations, native timber harvesting and general vegetation impacts</p> <p>Consistent with the risk of clearing as identified in the Brigalow Conservation Advice and Draft Recovery Plan, Conservation Advice for Reptiles of the Brigalow Belt and Conservation Advice for the Squatter Pigeon (Southern).</p>	<p>4. Vegetation clearing on the offset area is restricted to:</p> <ul style="list-style-type: none"> e) that necessary for the removal of non-native weeds or declared pests f) ensure public safety g) maintenance of existing roads, fence lines, water pipelines and firebreaks; and h) that necessary to establish and maintain access to BioCondition assessment and photo point monitoring sites. <p>Where vegetation clearing is sought for any other purpose, the Landholder must contact the relevant department administering the <i>Vegetation Management Act 1999 (Qld)</i>.</p> <p>5. Native forest practice (harvesting of timber for forestry purposes) <u>is not</u></p>	<p>Only in those areas subject to non-native weed control, fire control lines and fences.</p>	<p>Vegetation clearing for approved purposes may occur as required.</p>	<p>Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.</p>	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least four times annually.</p> <p>Quarterly inspections will monitor and document if there is evidence of recent forestry or timber harvesting activities.</p> <p>Quarterly inspections will monitor and document vegetation clearing that has occurred for an approved purpose.</p> <p>Additional monitoring required as a corrective action/s.</p>	<p>Trigger for corrective action: detection of prohibited forestry operations, native timber harvesting and general vegetation impacts.</p> <p>Corrective action: upon being notified or becoming aware of prohibited forestry operations, native timber harvesting and general vegetation impacts in the offset area, the Landholder is to reassess access protocols for any lessees etc., signage and general access within one fortnight.</p> <p>Reporting: the Offset Area Report will document any known prohibited forestry operations, native timber harvesting and general vegetation impacts that have occurred during the</p>

	<p>allowed under this Offset Area Management Plan.</p> <p>6. Clearing for new fencing will be on the outside of the offset area boundary or along the property boundary.</p> <p>Note: Any vegetation clearing must be undertaken in accordance with:</p> <ul style="list-style-type: none"> • best practice management methods; and • any applicable legislative requirements. For example, the clearing of endangered, vulnerable or near-threatened plant species or the tampering with animal breeding places under <i>Nature Conservation Act 1992 (Qld)</i> <p>Under the <i>Vegetation Management Act 1999</i>, clearing in Least Concern regional ecosystems for fences, roads or tracks is exempt clearing if it is less than 10 m in width. Any new fences, roads or tracks will be less than 10 m in width for each piece of infrastructure. Clearing to establish or maintain a necessary firebreak to protect infrastructure (other than fences, roads and tracks) to a maximum width of 20 m or 1.5 times the height of the</p>					reporting period and the correlating corrective actions. The report will document how this management action is performing and contributing to the enhancement of the offset area
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Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
	tallest adjacent tree, whichever is the greater. Additional management action/s required as a corrective action/s to prevent prohibited clearing.					
Access and signage Note that entry to the offset area can only be gained via the mining lease, which has access restrictions in place under the <i>Mineral Resources Act 1989</i> (Qld). Consistent with the risk of weed incursion as identified in the Brigalow Conservation Advice and Draft Recovery Plan, Conservation Advice for Reptiles of the Brigalow Belt.	4. Installation of signage along the offset area perimeter to alert traffic of the offset area. 5. Installation of slow speed signage at the main entry points to the offset area. Access is restricted to those authorised persons required to undertake actions described in this management plan, including the landholder, QCoal and Byerwen Coal staff and their contractors and assigns. Any other access is to be at the discretion of Byerwen Coal for specific purposes only. Public access to the offset area is prohibited. 6. The offset area is not to be utilised for any purpose including recreational activities, or any other activities that deter from achieving the outcomes of this plan.	Boundary/ entrance points to offset area	Signage to be installed by within three months of the Queensland Government approving the voluntary declaration.	Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.	Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least four times annually. Quarterly inspections will monitor and document if there is evidence of unauthorised access to the offset area. Quarterly inspections will monitor and document if signage is fit for purpose.	Trigger for corrective action: detection of prohibited access by unauthorised persons. Corrective action: upon being notified or becoming aware of prohibited access to the offset area, the Landholder is to reassess access protocols for any lessees etc., signage and general access within one fortnight. Trigger for corrective action: signage is not fit for purpose. Corrective action: signage will be repaired and maintained as required by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder. Reporting: the Offset Area Report will document any known incidences of prohibited

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
						access or signage maintenance issues that have occurred during the reporting period and the correlating corrective actions. The report will document how this management action is performing and contributing to the enhancement of the offset area
Fire Consistent with the risk of inappropriate fire regimes as identified in the Brigalow Conservation Advice and Draft Recovery Plan, Conservation Advice for Reptiles of the Brigalow Belt and Conservation Advice for the Squatter Pigeon (Southern).	2. Fire is to be excluded from the offset area except for low intensity ecological burns at the end of the wet season by: d) maintaining firebreaks relative to the offset areas; e) using a low intensity fire >7 years interval; and f) firebreaks are to be co-located with roads and fence lines on the property where possible. Note: Fire is not to be used as a tool for regrowth management on the offset areas.	May be undertaken throughout the offset areas.	All fire (apart from force majeure events) will be excluded from the offset area during Squatter pigeon (southern) breeding and nesting times being mostly the dry season (April to October). Fire control lines must be inspected quarterly. Maintenance must be undertaken as required and at least biennially (i.e. once every two years). If fire is used, it must be a low intensity fire at >7 years interval immediately after	Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder. The undertaking of an ecological burn will be by a suitably qualified person in consultation with an ecologist.	Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least four times annually. Quarterly inspections will monitor and document if there is evidence of wild fire, prohibited burning or force majeure events. Quarterly inspections will monitor and document if a prescribed low intensity ecological burn has occurred.	Trigger for corrective action: destruction of regrowth, fallen timber and the occurrence of deliberately lit hot fires Corrective action: upon being notified or becoming aware of a prohibited fire in the offset area, the Landholder is to reassess access protocols for any lessees etc., signage and general access within one fortnight. Corrective action: subsequent to any occurrence of fire in the offset area, the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder will: 1. inspect and repair, and widen if

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
			the end of the wet season, which is generally March to April. Ecological burns should not cover more than 30% of the offset area.			<p>necessary, all firebreaks; and</p> <ol style="list-style-type: none"> reassess fuel load reduction practices; and exclude grazing until the grass cover present at the end of the dry season of that year is a minimum: <ul style="list-style-type: none"> Brigalow communities 60% grass cover or 1500 kg/ha pasture biomass Eucalypt communities 60% grass cover or 1500 kg/ha pasture biomass. <p>Grass cover measurements must be in accordance with the methodology stated in the <i>Land Manager's Monitoring Guide</i> (Department of Environment and Resource Management, 2010) (DERM)ⁱⁱⁱ at Attachment 2 of this document, or any subsequent published version of this document.</p>

ⁱⁱⁱ *Land Manager's Monitoring Guide: Ground cover indicator*, Department of Environment and Resource Management, 2010, Queensland Government, Brisbane, available at <http://qldgov.softlinkhosting.com.au/liberty/opac/search.do#>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
						<p>Trigger for corrective action: low intensity ecological burn exceeds 30% of the offset area.</p> <p>Corrective action: measures to contain the fire are to be implemented immediately. Controlled back burning from the next fire control line is the preferred method.</p> <p>Reporting: the Offset Area Report will document any known incidences of fire that have occurred during the reporting period corrective actions. The report will document how this management action is performing and contributing to the enhancement of the offset area</p>
<p>Fencing</p> <p>Consistent with the risk of excess fire as identified in the Brigalow Conservation Advice and Draft Recovery Plan, and overgrazing as identified in the Conservation Advice for Reptiles of the Brigalow Belt and Conservation Advice for the Squatter Pigeon (Southern).</p>	Install and routinely inspect fencing to secure the offset area and prevent unauthorised access.	All external boundaries of the offset area. Where the boundary coincides with the property boundary, the fence may align with the property boundary. A	<p>Fencing of offset areas will be established within three months of the Queensland Government approving the voluntary declaration.</p> <p>If stock are grazing the offset</p>	Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least four times annually.</p> <p>Quarterly inspections will identify if fences</p>	<p>Trigger for corrective action: detection of prohibited access, stock grazing outside of allowed times and thresholds, overgrazing.</p> <p>Corrective action: upon being notified or becoming aware of prohibited access to the</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
		fenced area may include non-offset areas.	area, fencing must be inspected monthly. During non-grazing periods, fencing must be inspected quarterly.		are preventing stock and unauthorised people from accessing the offset area.	<p>offset area, the Landholder is to reassess fencing, signage and general access within one fortnight.</p> <p>Corrective action: upon being notified or becoming aware of an unsecure offset area (i.e. fencing is not fit for purpose), the Pastoral Manager is to undertake fence maintenance and repairs to resecure the offset area as soon as possible and within 10 days. This corrective action may include the installation of new fencing.</p> <p>Reporting: the Offset Area Report will document the installation, maintenance and repair of fences during the reporting period. The report will document how this management action is performing and contributing to the enhancement of the offset area.</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
<p>Following extreme weather conditions of drought, flood or cyclone</p> <p>Consistent with the general risks as identified in the Brigalow Conservation Advice and Draft Recovery Plan, Conservation Advice for Reptiles of the Brigalow Belt and Conservation Advice for the Squatter Pigeon (Southern).</p>	Determine the extent of damage to the offset area and fencing caused by the event.	Throughout the offset area with particular attention paid to riparian areas and the boundary fencing.	As soon as safely possible post a flood or cyclone event. For a drought event, inspections must be monthly.	Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder within one week of the cessation of an extreme event on Wollombi Station.</p> <p>Within the abovementioned timeframe, fencing will be inspected to determine if the offset area is secure.</p> <p>During drought events, monthly inspections will be conducted to record the vegetation condition in the offset area.</p>	<p>Trigger for corrective action: extreme weather conditions of flood or cyclone</p> <p>Corrective action: upon being notified or becoming aware of a flood or cyclone event occurring in offset area, the Pastoral Manager is to undertake fence maintenance and repairs to resecure the offset area within one fortnight.</p> <p>Trigger for corrective action: extreme weather conditions of drought</p> <p>Corrective action: upon being notified or becoming aware of a drought event occurring in offset area, the Pastoral Manager is to remove stock from the offset area within one fortnight.</p> <p>Reporting: the Offset Area Report will document the repair of fences and removal of stock from offset areas, as a result of extreme weather conditions, during the reporting</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
						period. The report will document how this management action is performing and contributing to the enhancement of the offset area.
<p>Grazing</p> <p>Consistent with the risk of excess fire as identified in the Brigalow Conservation Advice and Draft Recovery Plan, and overgrazing/habitat destruction as identified in the Conservation Advice for Reptiles of the Brigalow Belt and habitat destruction and food competition Conservation Advice for the Squatter Pigeon (Southern).</p>	<p>Stocking rates are not fixed as this region is subject to significant changes in grass cover with seasonal conditions.</p> <p>The use of stock in larger numbers for a short period of time in the late dry season and prior to the wet season and if required, again during winter is the preferred method of controlled grazing.</p> <p>Fire and grazing management relating to the Ornamental Snake offset area: A fire in the offset area is foreseen under one of two scenarios:</p> <ol style="list-style-type: none"> 1. a natural event beyond the control of the approval holder or the landholder • the establishment of fire control lines (i.e. firebreaks) will assist in mitigating the risk posed by such natural events 2. a low intensity ecological burn permitted by the Pastoral Manager, Landholder or suitably 	<p>Stock will be grazed in the offset areas for fuel reduction purposes only during the dry season.</p>	<p>As required when grass cover in non-remnant areas exceeds 60% during the dry season.</p> <p>The dry season is normally between April and October; however, if unseasonal rainfall should occur, then grazing is to be allowed only if there is no evidence of moisture in the stream order one gullies to ensure that "pugging" of the soil by livestock does not occur.</p>	<p>Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.</p>	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least monthly during grazing periods.</p> <p>Monthly inspections will record the minimum grass cover, pasture biomass and security (i.e. fences) of the offset area.</p> <p>Monthly inspections will record the evidence of "pugging" in stream order one gullies.</p>	<p>Trigger for corrective action: detection of stock grazing outside of the dry season</p> <p>Corrective action: upon being notified or becoming aware of prohibited stock grazing in the offset area, the Pastoral Manager is to remove the stock from the area (if present) and assess the adequacy of fencing within one fortnight. The Pastoral Manager is to undertake fence maintenance and repairs to resecure the offset area within one fortnight.</p> <p>Trigger for corrective action: in non-remnant areas grass cover is less than 60% or pasture biomass is less than 1500 kg/ha. (Non-remnant and remnant areas are identified in the most recent</p>

	<p>qualified person appointed by the Landholder</p> <p>A low intensity ecological burn permitted under the OAMP may not occur more frequently than once every seven years and the timing of such burns may only occur immediately after the end of the wet season (usually March or April). Furthermore, these low intensity ecological burns are prohibited during the Squatter Pigeon (southern) breeding and nesting times (i.e. the dry season). Consequently, the opportunity to conduct low intensity ecological burns will be very infrequent.</p> <p>Throughout the offset area, management actions for fire and grazing are interlinked due to the necessity to manage increased fuel loads that will establish as a consequence of reduced grazing intensity. As Brigalow trees in the offset area establish and mature, their resulting canopy cover will naturally diminish the fuel load as Buffel grass will decline in extent as the canopy cover increases. Until such time, intervention in the form of both low intensity grazing and infrequent low intensity ecological burns will achieve this outcome.</p> <p>The use of stock grazing in the Ornamental Snake offset area has the potential to adversely impact on the species' habitat</p>					<p>ecological condition survey.)</p> <p>Corrective action: upon being notified or becoming aware of exceedance of either threshold, the Pastoral Manager is to remove stock from the offset area within one fortnight. Grazing may recommence prior to the wet season if the grass cover increases to greater than 60% using the methodology in the <i>Land Manager's Monitoring Guide</i> (DERM, 2010) as attached, or any subsequent published version of this document, and pasture biomass exceeds 1500 kg/ha.</p> <p>Trigger for corrective action: in remnant Brigalow communities grass cover is less than 20%. (Non-remnant and remnant areas are identified in the most recent ecological condition survey.)</p> <p>Corrective action: upon being notified or becoming aware of exceedance of the grass cover threshold, the Pastoral Manager is to remove stock from the</p>
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	<p><i>if poorly managed.</i> At the time of the ecological survey, stock grazing in the offset area was permitted and the area was assessed as suitable habitat for the Ornamental Snake. Therefore the continued use of stock in the area, albeit more restricted, is expected to support the enhancement of the offset area.</p> <p>The management actions seek to avoid adverse impacts by monitoring the offset area more frequently during grazing periods. The Ornamental Snake offset area is comprised of regional ecosystems (RE) 11.4.9 and 11.4.2. Stock occupation will impact on grass cover, therefore upon a predefined minimum grass cover percentage being reached in each of these REs, stock must be removed from the offset area. Stock may not be reintroduced unless the grass cover (again) exceeds 80% during the dry season. Importantly, any sign of significant adverse impacts to low-lying offset areas as a result of stock use (e.g. pugging) will trigger the removal of stock from the offset area.</p> <p>The allowance of stock to the offset area triggers a higher management intensity to mitigate the increased risk of adverse impacts. This management approach will identify adverse impacts as</p>					<p>offset area within one fortnight. Grazing may recommence prior to the wet season if the grass cover increases to greater than 60% using the methodology in the <i>Land Manager's Monitoring Guide</i> (DERM, 2010) as attached, or any subsequent published version of this document.</p> <p>Trigger for corrective action: in remnant Eucalypt communities grass cover is less than 35% or pasture biomass is less than 1500 kg/ha. (Non-remnant and remnant areas are identified in the most recent ecological condition survey.)</p> <p>Corrective action: upon being notified or becoming aware of exceedance of either threshold, the Pastoral Manager is to remove stock from the offset area within one fortnight. Grazing may recommence prior to the wet season if the grass cover increases to greater than 60% using the methodology in the <i>Land Manager's Monitoring Guide</i> (DERM, 2010) as</p>
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	<p>they arise and trigger corrective action/s as necessary. The success of stock grazing in the Ornamental Snake offset area will become apparent during the first dry season under offset area management.</p>					<p>attached, or any subsequent published version of this document, and pasture biomass exceeds 1500 kg/ha.</p> <p>Trigger for corrective action: stock grazing occurs in the offset area during the dry season and pasture biomass is less than 1500 kg/ha at the end of the dry season.</p> <p>Corrective action: upon being notified or becoming aware of the pasture biomass being less than 1500 kg/ha at the end of the dry season, the Pastoral Manager is to review and adapt stock grazing practices for the following dry season. Evidence of this review and outcome/s must be included in the Offset Area Report.</p> <p>Trigger for corrective action: detection of stock grazing causing pugging in stream order one gullies or significant adverse impacts to low-lying offset areas.</p> <p>Corrective action: upon being notified or becoming aware of stock causing pugging in</p>
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Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
						<p>stream order one gullies or significant adverse impacts to low-lying offset areas, the Pastoral Manager is to remove stock from the offset area within 72 hours.</p> <p>Reporting: the Offset Area Report will document the grazing periods that occurred in the offset areas during the reporting period and the correlating corrective actions that occurred as part of grazing management. The report will document how this management action is performing and contributing to the enhancement of the offset area.</p>
<p>Pest animals</p> <p>Consistent with the risk of habitat damage and predation identified in the Conservation Advice for Reptiles of the Brigalow Belt and Conservation Advice for the Squatter Pigeon (Southern).</p>	<p>Minimise the introduction of pest animals and control of existing populations of pest animals (wild dogs, pigs, feral cats and foxes) within the offset areas in accordance with the <i>Land Protection (Pest and Stock Route Management) Act 2002</i> (Qld).</p> <p>Wild pig, deer and dog populations are generally small and highly transient, and therefore the scale of impact is small. Major damage to the environment/habitat occurs</p>	All offset areas.	<p>Preferably in the winter and spring months to minimise impacts to the Squatter Pigeon (southern) during breeding and nesting.</p> <p>Destruction of wetland habitat by feral pigs is also a threat to the Ornamental Snake, along with the associated</p>	Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least four times annually.</p> <p>Quarterly inspections will record the presence of wallow holes, tracks and</p>	<p>Trigger for corrective action: detection of twelve or more half grown and/or mature wild pigs, deer or dogs during a quarterly inspection.</p> <p>Corrective action: upon being notified or becoming aware of pest animals populations exceeding the threshold, the Pastoral Manager is to implement pest control measures within</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
	<p>when large numbers of animals congregate in the area.</p> <p>Current control of pigs and wild dogs is undertaken via a baiting program on the property. Additional to this measure, the Pastoral Manager, during quarterly inspections of the offset area may remove any wild pigs, deer or wild dogs that are seen. If an increase in pig, deer or dog activity is noted, an additional trapping, baiting and/or control program is to be instigated until the increased activity has ceased.</p> <p>There was no evidence of extensive damage from deer, foxes, rabbits or wild cats detected during surveys as part of the Environmental Impact Assessment, however, if the occurrence of these animals is detected, a control program integrated with that for wild pigs and dogs will be implemented.</p>		<p>destruction of frog habitat and direct competition for their food source (frogs).</p> <p>When a group of animals is observed, a control program will be implemented. The timing of control program will address the threats to both species.</p>		<p>visual incidents in the offset area.</p> <p>Note: baseline levels for pest animals are not able to be established due to the transient nature of the animals. Numbers are established via visual signs recorded during quarterly inspections.</p>	<p>one month. The Pastoral Manager or Landholder may approach neighbouring landowners to discuss the increased pest animal presence and an integrated control program may be developed.</p> <p>Reporting: the Offset Area Report will document the indications or sightings of pest animals during the reporting period and the correlating corrective actions. The report will document how this management action is performing and contributing to the enhancement of the offset area.</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
Pest plants (i.e. weeds) Consistent with the risk of excess fire from excessive weed cover as identified in the Brigalow Conservation Advice and Draft Recovery Plan, and and competition food sources and inappropriate habitat as per the Conservation Advice for the Squatter Pigeon (Southern)	<p>Keep the introduction, establishment and spread of non-native weeds including Declared Pest Plants listed under the <i>Land Protection (Pest and Stock Route Management) Act 2002</i> (Qld) to less than 10% weed cover in the offset area.</p> <p>Control existing infestations of non-native weeds including declared pest plants under the <i>Land Protection (Pest and Stock Route Management) Act 2002</i> (Qld) to ensure that the non-native weeds cover less than 10% of the offset area (e.g., Parthenium).</p> <p>Buffel Grass is recognised as being a threat to the vegetation communities and habitat in the offset area however is not referred to as a weed as it is not declared in the <i>Land Protection (Pest and Stock Route Management) Act 2002</i> (Qld). Control measures such as grazing and increasing canopy cover of vegetation are included in this plan to decrease the extent of Buffel Grass over time. Control of Buffel Grass is best managed via grazing during the dry</p>	Throughout the offset area	Weed control will be undertaken as early as practicable within the natural regeneration process throughout the offset areas and then periodically as required to treat the weeds at the optimum time in their life cycles to control and minimise the spread of the existing weed species.	Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least four times annually.</p> <p>Quarterly inspections will observe and record the presence of weeds and success of previously applied weed control measures. The inspection will include before and after photos of the weed control area. The field data sheets provided in Appendix A may assist with documenting weed presence and control measures.</p> <p>Quarterly inspections will be conducted by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder to record the minimum grass cover in the offset area. The following grass cover is to be present at the end of</p>	<p>Trigger for corrective action: pest plants occur in greater than 10% of the offset area</p> <p>Corrective action: upon being notified or becoming aware of pest plants being present in greater than 10% of the offset area, the Pastoral Manager is to implement pest control measures within one month. These measures may include, and are not limited to:</p> <ul style="list-style-type: none"> • foliar spraying; • basal bark spraying; • stem injection; • cut stump; • cut and swab; • stem scraper; and • wick applicators. <p>Reporting: the Offset Area Report will document the weed presence and weed control measures during the reporting period and the correlating corrective actions. The report will document how this management action is performing and contributing to the enhancement of the offset area.</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
	<p>season and increasing tree canopy cover.</p> <p>Spot spraying of patches of Parthenium is permitted.</p>				<p>the dry season as a minimum:</p> <ul style="list-style-type: none"> Brigalow communities 60% groundcover or 1500kg/ha pasture biomass Eucalypt Communities 60% groundcover or 850kg/ha pasture biomass. 	

Table 8B: Schedule of Management Actions for the additional Squatter Pigeon offset area on – Wollombi Station

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
<p>Forestry operations, native timber harvesting and general vegetation impacts</p> <p>Consistent with the risk of clearing as identified in the Conservation Advice for the Squatter Pigeon (Southern). General Vegetation Impacts are those impacts that occur as a result of weed control, public safety, existing fence, road and fire control line maintenance, stock management and monitoring and reporting.</p>	<ol style="list-style-type: none"> Native forest practice (harvesting of timber for forestry purposes) <u>is not</u> allowed under this Offset Area Management Plan. Clearing for new fencing will be on the outside of the offset area boundary or along the property boundary. <p>Note: Any vegetation clearing must be undertaken in accordance with:</p> <ul style="list-style-type: none"> best practice management methods; and any applicable legislative requirements. For example, the clearing of endangered, vulnerable or near-threatened plant species or the tampering with animal breeding places under <i>Nature Conservation Act 1992 (Qld)</i> <p>Additional management action/s required as a corrective action/s to prevent prohibited clearing.</p>	Only in those areas subject to non-native weed control, fire control lines and fences.		Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least four times annually.</p> <p>Quarterly inspections will monitor and document if there is evidence of recent forestry or timber harvesting activities.</p> <p>Quarterly inspections will monitor and document vegetation clearing that has occurred for an approved purpose.</p> <p>Additional monitoring required as a corrective action/s.</p>	<p>Trigger for corrective action: detection of prohibited forestry operations, native timber harvesting and general vegetation impacts.</p> <p>Corrective action: upon being notified or becoming aware of prohibited forestry operations, native timber harvesting and general vegetation impacts in the offset area, the Landholder is to reassess access protocols for any lessees etc., signage and general access within one fortnight.</p> <p>Reporting: the Offset Area Report will document any known prohibited forestry operations, native timber harvesting and general vegetation impacts that have occurred during the reporting period and the correlating corrective actions. The report will document how this management action is performing and contributing to the enhancement of the offset area</p>
<p>Access and signage</p> <p>Note that entry to the offset area can only be gained via</p>	<ol style="list-style-type: none"> Installation of signage along the offset area perimeter to alert traffic of the offset area. Installation of slow speed signage at the main entry 	Boundary/ entrance points to offset area	Signage to be installed by within three months of the Queensland Government approving the voluntary declaration.	Pastoral Manager, Landholder or suitable qualified person	Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least four times annually.	<p>Trigger for corrective action: detection of prohibited access by unauthorised persons.</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
<p>the mining lease, which has access restrictions in place under the Mineral Resources Act 1989 (Qld).</p> <p>Any traversing of the offset site for monitoring purposes is to follow contour lines and minimise impacts to vegetation as much as possible.</p> <p>.</p>	<p>points to the offset area. Access is restricted to those authorised persons required to undertake actions described in this management plan, including the landholder, QCoal and Byerwen Coal staff and their contractors and assigns. Any other access is to be at the discretion of Byerwen Coal for specific purposes only. Public access to the offset area is prohibited.</p> <p>3. The offset area is not to be utilised for any purpose including recreational activities, or any other activities that deter from achieving the outcomes of this plan.</p>			<p>appointed by the Landholder.</p>	<p>Quarterly inspections will monitor and document if there is evidence of unauthorised access to the offset area.</p> <p>Quarterly inspections will monitor and document if signage is fit for purpose.</p>	<p>Corrective action: upon being notified or becoming aware of prohibited access to the offset area, the Byerwen Coal is to reassess access protocols for any lessees etc., signage and general access within one fortnight.</p> <p>Damage to signage will be repaired within one fortnight of noting the damage</p> <p>Access protocols will be reviewed and amended if necessary and the impacted area's regeneration monitored during the quarterly inspections.</p> <p>Trigger for corrective action: signage is not fit for purpose.</p> <p>Corrective action: signage will be repaired and maintained as required by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.</p> <p>Reporting: the Offset Area Report will document any known incidences of prohibited access or signage maintenance issues that have occurred during the reporting period and the correlating corrective actions. The report will</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
						document how this management action is performing and contributing to the enhancement of the offset area
Fire Consistent with the risk of inappropriate fire regimes as identified in the Conservation Advice for the Squatter Pigeon (Southern).	<p>Fire is to be excluded from the offset area except for low intensity ecological burns at the end of the wet season by:</p> <ol style="list-style-type: none"> maintaining firebreaks relative to the offset areas; using a low intensity fire >7 years interval; and firebreaks are to be co-located with roads and fence lines on the property where possible. <p>Note: Fire is not to be used as a tool for regrowth management on the offset areas.</p> <p>A fire in the offset area is foreseen under one of two scenarios:</p> <ol style="list-style-type: none"> a natural event beyond the control of the approval holder or the landholder the establishment of fire control lines (i.e. firebreaks) will assist in 	<p>May be undertaken throughout the offset areas.</p>	<p>All fire (apart from force majeure events) will be excluded from the offset area during Squatter pigeon (southern) breeding and nesting times being mostly the dry season (April to October).</p> <p>Fire control lines must be inspected quarterly. Maintenance must be undertaken as required and at least biennially (i.e. once every two years).</p> <p>If fire is used, it must be a low intensity fire at >7 years interval immediately after the end of the wet season, which is generally March to April. Ecological burns should not cover more than 30% of the offset area.</p>	<p>Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.</p> <p>The undertaking of an ecological burn will be by a suitably qualified person in consultation with an ecologist.</p>	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least four times annually.</p> <p>Quarterly inspections will monitor and document if there is evidence of wild fire, prohibited burning or force majeure events. Fencing is to be checked and repaired (if necessary) to a stock proof condition within 10 days of any <i>Force Majeure</i> event.</p> <p>Quarterly inspections will monitor and document if a prescribed low intensity ecological burn has occurred.</p> <p>Weed cover is to be monitored by the same methodology and at the same time as the grass cover and weed control undertaken post a fire event to ensure weed cover is <5%.</p> <p>Grass cover measurements must be in accordance with Methodology 2B as stated in the <i>Land Manager's Monitoring Guide</i> (Department of Environment and Resource Management, 2010) (DERM)^{iv} provided as <i>Attachment 2</i> of the OAMP, or any</p>	<p>Trigger for corrective action: destruction of regrowth, fallen timber and the occurrence of deliberately lit hot fires</p> <p>Corrective action: upon being notified or becoming aware of a prohibited fire in the offset area, Byerwen Coal is to reassess and implement new access protocols for any lessees etc., signage and general access within one fortnight.</p> <p>Corrective action: subsequent to any occurrence of fire in the offset area, the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder will:</p> <ol style="list-style-type: none"> inspect and repair, and widen if necessary, all firebreaks; and reassess fuel load reduction practices; and

^{iv} *Land Manager's Monitoring Guide: Ground cover indicator*, Department of Environment and Resource Management, 2010, Queensland Government, Brisbane, available at <http://qldgov.softlinkhosting.com.au/liberty/opac/search.do#>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
	<p>mitigating the risk posed by such natural events</p> <p>4. a low intensity ecological burn permitted by the Pastoral Manager, Landholder or suitably qualified person appointed by the Landholder</p> <p>A low intensity ecological burn permitted under the OAMP may not occur more frequently than once every seven years and the timing of such burns may only occur immediately after the end of the wet season (usually March or April). Furthermore, these low intensity ecological burns are prohibited during the Squatter Pigeon (southern) breeding and nesting times (i.e. the dry season). Consequently, the opportunity to conduct low intensity ecological burns will be very infrequent.</p>		If a Force Majeure fire occurs within the offset areas, controlled burning is not to be undertaken for at least 7 years after.		subsequent published version of this document.	<p>6. exclude grazing until the ground cover present at the end of the dry season of that year is at a minimum of 60%:</p> <p>Trigger for corrective action: low intensity ecological burn exceeds 30% of the offset area.</p> <p>Corrective action: measures to contain the fire are to be implemented immediately. Controlled back burning from the next fire control line is the preferred method.</p> <p>Reporting: the Offset Area Report will document any known incidences of fire that have occurred during the reporting period corrective actions. The report will document how this management action is performing and contributing to the enhancement of the offset area</p>
<p>Fencing</p> <p>The proponent commits to installing fencing to protect the offset area. A fencing plan has been provided in Figure 5 of the</p>	Install and routinely inspect fencing to secure the offset area and prevent unauthorised access.	All external boundaries of the offset area.. A fenced area may include non-offset areas.	Fencing of offset areas will be established within three months of the Queensland Government approving the voluntary declaration.	Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least four times annually.</p> <p>Quarterly inspections will identify if fences are preventing stock and</p>	<p>Trigger for corrective action: detection of prohibited access, stock grazing outside of allowed times and thresholds, overgrazing. Damage to fencing that could allow unauthorised</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
<p>OAMP as provided at Schedule 1.</p> <p>Consistent with the risk of excess grazing as identified in the Conservation Advice for the Squatter Pigeon (Southern).</p>			<p>If stock are grazing the offset area or adjacent areas, fencing must be inspected monthly.</p> <p>During non-grazing periods, fencing must be inspected quarterly.</p>		<p>unauthorised people from accessing the offset area.</p> <p>Fencing is to be checked and repaired (if necessary) to a stock proof condition within 10 days of any <i>Force Majeure</i> event.</p>	<p>access to people or livestock.</p> <p>Corrective action: upon being notified or becoming aware of prohibited access to the offset area, the Landholder is to reassess fencing, signage and general access within one fortnight.</p> <p>Corrective action: upon being notified or becoming aware of an unsecure offset area (i.e. fencing is not fit for purpose), the Pastoral Manager is to undertake fence maintenance and repairs to resecure the offset area as soon as possible and within 10 days. This corrective action may include the installation of new fencing.</p> <p>Reporting: the Offset Area Report will document the installation, maintenance and repair of fences during the reporting period. The report will document how this management action is performing and contributing to the enhancement of the offset area.</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
<p>Following extreme weather conditions of drought, flood or cyclone</p> <p>Consistent with the general risks as identified in Conservation Advice for the Squatter Pigeon (Southern). Drought is defined as the district or property being Drought Declared by the Qld Government.</p>	Determine the extent of damage to the offset area and fencing caused by the event.	Throughout the offset area with particular attention paid to riparian areas and the boundary fencing.	As soon as safely possible post a flood or cyclone event. For a drought event, inspections must be monthly.	Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder within one week of the cessation of an extreme event on Wollombi Station.</p> <p>Within the abovementioned timeframe, fencing will be inspected to determine if the offset area is secure.</p> <p>During drought events, monthly inspections will be conducted to record the vegetation condition in the offset area.</p> <p>Weed cover is to be monitored by the same methodology and at the same time as the grass cover and weed control undertaken post a fire event to ensure weed cover is <5%.</p> <p>Fencing is to be checked and repaired (if necessary) to a stock proof condition within 10 days of any <i>Force Majeure</i> event.</p>	<p>Trigger for corrective action: extreme weather conditions of flood or cyclone</p> <p>Corrective action: upon being notified or becoming aware of a flood or cyclone event occurring in offset area, the Pastoral Manager is to undertake fence maintenance and repairs to resecure the offset area within one fortnight. Stock will be excluded following Force Majeure rain events until soil is sufficiently dry to prevent pugging.</p> <p>Trigger for corrective action: extreme weather conditions of drought</p> <p>Corrective action: upon being notified or becoming aware of a drought event occurring in offset area, the Pastoral Manager is to remove stock from the offset area within 5 days.</p> <p>Reporting: the Offset Area Report will document the repair of fences and removal of stock from offset areas, as a result of extreme weather conditions, during the reporting period. The report will document how this</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
						management action is performing and contributing to the enhancement of the offset area.
Grazing Consistent with the risk of excess grazing as identified in the Conservation Advice for the Squatter Pigeon (Southern).	<p>Stocking rates are not fixed as this region is subject to significant changes in grass cover with seasonal conditions.</p> <p>The use of stock in larger numbers for a short period of time in the late dry season and prior to the wet season and if required, again during winter is the preferred method of controlled grazing.</p> <p>Throughout the offset area, management actions for fire and grazing are interlinked due to the necessity to manage increased fuel loads that will establish as a consequence of reduced grazing intensity. As canopy trees and the shrub layers in the offset area establish and mature, their resulting canopy cover will naturally diminish the fuel load as Buffel grass will decline in extent as the canopy cover increases. Until such time, intervention in the form of both low intensity grazing and infrequent low intensity ecological burns will achieve this outcome.</p> <p>The management actions seek to avoid adverse impacts by</p>	<p>Stock will be grazed in the offset areas for fuel reduction purposes only during the dry season.</p>	<p>As required when ground cover in non-remnant areas exceeds 60% during the dry season. Crash grazing events are only to be undertaken during December; however, if unseasonal rainfall should occur, then grazing is to be allowed only if there is no evidence of moisture in the stream order one gullies to ensure that "pugging" of the soil by livestock does not occur.</p>	<p>Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.</p>	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least monthly during grazing periods.</p> <p>Monthly inspections will record the minimum grass cover, pasture biomass and security (i.e. fences) of the offset area.</p> <p>Monthly inspections will record the evidence of "pugging" in stream order one gullies.</p>	<p>Trigger for corrective action: detection of stock grazing outside of the dry season, or during the dry season exclusion period</p> <p>Corrective action: upon being notified or becoming aware of prohibited stock grazing in the offset area, the Pastoral Manager is to remove the stock from the area (if present) and assess the adequacy of fencing within 10 days. The Pastoral Manager is to undertake fence maintenance and repairs to resecure the offset area within 10 days.</p> <p>Trigger for corrective action: in non-remnant areas ground cover is less than 60%.</p> <p>Corrective action: upon being notified or becoming aware of exceedance of the threshold, the Pastoral Manager is to remove stock from the offset area within 5 days. Grazing may recommence prior to the wet season if the ground cover increases to greater than</p>

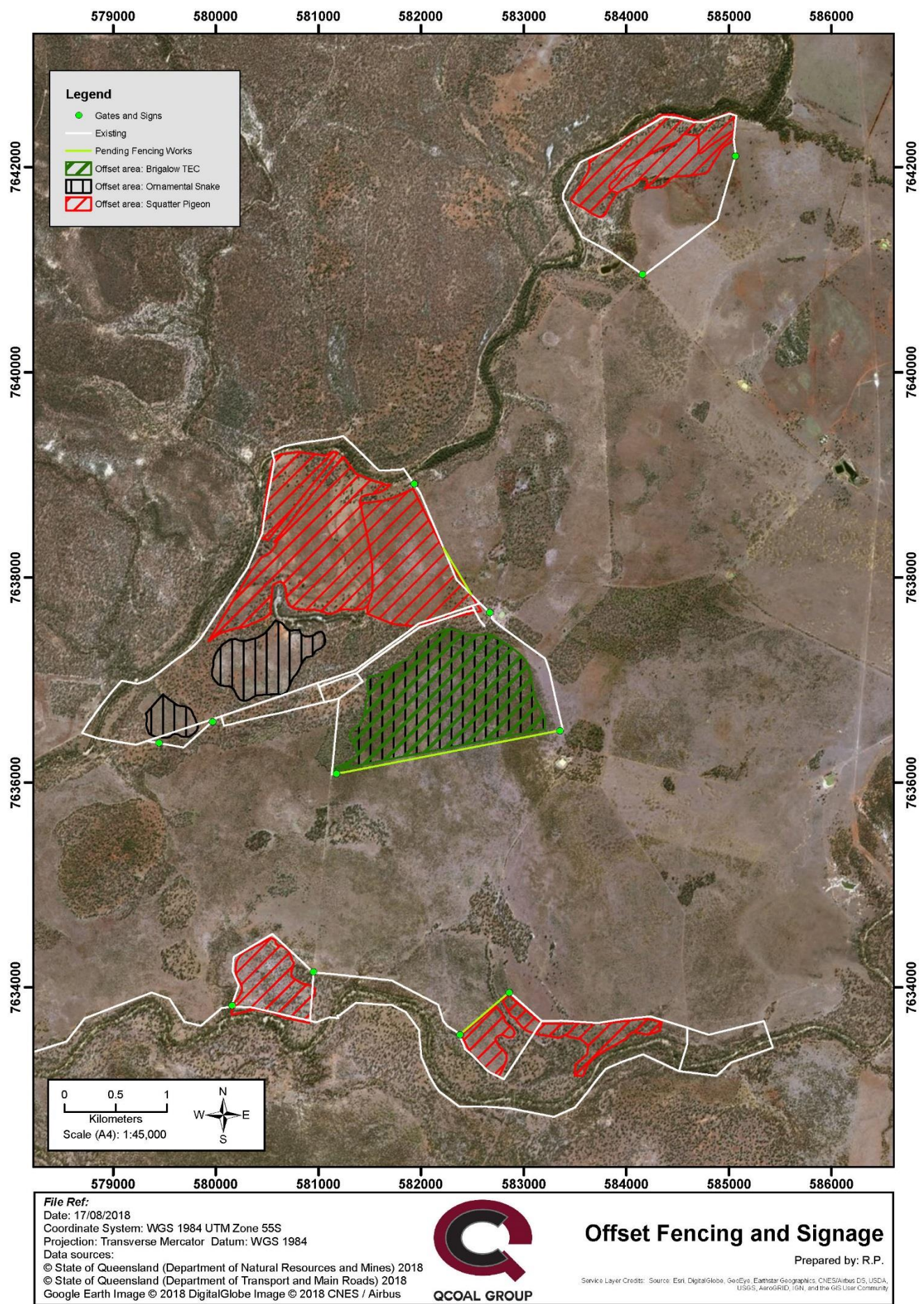
	<p>monitoring the offset area more frequently during grazing periods. Importantly, any sign of significant adverse impacts to low-lying offset areas as a result of stock use (e.g. pugging) will trigger the removal of stock from the offset area.</p> <p>The allowance of stock to the offset area triggers a higher management intensity to mitigate the increased risk of adverse impacts. This management approach will identify adverse impacts as they arise and trigger corrective action/s as necessary. The success of stock grazing in the Squatter Pigeon (southern) offset area will become apparent during the first dry season under offset area management.</p>					<p>60% using methodology 2Bin the <i>Land Manager's Monitoring Guide (DERM, 2010)</i> as per Attachment 2 of the OAMP, or any subsequent published version of this document.</p> <p>Trigger for corrective action: stock grazing occurs in the offset area during the dry season and ground cover falling below 60%.</p> <p>Corrective action: upon being notified or becoming aware that the ground cover drops below 60% during the dry season, the Pastoral Manager is to review and adapt stock grazing practices for the following dry season. Evidence of this review and outcome/s must be included in the Offset Area Report.</p> <p>Trigger for corrective action: detection of stock grazing causing pugging in stream order one gullies or significant adverse impacts to low-lying offset areas, all of which are to be inspected during the quarterly inspections</p> <p>Corrective action: upon being notified or becoming aware of stock causing pugging in stream order one gullies or significant adverse impacts to low-lying offset areas, the Pastoral Manager</p>
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Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
						<p>is to remove stock from the offset area within 72 hours.</p> <p>Corrective action: upon being notified or becoming aware of a drought event occurring in offset area, the Pastoral Manager is to remove stock from the offset area within 5 days.</p> <p>Reporting: The Offset Area Report will document the grazing periods that occurred in the offset areas during the reporting period and the correlating corrective actions that occurred as part of grazing management. The report will document how this management action is performing and contributing to the enhancement of the offset area.</p>
<p>Pest animals</p> <p>Consistent with the risk of habitat damage and predation identified in the Conservation Advice for the Squatter Pigeon (Southern).</p>	<p>Minimise the introduction of pest animals and control of existing populations of pest animals (wild dogs, pigs, feral cats and foxes) within the offset areas in accordance with the <i>Land Protection (Pest and Stock Route Management) Act 2002</i> (Qld).</p> <p>Wild pig, deer and dog populations are generally small and highly transient, and therefore the scale of impact is small. Major damage to the environment/habitat occurs</p>	All offset areas.	<p>Preferably in the winter and spring months to minimise impacts to the Squatter Pigeon (southern) during breeding and nesting.</p> <p>Destruction of wetland habitat by feral pigs is also a threat to the Ornamental Snake, along with the associated destruction of frog habitat and direct competition for their food source (frogs).</p>	Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least four times annually.</p> <p>Quarterly inspections will involve traversing the offset area with streams, low lying areas and vehicle access tracks being noted for to record the presence of wallow holes, tracks and visual incidents in the offset area. If detected, these areas will be GPS and photographed and rechecked at the next quarterly inspection.</p> <p>Note: baseline levels for pest animals are not able to be established due to</p>	<p>Trigger for corrective action: detection of twelve or more half grown and/or mature wild pigs, deer or dogs during a quarterly inspection.</p> <p>Corrective action: upon being notified or becoming aware of pest animal populations exceeding the threshold, the Pastoral Manager is to implement pest control measures within one month. The Pastoral Manager or Landholder may approach neighbouring landowners to discuss the</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
	<p>when large numbers of animals congregate in the area. Current control of pigs and wild dogs is undertaken via a baiting program on the property. Additional to this measure, the Pastoral Manager, during quarterly inspections of the offset area may remove any wild pigs, deer or wild dogs that are seen. If an increase in pig, deer or dog activity is noted, an additional trapping, baiting and/or control program is to be instigated until the increased activity has ceased.</p> <p>There was no evidence of extensive damage from deer, foxes, rabbits or wild cats detected during surveys as part of the Environmental Impact Assessment, however, if the occurrence of these animals is detected, a control program integrated with that for wild pigs and dogs will be implemented.</p>		When a group of animals is observed, a control program will be implemented. The timing of control program will address the threats to both species.		the transient nature of the animals. Numbers are established via visual signs recorded during quarterly inspections.	<p>increased pest animal presence and an integrated control program may be developed.</p> <p>Reporting: the Offset Area Report will document the indications or sightings of pest animals during the reporting period and the correlating corrective actions. The report will document how this management action is performing and contributing to the enhancement of the offset area.</p>
<p>Pest plants (i.e. weeds)</p> <p>Consistent with the risk of excess fire from excessive weed cover as identified in the Conservation Advice for the Squatter Pigeon (Southern)</p>	<p>Keep the introduction, establishment and spread of non-native weeds including Declared Pest Plants listed under the <i>Land Protection (Pest and Stock Route Management) Act 2002</i> (Qld) to less than 10% weed cover in the offset area.</p> <p>Control existing infestations of non-native weeds including declared pest plants under the <i>Land Protection (Pest and Stock</i></p>	Throughout the offset area	Weed control will be undertaken as early as practicable within the natural regeneration process throughout the offset areas and then periodically as required to treat the weeds at the optimum time in their life cycles to control and minimise the spread of the existing weed species.	Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder.	<p>Monitoring of this management action will be undertaken by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder at least four times annually. Weed cover is to be monitored by the same methodology and at the same time and at the same time as the grass cover measurements.</p> <p>Quarterly inspections will observe and record the presence of weeds and success of previously applied weed</p>	<p>Trigger for corrective action: pest plants occur in greater than 10% of the offset area</p> <p>Corrective action: upon being notified or becoming aware of pest plants being present in greater than 5% of the offset area, the Pastoral Manager is to implement pest control measures within one month. These measures</p>

Management action	How the action will be carried out	Where the action will be carried out	When the action will be carried out	Who will be carrying out the action	Monitoring scope, frequency and timing	Triggers, corrective actions and performance reporting
	<p><i>Route Management) Act 2002</i> (Qld) to ensure that the non-native weeds cover less than 10% of the offset area (e.g., Parthenium).</p> <p>Buffel Grass is recognised as being a threat to the vegetation communities and habitat in the offset area however is not referred to as a weed as it is not declared in <i>the Land Protection (Pest and Stock Route Management) Act 2002</i> (Qld). Control measures such as grazing and increasing canopy cover of vegetation are included in this plan to decrease the extent of Buffel Grass over time. Control of Buffel Grass is best managed via grazing during the dry season and increasing tree canopy cover.</p> <p>Spot spraying of patches of Parthenium is permitted.</p>				<p>control measures. The inspection will include before and after photos of the weed control area. The field data sheets provided in Appendix A may assist with documenting weed presence and control measures.</p> <p>Quarterly inspections will be conducted by the Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder to record the ground cover in the offset area. The following ground cover is to be present at the end of the dry season which is to be at the minimum of 60% at the end of the dry season.</p>	<p>may include, and are not limited to:</p> <ul style="list-style-type: none"> • foliar spraying; • basal bark spraying; • stem injection; • cut stump; • cut and swab; • stem scraper; and • wick applicators. <p>Reporting: the Offset Area Report will document the weed presence and weed control measures during the reporting period and the correlating corrective actions. The report will document how this management action is performing and contributing to the enhancement of the offset area.</p>

Figure 5: Fencing plan – offset area Wollombi Station



6. Monitoring requirements

Monitoring of the offset area will occur in accordance with **Table 9**. It is noted that all costs and responsibilities associated with the implementation, and monitoring and reporting of the management plan rests with Byerwen Coal Pty Ltd. The location of the monitoring sites is shown in **Table 10**, and illustrated in the map at **Figure 6**.

Table 9A: Schedule of monitoring – offset area, Wollombi Station

Monitoring	Attributes monitored	Frequency	Method	Location/s
Surveys undertaken by Ecologists				
Baseline assessment	Refer 'ecological condition' below	Completed in 2015/16 and is an input into the OAMP	Field observations, vegetation assessment as per the <i>Guide to determining terrestrial habitat quality – a toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy (version 1.1 December 2014)</i> (DEHP, 2014).	Sites listed at Table 10 of the OAMP.
Ecological condition assessment	Recruitment of woody perennial species in EDL	In the early dry season (June or July) in years 2020, 2025, 2030, 2035, 2040, and 2044	Field observations, vegetation assessment as per the <i>Guide to determining terrestrial habitat quality – a toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy (version 1.1 December 2014)</i> (DEHP, 2014)*. Data for each of the ecological condition attributes monitored will be collected at each site listed in Table 10 of the OAMP and reported on and presented in a sequential manner (including previous data collected) to quantify change from the benchmark collected in 2015/16. This will record the change in each attribute measured and hence the condition of the ecological community and habitat, thus enabling a statistical comparison to previous years' data and the progression of the offset site condition and EPBC Act Offset Assessment Guide Calculator inputs.	Sites listed at Table 10 of the OAMP.
	Native plant species richness – trees			
	Native plant species richness – shrubs			
	Native plant species richness - grasses			
	Native plant species richness – forbs			
	Tree canopy height			
	Tree canopy cover			
	Shrub canopy cover			
	Native perennial grass cover			
	Organic litter			
	Large trees			
	Coarse woody debris			
	Non-native plant cover			
	Non-remnant or remnant status			

Monitoring	Attributes monitored	Frequency	Method	Location/s
Squatter pigeon survey	As per the EPBC Act guidelines	In the early dry season (June or July) in years 2020, 2025, 2030, 2035, 2040 and 2044.	As per the EPBC Act guidelines	Sites listed at Table 10 of the OAMP.
Landholder/Pastoral Manager/Authority Holder Records				
<i>Record keeping commences within three months of the Queensland Government approving the voluntary declaration</i>				
Photo points	General vegetation condition	Annually in the early dry season (June or July) until, and including, May 2044	Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder will undertake quarterly inspections of the offset area to observe and record grass cover levels, pest plants, accessibility (i.e. condition of fencing), signage, evidence of fire and evidence of pest animal incursion. The inspection records will serve as the primary data source for the Offset Area Report.	Sites listed at Table 10 of the OAMP.
Grazing	Stocking rates Grass cover Pasture biomass Pugging of the soil by livestock	Monitored monthly during grazing periods and reported annually until, and including, May 2044	Photo points to be undertaken as per the method described in the <i>Land Manager's Monitoring Guide</i> (DERM, 2010) (or any subsequent published version of this document) provided at Attachment 2 of the OAMP,	Within Offset Areas
Fire	Occurrence/triggers, corrective actions, timing and result of the control measures	Monitored quarterly and reported annually until, and including, May 2044		
Pest plants	Occurrence/triggers, corrective actions, timing and result of the control measures	Monitored quarterly and reported annually until, and including, May 2044		
Pest animals	Occurrence/triggers, corrective actions, timing and result of the control measures	Monitored quarterly and reported annually until, and including, May 2044		
Access and signage	Occurrence/triggers, corrective actions, timing and result of the control measures	Monitored quarterly and reported annually until, and including, May 2044		

*A methodology for assessing ecological condition published subsequent to the *Guide to determining terrestrial habitat quality – a toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy (version 1.1 December 2014)* (DEHP, 2014) that captures the required scope of information may be used.

Table 9B: Schedule of monitoring – additional squatter pigeon offset area, Wollombi Station

Monitoring	Attributes monitored	Frequency	Method	Location/s
Surveys undertaken by Ecologists				
Baseline assessment	Refer 'ecological condition' below	Completed in 2015/16 and is an input into the OAMP A baseline survey for weeds and Squatter Pigeon (as per the Survey Guidelines for Australia's Threatened Birds , EPBC Act survey guidelines 6.2) populations will be undertaken by June 2019 and the results included in the first Annual Report.	Field observations, vegetation assessment as per the <i>Guide to determining terrestrial habitat quality – a toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy (version 1.1 December 2014)</i> (DEHP, 2014).	Sites listed at <i>Table 10</i> of the OAMP.
Ecological condition assessment	Recruitment of woody perennial species in EDL	Early dry season (June or July) in years 2020, 2025, 2030, 2035, 2040 and 2044	Field observations, vegetation assessment as per the <i>Guide to determining terrestrial habitat quality – a toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy (version 1.1 December 2014)</i> (DEHP, 2014)*. Data for each of the ecological condition attributes monitored will be collected at each site listed in <i>Table 10</i> of the OAMP and reported on and presented in a sequential manner (including previous data collected) to quantify change from the benchmark collected in 2015/16. This will record the change in each attribute measured and hence the condition of the ecological community and habitat, thus enabling a statistical comparison to previous years' data and the progression of the offset site condition and EPBC Act Offset Assessment Guide Calculator inputs.	Sites listed at <i>Table 10</i> of the OAMP.
	Native plant species richness – trees			
	Native plant species richness – shrubs			
	Native plant species richness - grasses			
	Native plant species richness – forbs			
	Tree canopy height			
	Tree canopy cover			
	Shrub canopy cover			
	Native perennial grass cover			
	Organic litter			
	Large trees			
	Coarse woody debris			
	Non-native plant cover			
	Non-remnant or remnant status			
Ground cover	Ground cover	Annually in the early dry season (June or July) for the first five years, and biennially for the remainder of the approval period.	As per the <i>Guide to determining terrestrial habitat quality – a toolkit for assessing land based offsets under the Queensland</i>	Sites listed at <i>Table 10</i> of the OAMP

Monitoring	Attributes monitored	Frequency	Method	Location/s
			<i>Environmental Offsets Policy (version 1.1 December 2014) (DEHP, 2014)*.</i>	
Squatter pigeon survey	Squatter pigeon populations	Early dry season (June or July) in years 2020, 2025, 2030, 2035, 2040 and 2044	As per the Survey Guidelines for Australia's Threatened Birds. EPBC Act survey guidelines 6.2	Sites listed at Table 10 of the OAMP.
Quarterly Landholder/Pastoral Manager/Authority Holder Records and monitoring <i>Record keeping commences within three months of the Queensland Government approving the voluntary declaration</i>				
Photo points	General vegetation condition	Annually in the early dry season (June or July) until, and including, May 2044	Pastoral Manager, Landholder or suitable qualified person appointed by the Landholder will undertake quarterly inspections of the offset area to observe and record grass cover levels, pest plants, accessibility (i.e. condition of fencing), signage, evidence of fire and evidence of pest animal incursion. The inspection records will serve as the primary data source for the Offset Area Report. Photo points and monitoring is to be undertaken as per the <i>Level 1 monitoring in the Land Manager's Monitoring Guide (DERM, 2010)</i> (or any subsequent published version of this document) provided at Attachment 2 of the OAMP,	Sites listed at Table 10 of the OAMP.
Grazing	Stocking rates Grass cover Pasture biomass Pugging of the soil by livestock	Monitored monthly during grazing periods and reported annually until, and including, May 2044 <i>Level 1 monitoring as per the Land Manager's Monitoring Guide (DERM, 2010)</i>		Within Offset Areas
Fire	Occurrence/triggers, corrective actions, timing and result of the control measures. as per Table 8.	Monitored quarterly and reported annually until, and including, May 2044		
Pest plants	Occurrence/triggers, corrective actions, timing and result of the control measures. as per Table 8.	Monitored quarterly and reported annually until, and including, May 2044. Weed cover is to be monitored by the same methodology and at the same time and at the same time as the grass cover measurements.		
Pest animals	Occurrence/triggers, corrective actions, timing and result of the control measures. as per Table 8.	Monitored quarterly and reported annually until, and including, May 2044. Quarterly inspections will involve traversing the offset area with streams, low lying areas and vehicle access tracks being noted for to record the presence of wallow holes, tracks and visual incidents in the offset area. If detected, these areas will be GPS and photographed and rechecked at the next quarterly inspection.		
Access and signage	Occurrence/triggers, corrective actions, timing and result of the control measures as per Table 8.	Monitored quarterly and reported annually until, and including, May 2044		

*A methodology for assessing ecological condition published subsequent to the *Guide to determining terrestrial habitat quality – a toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy (version 1.1 December 2014)* (DEHP, 2014) that captures the required scope of information may be used.

Table 10: Monitoring sites

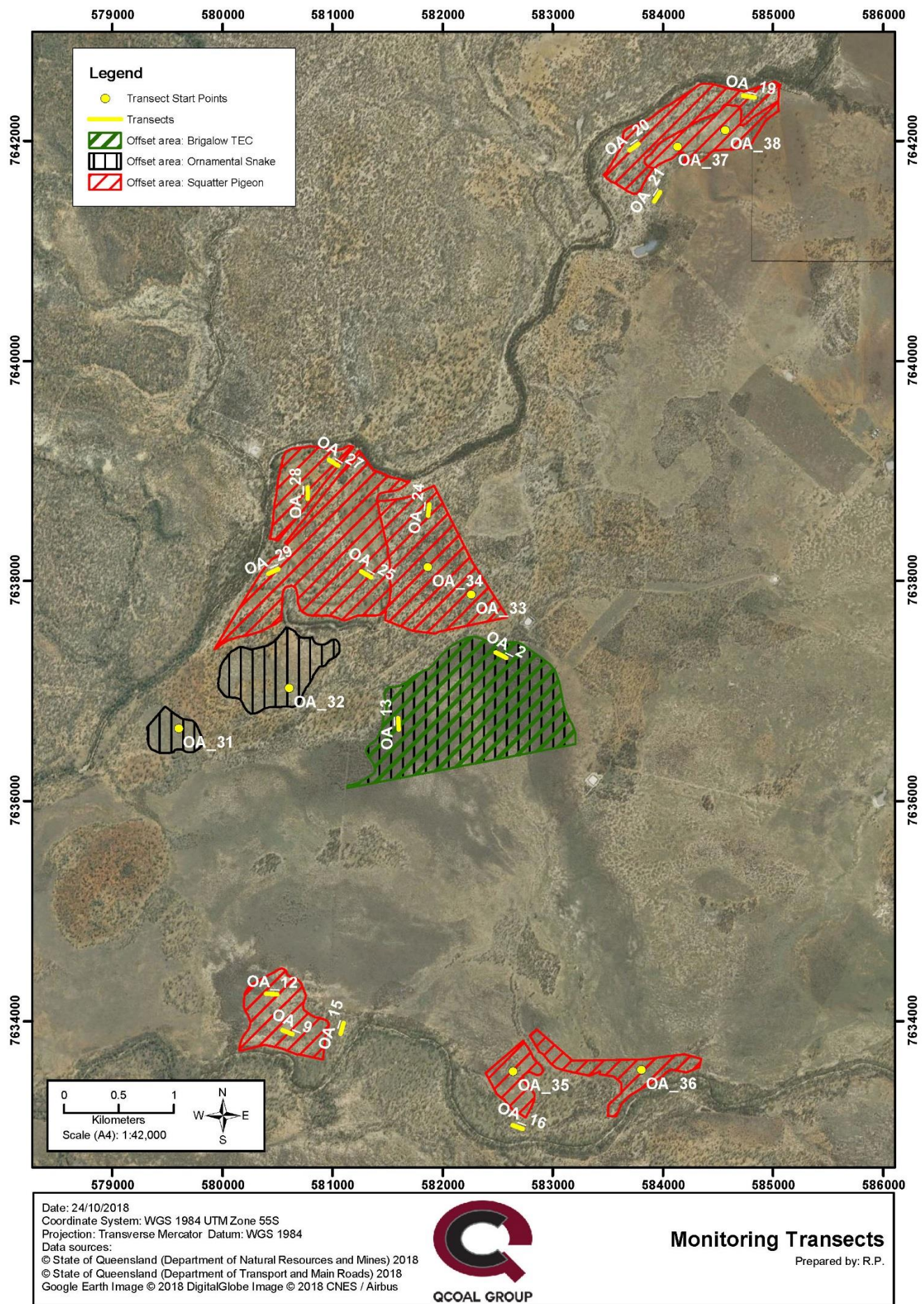
Coordinates system: GDA_1994_MGA_Zone_55

Assessment unit	Polygon	Site number	Related quaternary site number	Start point longitude/eastings	Start point latitude/northings	End point longitude / eastings	End point latitude/northings
O_AU6	32	EEM-OA-2	-	147.79648	-21.36447	147.79557	-21.36406
				582576	7637305	582484	7637350
O_AU1	34	EEM-OA-9	-	147.77793	-21.39548	147.77705	-21.39512
				580,637	7,633,883	580,546	7,633,922
O_AU1	34	EEM-OA-12	-	147.77659	-21.39216	147.77560	-21.39214
				580,499	7,634,250	580,397	7,634,253
O_AU6	32	EEM-OA-13	-	147.78710	-21.37041	147.78706	-21.36950
				581,601	7,636,652	581,598	7,636,753
O_AU1	1	EEM-OA-15	-	147.78210	-21.39536	147.78242	-21.39452
				581,069	7,633,893	581,102	7,633,986
O_AU1	31	EEM-OA-19	-	147.81798	-21.31844	147.81697	-21.31825
				584,833	7,642,389	584,727	7,642,409
O_AU1	31	EEM-OA-20	-	147.80783	-21.32227	147.80705	-21.32280
				583,778	7,641,969	583,697	7,641,912
O_AU1	8	EEM-OA-21	-	147.80925	-21.32699	147.80977	-21.32622
				583,922	7,641,446	583,977	7,641,531
O_AU9	60	EEM-OA-24		147.78968	-21.35195	147.78958	-21.35285
				581,878	7,638,695	581,868	7,638,595
O_AU4	45	EEM-OA-25	-	147.78464	-21.35792	147.78375	-21.35745
				581,353	7,638,036	581,261	7,638,088
O_AU4	45	EEM-OA-26	-	147.78390	-21.35048	147.78313	-21.35094
				581,280	7,638,860	581,200	7,638,809
O_AU1	53	EEM-OA-27*	-	147.78172	-21.34880	147.78087	-21.34834
				581,055	7,639,047	580,968	7,639,098
O_AU10	56	EEM-OA-28	-	147.77903	-21.35153	147.77902	-21.35057
				580,775	7,638,746	580,774	7,638,852
O_AU4	45	EEM-OA-29	-	147.77648	-21.35732	147.77562	-21.35768
				580,508	7,638,107	580,418	7,638,067
O_AU11	39	EEM-OA-31	T25	147.76781	-21.37040	TBC as part of 2020 ecological condition assessment	
				579,601	7,636,664		
O_AU11	43	EEM-OA-32	T26	147.77747	-21.36705	TBC as part of 2020 ecological condition assessment	
				580,604	7,637,030		
O_AU6	Adjacent 6 and 7	TBD	-	New EEM site to be established in year 2020 ecological condition survey			
O_AU1	25	EEM-OA-15	-	New EEM site to be established in year 2020 ecological condition survey			
O_AU1	7	EEM-OA-16	-	147.79725	-21.40281	147.79815	-21.40311
				582,635	7,633,061	582,729	7,633,027
O_AU9	60	EEM-OA-33	-	147.79335	-21.35933	TBC as part of 2020 ecological condition assessment	
				582,255	7,637,876		
O_AU9	60	EEM-OA-34	-	147.78954	-21.35707	TBC as part of 2020 ecological condition assessment	
				581,861	7,638,128		

Assessment unit	Polygon	Site number	Related quaternary site number	Start point longitude/eastings	Start point latitude/northings	End point longitude / eastings	End point latitude/northings
O_AU6	30	EEM-OA-35	-	147.79726	-21.39840	TBC as part of 2020 ecological condition assessment	
				582,638	7,633,550		
O_AU6	30	EEM-OA-36	-	147.80848	-21.39820	TBC as part of 2020 ecological condition assessment	
				583,802	7,633,566		
O_AU5	66	EEM-OA_37	-	147.81124	-21.32246	TBC as part of 2020 ecological condition assessment	
				584,131	7,641,948		
O_AU5	66	EEM-OA-38	-	147.81539	-21.32108	TBC as part of 2020 ecological condition assessment	
				584,562	7,642,098		

*Part of this plot was located outside the offset area (approximately 50%). The above coordinates reflect a shift in the plot to the north west so it coincides wholly within the offset area.

Figure 6: Offset monitoring site locations



7. Reporting

Byerwen Coal Pty Ltd will report on the offset area management and submit the reports to the Commonwealth and State administering authorities annually for the first 4 years for the life of this plan and thereafter each 5 years, starting at year 5 (2020), for the life of this plan (i.e. until 2035) (**Table 11**).

Ongoing monitoring is required to enable this OAMP to achieve the identified outcomes.

The frequency of monitoring has been determined based on the estimated rate of improvement of the vegetation and habitat attributes. The expected rate of change is likely to be moderate, with high opportunities for improvement and, with good management, a low risk of decline. Accordingly, monitoring frequency has been established on an initial annual monitoring cycle followed by a five year ecological condition monitoring cycle (**Table 11**).

Table 11: Schedule of reporting – offset area, Wollombi Station

Report details	Reporting period	Submission due date
Offset Area Report detailing photo point and management actions	Grant of voluntary declaration (estimated mid 2017) to the end of the 2018 wet season, approximately 1 May 2018	Within 60 days of the quarterly inspection completed at the end of the wet season
Offset Area Report detailing photo point and management actions	From the end of the wet seasons to the end of the following wet season, approximately 1 May 2018 to 1 May 2019	Within 60 days of the quarterly inspection completed at the end of the wet season
Annual Offset Area Report to be completed annually until the end of the year 2044 wet season and the final submission will be within 60 days of the last quarterly inspection.		
Ecological condition assessment to compare habitat quality to previous survey; squatter pigeon survey	The end of the 2020 wet season, approximately 1 May 2020	Within 60 days of the ecological condition assessment survey at the end of the wet season
Ecological condition assessment to compare habitat quality to previous survey; squatter pigeon survey	The end of the 2025 wet season, approximately 1 May 2025	Within 60 days of the ecological condition assessment survey at the end of the wet season
Ecological condition assessment to compare habitat quality to previous survey; squatter pigeon survey	The end of the 2030 wet season, approximately 1 May 2030	Within 60 days of the ecological condition assessment survey at the end of the wet season
Ecological condition assessment to compare habitat quality to previous survey; squatter pigeon survey	The end of the 2035 wet season, approximately 1 May 2035	Within 60 days of the ecological condition assessment survey at the end of the wet season
Ecological condition assessment to compare habitat quality to previous survey; squatter pigeon survey	The end of the 2040 wet season, approximately 1 May 2040	Within 60 days of the ecological condition assessment survey at the end of the wet season
Ecological condition assessment to compare habitat quality to previous survey; squatter pigeon survey	The end of the 2044 wet season, approximately 1 May 2044	Within 60 days of the ecological condition assessment survey at the end of the wet season

8. Consent

Administering authority

SIGNED by the <insert name, position> to indicate approval of the Offset Area Management Plan.

Name:

Signature:

Witness name:

Signature:

Date:

Landholder

The Landholder agrees:

1. A non-compliance with the requirements of this Offset Area Management Plan shall constitute a breach of the terms and conditions of the legally binding mechanism entered into.
2. To notify the State in writing of an Event, or the likelihood of the occurrence of an Event.
Event means any agreement or understanding entered into or accepted by and or circumstance permitted or suffered by the landholder which effects a change of ownership, control or use of the offset area, the exercise of power of sale under any Mortgage, the granting of a Mortgage, the appointment of a receiver, the death of a landholder or any other circumstance which may allow or permit a person, other than the landholder to own, control or use the offset area.
In notifying the State of an Event, the landholder will notify the State of the nature of the change, or potential change of ownership, control or use result from the Event, and the name and address of any person who may own, control or use the offset area as a result of the Event.
3. That if, at the time of execution of this Offset Area Management Plan, there exists a Property Map of Assessable Vegetation (PMAV) over the offset area or a part of it, the landholder hereby agrees, where the management plan area is identified as Category X on the PMAV, to the replacement of the PMAV by the State to reflect the offset area as Category A.
4. To take all necessary steps as may be required to accomplish the obligations contained in this Offset Area Management Plan.

The Landholder acknowledges:

5. That before the State will agree to the release this Offset Area Management Plan the State must be satisfied that the results of the ecological assessments demonstrate achievement of the objectives contained in this Offset Area Management Plan.

The Landholder notes:

6. All reports, notices or requests for amendment in relation to this Offset Area Management Plan must be in writing and delivered to the administering authority at the following address:
<Insert departmental name>
<Insert postal address and telephone number>

SIGNED by *Christopher Ian Wallin* being the current owner of the abovementioned property to indicate that the terms of this Offset Area Management Plan including responsibilities under the Offset Area Management Plan, have been read, understood and accepted.

Name:

Signature:

Witness name:

Signature:

Date:

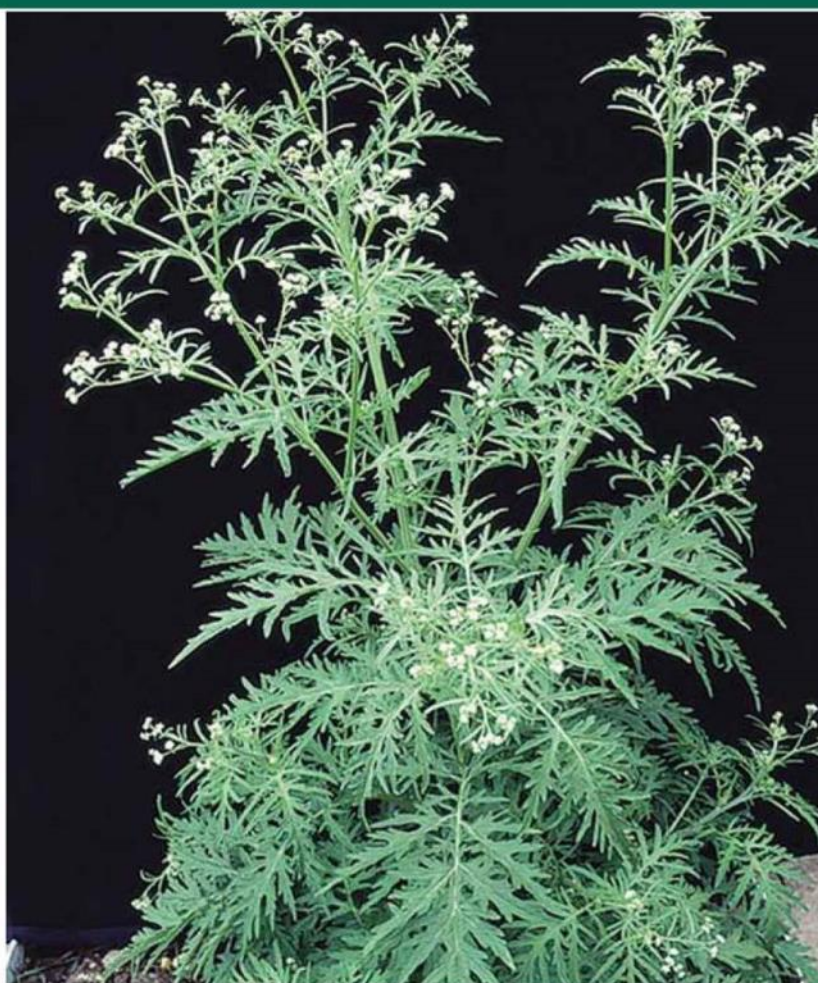
Attachment 1: Baseline Data

Wollombi Station – Site Observations (Appendix A from Field Assessment Report) Ecological Condition Scoresheets

Please see pdf file supplied separately.

Parthenium weed

Parthenium hysterophorus



Parthenium costs the beef industry a total of \$16.5 million per year and cropping industries several million dollars per year.

Declaration details

In Queensland, Parthenium is a Class 2 declared plant.

Under the *Land Protection (Pest and Stock Route Management) Act 2002*, Class 2 declaration requires landholders to control pests on the land and waters under their control. A local government may serve a notice upon a landholder requiring control of declared pests.



Queensland Government

PP2 June 2011

Description and general information

Size

Parthenium weed is an annual herb with a deep tap root and an erect stem that becomes woody with age. As it matures, the plant develops many branches in its top half and may eventually reach a height of two metres.

Leaves

Its leaves are pale green, deeply lobed and covered with fine soft hairs.

Flowers

Small creamy white flowers occur on the tips of the numerous stems. Each flower contains four to five black seeds that are wedge-shaped, two millimetres long with two thin, white scales.

Lifecycle

Parthenium weed normally germinates in spring and early summer, produces flowers and seed throughout its life and dies around late autumn. However, with suitable conditions (rain, available moisture, mild temperatures), parthenium weed can grow and produce flowers at any time of the year. In summer, plants can flower and set seed within four weeks of germination, particularly if stressed.

Potential damage

Parthenium weed is a vigorous species that colonises weak pastures with sparse ground cover. It will readily colonise disturbed, bare areas along roadsides and heavily stocked areas around yards and watering points. Parthenium weed can also colonise brigalow, gidgee and softwood scrub soils. Its presence reduces the reliability of improved pasture establishment and reduces pasture production potential.

Parthenium weed is also a health problem as contact with the plant or the pollen can cause serious allergic reactions such as dermatitis and hay fever.

Habitat and distribution

Parthenium weed is capable of growing in most soil types but becomes most dominant in alkaline, clay loam soils.

The plant is well established in Central Queensland and present in isolated infestations west to Longreach and in northern and southern Queensland.

Infestations have also been found in northern and central parts of New South Wales and it is capable of growing in most states of Australia.

Control

Prevention and weed seed spread

As with most weeds, prevention is much cheaper and easier than cure. Pastures maintained in good condition, with high levels of grass crown cover, will

limit parthenium weed colonisation. Drought, and the subsequent reduced pasture cover, creates the ideal window of opportunity for parthenium weed colonisation when good conditions return.

Parthenium seeds can spread via water, vehicles, machinery, stock, feral and native animals and in feed and seed. Drought conditions aid the spread of seed with increased movements of stock fodder and transports.

Vehicles and implements passing through parthenium weed infested areas should be washed down with water. Wash down facilities are located in Alpha, Biloela, Charters Towers, Emerald, Gracemere, Injune, Monto, Moura, Rolleston, Springsure and Taroom. Particular care should be taken with earthmoving machinery and harvesting equipment. The wash down procedure should be confined to one area, so that plants that establish from dislodged seed can be destroyed before they set seed.

Extreme caution should be taken when moving cattle from infested to clean areas. Avoid movement during wet periods as cattle readily transport seed in muddy soil. On arrival, cattle should be held in yards or small paddocks until seed has dropped from their coats and tails prior to their release into large paddocks. Infestations around yards can be easily spotted and controlled whereas infestations can develop unnoticed in large paddocks.

Particular care should be taken when purchasing seed, hay and other fodder materials. Always keep a close watch on areas where hay has been fed out for the emergence of parthenium or other weeds.

Property hygiene is important. Owners of clean properties should ensure that visitors from infested areas do not drive through their properties. If your property has parthenium weed on it, ensure that it is not spread beyond the boundary or further within the property.

Pasture management

Grazing management is the most useful method of controlling large-scale parthenium weed infestations. Maintain pastures in good condition with high levels of ground and grass crown cover. This may require rehabilitation of poor pastures, followed by a sound grazing maintenance program.

Sown pasture establishment—Poor establishment of sown pastures can allow parthenium weed colonisation. pasture agronomist Aerial seeding prior to scrub pulling is normally beneficial.

Overgrazing—High grazing pressure caused by drought or high stock numbers decreases the vigour and competitiveness of pastures and allows the entry and spread of parthenium weed. Maintenance of correct stock numbers is most important in controlling parthenium weed. pasture agronomist

Pastures spelling—In situations of serious infestation, pasture spelling is essential for rehabilitation. Total spelling is much more effective than simply reducing the

2 Parthenium weed *Parthenium hysterophorus*

stocking rate. However, overgrazing of the remainder of the property must be avoided.

The most appropriate time for pasture spelling is the spring–summer growing period, with the first 6–8 weeks being particularly important. If the condition of perennial grasses (native or sown) is low, spelling for the entire growing season may be required or introduced grasses may need to be re-sown. Herbicide treatment can hasten the rehabilitation process by removing a generation of parthenium seedlings and allowing grass seedlings to establish without competition. In the presence of parthenium weed, grass establishment is poor.

Grazing during winter should not increase the parthenium weed risk. Most tropical grasses are dormant and can tolerate moderate grazing during this period. However, parthenium weed may germinate and grow at this time.

Fencing—One of the main problems in controlling parthenium weed is the large paddock size and the variability of country within paddocks. The resulting uneven grazing pressures encourage parthenium weed to colonise the heavily grazed country. Ideally, similar land types should be fenced as single units. Fencing can be used to great effect to break up large paddocks, allowing more flexible management such as pasture spelling or herbicide application, options not available previously.

Burning—Burning is not promoted as a control strategy for parthenium weed. However, research suggests that burning for pasture management (e.g. woody weed control) should not result in an increased infestation if the pasture is allowed to recover prior to the resumption of grazing. Stocking of recently burnt areas known or suspected to contain parthenium decreases pasture competition and favours parthenium, ultimately creating a more serious infestation.

Herbicide control

Non-crop areas—Parthenium weed should be sprayed early before it can set seed. A close watch should be kept on treated areas for at least two years.

Small and/or isolated infestations should be treated immediately. Herbicide control will involve a knockdown herbicide to kill plants that are present and a residual herbicide to control future germinations. Repeated spraying may be required even within the one growing season to prevent further seed production.

Extensive infestations will require herbicide treatment in conjunction with pasture management. Timing of spraying is critical so that parthenium weed is removed when plants are small and before seeding has occurred. Grasses should be actively growing and seeding so that they can recolonise the infested area.

Table 1 shows the herbicides registered for parthenium weed control and application rates. Before using any herbicide always read the label carefully. All herbicides must be applied strictly in accordance with the directions on the label.

Cropping areas—Controlling parthenium weed in cropland requires selective herbicide use and/or crop rotations. For further information on parthenium weed control in crops consult your local biosecurity officer.

Biological control

The combined effects of biological control agents reduced the density and vigour of parthenium weed and increased grass production.

There are currently a number of insect species and two rust pathogens that have been introduced to control parthenium weed—a selection of these are outlined below.

Epiblema strenuana is a moth introduced from Mexico established in all parthenium weed areas. The moth's larvae feed inside the stem, forming galls that stunt the plant's growth, reduce competitiveness and seed production.

Listronotus setosipennis is a stem-boring weevil from Argentina but is of limited success in reducing parthenium weed infestations.

Zygogramma bicolorata is a defoliating beetle from Mexico which is highly effective where present. It emerges in late spring and is active until autumn.

Smicronyx lutulentus (Mexico) lays eggs in the flower buds where the larvae feed on the seed heads.

Conotrachelus albocinereus (stem-galling weevil from Argentina) produces small galls and is still becoming established in Queensland.

Bucculatrix parthenica (leaf mining moth from Mexico) larvae feed on leaves, leaving clear windows in the leaf.

Carmentia ithacae is a stem boring moth from Mexico which is becoming established at favourable sites in the northern Central Highlands.

Puccinia abrupta is a winter rust from Mexico that infects and damages leaves and stems. It is currently established over a wide area from Clermont south. It requires a night temperature of less than 16 degrees and 5–6 hours of leaf wetness (dew). Sporadic outbreaks occur where weather conditions are suitable.

Puccinia melampodii is a summer rust from Mexico that weakens the plant by damaging the leaves over the summer growing season. It is currently established and spreading at a number of sites from north of Charters Towers to Injune in the south.

Manual control

Hand pulling of small areas is not recommended. There is a health hazard from allergic reactions and a danger that mature seeds will drop off and increase the area of infestation.

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).

Table 1 Herbicides registered for parthenium weed.

Herbicide	Rate	Situation	Comments
2,4-D amine 500 g/L	0.4 L/100 L	Land—industrial, pastures; rights-of-way	Spot spray
atrazine 500 g/L max 3 kg/ha/yr	3.6–6 L/ha	Fields and fallow	Boom spray
	6 L/ha	Land—industrial, commercial, non-agricultural, roadside, right-of-way	Boom spray
atrazine 900 g/kg max 3 kg/ha/yr	2–3.3 kg/ha	Fields and fallow	Boom spray
	3.3 kg/ha	Land—non-agricultural, commercial, industrial	Boom spray
2,4-D + picloram (Tordon 75-D)	125 ml/100 L	Land—commercial, industrial, pastures, right-of-way	Spot spray
	3 L/ha	Land—commercial, industrial, pastures, right-of-way	Boom spray
2,4-D ester ¹	.025 L/10 L	Land—non-agricultural, pastures	Rosette stage
glyphosate (450 g/L)	0.8–1.2 L/ha	Fields and fallow	Spot spray
metsulfuron methyl	5–7 g/ha	Fields and fallow	Seedlings only
	5 g/100 L	Land—commercial, industrial, pastures, rights-of-way	Spot spray
hexazinone	3.5 L/ha or 7 L/10 L/20 m ²	Land—commercial, industrial, pastures, rights-of-way	Boom spray or spot spray
dicamba (200 g/L) (500 g/L) (700 g/kg)	0.7–2.8 L/ha or 0.1–0.19 L/100L	Grass pastures	Boom spray or spot spray
	0.28–1.1 L/ha or 0.40–0.76 L/100L	Grass pastures	Boom spray or spot spray
	200–800 g/ha or 30–60 g/100 L	Grass pastures	Boom spray or spot spray

¹Use restricted in some areas of Central Queensland

Notes The registered rates are for non-crop uses. Consult label for in-crop recommendations.
For power hand spray or knapsack use, spray plants to the point of runoff.

Fact sheets are available from Department of Employment, Economic Development and Innovation (DEEDI) service centres and our Customer Service Centre (telephone 13 25 23). Check our website at www.biosecurity.qld.gov.au to ensure you have the latest version of this fact sheet. The control methods referred to in this fact sheet should be used in accordance with the restrictions (federal and state legislation, and local government laws) directly or indirectly related to each control method. These restrictions may prevent the use of one or more of the methods referred to, depending on individual circumstances. While every care is taken to ensure the accuracy of this information, DEEDI does not invite reliance upon it, nor accept responsibility for any loss or damage caused by actions based on it.

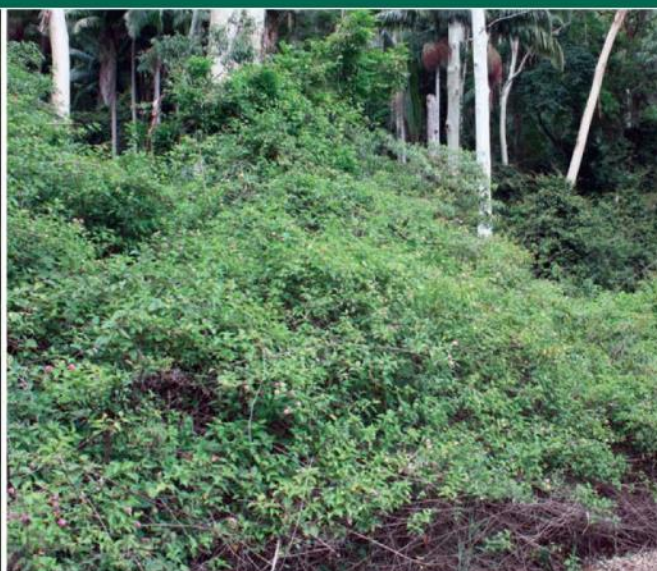
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4 Parthenium weed *Parthenium hysterophorus*

Lantana

Lantana camara



Currently, lantana covers more than 5 million ha of subcoastal New South Wales to Far North Queensland. Small infestations of lantana have also been found in central west Queensland, the Northern Territory, Western Australia, South Australia and Victoria. Efforts are under way to control these.

Lantana is mainly spread by fruit-eating birds and mammals. It forms dense thickets that smother and kill native vegetation and are impenetrable to animals, people and vehicles.

Research indicates more than 1400 native species are negatively affected by lantana invasion, including many endangered and threatened species. As lantana is a woody shrub that has thin, combustible canes, its presence can also create hotter bushfires.

Declaration details

All lantana species are declared Class 3 plants under the *Land Protection (Pest and Stock Route Management) Act 2002*. Lantana species cannot be sold or distributed and landholders may be required to control these plants if they pose a threat to an environmentally significant area.

Description and general information

Lantana is a heavily branched shrub that can grow in compact clumps, dense thickets or as a climbing vine.

The stems are square in cross section, with small, recurved prickles. Most leaves are about 6 cm long and are covered in fine hairs. They are bright green above, paler beneath and have round-toothed edges. Leaves grow opposite one another along the stem. When crushed the leaves produce a distinctive odour.

Flowers appear throughout most of the year in clustered, compact heads about 2.5 cm in diameter. Flower colours vary from pale cream to yellow, white, pink, orange and red. Lantana produces round, berry-like fruit that turn from glossy green to purplish-black when ripe.

For rural producers, lantana poses problems of stock poisoning and invasion of desirable pasture. An economic impact assessment indicated lantana costs the Queensland grazing sector in excess of \$70 million (2005–06 values) per year. PP34 January 2011 It is now illegal to sell or distribute any variety of lantana in Queensland. However, garden plantings are still common in many areas and have the potential to cause problems of their own.

Great state. Great opportunity.



Research indicates some ornamental lantana varieties have the ability to set seed and can spread vegetatively. They also produce some viable pollen and have the potential to cross-pollinate with wild forms, creating new varieties that could naturalise in the environment.

If the number of naturalised varieties increase due to genetic drift from ornamental varieties, it will make finding effective biological control agents even more difficult, and potentially extend the climatic tolerances and range of the weed's spread.

Habitat and distribution

Lantana is native to the tropical and subtropical regions of North, Central and South America.

Lantana is found throughout most coastal and subcoastal areas of eastern Australia, from the Torres Strait islands to southern New South Wales. It grows in a wide variety of habitats, from exposed dry hillsides to wet, heavily shaded gullies.

Toxicity

Many lantana varieties are poisonous to stock. It is difficult to tell which varieties are toxic so it is better to treat all forms as potentially poisonous. The toxins in lantana include the triterpene acids, lantadene A (rehmannic acid), lantadene B, and their reduced forms.

Most cases of lantana poisoning occur when new stock are introduced into lantana-infested areas. Stock bred on lantana-infested country avoid lantana unless forced to eat it due to lack of other fodder. Young animals introduced to lantana areas are most at risk.

Symptoms of lantana poisoning depend on the quantity and type of lantana consumed and, under some circumstances, the intensity of light to which the animals are exposed.

Early symptoms of depression are noticeable, with head swaying, loss of appetite, constipation and frequent urination. After a day or two the eyes and the skin of the nose and mouth start yellowing with jaundice, and the muzzle becomes dry and warm. The eyes may become inflamed and have a slight discharge. The animal also becomes increasingly sensitive to light. Finally, the muzzle becomes inflamed, moist and very painful ('pink nose'). Areas of skin may peel and slough off. Death commonly occurs 1–4 weeks after symptoms occur. Death from acute poisoning can occur 3–4 days after eating the plant.

If animals show any of the early symptoms, they should be moved to lantana-free areas, kept in the shade and monitored. Veterinary treatment should be sought immediately. Some remedies may include intravenous fluids, treating skin damage with antibiotics, or drenching with an activated charcoal slurry.

Care should be taken when introducing new or young animals into a paddock if lantana is present. Ensure they have enough fodder to stop them eating lantana in quantities sufficient to result in poisoning. During drought, animals should not be placed in lantana-infested areas without alternative food.

Control

Using a mix (integration) of control methods gives the best results. Size, density and geographic location of infestations are important considerations for choosing which control methods to use. A general principle is to commence control programs in areas of light infestations and work towards the denser infestations.

For large lantana infestations, treatment with herbicides by foliar spraying is usually not economically feasible. However, fire, dozing/stick raking, slashing/cutting, aerial helicopter spraying can reduce dense infestations, making follow-up spot treatments with chemicals more economically viable.

Lantana seed banks remain viable for at *least* four years, so follow-up control to kill seedlings before they mature is vital to ensure initial management efforts to control the parent bush are not wasted.

Appropriate fire regimes may become part of a management program to ensure lantana invasiveness is reduced and pasture is maintained.

Removal of lantana within areas of remnant vegetation may require a permit under the *Vegetation Management Act 1999*. Further information should be sought from the Department of Environment and Resource Management before works commence.

Mechanical control

Stick raking or ploughing can be effective in removing standing plants. However, regrowth from stumps and/or increased seedling germination in disturbed soil is common and the site will require follow-up treatment.

Grubbing of small infestations—for example, along fence lines—can be a useful and effective method of removing plants, although this is time consuming.

Repeated slashing can also reduce the vigour of lantana, exhausting its stored resources and reducing its likelihood of re-shooting.

Some locations—for example, very steep inclines or gullies—are not suitable for mechanical control options because of the danger of overturning machinery and soil erosion.

Fire

Regular burning will reduce the capacity of plants to survive; however, initial kill rates are variable.

The effectiveness of this method will depend on the suitability of available fuel loads, fire intensity, temperature, relative humidity, soil moisture and season. Pasture re-establishment can then provide competition to inhibit lantana seed germination.

Fire is not recommended in non-fire tolerant vegetated areas such as rainforest, or wooded or plantation areas.

A typical control program for fire may include:

- exclude stock to establish a pasture fuel load
- burning (may require a permit)
- sow improved pastures—consult your local Biosecurity Queensland officer for advice
- continue to exclude stock until pasture has established and seeded
- burn again in summer before rain and spot spray lantana regrowth when > 0.5 m high and when it is actively growing (see Table 1).

Herbicide control

Herbicide recommendations for lantana are shown in Table 1. Users of herbicides have a legal obligation to read herbicide labels and use only the registered rates. Always use herbicides responsibly; adhere to legislation and safety requirements.

Variation in results can be a result of inconsistent application methods, mix rates or seasonal variation. Red-flowered and pink-edged red-flowered lantana are often considered the most difficult to control because their leaves are often smaller and tougher. However, herbicides can kill these varieties if you carefully follow application procedures.

For single-stemmed lantana, basal bark spraying and cut stump methods also give good results at any time of year (but best when the plant is actively growing). On multi-stemmed varieties, you will obtain best results by carefully applying herbicide to each stem.

When treating actively growing plants less than 2 m high, overall spraying of foliage to the point of run-off is recommended. Splatter gun techniques are also effective and particularly useful in hard-to-access areas. This is best done in autumn—when sap flows draw the poison down into the root stock, but before night temperatures get too cold.

Remove grazing animals from spray areas during and soon after treatment. Stress can cause increased sugar levels in the leaves of lantana plants, making them more palatable.

Landholders and contractors should check if the property is situated in a hazardous area. This prevents the use of some chemicals, as defined in the *Agricultural Chemicals Distribution Control Act 1966*.

Biological control

Since 1914, 32 biological control agents have been introduced into Australia in an attempt to control lantana. Eighteen have established, of which several insect species cause seasonal damage, reducing the vigour and competitiveness of lantana in some areas.

Biosecurity Queensland research programs continue to investigate agents suitable for release in Australia, and test the viability of these agents in an effort to identify more effective biological control agents.

It is important to remember that biological control alone should not be relied upon for managing lantana infestations. Consideration should be given to other available control techniques.

The four most important biological control agents are:

- **sap-sucking bug (*Teleonemia scrupulosa*)**
Found in dry areas from Cooktown to Wollongong, this small, mottled, bug feeds on the underside of leaves, growing tips and flower buds, causing the leaves to drop early and stopping the plant from flowering.
- **leaf-mining beetle (*Uroplata girardi*)**
Found in most lantana infestations from Cape Tribulation to Sydney as well as around Darwin, except in very dry or high altitude areas. The adult beetles are dark brown. They shelter in curled leaves and feed on the upper leaf surfaces. Larvae feed in leaves causing blotches to spread across the leaf. This beetle reduces plant vigour and can suppress flowering.
- **leaf-mining beetle (*Octotoma scabripennis*)**
Found in most lantana infestations from Atherton to Wollongong. Adults of this species feed on the upper leaf surface, while larvae feed and mine the centre of the leaf and cause blotches. This activity reduces plant vigour and can suppress flowering.
- **seed-feeding fly (*Ophiomyia lantanae*)**
Found from Cape Tribulation to Eden in New South Wales and also around Darwin and Perth. *Ophiomyia* is a small black fly that feeds on flowers and lays eggs on the green fruits. The maggots of the fly eat the seed and make the fruit unattractive to birds, reducing seed spread.

Other agents such as *Aconophora compressa* (a stem-sucking bug) and *Leptobyrsa decora* (a sap-sucking bug) have caused some damage in specific geographic areas.

Note: Landholders are advised not to consume their time collecting established insects for distribution. Due to their own ability to disperse, these insects will be periodically/seasonally present in areas that are climatically suitable for them.

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).

Table 1. Herbicides for control of lantana

Method of application: active ingredient (trade name) ^a	Rate	Optimum time ^b	Remarks
Foliar (overall) spray			
Fluroxypyr (Starane® 200)	0.5 L to 1 L/100 L water	December to April	Thorough wetting of plants is required, higher rate should be used for larger plants
Glyphosate (Roundup® 360, Glyphosate 360®)	1 L/100 L water	October to April	Wet plant thoroughly. Glyphosate affects any green plant it comes into contact with. Glyphosate is available in a range of strengths
Picloram + 2,4-D (Tordon® 75-D)	0.65 L/100 L water	February to April	Wet plant thoroughly. Legumes are affected if sprayed
Dichlorprop (Lantana® 600)	0.5 L/100 L water	December to April	Must thoroughly wet all leaves. Please refer to product label for situation details
Picloram + triclopyr + aminopyralid (Grazon Extra®)	0.35 L to 0.5 L/100 L water	February to April	Wet plant thoroughly. Use the higher rate on larger plants. Legumes may be affected if sprayed
2,4-D amine (Amicide® 625)	0.32 L/100 L water	March to May	Red-flowered lantanas are more resistant to 2,4-D. Will kill young legumes
Metsulfuron methyl, (Brush-off®, Brushkiller® 600, Lynx® 600)	10 g/100 L water ^b	March to May	Results variable. Not found effective in tropics. Follow-up sprays are necessary
Metsulfuron methyl + glyphosate (Cutout®)	95 g/100 L water	March to May	Apply to bushes up to 2 m tall. Spray to thoroughly wet all foliage and stems. Spray to penetrate throughout the bush
Metsulfuron methyl + glyphosate (Trounce®)	173 g/100 L water	March to May	Apply when actively growing. Do not apply during periods of stress
Aminopyralid + fluroxypyr (Hotshot®)	0.5 L to 0.7 L/100 L water	October to April	Spray all foliage, including stems, to the point of run-off
(i) Basal bark (ii) Cut stump			
Triclopyr (Garlon 600®)	1 L/60 L diesel	Any time. Best results when actively growing	(i) Apply to lower 40 cm of every stem. Must ensure complete coverage around stem (ii) Cut close to ground level. Immediately apply herbicide
2,4-D ester (AF Rubber Vine Spray®)	2.5 L/100 L diesel	Any time. Best results when actively growing	As above
Picloram + Triclopyr (Access®)	1 L/60 L diesel	Any time. Best results when actively growing	As above
Picloram (Vigilant® Herbicide Gel)	3 mm to 5 mm gel	Any time. Best results when actively growing	(ii) If diameter of stump is > 20 mm, use a minimum of 5 mm gel thickness
Glyphosate (Roundup®, Weedmaster Duo®)	Neat	Any time. Best results when actively growing	Off-label permit
Splatter gun			
Glyphosate (Roundup® 360)	1:9 glyphosate + water	October to April	2 x 2 ml dose per 0.5 m height of lantana
Metsulfuron methyl (Brushkiller® 600, Lynx® 600)	2 g/L water	March to May	As above
Aerial			
Picloram + triclopyr + 2,4-D (Grazon® DS + 2,4-D amine 625 g/L)	1.5 L + 6 L/ha or 10 L/ha (Grazon®)	When plant actively growing	Helicopter only. Minimum of 200 L water per hectare. Follow-up re-spray will be required. Do not burn within six months of treatment
Dichlorprop (Lantana® 600)	6 L to 8 L/ha	When plant actively growing	As above

a Only some common trade names provided.

b Optimum times are only a guide. Lantana must be actively growing for the herbicide to work.

® = Registered trade name.

Labels often recommend the additional use of a wetting agent or surfactant within the mix. Herbicides types vary in their selectivity against other species and soil residual.

This fact sheet is developed with funding support from the Land Protection Fund.

Fact sheets are available from Department of Agriculture, Fisheries and Forestry (DAFF) service centres and our Customer Service Centre (telephone 13 25 23). Check our website at www.biosecurity.qld.gov.au to ensure you have the latest version of this fact sheet. The control methods referred to in this fact sheet should be used in accordance with the restrictions (federal and state legislation, and local government laws) directly or indirectly related to each control method. These restrictions may prevent the use of one or more of the methods referred to, depending on individual circumstances. While every care is taken to ensure the accuracy of this information, DAFF does not invite reliance upon it, nor accept responsibility for any loss or damage caused by actions based on it.

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Mother-of-millions

Bryophyllum delagoense (syn. *B. tubiflorum*, *Kalanchoe delagoensis*), *Bryophyllum* × *houghtonii* (syn. *B. daigremontianum* × *B. delagoense*, *Kalanchoe* × *houghtonii*)



Mother-of-millions are native to Madagascar and are escaped ornamental plants. Five species are commonly naturalised in Queensland. It is well adapted to dry areas because of its succulent features.

As the name suggests, one plant can reproduce a new generation from masses of embryoids (plantlets) that are formed on the leaf edges. This makes these plants hard to eradicate and follow up controls are essential.

These plants, especially their flowers, are poisonous to stock and occasionally cause a significant number of cattle deaths. When cattle are under stress or in unusual conditions they are more likely to eat plants that they would not normally eat. Shifting cattle to new paddocks, moving stock through infested rubbish dumps and wastelands, and reduction of availability of feed due to flood or drought can all contribute to cattle eating mother-of-millions and being poisoned. The plant flowers from May to October (during the drier months of the year) and the scarcity of feed at this time may cause cattle to consume lethal amounts of mother-of-millions.

Poisoned cattle show signs of dullness, loss of appetite, diarrhoea and heart failure. Some cattle may drool saliva or dribble urine. There are two responses to poisoning:

1. acute—where cattle die within a day
2. chronic—where cattle may take up to five days to die.

Some cattle may make a slow recovery if insufficient plant material was eaten.

Poisoned cattle must be treated within 24 hours of consuming the plant. The treatment is intense and needs to be given by a veterinarian, or under their direction, because of the drugs and materials used. The treatment is costly—\$70 or more for one adult cow, plus veterinary fees.

Declaration details

Bryophyllum delagoense syn. *B. tubiflorum*, *Kalanchoe delagoensis* and the hybrid *Bryophyllum* × *houghtonii* syn. *B. daigremontianum* × *delagoense*, *Kalanchoe* × *houghtonii* are declared Class 2 plants under the *Land Protection (Pest and Stock Route Management) Act 2002*.

Great state. Great opportunity.



A Class 2 pest is one that has already spread over substantial areas of Queensland, but its impact is so serious that there is a need to try and control it and avoid further spread onto properties that are still free of the pest. By law, all landholders must try to keep their land free of Class 2 pests and it is an offence to keep or sell these pests without a permit. A local government may serve a notice upon a landholder requiring control of declared pests.

Description and general information

Mother-of-millions are erect, smooth, fleshy succulent plants growing to 1 m or more in height.

All species form tall flower spikes in winter with clusters of bell-shaped flowers. Each species has a distinctive leaf shape, but all produce small plantlets along the edges of the leaves. These plantlets drop readily, develop roots and establish quickly to form a new colony.

Bryophyllum delagoense syn. *B. tubiflorum* and *Kalanchoe delagoensis* (common mother-of-millions, mission bells, Christmas bells) has grey-brown, fleshy, tubular-like leaves with up to seven projections at the tip of each leaf. The flowers are orange-red and occur in a cluster at the top of a single stem. Seeds can germinate for some years.

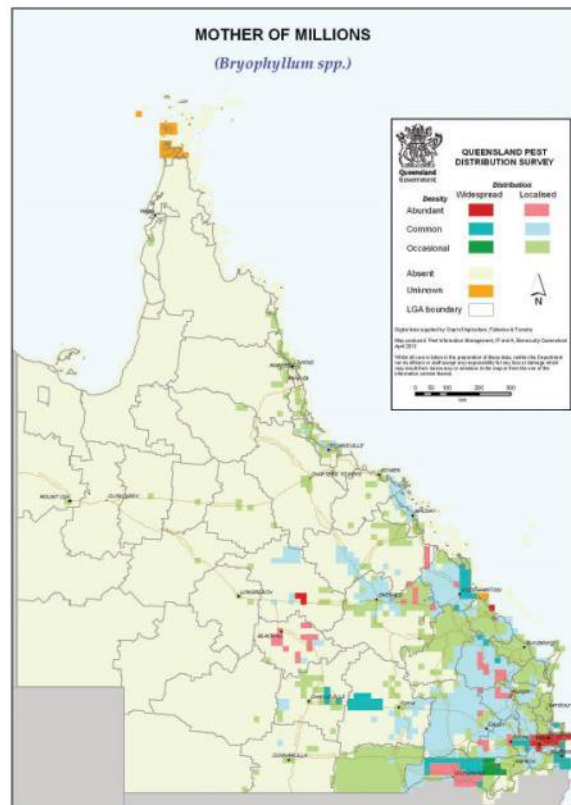
Bryophyllum × *houghtonii* syn. *B. daigremontianum* × *B. delagoense*, *Kalanchoe* × *houghtonii* (hybrid or crossbred mother-of-millions) has similar flowers arranged in a branched cluster at the top of the stem. Its leaves are boat shaped with thick stalks and notches along the edges of the leaves.

A third species, *Bryophyllum pinnatum* (resurrection plant, live-leaf), is also problematic but is not a declared pest plant. This plant has yellow-green, oval, fleshy leaflets with wavy edges and up to five leaflets per leaf. Its flowers are yellowish-green, often tinged with pink, and occur in loose clusters on stalks growing at intervals along the upper portion of the stem.

Habitat and distribution

These popular garden plants have escaped cultivation and spread in various areas of Queensland. They have become a problem in pasture lands in the central highlands around Clermont, Emerald and Dingo, and the Burnett, Moreton and Darling Downs scrub regions. The plants establish well in leaf litter or other debris on shallow soils in shady woodlands, and often grow on roadsides, along fence lines and around old rubbish dumps. They can spread from these areas, especially in flood, and establish if pastures are run down. They are adapted to dry conditions and can survive long periods of drought.

Map 1. Distribution of mother-of-millions in Queensland



Prevention

The best form of weed control is prevention. Always treat weed new infestations when small—do not allow weeds to establish. Weed control is not cheap, but it is cheaper to do it now rather than next year, or the year after. Proper planning ensures better value for each dollar spent.

Permanent control of mother-of-millions infested areas is best ensured by establishing more desirable plants in that location to compete successfully with future mother-of-millions seedlings and plantlets. This is best achieved through soil preparation, replanting, fertilising and using the area more productively.

Ensure scattered infestations and small dumping areas on properties are regularly checked and cleaned up. Day-to-day hygiene management will help prevent establishment of these weeds.

Co-operative control upstream and downstream of problem areas will help prevent re-infestation from other areas.

To prevent poisoning, keep stock (especially hungry stock) away from infested areas until the plants are controlled.

Control

Look at weed problems carefully. Decide whether to contain the weed to stop new infestations developing while reducing existing weeds. Determine what weed control is required by legislation. Determine how weed control fits into your property management. What can be done to restore and prevent re-establishment?

The best approach is usually to combine different methods. Control may include chemical, mechanical, fire and biological methods combined with land management changes. The control methods chosen should suit the specific weed and particular situation.

Fire

When suitable (e.g. after grading firebreaks), burn infestations and the accompanying debris on which mother-of-millions plants thrive. This is the most economical form of control, encourages grass competition and lessens the problem for following years, requiring only spot spraying with selective herbicides.

Biological control

The South African citrus thrips is present in Queensland and is quite widespread through the south of the state. The thrip damages the outer tissue of the mother-of-millions plant and also lays its eggs under the outer tissue. Where high populations of thrips exist, the number of viable plantlets and flowers forming on mother-of-millions is reduced.

The thrips populations vary from year to year, according to mother-of-millions populations and climate. The South African citrus thrips should not be seen as a long term control strategy—only a control option to complement other techniques such as herbicide treatment and burning.

Mechanical control

For small areas, pull up plants by hand and burn on a wood heap. Alternatively, bag the plants and dump them in a bin, the contents of which are buried at council refuse tips rather than being recycled into mulch.

Herbicide control

Before using any herbicide always read the label carefully. All herbicides must be applied strictly in accordance with the directions on the label. Where the addition of a wetting agent is recommended, always use a commercial wetting agent or surfactant.

Mother-of-millions may be controlled with herbicides at any time of the year, but infestations are easiest to see in winter when the plants are in flower. Treating infestations at this time of year also has the benefit of preventing new seeds from developing on common mother-of-millions.

Table 1 details the herbicides registered for mother-of-millions control.

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland (call 13 25 23 or visit our website at www.biosecurity.qld.gov.au).



South African citrus thrips adult



South African citrus thrips damage to mother-of-millions

Table 1. Herbicides registered for the control of mother-of-millions

Situation	Herbicide	Rate	Comments ¹
Pastures, non-crop land	2,4-D acid (AF 300)	7 L/1000 L water per ha	Overall spray handgun
		70 ml/10 L water	Overall spray knapsack
Pastures, rights of way, non-crop land, forests, non-agricultural land, commercial/industrial areas	picloram + triclopyr (e.g. Grass-up, Grazon DS, Picker)	50 ml/10 L water	Overall spray knapsack Apply at flowering
	fluroxypyr	600 ml/100 L water + surfactant	Apply to seedlings and young plants before flowering
	picloram + triclopyr + aminopyralid (e.g. Grazon Extra)	50 ml/10 L water	Add 100% concentrate non-ionic surfactant (e.g. BS 1000) at 100 ml/100 L water Apply at flowering

Read the label carefully before use. Always use the herbicide in accordance with the directions on the label.

Note: 1. Thorough, even coverage of leaves and plantlets is necessary.



This fact sheet is developed with funding support from the Land Protection Fund.

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**Queensland
Government**

Wildlife Online Extract

Search Criteria: Species List for a Specified Point

Species: All

Type: All

Status: All

Records: All

Date: All

Latitude: -21.3642

Longitude: 147.8209

Distance: 10

Email: david.sasse@earthtrade.com.au

Date submitted: Wednesday 25 Nov 2015 11:10:29

Date extracted: Wednesday 25 Nov 2015 11:20:03

The number of records retrieved = 74

Disclaimer

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Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	amphibians	Bufonidae	<i>Rhinella marina</i>	cane toad	Y			17
animals	amphibians	Hylidae	<i>Litoria rubella</i>	ruddy treefrog		C		9
animals	amphibians	Hylidae	<i>Litoria caerulea</i>	common green treefrog		C		31
animals	amphibians	Hylidae	<i>Cyclorana cultripes</i>	grassland collared frog		C		1
animals	amphibians	Hylidae	<i>Litoria latopalmata</i>	broad palmed rocketfrog		C		1
animals	amphibians	Hylidae	<i>Cyclorana alboguttata</i>	greenstripe frog		C		3
animals	amphibians	Hylidae	<i>Cyclorana novaehollandiae</i>	eastern snapping frog		C		7
animals	amphibians	Hylidae	<i>Litoria inermis</i>	bumpy rocketfrog		C		4
animals	amphibians	Limnodynastidae	<i>Limnodynastes tasmaniensis</i>	spotted grassfrog		C		11
animals	mammals	Dasyuridae	<i>Antechinus flavipes flavipes</i>	yellow-footed antechinus (south-east Queensland)		C		1
animals	mammals	Dasyuridae	<i>Sminthopsis macroura</i>	stripe-faced dunnart		C		6
animals	mammals	Dasyuridae	<i>Planigale ingrami</i>	long-tailed planigale		C		4
animals	mammals	Macropodidae	<i>Macropus giganteus</i>	eastern grey kangaroo		C		2
animals	mammals	Muridae	<i>Rattus tunneyi</i>	pale field-rat		C		1
animals	mammals	Muridae	<i>Mus musculus</i>	house mouse	Y			4
animals	mammals	Muridae	<i>Pseudomys sp.</i>					1
animals	mammals	Potoroidae	<i>Aepyprymnus rufescens</i>	rufous bettong		C		1
animals	mammals	Tachyglossidae	<i>Tachyglossus aculeatus</i>	short-beaked echidna		SL		3
animals	reptiles	Agamidae	<i>Diporiphora australis</i>			C		6
animals	reptiles	Agamidae	<i>Pogona barbata</i>	bearded dragon		C		21
animals	reptiles	Boidae	<i>Aspidites melanocephalus</i>	black-headed python		C		3
animals	reptiles	Boidae	<i>Antaresia maculosa</i>	spotted python		C		4
animals	reptiles	Carphodactylidae	<i>Nephurus asper</i>	spiny knob-tailed gecko		C		1
animals	reptiles	Chelidae	<i>Chelodina longicollis</i>	eastern snake-necked turtle		C		2
animals	reptiles	Colubridae	<i>Tropidonophis mairii</i>	freshwater snake		C		5
animals	reptiles	Diplodactylidae	<i>Strophurus williamsi</i>	soft-spined gecko		C		5
animals	reptiles	Diplodactylidae	<i>Lucasium steindachneri</i>	Steindachner's gecko		C		10
animals	reptiles	Diplodactylidae	<i>Diplodactylus platyurus</i>	eastern fat-tailed gecko		C		5
animals	reptiles	Elapidae	<i>Suta suta</i>	myall snake		C		20
animals	reptiles	Elapidae	<i>Furina ornata</i>	orange-naped snake		C		1
animals	reptiles	Elapidae	<i>Furina diadema</i>	red-naped snake		C		1
animals	reptiles	Elapidae	<i>Denisonia maculata</i>	ornamental snake		V	V	20
animals	reptiles	Elapidae	<i>Cryptophis boschmai</i>	Carpentaria whip snake		C		2
animals	reptiles	Elapidae	<i>Demansia psammophis</i>	yellow-faced whipsnake		C		12
animals	reptiles	Elapidae	<i>Demansia vestigiata</i>	lesser black whipsnake		C		4
animals	reptiles	Elapidae	<i>Pseudonaja textilis</i>	eastern brown snake		C		3
animals	reptiles	Elapidae	<i>Vermicella annulata</i>	bandy-bandy		C		1
animals	reptiles	Elapidae	<i>Hoplocephalus bitorquatus</i>	pale-headed snake		C		1
animals	reptiles	Gekkonidae	<i>Gehyra dubia</i>			C		3
animals	reptiles	Gekkonidae	<i>Heteronotia binoei</i>	Bynoe's gecko		C		2
animals	reptiles	Pygopodidae	<i>Pygopus schraderi</i>	eastern hooded scaly-foot		C		5
animals	reptiles	Pygopodidae	<i>Lialis burtonis</i>	Burton's legless lizard		C		1
animals	reptiles	Scincidae	<i>Morethia boulengeri</i>			C		8
animals	reptiles	Scincidae	<i>Pygmaeascincus timlowi</i>	dwarf litter-skink		C		1
animals	reptiles	Scincidae	<i>Ctenotus allotropis</i>			C		1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	reptiles	Scincidae	<i>Tiliqua scincoides</i>	eastern blue-tongued lizard		C		1
animals	reptiles	Scincidae	<i>Ctenotus spaldingi</i>			C		1
animals	reptiles	Scincidae	<i>Eremiascincus fasciolatus</i>	narrow-banded sand swimmer		C		1
animals	reptiles	Typhlopidae	<i>Anilius ligatus</i>	robust blind snake		C		1
animals	reptiles	Typhlopidae	<i>Anilius unguirostris</i>	claw-snouted blind snake		C		1
animals	reptiles	Varanidae	<i>Varanus tristis</i>	black-tailed monitor		C		1
plants	higher dicots	Acanthaceae	<i>Pseuderanthemum variabile</i>	pastel flower		C		1/1
plants	higher dicots	Apocynaceae	<i>Alstonia constricta</i>	bitterbark		C		1/1
plants	higher dicots	Asteraceae	<i>Acanthospermum hispidum</i>	star burr	Y			1/1
plants	higher dicots	Asteraceae	<i>Senecio pinnatifolius</i> var. <i>pinnatifolius</i>			C		1/1
plants	higher dicots	Asteraceae	<i>Zinnia peruviana</i>	wild zinnia	Y			1/1
plants	higher dicots	Boraginaceae	<i>Ehretia membranifolia</i>	weeping koda		C		1/1
plants	higher dicots	Capparaceae	<i>Capparis lasiantha</i>	nipan		C		1/1
plants	higher dicots	Chenopodiaceae	<i>Dysphania carinata</i>			C		1/1
plants	higher dicots	Combretaceae	<i>Terminalia oblongata</i> subsp. <i>oblongata</i>			C		1/1
plants	higher dicots	Convolvulaceae	<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>			C		1/1
plants	higher dicots	Convolvulaceae	<i>Evolvulus alsinoides</i>			C		1/1
plants	higher dicots	Convolvulaceae	<i>Xenostegia tridentata</i>			C		1/1
plants	higher dicots	Fabaceae	<i>Tephrosia juncea</i>			C		1/1
plants	higher dicots	Goodeniaceae	<i>Goodenia hirsuta</i>			C		1/1
plants	higher dicots	Malvaceae	<i>Gossypium australe</i>			C		1/1
plants	higher dicots	Molluginaceae	<i>Glinus lotoides</i>	hairy carpet weed		C		1/1
plants	higher dicots	Myrtaceae	<i>Eucalyptus persistens</i>			C		1/1
plants	higher dicots	Plantaginaceae	<i>Scoparia dulcis</i>	scoparia	Y			1/1
plants	higher dicots	Rubiaceae	<i>Everistia vacciniifolia</i> forma <i>vacciniifolia</i>			C		1/1
plants	higher dicots	Sapindaceae	<i>Dodonaea triangularis</i>			C		1/1
plants	monocots	Poaceae	<i>Aristida calycina</i> var. <i>praealta</i>			C		1/1
plants	monocots	Poaceae	<i>Brachyachne convergens</i>	common native couch		C		1/1
plants	monocots	Poaceae	<i>Cenchrus setigerus</i>		Y			1/1

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992*. The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ().

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999*. The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).

This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.

This number is output as 999 if it equals or exceeds this value.

Attachment 2: Land Manager's Monitoring Guide

Department of Environment
and Resource Management

Land Manager's Monitoring Guide

Ground cover indicator

Tomorrow's Queensland:
strong, green, smart, healthy and fair



Prepared by:

Environment and Resource Sciences

Department of Environment and Resource Management

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August 2010

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What is it?

Ground cover is provided by living or dead plants and any of their parts that fall to the surface of the ground.

Cover may also be provided by pebbles and rocks or a crust of cryptogamic materials (plant life without 'true' flowers and seeds, such as mosses, lichens and fungi). Groundcover may be considered as being anything below your eye level that intercepts a vertically falling raindrop.

In most landscapes under natural conditions, there is usually some form of cover on the soil surface. Exceptions include environments that are inhospitable to plant growth including degraded or eroded landscapes, some deserts, and salt pans. In forests, much of the ground cover is provided by fresh or slightly decomposed leaves, bark, fallen logs/limbs, twigs, flowers and fruits (collectively referred to as forest litter). In woodlands and grasslands most of the cover is provided by a variety of herbaceous plants and low growing shrubs. In arid and sub arid Australia, cryptogamic crusts can provide a significant amount of ground cover. These crusts are made up of various cyanobacteria, lichens, mosses and fungi.

Cover is also provided by crops and the stubble that remains after harvest. Weeds have few positive benefits, but the ability of many weed species to rapidly colonise an area can provide effective ground cover. In the urban environment, cover may be provided by landscaped surfaces, gardens and infrastructure such as concrete, bitumen and buildings; however such impermeable surfaces generate high rates of runoff which may lead to off-site erosion problems.

Tree canopies usually provide minimal protection against raindrop impact and tree trunks have no effect on impeding surface flows. For control of erosion, surface cover is essential and bare areas beneath trees are vulnerable.

The amount of ground cover is constantly varying and is dependent on a range of factors including:

- **plant type**—Plants have different growing habits (spreading or erect), life spans (annual or perennial), and decomposition rates. (The stubble of cereal crops can provide protection for up to 12 months while the leaves of some crops such as sunflower, legumes and cotton rapidly break down.)
- **growth rates**—Plant growth is affected by many factors including soil moisture, fertility levels and seasonal conditions.
- **land management**—Grazing, crop and fire management practices have a major impact on ground cover levels.

Ground cover has a number of important functions relating to productivity and environmental health:

- It prevents water erosion by absorbing the impact of falling raindrops that may otherwise cause the soil surface to seal and contribute to excessive runoff.
- It reduces the velocity of runoff and encourages it to spread out rather than to concentrate and develop into an erosive force. Organic matter (including animal dung) and soil can be deposited when overland flow is obstructed by surface cover. Such accumulations are referred to as 'sinks' or 'fertile patches' (Tongway 1994) where the additional water and nutrients provide an improved environment for plants to germinate and grow.
- It prevents erosion from wind by reducing the wind velocity adjacent to the soil surface and provides an effective barrier between the soil and the air above it.
- It moderates the temperature on the soil surface and helps to reduce evaporation rates from the soil surface.
- It is a natural habitat and food source for a wide variety of living organisms and is used to assess and monitor the health of native vegetation.
- It allows for the recycling of nutrients as plant products are allowed to decompose and nutrients are returned to the soil.

Other factors and related indicators

Consideration could be given towards monitoring the following indicators that have an association with ground cover:

- Hillslope erosion
- Gully erosion
- Wind erosion
- Water infiltration
- Pasture composition
- Native species richness

- Soil condition
- Saline land
- Impact of fire
- A range of indicators relating to water quality.

Why monitor this indicator?

The section 'What is it?' indicates the essential role that ground cover plays in ensuring the healthy functioning of a landscape. Land management practices that contribute to low levels of ground cover leave the land vulnerable to land degradation. Monitoring ground cover can:

- help you assess the degree of risk of land degradation occurring
- determine landscapes that are already in a degraded condition.

Graziers make a mental note of the condition of their pastures during their day-to-day activities on the property. However, it becomes difficult to recall how the pastures may have looked in previous seasons unless some observations have been recorded. Our memories can be short, confused or biased; a documented record allows comparison with previous seasons and allows the data to be shared. Grazing lands that have a consistently low level of cover provide a strong indication of excessive stocking rates and degraded land. Figure 1 shows how photographs have been used to compare pasture condition at the same point over a span of three years.

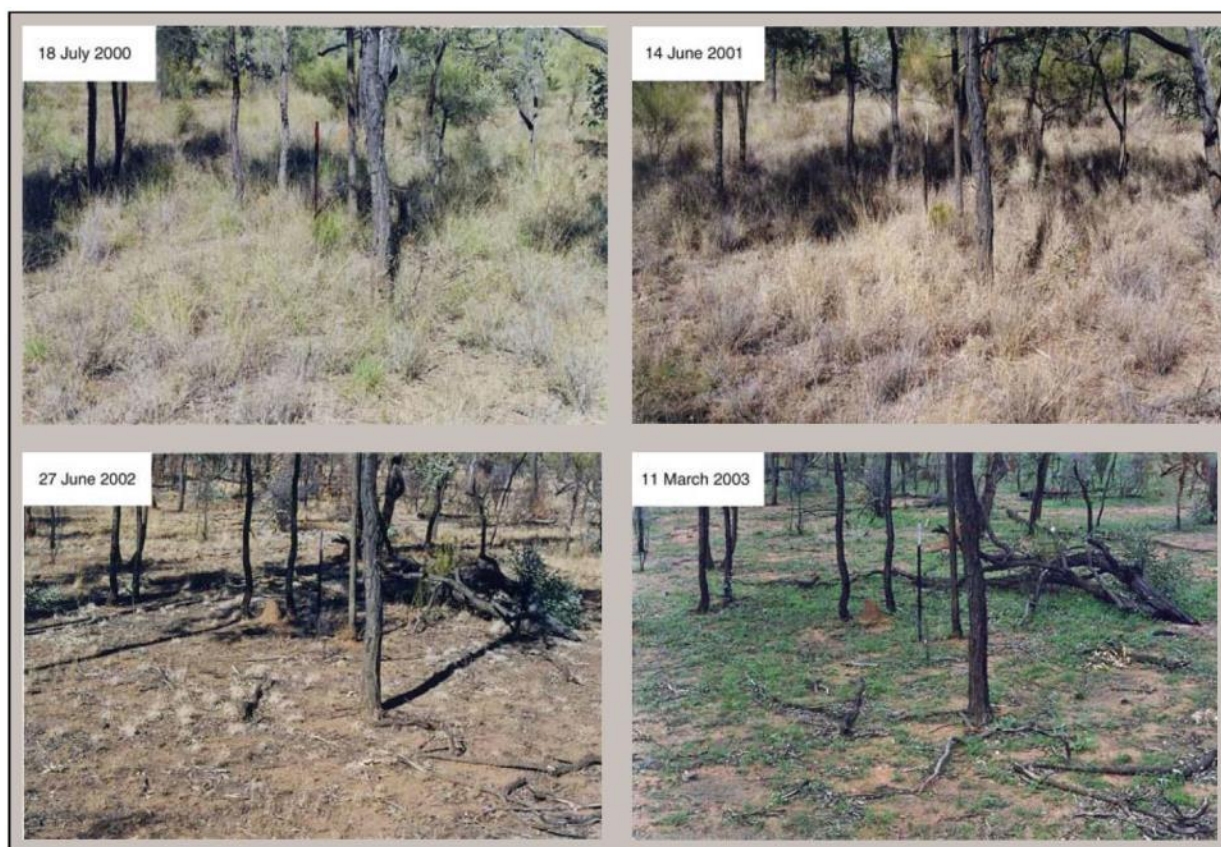


Figure 1: Photographs comparing ground cover at the same point over a three year span

Cover levels in cropping lands may vary dramatically depending on land management practices, the stage of growth of the crop and the crop type. An alternative to regularly monitoring ground cover in paddocks used for cropping is to monitor the adoption of land management practices that affect cover levels, for example, fallow management techniques such as zero tillage and green cane trash blanketing may provide 100% cover throughout the year.

At the catchment scale, an overall indication of ground cover can be used as an assessment of catchment health and the vulnerability of the land to soil erosion and its associated impact on water quality. Techniques such as cross-landscape transects and assessment of satellite imagery can be used. By monitoring on a regular basis, relevant stakeholders can assess change in ground cover levels and associated land management practices over time.

Ground cover measurement is an important component of assessing the health of a landscape from a biodiversity viewpoint. When making observations for biodiversity purposes, we are interested in the different components that make up ground cover, rather than the total amount of cover.

Planning to monitor this indicator

What are your monitoring objectives?

Consider what you are trying to achieve by monitoring ground cover. You may just be interested in the total amount of ground cover, or for an assessment of biodiversity you will need to assess the amount of cover provided by different components such as native plants, weeds, litter and rocks.

If you are confident that your land management practices are consistently providing adequate levels of ground cover, then there may be little point in measuring it. Land managers should be aware of ground cover levels under different land use and management practices because it affects the susceptibility of their property to land degradation. Of special interest is any land with cover levels of less than 40%.

As ground cover may be subject to considerable variation from month to month, there is generally not a great need to monitor it with a high level of precision. A visual assessment of ground cover, as provided in Level 1 of 'How do you measure it?' will provide you with a method of making a rapid assessment of ground cover. Measurements at established sites can be taken to provide a higher level of accuracy, as described in Levels 2a (for overall ground cover) and 2b (for biodiversity assessment) of 'How do you measure it?'.

You also need to consider other indicators that you may wish to measure, for example, if you wanted to monitor plant species as well as cover, you would need to take more measurements if you had an interest in finding rare plants.

How will your data be used?

Primarily your data will be for your own use. However other land managers, catchment groups or your regional body may be interested in your ground cover monitoring. Some regional bodies have set targets of ground cover that they hope land managers in their region will be able to achieve. If you intend to share your data with others, you should check to see if your proposed data collection procedures will be compatible with theirs.

What will you monitor?

Existing standards

Some Queensland Government programs, including the Reef Protection Package and Delbessie Agreement (for renewal of rural land leases) have monitoring requirements tailored for each program, but based on existing monitoring methods. These requirements may be fulfilled in part by the methods in this and other indicator guides, however if your property occurs in selected reef catchments or includes leased land you should refer to the specific guides provided for these individual programs. These include guides for producers that are preparing Environmental Risk Management Plans (ERMPs) under the Reef Protection Package <<http://www.reefwisefarming.qld.gov.au/>> and for land condition assessment under Delbessie land management agreements <http://www.derm.qld.gov.au/land/state/rural_leasehold/land_cond_assessments.html>.

There are no formal standards for monitoring ground cover in Queensland. The use of a quadrat (described in Levels 2a and 2b of 'How do you measure it?') is recommended in order to estimate percentage ground cover. Comparisons can be made with graphical presentations (Figure 2) or photos of a range of different cover levels (Figure 3).

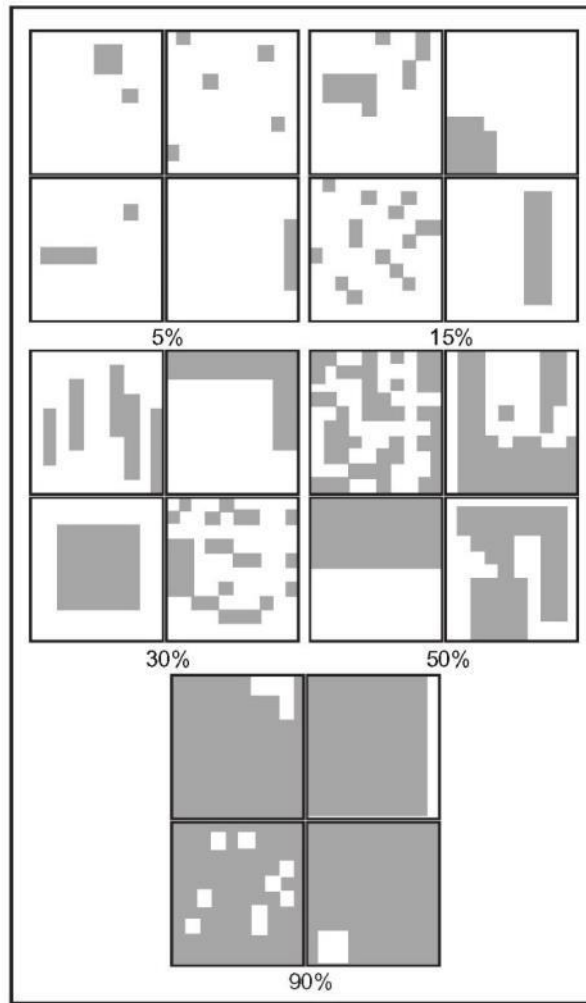


Figure 2: Examples of ground cover patterns as they appear in a quadrat for 5%, 15%, 30%, 50% and 90% cover (Department of Natural Resources 1997)

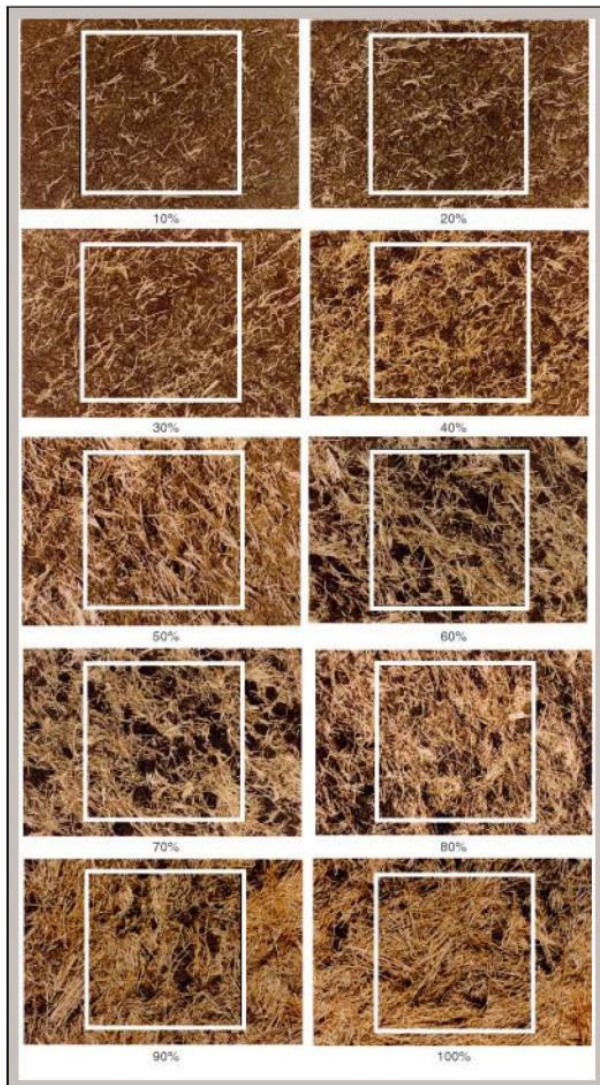


Figure 3: Photographs of wheat stubble cover levels in 10% increments (Molloy 1988)

The spreadsheets provided for Level 2a and 2b allow you to add quadrat measurements in increments of 10%. The spreadsheet will then calculate an average cover level for the site.

An alternative way of grouping cover levels into categories is provided in Grass Check (Department of Natural Resources 1997). These categories are less than 5%, 5–15%, 15–30%, 30–50%, 50–90% and >90%. This categorisation places emphasis on the measurements at the lower end of the scale because surface cover levels are considered to become critical once they drop below 30%.

When monitoring for biodiversity assessment, your data can be compared with benchmark data prepared for the vegetation

zone or regional ecosystem you are monitoring. It is intended that this information will become available on the Queensland Department of Environment and Resource management website.

The CD, 'Pasture photo standards' (Department of Primary Industries 2003) provides colour photos of oblique views of different pasture types (Brigalow belt, Channel country, Central Queensland coast, Cape York Peninsula, Desert uplands, Einasleigh uplands and Wet Tropics, Gulf Plains, Mitchell Grass Downs, Mulga Lands, North West Highlands, Wide Bay and Southeast Queensland, and Southern Brigalow and New England Tablelands). For each pasture type there are photos of six pasture yields from very low to very high. The photos can be used for estimating the amount of fodder available (in kg/ha) to assist in determining future grazing strategies. Because they are oblique views, they are not suitable for directly estimating ground cover as they can tend to result in overestimating the real value. The CD is available from the Queensland Government Bookshop <<https://www.bookshop.qld.gov.au/>> - Search for 'Pasture photo standards'.

Existing monitoring in your area

Before you start monitoring any indicator, it is recommended that you explore who else is monitoring in your area, what they are monitoring and how they are monitoring it. Doing this will not only make sharing your data easier if you choose to do so but will also help you become more familiar with:

- Any area-specific issues that may influence your monitoring
- What strategies and/or methods have proven successful within your area.

Where will you monitor?

You need to determine whether you will monitor ground cover levels on the whole of your property or selected areas that may be of concern, for example, areas that may have cover levels that are less than the critical value of 30–40% (either permanently or occasionally).

If you decide to establish monitoring sites, a decision is needed on whether it is better to take many cover measurements at one site in a paddock or to make a similar number of measurements spread over a number of sites. There are no hard and fast rules as to how many sites you should monitor in a paddock and how many observations you should make. The sites should be accessible and away from fences, tracks, waterways and watering points to ensure that they are representative of a large area of your paddock. Aerial photos or satellite images may be useful in assisting with site selection.

Where different land types occur in the one paddock or where there are areas of special interest (e.g. an area being rehabilitated), it is preferable to have at least one site in each system or zone. The records for each system should be kept separately, since averaging them may lead to a misleading result. For example, if one half of a paddock has 20% cover and the other half 80% cover, the average cover is 50%. This approach does not convey the message that half of this paddock is at high risk from land degradation and may indicate a case for creating an additional paddock so that appropriate management practices can be applied.

To monitor for BioCondition Assessment <<http://www.derm.qld.gov.au/wildlife-ecosystems/biodiversity/biocondition.html>>, ideally all vegetation types and all areas subject to different levels of management on the property should be monitored for ground cover. The combination of a particular vegetation type and management action is called a zone. Considerable thought needs to go into the placement of your monitoring areas within these zones to minimise the number of sites but to still ensure you represent the range of vegetation and management actions on the property.

When and how often will you monitor?

While adequate cover levels are desirable throughout the year, the summer months represent the period of highest erosion risk in Queensland. Figure 4 shows the average monthly erosivity value of the rainfall for Emerald and Pittsworth. Erosivity combines the amount and intensity of rainfall and is highly related to erosion potential.

This period of high erosion risk is a desirable time in which to monitor ground cover. However, in grazing lands there are advantages in monitoring pastures at the end of the growing season, around April. This allows graziers to make decisions on future stocking rates. An added bonus is that temperatures at this time of the year are more comfortable for field monitoring!

Additional monitoring can be undertaken at strategic times such as during a drought, at the end of the dry season or a month after major rainfall.

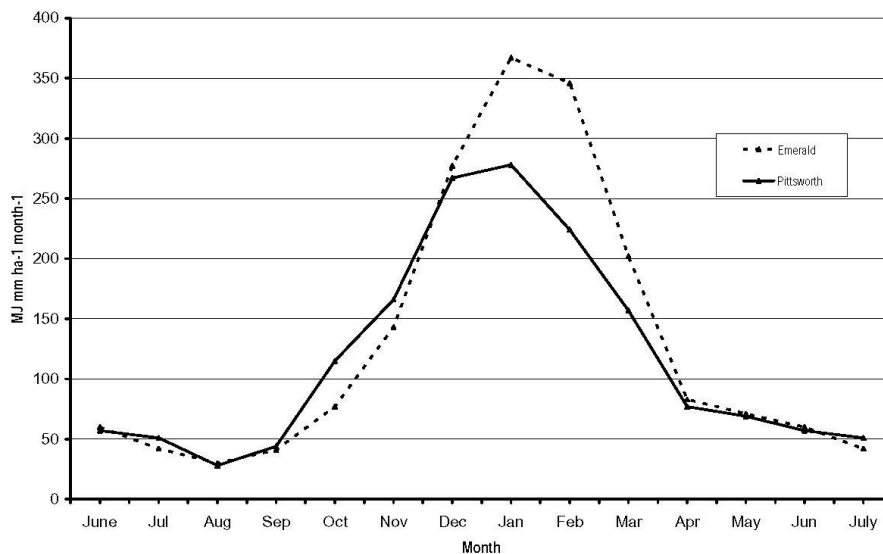


Figure 4: Average monthly rainfall erosivity values for Emerald and Pittsworth

How do you measure it?

For this indicator, two levels for estimating ground cover are described:

- Level 1 involves an overall visual assessment while driving or walking around a paddock. It is appropriate for all forms of land use.
- Level 2 provides a more accurate assessment by estimating ground cover levels using quadrat readings at established monitoring sites:
 - Level 2a describes a system that is most appropriate for grazing lands although it could be used in a cropping situation
 - Level 2b is recommended when monitoring for biodiversity assessment.

A number of methods of measuring ground cover have been published and there are no set rules as to which is the best method to use. However, some Queensland Government programs including the Reef Protection Package and Delbessie Agreement (for renewal of rural land leases) have monitoring requirements which may be fulfilled in part by the methods in this and other indicator guides. If your property occurs in selected reef catchments or includes leased land you should refer to the specific guides provided for these individual programs including those for Environmental Risk Management Plans (ERMPs) <<http://www.reefwise farming.qld.gov.au/>> and for land condition assessment under Delbessie land management agreements <http://www.derm.qld.gov.au/land/state/rural_leasehold/land_cond_assessments.html>.

Since ground cover levels are constantly changing, there may not be a need for you to measure with a high level of precision and the visual assessment described for Level 1 may suffice for most situations. In Levels 2a and 2b, the use of quadrats is described for estimating cover levels where a higher level of precision is required.

Besides using quadrats, it is also possible to measure ground cover using a point observation method rather than a quadrat. In this case, a straight piece of wire or a point on the toe of your boot can be used to record the presence or absence of cover. To avoid confusion, this method has not been described in this indicator. A description of such a method can be found in Francis and Payne (2003).

A Queensland Department of Environment and Resource Management state wide ground cover monitoring program reports annually on percentage of ground cover in Queensland based on Landsat imagery starting in 1988. This low cost imagery enables a more dynamic monitoring of ground cover by remote sensing and opens up new opportunities for monitoring and time series analysis of up to 20 images per year. Recent research by the Queensland Department of Environment and Resource Management (as at 2010) indicates that ground cover may soon be able to be monitored remotely and at low cost with the ability to distinguish between bare ground, green vegetation and dry (or non-green) vegetation cover.

The use of photopoints is recommended to support any system of assessing ground cover.

Use of photopoints – photographic records

It is preferable that a photographic record is kept for all ground cover monitoring sites. A sequence of photos taken annually from exactly the same location in a paddock can record changes in ground cover, woody plant populations and feed availability (Figure 1). They show the long-term effects of management as well as short-term changes caused by seasonal conditions and the effects of grazing management.

Photos should be taken on a clear day between 9 am and 3 pm. You will always get a better photo by having the sun behind your back. To do this you need to be facing south (in the Southern Hemisphere!). Photos can be taken from two angles: the 'trayback' and the 'landscape'.

The 'trayback' photo

This photo angle will best illustrate ground condition and the amount of feed available in a pasture. A step ladder could be used as an alternative to a vehicle. The vehicle trayback is set up at the post from which the photo is being taken (Figure 5). Facing south, focus the middle of the viewfinder on the base of the sighter post.

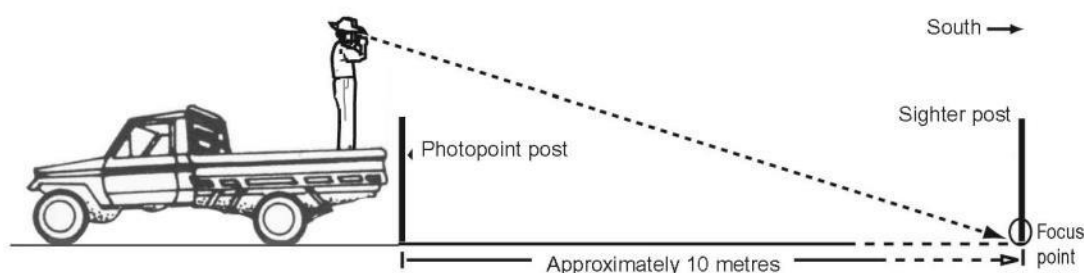


Figure 5: Taking the 'trayback' photo (Department of Natural Resources 1997)

The landscape photo

This photo angle will best illustrate the general condition of the site showing major changes in shrub and tree populations. Stand next to the photopoint post as in Figure 6. Position the top of the sighter post in the middle of the viewfinder and focus on infinity.

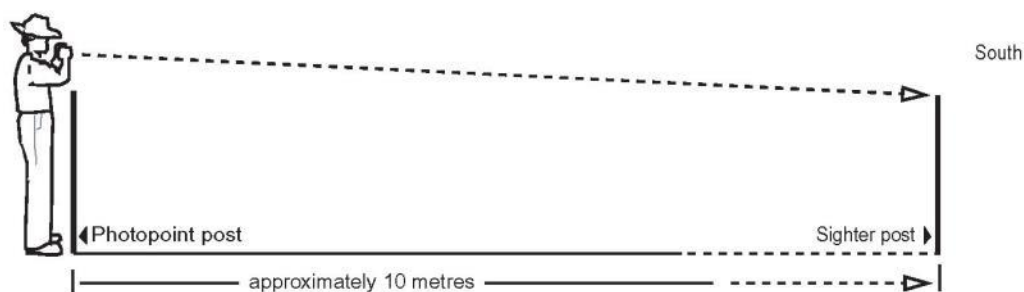


Figure 6: Taking the landscape photo (Department of Natural Resources 1997)

It is a good idea to have a sign on the post in the photograph to indicate the site details. The date should be noted (cameras often have the facility to do this automatically) as well as the time, photo number and site number. If the photos are printed, appropriate details should be written on the back and they should be filed appropriately. If you are using a digital camera, most suppliers provide software for storing and showing a collection of photographs and adding notes for each picture. As with all computer records, you should make regular backups of your electronic records, such as by burning a CD.

How do you measure it? – Level 1 monitoring

Key aspects of level 1 monitoring

Level 1 monitoring involves a visual assessment of percentage ground cover by making a number of observations as you drive or walk around a paddock. The method does not require the use of quadrats although they could be used initially to assist the observer in gaining skills in estimating cover by making comparisons with the diagrams in Figures 2 and 3.

It is recommended that photographs be taken to provide a permanent record as described in 'Use of photopoints – photographic records'.

In grazing lands, you need to decide if you are going to establish some permanent monitoring sites within each paddock or whether you are going to make an estimate by just walking or driving around the paddock. Permanent monitoring sites are useful when taking photographs so that you can compare identical locations over a period of years.

Paddocks used for cropping will generally have much more uniform ground cover levels than grazing paddocks. It is generally not practical to establish permanent monitoring sites in cropping areas because of their interference with tillage, spraying and harvesting activities. It is usually sufficient to make observations of ground cover in cultivated paddocks by making an overall observation. There is little point in going to a lot of effort to establish a precise level of ground cover for a cultivated paddock since the cover levels can change rapidly as a crop develops.

Skills needed

- Knowledge of the paddock or resource area to allow you to determine suitable monitoring sites
- Ability to estimate ground cover. You can 'calibrate' your eye by using some quadrats and making comparisons with the cover levels provided in Figures 2 and 3

Equipment

- A camera
- If monitoring sites are to be established, two steel pegs are required for each site.

Time taken

- 15 minutes to establish each monitoring site (if required)
- 5 minutes per site, plus travel time in moving from site to site

Setting up

If setting up permanent monitoring sites, consideration needs to be given to the information provided in the selection of monitoring sites in 'Developing your monitoring plan'. It may be appropriate to divide a paddock into two or more zones, keeping separate records for each zone. This would be advisable where there were contrasting cover levels in a paddock resulting from different land types or different grazing pressure associated with the location of a watering point.

Install two steel pegs at the selected sites. The posts should be in a north-south direction at a distance of around 10 metres apart and provided with an identification number. For more information see 'Use of photopoints – photographic records'.

Monitoring procedure

1. Make a visual assessment of the cover at the site. Record the percentage cover using 'Recording sheet' (refer also to 'How to record your results').

2. Where monitoring sites are being used, take a photograph from the photopoint post.

Data quality considerations

As this method is only a visual assessment it is somewhat subjective and there is likely to be some variation in the assessments made by different people. As ground cover levels are constantly changing depending on seasonal conditions and land management practices, a high level of precision is generally not required and this method of assessment should suffice for many situations.

How do you measure it? – Level 2a monitoring

Key aspects of level 2a monitoring

Level 2a monitoring involves setting up a 'monitoring triangle' (see 'Setting up', Figure 8) and taking measurements using a quadrat as you walk around each side of the triangle. It is primarily intended for use in monitoring ground cover in grazing lands.

An advantage of using a monitoring triangle compared to a straight line transect is that you end up at your starting point, rather than having to 'backtrack' to the starting point. A triangle may also provide a better sample of the landscape because of the three different directions of travel.

Skills needed

- Knowledge of the paddock or resource area to allow you to determine suitable monitoring sites
- Ability to estimate ground cover percentage within a quadrat
- Basic maths and ability to use a computer spreadsheet for calculating average percentage cover at a site

Equipment

- Four steel posts for each site. Three are required for the monitoring triangle and another for the photopoint post
- A quadrat for measuring cover (can be made for minimal cost in the property workshop)
- A camera
- GPS unit (optional)

Figure 7 shows two different types of quadrats. Grass Check (Department of Natural Resources 1997) makes the following recommendations for their use:

- 50 cm by 50 cm quadrat for areas with more than 500 mm rainfall, or areas with good Mitchell or buffel grass cover
- 100 cm by 50 cm quadrat for other pasture areas.

To facilitate the estimation of percentage cover, the sides of the quadrat can be painted in alternate colours to divide it into 10 cm lengths. An open end allows the quadrat to be used where there are obstructions such as trees or shrubs.

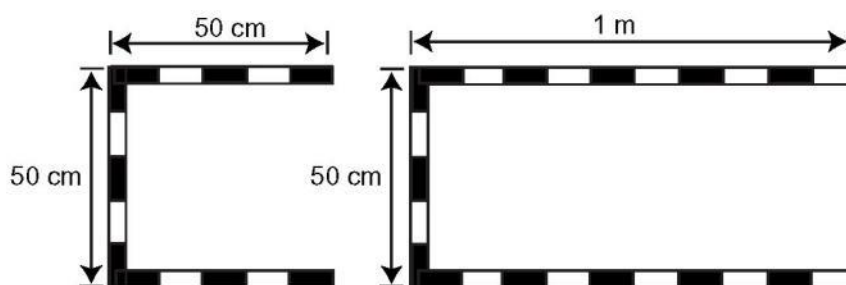


Figure 7: Two types of quadrats used for measuring ground cover

Time taken

- 45 minutes to locate and establish a monitoring site
- 30 minutes to take the recordings and the photograph per site

Setting up

You need to decide how many monitoring sites you will establish in a paddock and where you will locate them. The section 'Where will you monitor?' has advice on selecting suitable monitoring sites.

The monitoring triangle as indicated in Figure 8 is marked out as follows:

1. At the northern end of the triangle, drive in two posts or place markers, 10 m apart in a north-south direction. The northernmost marker is the photopoint post and the other is referred to as point 1.
2. From point 1, measure or step out a triangle with each side 100 m long and place markers for points 2 and 3. The easiest way to do this is to go south 87 m, then 50 m left and right from that point.
3. If the site is covered with trees and shrubs, mark the sides of the triangle with a marker every 50 m or put coloured markers on some trees.
4. The location of each site should be numbered and marked on a property plan. GPS recordings may also be taken.

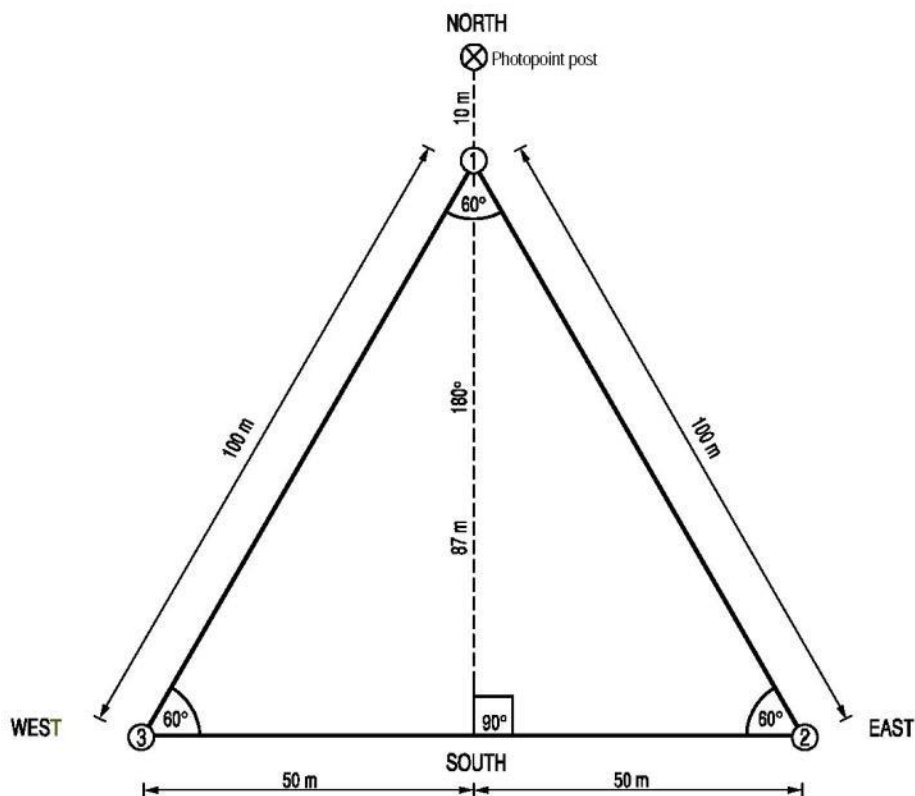


Figure 8: Approximate dimensions for a monitoring triangle

Note that a high level of precision is not required when marking out the triangle. It would be acceptable to use 100 paces instead of 100 metres. It would also be appropriate to reduce or enlarge the size of the triangle (e.g. a triangle with 50 metre sides would be acceptable in small paddocks).

If using steel posts they should be made safe and visible to motor bike and horse riders; for example, attach a piece of PVC pipe over the top or paint the posts white and place a protective cap over them. On open areas such as Mitchell

grass downs, it may be necessary to place some old tyres around the posts to alleviate the effects of stock gathering to rub on the posts and increasing stock pressure in the area.

Monitoring procedure

1. In order to take 50 recordings around the triangle, you would need to make 17 observations on two sides and 16 on the third side. This would mean taking observations at regular spacings of every 6 or 7 paces depending on your length of stride.
2. At each observation point, place the quadrat in front of the leading foot and estimate the ground cover percentage by comparing with Figure 2 or Figure 3. The measurement includes cover occupied by grass, herbage, leaves, litter and manure. Cover provided by low shrubs of less than 1 metre is included but not higher shrub or tree canopy. Tip: Consider cover as being anything below your eye level that intercepts a raindrop that is falling vertically, or mentally 'move' all of the cover to one corner of the quadrat and estimate the cover that way.
3. Record your estimated percentage using the 'Level 2a Recording sheet' (refer also to 'How to record your results').
4. Continue walking around the transect until you have a total of 50 estimates.
5. Take your landscape and trayback photographs at the photosite point. Record any relevant notes that relate to the photo.

Data quality considerations

This technique is based on the method described in Grass Check (Department of Natural Resources 1997). However, the recommended number of observations along the three sides of the triangle has been reduced from 100 to 50. There is a trade-off between the number of observations you make at a single monitoring site and the number of sites you have in a paddock. There is little point in making a large number of observations at one site if that site is not representative of the whole paddock.

How do you measure it? – Level 2b monitoring

Key aspects of level 2b monitoring

Level 2B monitoring is consistent with the BioCondition Assessment Framework developed by the Queensland Department of Environment and Resource Management <<http://www.derm.qld.gov.au/wildlife-ecosystems/biodiversity/biocondition.html>>. The framework provides a means of assessing biodiversity at a patch, property or paddock scale that is compared to benchmarks for a particular vegetation type. A total of ten site-based attributes and three landscape-based attributes are assessed. For BioCondition Assessment, the following components of ground cover are measured: organic litter, native perennial and annual grasses, native non-grasses (herbs, forbs and others), introduced plants (weeds), rock cover, fallen logs and bare ground.

Skills needed

- Knowledge of local vegetation types and associated land management practices to allow you to determine suitable monitoring sites
- Ability to estimate ground cover percentage within a quadrat
- Basic maths and ability to use a computer spreadsheet for calculating average percentage cover at a site

Equipment

- Two steel posts for permanently marking the transect
- A 1 m by 1 m quadrat (can be made for minimal cost in the property workshop). To facilitate the estimation of percentage cover, the sides of the quadrat can be painted in alternate colours to divide it into 10 cm lengths. An open end allows the quadrat to be used where there are obstructions such as trees or shrubs.
- A camera
- GPS unit (optional)

Figure 9 shows an example of a quadrat recommended for use in monitoring for biodiversity.

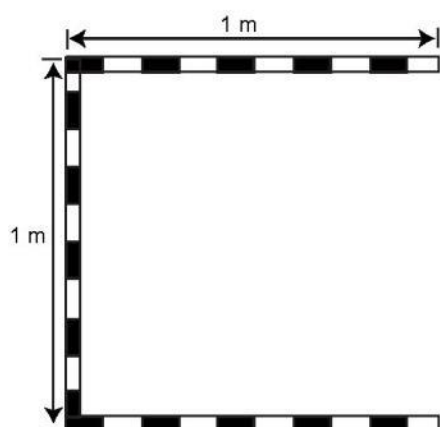


Figure 9: Quadrat recommended for use in measuring ground cover for BioCondition assessment

Time taken

- 30 minutes to locate and establish a monitoring site as illustrated in Figure 10.
- 15 minutes to take and record the ground cover observations and to take a photograph at each site

Setting up

To monitor for BioCondition Assessment, ideally all vegetation types and all areas subject to different levels of management on the property should be monitored for ground cover. The combination of a particular vegetation type and management action is called a zone. Some thought needs to go into the placement of your monitoring areas within these zones to minimise the number of sites but still ensure you represent the range of vegetation and management actions on the property.

Figure 10 shows the layout for a monitoring site used to assess the ground cover component for BioCondition Assessment. Ideally the transect should be across the slope and the photopoint should be the most northerly post.

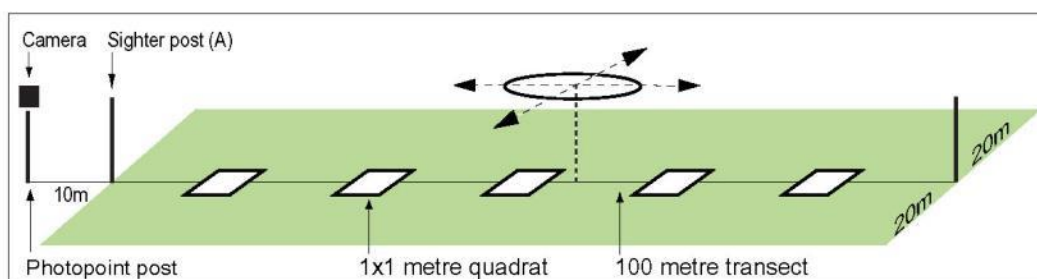


Figure 10: Standard monitoring site for BioCondition Assessment

The two end points of the transect should be permanently marked with, for example, steel posts. If using posts they should be made safe and visible to motor bike and horse riders (e.g. by attaching a piece of PVC pipe over the top or painting the posts white and placing a protective cap over them). On open areas such as Mitchell grass downs, it may be necessary to place some old tyres around the posts to alleviate the effects of stock gathering to rub on the posts and increasing stock pressure in the area. The location of each site should be numbered and marked on a property plan and/or GPS recordings should also be taken and entered into your GIS.

Monitoring procedure

1. Commencing at one end of the 100 m transect, walk a distance of 10 metres and place the quadrat in front of your leading foot and estimate the ground cover within the quadrat. You need to make separate ground cover assessments

for the following components:

- native perennial grasses
- native annual grasses
- native herbs and forbs (non-grass)
- native shrubs (less than 1 metre height)
- weeds
- litter
- rock
- bare
- fallen logs
- cryptograms.

Tip: Consider cover as being anything below your eye level that intercepts a raindrop that is falling vertically or mentally 'move' all of the cover to one corner of the quadrat and estimate the cover that way. Cover provided by low shrubs of less than 1 metre is included but not higher shrubs or tree canopies.

2. Record your estimated percentage cover within the quadrat on the relevant level 2b recording sheet. (refer also to 'How to record your results').
3. Continue walking along the transect making estimates with the quadrat every 20 metres until you have a total of five estimates
4. Take your landscape and trayback photographs at the photopoint. For biodiversity monitoring, you should also take four additional landscape photographs from the centre point of the transect, one each facing the four points of the compass (north, south, east and west). Make any relevant notes against your photographs.

How to record your results

The information you collect while monitoring is referred to as data. Data is distinct pieces of information (e.g. numbers, text or images) that can be stored electronically, on paper or as samples. An organised collection of data with a common theme is called a dataset. For example, a collection of data about a particular geographic area for a particular time period would form a dataset.

When you are working in the field, the simplest way to record your data is to have a field recording sheet with you. A field recording sheet will help ensure that your data is recorded in a way that is easy to enter into a spreadsheet and also acts as a checklist to ensure that you don't miss recording any important information.

'Recording sheets' for each of the different methods of measuring cover (Levels 1, 2a and 2b) are provided with this indicator material. Examples of completed recording sheets are also provided. Blank data sheets can be printed off for use in the field. Your data can be entered into the electronic version of the field recording sheet if you want to use the automatic totalling and averaging functions. You can also enter the summary data on to the data recording sheet for the long-term collation of your data and creation of charts.

Metadata

There are two aspects to recording information: the information (data) you collect each time you monitor and the metadata associated with your monitoring data. Metadata is pieces of information that describe data or is 'data about data'. It describes the 'who, what, when, where, why and how' about a data set. Metadata is critical to preserving the usefulness of data over time.

It is important to record the information shown in Table 1 below. This table is available in the spreadsheets that can be downloaded for each of the indicator levels in 'How do you measure it?'

Table 1: Typical data sheet for recording metadata that describes the dataset

Key element	Metadata
Short description of the contents of the dataset	
Name of the land manager or business responsible for the dataset	
Brief assessment of reliability of the information in the dataset	
Brief history of the source and processing steps used to produce the dataset	
Maintenance and update frequency of the dataset	
Location or area the data relates to	

What does your data mean?

Percentage ground cover can be highly variable and strongly influenced by the weather, seasonal growth patterns, land type and land use and management practices. Figure 11 provides an example of how the average cover levels may vary in a paddock (similar graphs can be produced from the spreadsheets provided in 'How to record your results' of this indicator. The annual rainfall has been added to the graph. Keep in mind that rainfall occurs sporadically and it is quite possible that a high proportion of the rainfall may have occurred in one or two months at the beginning, middle or end of the recording period.

A minimum level of 30–40% cover is required in order to ensure a reasonable level of protection from erosion and to perform the other ecological functions of ground cover as described in 'What is it?'. Higher levels of cover will increase the benefits that cover provides. In grazing lands the 30% to 40% cover level should exist at the beginning of the summer storm season. To achieve this, a surface cover level of around 70% is desirable at the end of the summer growing season.

Figure 11 shows the relationship between annual soil erosion and ground cover over 14 years at Greenmount on the Darling Downs. Figure 12 shows the relationship between ground cover and runoff as well as soil loss derived from 7 years of measurements on pasture land in Central Queensland.

Minimising soil erosion and runoff has important implications for water quality since runoff will usually contain sediment, nutrients and any agricultural chemicals that may have been applied to the soil (Finlayson and Silburn 1996).

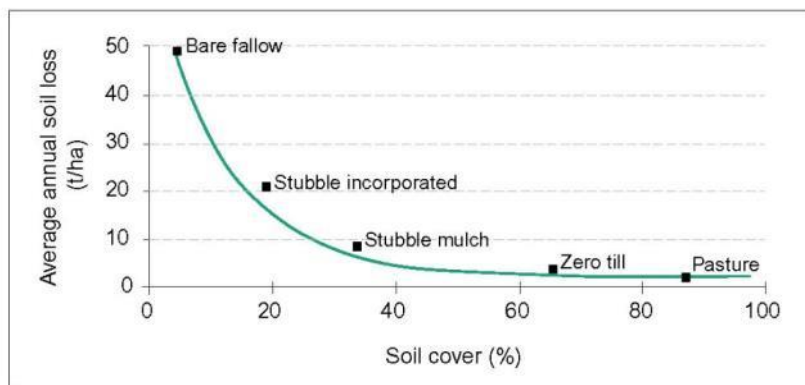


Figure 11: Annual average soil loss (1978–92) vs. cover for contour bay catchments on the eastern Darling Downs (Freebairn 2004)

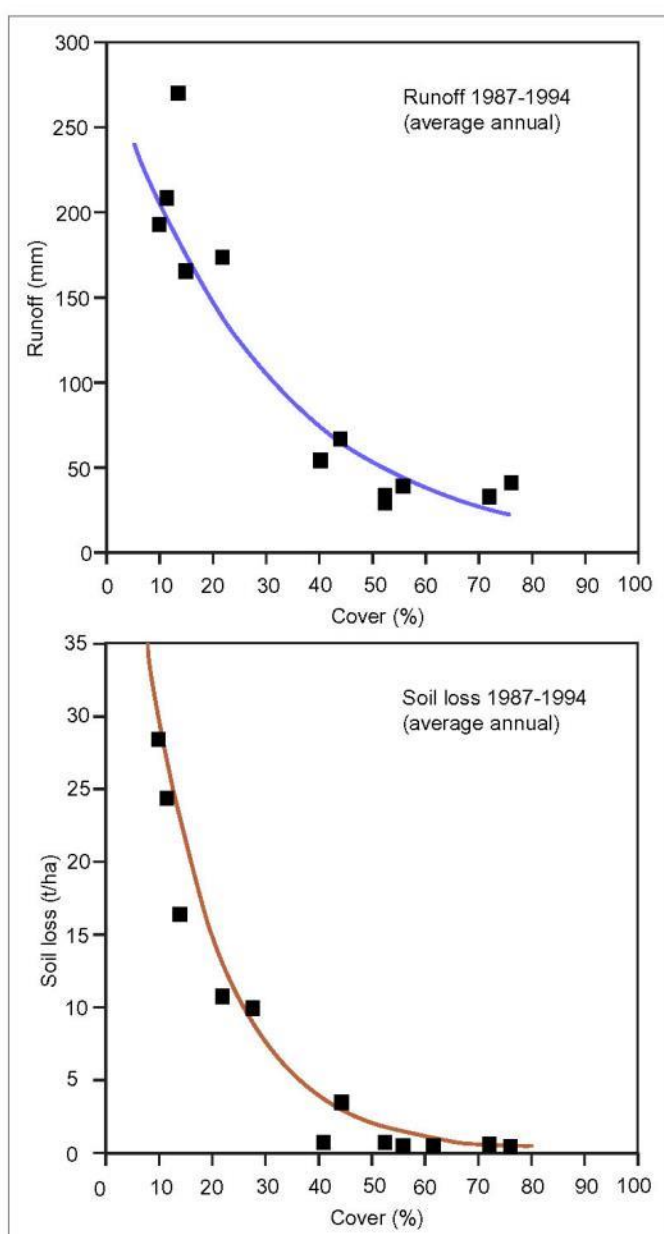


Figure 12: Average annual runoff and soil loss (1987–94) vs. ground cover for native pasture in Central Queensland (Mark Silburn, Queensland Department of Natural Resources and Water, pers. comm. 2005)

When monitoring for biodiversity values in the ground cover, your data would need to be compared with benchmark data prepared for the vegetation zone or regional ecosystem type you are monitoring. It is intended that this information will become available soon on the Queensland Department of Environment and Resource Management website. However, in general, to maintain ecological processes important for biodiversity, good ground cover (>50%) comprising litter, fallen logs and native plant species is the key. Litter and fallen logs provide habitat for ground-dwelling vertebrate and invertebrate fauna, as well as influencing soil microclimate, structure and composition.

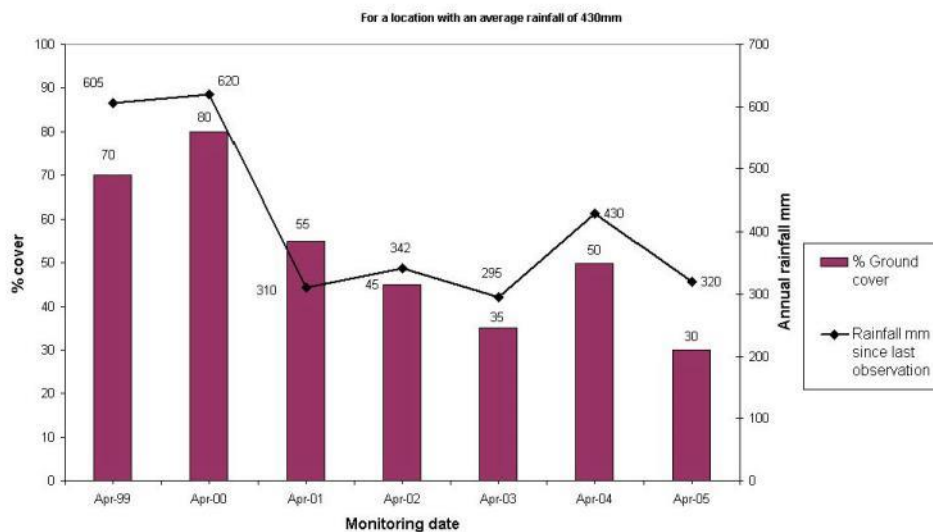


Figure 13: Rainfall and changes in pasture ground cover from 1999 to 2005

What are some management options?

These management options are only generalisations and should be interpreted with caution. It is important to remember that each situation is unique and so the most appropriate management option will also vary.

Grazing lands

Pastures need to be managed so that adequate levels of cover are maintained on the soil surface. Excessive grazing pressure, especially during periods of drought, leads to bare, vulnerable soil surfaces. The period of greatest risk is in late spring and early summer when cover levels are often low and rainfall intensities can be high. High grazing pressure also has an impact on both biodiversity and productivity because it can lead to pressure on the most palatable species, remove litter and lead to the introduction of weeds.

The data you collect and the charts you prepare, combined with your production records, can help you identify which paddocks or parts of a paddock are most productive and the conditions under which they maintain good cover. Your monitoring will also highlight the areas that lose cover quickly and require careful management.

Stocking rates should be based on the amount of grass in the paddock and the condition of the pasture, taking into account likely rainfall patterns for the next spring and summer. Seasonal forecasts including the Southern Oscillation Index (SOI) are a useful aid to management decisions at certain times of the year. A strongly negative SOI, especially in spring, can herald an El Niño and significant chance of drought; a positive SOI indicates a chance of wetter than normal conditions.

AussieGRASS (Australian Grassland and Rangeland Assessment by Spatial Simulation) is a simulation model developed to predict and to monitor historical grass production and land cover across Queensland and all Australian regions <<http://www.longpaddock.qld.gov.au/rainfallandpasturegrowth/index.php>>. At property or regional scale, maps from AussieGRASS output give the user a free monthly updated view of the current, historical and 3-month projected outlook of rainfall, pasture growth and grassfire risk. By taking account of livestock grazing by region, the pasture growth maps provide another valuable tool for producers to help base their decisions of stock and pasture management upon. These may include sites for stock agistment, buying and selling of produce and livestock decisions or status of pasture growth regionally or State wide.

As you increase your understanding of the responsiveness of your paddocks, you can begin to incorporate your results into your property management plan or farm management system by identifying different areas of your property according to their risk of developing low ground cover.

Strategies that can be used to respond to a poor seasonal outlook include heavy culling and sale, early weaning, agisting,

custom feedlotting and supplementary feeding. Regular planning includes stocking up with hay and supplements when prices are attractive. Some of these stockpiles can be used each winter to enhance normal management and replaced to ensure the reserves are always of good quality. Overdependence on supplementary feeding is an indication of excessive grazing pressure.

When assessing stocking rates the effects of native animals such as kangaroos and pests such as rabbits need to be considered.

Opportunistic spelling should be part of a grazing strategy. A total spell in a good summer season may be required to allow desirable grasses to recover from past overgrazing. Grazing pressure can also be managed by the location of watering points. They need to be located to minimise stock concentration in areas vulnerable to erosion.

Fire is a key tool for managing pastures and woody weeds but it needs to be managed carefully. Burnt pastures need to be spelled to allow around 20 cm regrowth before grazing. Your fire regime should be tailored to the land type, needs of the pasture species and any nature conservation considerations such as ground feeding or nesting birds. Burning too frequently may prevent pasture species from seeding or regenerating after drought or heavy grazing. No fire will allow regeneration of native trees and shrubs and woody weed species in cleared or naturally open country. A permit is necessary before burning and the conditions of the Vegetation Management Act need to be complied with.

The Queensland Department of Employment, Economic Development and Innovation provides a range of guides on management of specific types of pastures <http://www.dpi.qld.gov.au/27_7791.htm>. For more details check the reference Partridge (1992).

Graziers may wish to use the Stocktake package <www.dpi.qld.gov.au/stocktake>. It is a paddock-scale land condition monitoring method used as part of a grazing land management package recommended by the Queensland Department of Employment, Economic Development and Innovation. It has been developed to provide grazing land managers with a practical, systematic way to:

- Assess land condition and long-term carrying capacity
- Calculate seasonal forage budgets
- Integrate this information into a sustainable long-term production system.

Cropping lands

Crops need to be managed so that cover levels of at least 30–40% are provided throughout the year but especially during the summer months when there is a greater chance of high-intensity rainfall. After harvest, crop stubbles (referred to as 'trash' in the sugar cane industry) need to be retained on the soil surface, rather than being burnt or buried by tillage implements. Table 2 shows the amount of wheat or barley stubble cover removed by various tillage operations. The use of herbicides and specialised machinery has allowed the practices of reduced or zero tillage which result in maximum levels of ground cover retention.

Table 2: Estimated reduction in wheat or barley stubble cover from different farming operations (Department of Primary Industries and Fisheries brochure 'Measuring stubble cover – Photostandards for winter cereals')

Implement	Residue buried by each tillage operation	
	Fresh stubble	Old (brittle) stubble
Disc plough	60–80%	80–90%
Chisel plough	30–40%	40–60%
Blade plough	20–30%	30–50%
Boomspray	Negligible	Negligible

The term 'opportunity cropping' refers to the practice of planting a crop when sufficient soil water is available rather than according to a fixed rotation. It allows landholders to maximise surface cover levels.

Some non-cereal row crops such as sunflower, grain legumes and cotton provide inadequate levels of surface cover. Row spacings also affect the amount of cover provided by a crop.

Minimum tillage practices also apply to horticultural cropping. Cover crops can be grown during a fallow period to provide

protection from erosion as well as providing organic matter to improve the water-holding capacity of the soil. Cover may also be provided by using a surface mulch of plant residue from crops such as pineapples and bananas while in many tree crops a grass sod is recommended beneath the trees.

Urban areas

In an established urban environment, adequate ground cover should be provided by appropriate landscaping. Vulnerable areas will be land that has been disturbed while it is undergoing development and areas subject to high rates of pedestrian traffic on land that has not been given adequate protection (e.g. school grounds often have bare areas where high rates of runoff and erosion may occur).

A range of specialised products including hydromulching and geotextiles can be used to provide surface cover and to manage runoff on development sites. Disturbed land in urban areas is sometimes protected by fast-growing vegetation such as millet (summer growing) or oats (winter growing). These plants provide protection while the soil is in a loose and friable condition. When these annual crops mature, the remaining stubble will continue to provide some protection and by this time the soil will have consolidated and be less prone to erosion.

Protected areas

Private landholders can assist with maintaining biodiversity by providing a nature refuge on their property with assistance provided by the Queensland Department of Environment and Resource Management. A nature refuge is established via a voluntary conservation agreement between a landholder and the Queensland Government. A nature refuge is a category of protected area under the *Nature Conservation Act 1992*.

Each agreement is tailored to suit the management needs of the particular area and the needs of the landholder. In most cases, the agreement allows for the ecologically sustainable use of natural resources to continue. A nature refuge can cover part or all of a property protecting wildlife and wildlife habitat and emphasising the conservation of biodiversity as an important part of property management.

Other information sources

Books

Boulter, SL, Wilson, BA, Westrup, J, Anderson, ER, Turner, EJ, and Scanlan, JC (Editors) 2000, *Native vegetation management in Queensland – Background science and values*, Queensland Department of Natural Resources.

Tongway, DJ and Hindley, NL 2005, *Landscape function analysis – Procedures for monitoring and assessing landscapes, with special reference to minesites and rangelands*, CSIRO Sustainable Ecosystems.

CD-ROMs

Department of Primary Industries 2003, *Pasture Photo Standards CD*, Queensland Department of Primary Industries, is available from the Queensland Government Bookshop <<https://www.bookshop.qld.gov.au/>> - Search for 'Pasture photo standards'.

PrimeNotes CD ROM Version 18 produced in May 2005 by the Queensland Department of Primary Industries and Fisheries contains over 5000 fact sheets about issues related to natural resource management and agricultural production. Fourteen agencies throughout Australia contributed information to the CD. This publication is available from some libraries.

Fact sheets

The Queensland Department of Environment and Resource Management has several fact sheets that are related to this topic:

- Soil limitation to water entry – understanding restrictive soil layers (L40)
- Erosion control in cropping land (L13)
- Erosion in school grounds (L42)
- Erosion control in grazing lands (L91)
- Managing for drought in grazing lands (L90)
- Identifying and monitoring salt-affected areas (L53)
- Catchments and water quality (C2)

Cater, D 2002, *The amount of stubble needed to reduce wind erosion*, Farmnote No 67/2002, Western Australia Department of Agriculture. <http://www.agric.wa.gov.au/objtwt/imported_assets/content/lwe/land/erosion/fn067_2002.pdf>

Journal articles

Molloy, JM and Moran, CJ 1991, Compiling a field manual from overhead photographs for estimating crop residue cover, *British Soil Use and Management Journal* 7, 177–83.

Websites

Landscape function analysis: A systems approach to assessing rangeland condition, CSIRO Sustainable Ecosystems web site <<http://www.csiro.au/services/EcosystemFunctionAnalysis.html>>

Stocktake – Grazing land management package, Queensland Department of Primary Industries and Fisheries <http://www.dpi.qld.gov.au/27_11643.htm>

Queensland Department of Environment and Resource Management fact sheets <http://www.derm.qld.gov.au/services_resources/item_list.php?category_id=123>

BioCondition Assessment Framework, Queensland Department of Environment and Resource Management <<http://www.derm.qld.gov.au/wildlife-ecosystems/biodiversity/biocondition.html>>.

Glossary

Fallen logs

Fallen logs refer to coarse woody debris or dead timber on the ground greater than 10 cm diameter and greater than 0.5 m in length.

Grazing pressure

This term refers to the amount of feed available compared to the rate of removal by grazing animals. The ideal stocking rate is flexible, so as to maintain a moderate grazing pressure most of the year and to match stock numbers to available feed. When assessing stocking rates, the effects of native animals such as kangaroos and pests such as rabbits need to be considered.

Ground cover

Ground cover is provided by plants (living or dead) and any parts of the plant that fall to the surface of the ground. Cover may also be provided by pebbles and rocks and 'crusts' formed by fungi, mosses, etc. In the urban environment, infrastructure such as concrete, bitumen and buildings may provide cover but their impermeability leads to high rates of runoff with consequent water loss and adverse effects downstream.

Herbaceous plants

Plants with soft, rather than woody stem tissues.

Infiltration

The movement of water from the soil surface into the soil profile. Surface cover assists infiltration by minimising raindrop impact and by retarding the flow of runoff across the soil surface. Soil characteristics affecting infiltration rates include surface seals, hard-setting layers, surface and subsurface compaction and impermeable subsoils. Infiltration rates are usually higher within plant tussocks compared to the area between tussocks because of the presence of plant roots and higher levels of biological life in this zone.

Litter

The ground cover provided in forests, woodlands and pastures by fresh or slightly decomposed leaves, bark, twigs, flowers and fruits. Litter is defined in BioCondition as including both fine and coarse organic material such as fallen leaves, twigs and branches less than 10 cm diameter.

Minimum tillage

A conservation tillage system in which the crop is grown with the fewest possible tillage operations. Herbicides and/or grazing may be used for fallow weed control.

Opportunity cropping

The practice of planting a crop whenever soil moisture reserves are considered sufficient, rather than according to a rigid rotational pattern. This leads to an increase in cropping frequency (e.g. two crops in three years) and greater levels of surface cover.

BioCondition Assessment Framework

The BioCondition Assessment Framework developed by the Queensland Department of Environment and Resource Management provides a means of assessing ecosystem condition for biodiversity at a patch, property or paddock scale that is compared to benchmarks for the particular vegetation type. It uses data from ten attributes to compile a dataset for conducting a BioCondition Assessment.

Rainfall erosivity

A measure of the capacity of the rainfall in a given location to cause erosion. It takes into account the combined effects of rainfall quantity and its kinetic energy (intensity). In most areas of Queensland, rainfall erosivity peaks in January–February and reaches a low point in August–September.

Raindrop impact

The result of the violent break-up and dispersion of raindrops when they hit the ground surface. If the surface is not protected, soil particles may be dislodged and scattered a considerable distance, due to the energy of the raindrop's impact. Dislodged particles are easily transported away by overland flow.

Stubble

The straw residue that remains after a grain crop has been harvested. It includes standing straw and that discharged by a harvester.

Stubble burning

A management practice in which the stubble from a crop is burnt after the harvest or prior to the sowing of the next crop. Stubble burning exposes the soil to erosion and destroys a potential source of soil organic matter.

Stubble incorporation

A management practice where stubble is incorporated into the surface soil by tillage, thereby promoting stubble breakdown and reducing the amount of protection that surface stubble can provide against erosion.

Stubble mulching

A conservation farming practice where stubble is retained on the surface of the soil by using suitable farm machinery such as chisel or blade ploughs. Implements such as disc ploughs are not suitable for stubble mulching since they incorporate an excessive amount of stubble into the soil.

Trash

Trash is the stubble remaining after the harvest of a sugarcane crop. The term 'green cane trash blanket' refers to a protective blanket of cane trash over the soil surface.

Zero tillage (or no tillage)

A minimum tillage practice in which the crop is sown directly into a soil not tilled since the harvest of the previous crop. Weed control is achieved by the use of herbicides and the retained stubble provides erosion control.

Opportunity cropping

The practice of planting a crop whenever soil moisture reserves are considered sufficient, rather than according to a rigid rotational pattern. This leads to an increase in cropping frequency (e.g. two crops in three years) and greater levels of surface cover.

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Landholder Record Forms

The Land Manager's Monitoring Guide

Indicator: Ground cover

Level 1 field recording sheet - visual observations

[illegible]

The Land Manager's Monitoring Guide

Indicator: Ground cover

Metadata recording sheet

Key element	Metadata
Short description of the contents of the dataset.	e.g. Ground cover at "specified property"
Name of the land manager or business responsible for the dataset.	
Brief assessment of reliability of the information in the dataset.	Record which method you have decided to use, e.g. Level 1, 2a or 2b monitoring plus brief description of the method
Brief history of the source and processing steps used to produce the dataset.	Record which method you have decided to use, e.g. Level 1, 2a or 2b monitoring plus brief description of the method
Maintenance and update frequency of the dataset.	
What location or area does the data relate to.	Provide property or other location details and/or GPS Eastings and Northings

The Land Manager's Monitoring Guide

Indicator: Ground cover

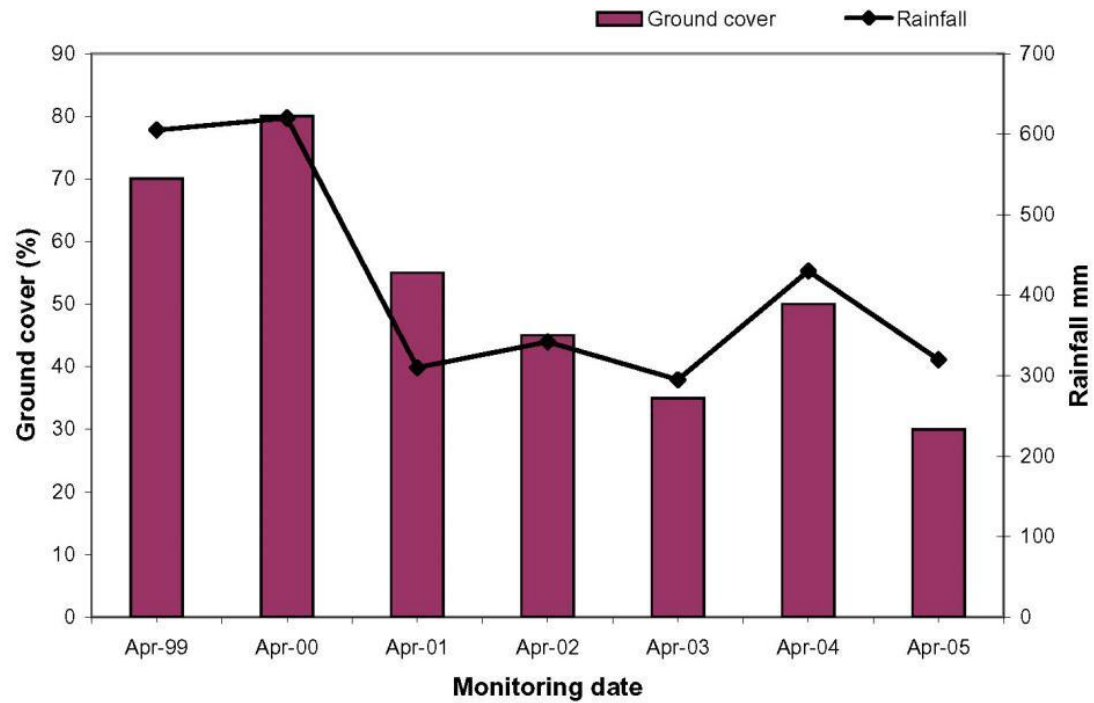
Level 1 field spreadsheet - pastures

[illegible]

Example Chart

The Land Manager's Monitoring Guide

Rainfall and changes in pasture cover from 1999 to 2005



For a location with an average rainfall of 430mm

The Land Manager's Monitoring Guide

Indicator: Ground cover

Level 1 example field recording sheet - visual observations

Date	30/2/05					Recorder	Jane W
Paddock name	Observation					Average cover (%)	Comments
	1	2	3	4	5		
Tank paddock	40	60	40	35	35	42	
Creek paddock	45	30	55	65	45	48	
Carinya paddock	35	40	55	25	35	38	
Home paddock	60	40	45	55	65	53	
Far paddock	40	35	45	60	55	47	

The Land Manager's Monitoring Guide

Indicator: Ground cover

While every care is taken to ensure the accuracy of this information, the Department of Environment and Resource Management does not invite reliance upon it, nor accept responsibility for any loss or damage caused by actions based on it.

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