Offset Management Plan

Foxleigh Coal Mine Extension

EPBC Act Approval (2010/5421)

Middlemount South Pty Ltd

APPROVALS

Rev	Date	Description
8	08/12/2016	Plan amended based on feedback from Department of the Environment and Energy
7	23/11/2016	Draft amended based on comments and final reissued to client
6	07/11/2016	Draft issued to client
5	08/06/2016	Final issued to client
4	11/03/2016	Final issued to client
3	21/10/2015	Draft issued to client for comment
2	12/12/2014	Final issued to client
1	02/10/2014	Final issued to client
0	26/09/2014	Final issued to client

	Name	Position	Date
APPROVER	Rebecca Enright	Senior Manager	08/12/2016

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DECLARATION OF ACCURACY

In making this declaration, I am aware that section 491 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or the *Environment Protection and Biodiversity Conservation Regulations 2000* (Cth). The offence is punishable on conviction by imprisonment or a fine, or both. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed

BRIAN SPENCER GM

Full name (please print)

Organisation (please print)

FOXLEIGH MINE MANAGEMENT.

Date 8/12/16.

CONTENTS

1 INTRODUCTION

Middlemount South Pty Ltd is proposing to extend the existing open cut Foxleigh Coal Mine (the Foxleigh Coal Mine Extension (the project)) within the Foxleigh Plains Mining Lease areas, specifically MLs 70429, 70430 and 70431 (Figure 1). The project received approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act, Reference Number 2010/5421) to disturb matters of national environmental significance (MNES), including Brigalow (*Acacia harpophylla* dominant and co-dominant) threatened ecological community (TEC) and squatter pigeon primary habitat as shown in Table 1. It is noted that the squatter pigeon primary habitat includes the 83.7 ha of Brigalow TEC, and hence the total area of MNES approved to be disturbed under the EPBC Act approval, is 181 ha.

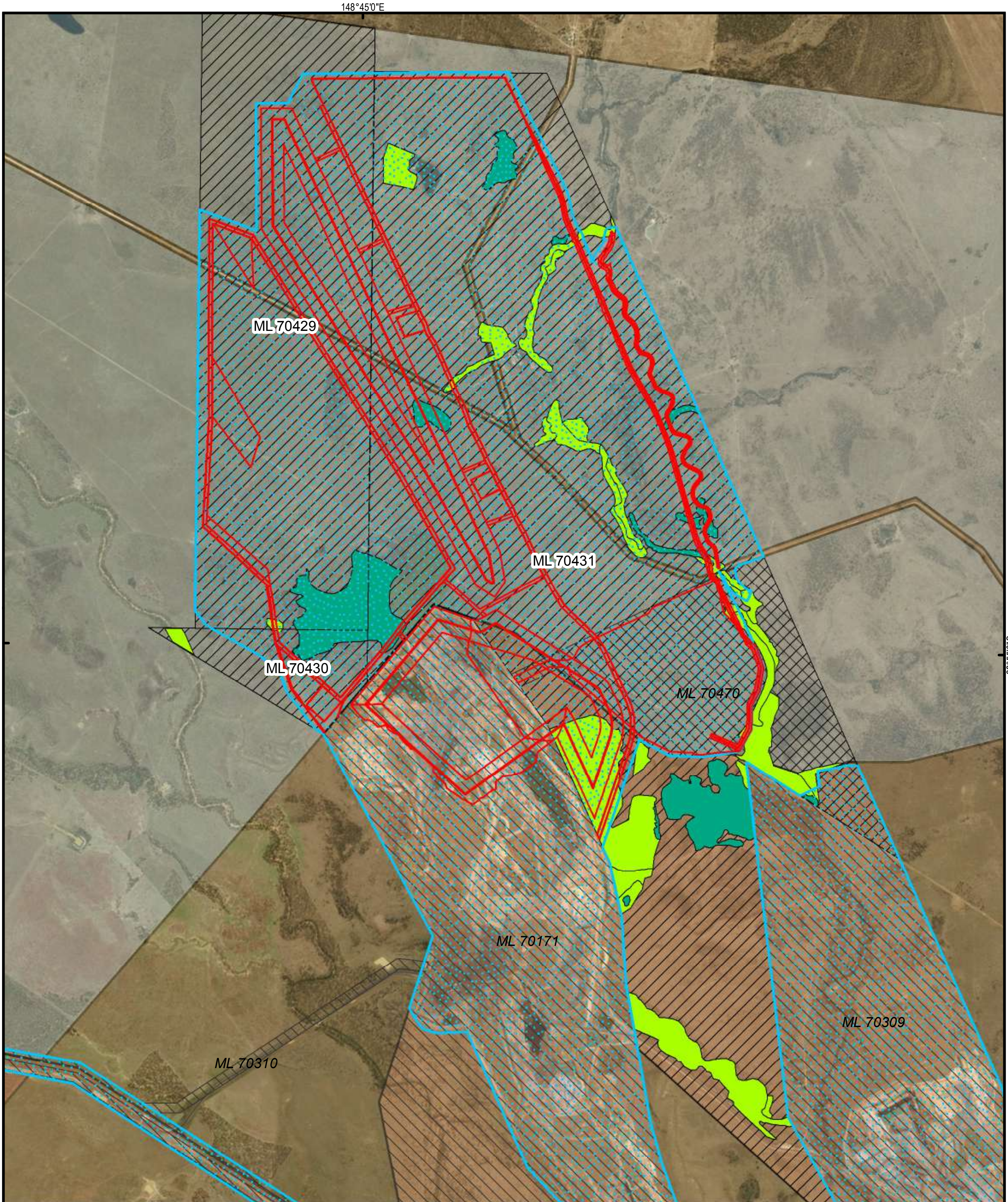
Table 1: Description of the MNES approved to be impacted by the project

MNES	EPBC Act status	Description of impacted values	Impact area (ha)
Brigalow (*Acacia harpophylla* dominant and co-dominant) threatened ecological community (TEC)#	Endangered	Brigalow TEC impacted by the Foxleigh Coal Mine Extension includes areas of remnant and regrowth regional ecosystems (RE): ▶ RE 11.3.1 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains) ▶ RE 11.4.9 (*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains) ▶ RE 11.9.5 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks)	83.70
Squatter Pigeon (Southern) (*Geophaps scripta scripta*)	Vulnerable	The Foxleigh Coal Mine Extension will impact on primary breeding and foraging habitat for the squatter pigeon. Breeding and foraging habitat for the squatter pigeon consists of dry, open sclerophyll woodlands and scrub dominated by Eucalyptus, Corymbia, Acacia and Callitris species, specifically: ▶ Foraging habitat (high value) – Gravelly, sandy, loamy soils, open-forest to woodland communities (dominated by Eucalyptus, Corymbia, Acacia or Callitris species), within 3 km of a permanent or seasonal water body. ▶ Breeding habitat (high value) – Well-draining, gravelly, sandy or loamy soils, open-forest to woodland communities with patchy, tussock understories, within 1 km of a permanent water body.	181

Defined in the EPBC Act approval as patches of Brigalow TEC that are at least 0.5 ha in size; and where regrowth is at least 15 years old.

This offset management plan has been prepared to satisfy conditions 4 and 5 of the EPBC Act approval and guide the establishment and management of offset areas that will compensate for approved, unavoidable impacts on MNES. Appendix A details conditions 4 and 5 of the EPBC Act approval along with a cross reference to where each specific requirement has been addressed in this document. This plan specifically includes:

- details of the offset attributes (section 2.3.1)
- a description of the baseline conditions in the offset areas that were used to establish performance indicators and appropriate management methods (section 2.5)
- a strategy and management actions to improve the condition of Brigalow TEC and Squatter Pigeon primary habitat within the offset areas over the period of the offset to achieve the future condition targets (sections 3, 4 and 5)
- a completed offsets assessment guide for the proposed offset and a discussion as to how figures used to complete the guide were derived (section 2.6 and Appendix E).



Middlemount South Pty Ltd

Figure 1:
Project impact area

- Lot 4 SP248577
- Lot 20 SP276924
- Foxleigh Plains MLs
- Non-project MLs
- Foxleigh conceptual layout
- Disturbance footprint
- MNES squatter pigeon habitat
- MNES brigalow and squatter pigeon habitat

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)
The following datasets are © State of Qld:
- Cadastral Data (2011)

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Date: 23-11-2016 Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994 Scale: 1:50,000 @ A4

Location diagram

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2 PROJECT OFFSETS

2.1 SUMMARY

Offset areas to acquit the project's impacts on MNES and satisfy the relevant EPBC Act approval conditions are located across two properties: Lot 4 on SP248577 and Lot 20 on SP276924 (Figure 2). These properties are currently owned and managed by Middlemount South and are used for cattle grazing and coal exploration activities. The offset areas are located within and adjacent to the project's mining leases; however, Middlemount South have strategically located all offset areas outside any proposed mining areas and exploration areas. One of the offset areas (management zone B) is located adjacent to a haul road going to ML 70309; however, the haul road will not be used after the pit is completed (anticipated by end of 2017) and as such this road is not expected to have impacts on the offset after this period. The proponent will notify the regulators within 30 days of the road being decommissioned.

The offset areas are located across 13 different patches of vegetation which provide a combined total offset area of 149.34 ha of Brigalow TEC and 317.32 ha of squatter pigeon primary habitat as shown in Table 2 and Figure 3.

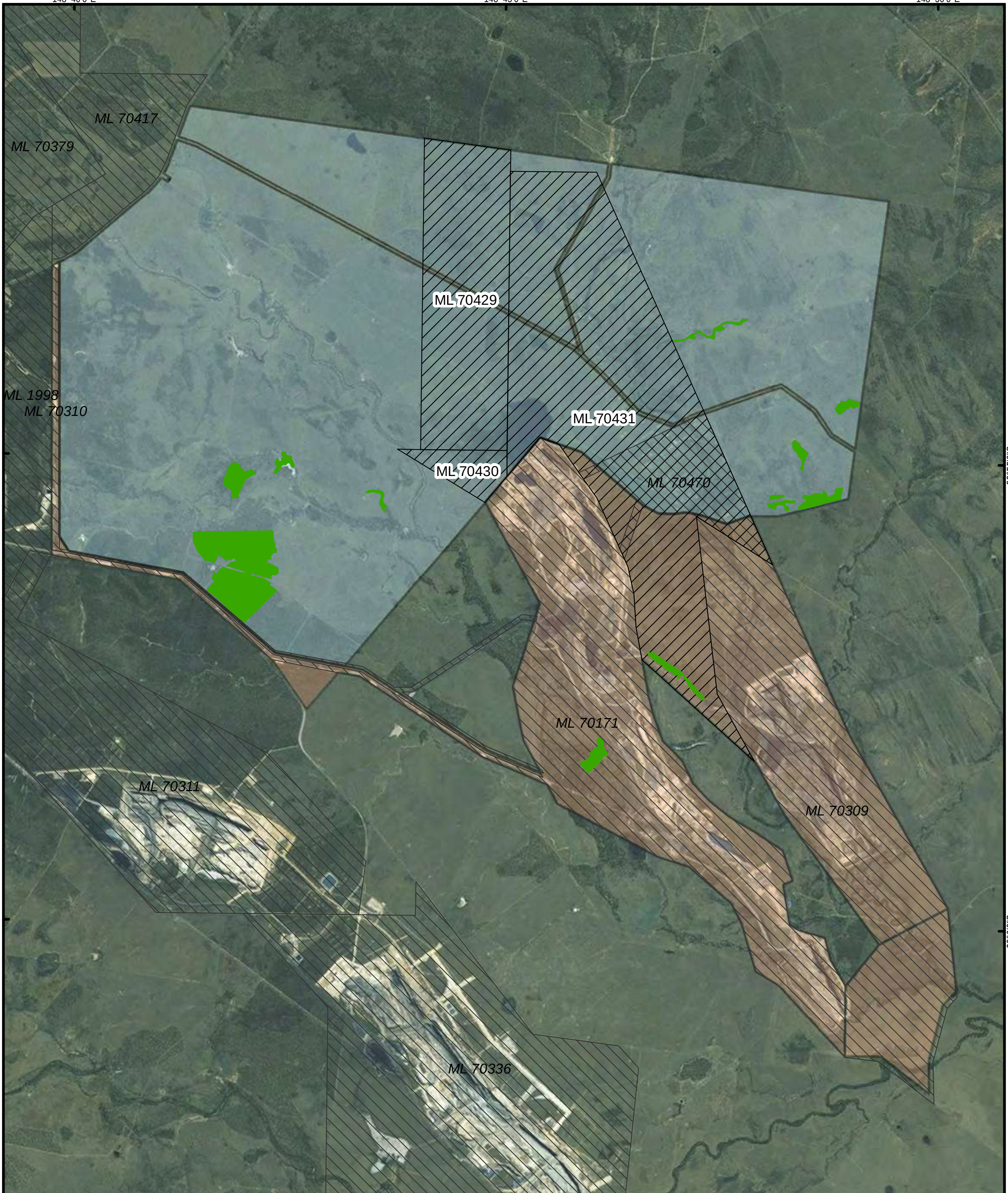
Detailed field surveys of the offset areas were undertaken over a period from October 2012 to April 2013 including ecological equivalence assessments in accordance with the Queensland Government's Ecological Equivalence Methodology. The results of these surveys are presented in Appendix C as the Biodiversity Offset Field Survey Report & Offset Proposal Foxleigh Plains & Cockatoo Creek Diversions; (Anglo American 2014). Targeted fauna surveys were also undertaken in 2014 and the results are included in Appendix D.

Section 2.5 provides a description of the baseline condition of Brigalow TEC and squatter pigeon habitat based on the results of the ecological equivalence assessments and targeted fauna surveys within the offset areas.

The offset areas were assessed in accordance with the requirements under the EPBC Act Environmental Offsets Policy (see Section 2.2). The results of the field surveys were used to assess the suitability and the size of the offset areas under the EPBC Act offsets assessment guide. Based on the results of the offsets assessment guide, the proposed offset areas have the ability to acquit over 100% of the project's offset requirements for Brigalow TEC and the squatter pigeon (Table 2). Detailed justifications for the inputs used as part of the offsets assessment guide for Brigalow TEC and squatter pigeon habitat are presented in Section 2.6.

Table 2: Summary of the offset areas to be secured on Lot 4 and Lot 20

MNES	Approved impact area (ha)	Offset area		Maximum offset acquittal under offsets assessment guide
		Description	Total of offset areas (ha)	
Brigalow TEC	83.70	Remnant and regrowth vegetation communities comprising RE 11.4.9 and RE 11.3.1, as listed under the EPBC Act conservation advice for Brigalow TEC	149.34	102%
Primary squatter pigeon habitat	181	Vegetation comprising dry, open sclerophyll woodlands and scrub dominated by Eucalyptus, Corymbia, Acacia and Callitris species, providing suitable breeding and foraging habitat, including remnant and regrowth: RE 11.3.1, RE 11.4.9 and RE 11.4.9/11.5.2/11.5.3	317.32	103%



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Location diagram

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Figure 2: Offset areas

- Lot 4 SP248577
- Lot 20 SP276924
- Foxleigh Plains MLs
- Non-project MLs
- Offset values

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)
The following datasets are © State of Qld:
- Cadastral Data (2011)

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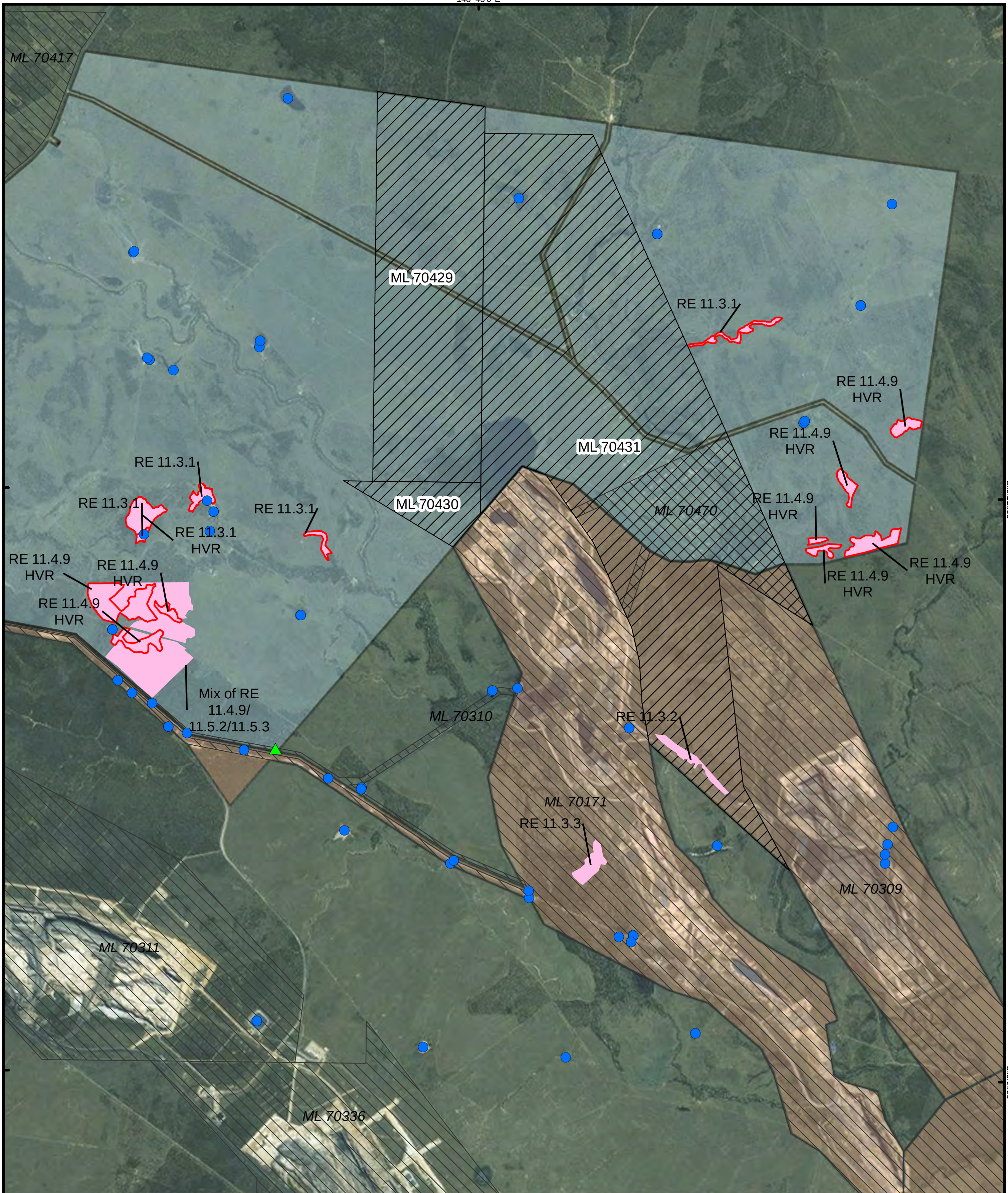

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Location diagram

Figure 3: Environmental values within the offset areas

- Lot 4 SP248577
- Lot 20 SP276924
- Foxleigh Plains MLs
- Non-project MLs
- Squatter pigeon record
- Water points

MNES values

- Squatter pigeon habitat
- Brigalow TEC

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)
The following datasets are © State of Qld:
- Cadastral Data (2011)

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2.2 EPBC ACT ENVIRONMENTAL OFFSETS FRAMEWORK

Table 3 provides an overview of how the offsets for the project meet the requirements of the EPBC Act Environmental Offsets Policy.

Table 3: EPBC Act Environmental Offsets Policy Requirements

Policy requirement	Foxleigh Coal Mine Extension offsets
Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action	The proposed offset areas are able to acquit a minimum of 100% of the project offset requirements for each matter in accordance with the offsets assessment guide (section 2.6). The offset areas will be managed to maintain and/or improve the condition and viability of the species habitat and vegetation communities in accordance with the objectives and outcomes of this offset management plan (OMP). This OMP sets out specific offset objectives as well as management and monitoring actions to be undertaken. The offset site will be managed and monitored until the objectives of this OMP have been achieved. It is anticipated that the management objectives will be achieved within the management period ending in 2034.
Suitable offsets must be built around direct offsets but may include other compensatory measures	Middlemount South will acquit 100% of the project's offset requirements through the delivery of direct land based offsets. These direct offset areas have been identified in accordance with the EPBC Act Environmental Offsets Policy and offsets assessment guide.
Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter	The threatened status of the impacted protected matters is taken into account by the offsets assessment guide in calculating the area of the offset to be provided. The offsets areas were specifically identified to be within the known distribution of each of the offset matters and contain compliant vegetation communities and habitat requirements based on published scientific literature and species records. In addition, detailed field assessments were undertaken in accordance with the Queensland Government's Ecological Equivalence Methodology in order to accurately identify the type and condition of the vegetation.
Suitable offsets must be of a size and scale proportionate to the impacts on the protected matter	The size of the offset area to be secured has been calculated in accordance with the offsets assessment guide. The inputs and justifications are based on the results of detailed field assessments as presented in Table 6, and Appendix E.
Suitable offsets must effectively account for and manage the risks of the offset not succeeding	The use of 100% direct offsets is considered to provide greater certainty that the offset will deliver a conservation gain for the offset matters in comparison to the use of other compensatory measures. The implementation of the OMP will include specific management actions to reduce the risk of threatening processes on each of the offset properties.
Suitable offsets must be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude state or territory offsets)	The proposed offsets are zoned rural and rural activity under the Isaac Regional Council planning scheme. These areas have been historically used for cattle grazing. The proposed offset areas are subject to a number of current and potential threats, including weed outbreaks (*Megathyrsus maximus var maximus*) and pasture grasses (buffel grass), grazing, pest animals, including pigs (*Sus scrofa*), potential future development and lack of long term security.
Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable	The principles and approach to identifying, securing and establishing offsets for the project are based on the key requirements of the EPBC Act Environmental Offsets Policy. Offset areas have been identified and deemed suitable using an evidence-based and scientifically robust approach.
Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.	The OMP outlines a clear governance framework and delivery pathway to legally secure the offset areas on the property title, which will be monitored, and audited/enforced in accordance with the project's EPBC Act approval.

2.3 PROPERTY DETAILS

2.3.1 Departmental reference details

The departmental reference and assessment details for the offset areas are outlined in Table 4. Appendix B includes details of the offset area attributes including a figure and table of reference coordinates for the offset area as per condition 5a of the EPBC Act approval.

Table 4: Reference Details and EPBC Act Triggers

Reference and Assessment Details	
EPBC Act Referral Reference: 2010/5421	
Offset property real property description (Primary Lot on Plan/s) and address: Lot 4 on SP248577: 57 Foxleigh Road, Mackenzie River, QLD 4705 Lot 20 SP276924: 5628 Dysart Middlemount Road, Mackenzie River, QLD 4705	
Tenure: Freehold	**Primary Local Government Area**: Isaac Regional
Referral Trigger	**Offset Trigger under EPBC Act**
Controlling provisions under the EPBC Act	☒ Threatened ecological communities – Brigalow TEC ☒ Threatened species – Squatter Pigeon

2.3.2 Landholder and property details

Landholder and property details are outlined in Table 5.

Table 5: Landholder and Property Details for Lot 4 SP248577 and Lot 20 SP276924

Landholder Details	
Registered Owner/s on Title: Foxleigh Land Pty Ltd	ACN: 088 327 226
Contact person (if required): The General Manager	T: 07 4985 9000 F: 07 4985 7000 E: admin@angloamercan.com
Postal Address: PO Box 21 Middlemount Queensland 4746	
Property Details	
Real property description (lot on plan/s): Lot 4 SP248577	
Tenure: Freehold	Primary Local Government Area: Isaac Regional Council
Planning Scheme Zone: Rural	Property area (ha): 12,140 ha Offset Area (ha): 286.18 ha
Easements, Encumbrances and Interests*:	▶ Easement in Gross No 602798732 – Easement K on Plan ROP130 ▶ Easement in Gross No 602798733 – Easement K on Plan ROP130 ▶ Easement No 704795165 – Easement A on SP128608 ▶ Easement No 709480729 – Easement B on SP178461 ▶ Easement in Gross No 710031652 – Easement E on SP178460 ▶ Easement in Gross No 712254755 – Easements Q and R on SP209956
Property Details	
Real property description (lot on plan/s): Lot 20 SP276924	
Tenure: Freehold	Primary Local Government Area: Isaac Regional Council
Planning Scheme Zone: Rural	Property area (ha): 5,380 ha Offset Area (ha): 31.15 ha

Property Details	
Easements, Encumbrances and Interests*:	▶ Easement No 602798728 – Easement J on Plan ROP128 ▶ Easement No 602798729 – Easement J on Plan ROP128 ▶ Easement No 704795162 – Easement B on SP128608 ▶ Easement No704795165 – Easement A on SP128608 ▶ Easement No 704873395 – Easements C, D and E on SP138787 ▶ Easement No 704873398 – Easement A on SP138787 ▶ Easement No 70980729 – Easement B on SP178461 ▶ Easement No 709965025 – Easement D on SP178463

2.4 VEGETATION PROTECTION

The offset areas will be protected by a Voluntary Declaration under section 19E and 19F of the *Vegetation Management Act 1999* (VM Act) and will be declared as an area of high nature conservation value. The Voluntary Declaration will be registered on property's title and will be binding on current and future landholders. The Voluntary Declaration will be lodged following approval of this OMP by Minister for the Environment and Energy (or delegate).

The Voluntary Declaration will remain in place until the objectives of this OMP (as outlined in section 3.1) have been achieved. Specifically, the objectives are to improve the vegetation to a condition such that it will be protected as remnant vegetation under the VM Act (or subsequent Queensland vegetation protection legislation). The offset property will be incorporated into the Queensland Government property map of assessable vegetation (PMAV) and the Department of Natural Resources and Mines administered vegetation management mapping accordingly revised. The revision of the VM Act mapping will provide ongoing statutory protection for the offset areas under the VM Act, and the Voluntary Declaration will be revoked by Foxleigh only when the offset area is protected under the VM Act.

This two stage process will effectively provide in-perpetuity protection of the offset areas, in accordance with the requirements of the EPBC Act approval.

2.5 OFFSET VALUES

The following sections provide a description of Brigalow TEC and squatter pigeon habitat contained within offset areas including how the proposed areas would satisfy the relevant definitions under the EPBC Act and their current baseline condition. Figure 4 spatially presents the baseline condition for each of the proposed offset areas.

Vegetation on the properties and within the offset areas was considered to be disturbed and degraded as a result of over grazing and minimal management for conservation purposes. It is also noted that none of the offset areas are mapped as remnant vegetation under the VM Act on a regulated vegetation management map. As part of this OMP the offsets will be managed to control grazing, weeds and fire risk, which will promote natural regeneration and achieve the desired future condition. This will aim to improve the overall ecological functioning of the offset areas to the extent that these areas will achieve remnant status and will be protected under Queensland legislation. Offset management objectives and actions are discussed in Section 3.1 and Section 4 (respectively).

2.5.1 Brigalow TEC

Vegetation within the offset areas are analogous with Brigalow TEC comprising field verified remnant and regrowth regional ecosystem (RE) 11.4.9 (*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains) and RE 11.3.1 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains), as listed under the EPBC Act conservation advice for Brigalow TEC. All Brigalow TEC patches within the offset areas have been identified to meet the definition of Brigalow TEC under the EPBC Act whereby:

- patches are at least 0.5 ha on size and
- regrowth is at least 15 years old.

The offset area comprises 13 patches of Brigalow TEC ranging from 2.5 ha to 42.1 ha in size. Areas considered as regrowth Brigalow TEC have not been cleared within the last 15 years; however, did not meet the structural requirements to be classed as remnant vegetation under the VM Act[1].

The species composition and structural elements of RE 11.4.9 and 11.3.1 within the offset area are consistent with typical characteristics of those RE and Brigalow TEC. The canopy layer of the Brigalow TEC in the offset areas is dominated by Brigalow and poplar box. The sub-canopy species composition varies amongst the Brigalow TEC stands and includes eucalyptus, yellow and red bauhinia, white wood, yellow wood, currant bush and warrior bush. Understory diversity is relatively low with only a few species present on all sites.

Buffel grass was identified to be present throughout all Brigalow TEC within the offset areas which is known to be associated with reduced native species diversity and changes in the fuel characteristics of the vegetation increasing the risk of uncontrolled fire events. Across each of the Brigalow TEC offset areas, non-native plant cover, mainly buffel grass, was assessed to be less than 50% of total vegetation cover.

Based on the results of the ecological equivalence assessments undertaken by Anglo American, the overall baseline condition of Brigalow TEC within the offset areas was considered as moderately dysfunctional condition (Figure 4). This condition rating was assessed using the results of the BioCondition assessments presented in Appendix F in accordance with the BioCondition Assessment Methodology. The results of ongoing monitoring of Brigalow TEC vegetation will be used to determine the condition rating to assess the offset areas in achieving the objectives of this OMP. Section 3.1.1 provides further detail on the BioCondition condition rating for the offset area.

Several patches of Brigalow TEC within proposed offset areas have been impacted by herbicide (Graslan active constituent 200 g/kg Tebuthiuron), including dieback of regrowth vegetation (see Figure 4). Those patches cover an area of 42.32 ha and represent 28% of the total offset for Brigalow TEC and 13% of the total offset area for Squatter Pigeon habitat. It is expected that these areas will recover over the next five years. Middlemount South will monitor these patches to determine whether dieback or lack of regeneration requires alternative offsets. If required, Middlemount South will consider the suitability of Brigalow TEC located on its nearby land.

2.5.2 Squatter pigeon

Baseline fauna surveys were undertaken within the offset areas, located in Lot 4 SP248577, in May and October 2014 by Cumberland Ecology. The results of the fauna surveys undertaken in the offset areas are provided in Appendix D. Additional targeted surveys for squatter pigeon will be conducted in the offset areas located in Lot 20 SP276924 within 6 months of approval of this OMP.

As part of targeted fauna surveys undertaken in 2014, all offset areas were identified to provide suitable breeding and foraging habitat for the squatter pigeon (Cumberland Ecology, 2014). Vegetation within the offset areas consists of dry, open sclerophyll woodlands and scrub dominated by Eucalyptus, Corymbia,

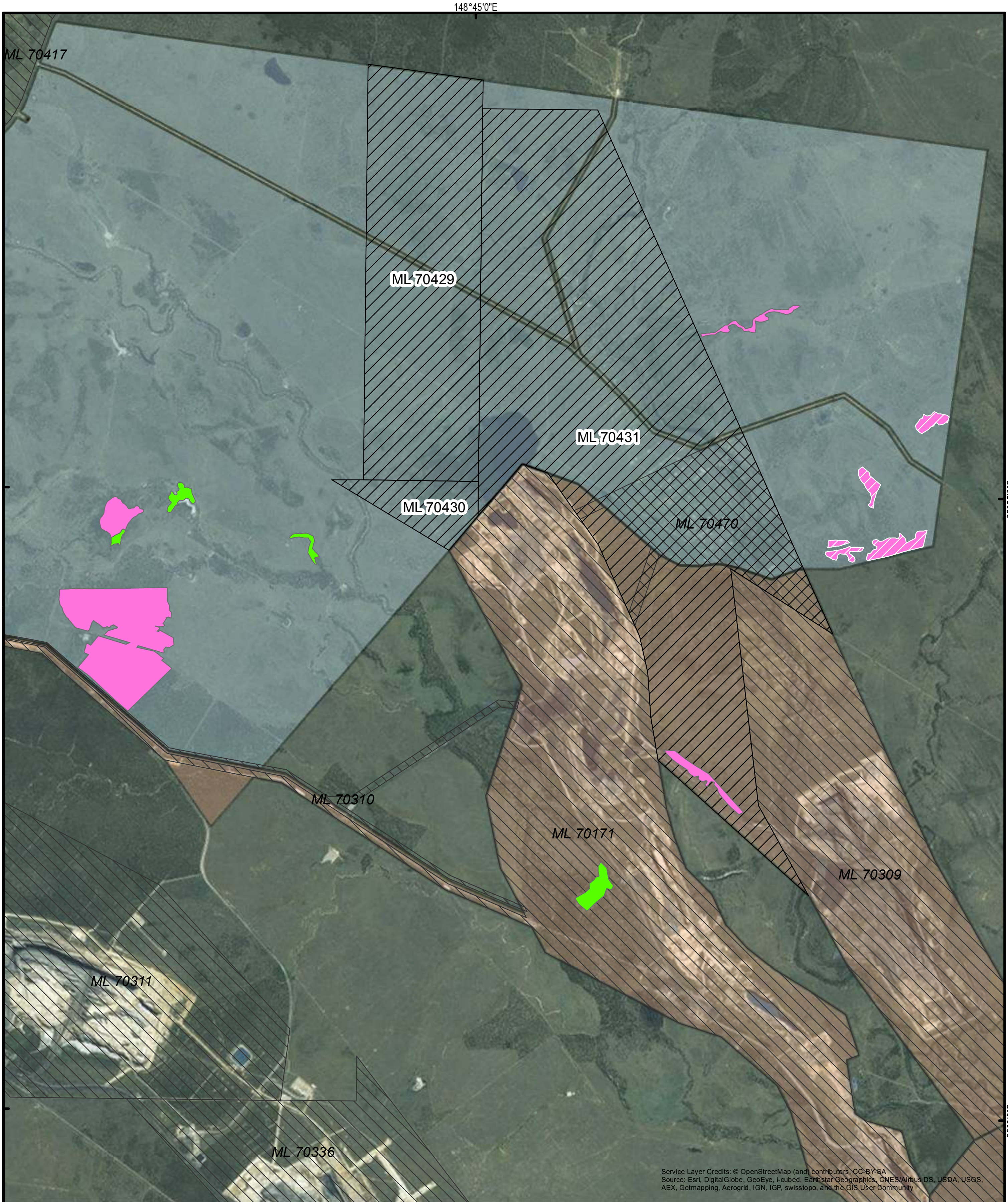
[1] As part of field verification of the offset areas vegetation structure was compared with corresponding Queensland herbarium RE Benchmark data to determine the status (i.e. regrowth or remnant). See Appendix B, the Biodiversity Offset Field Survey Report & Offset Proposal Foxleigh Plains & Cockatoo Creek Diversions; (Anglo American, 2014), for further detail.

Acacia and Callitris species, comprising remnant and high value regrowth RE 11.3.1, 11.4.9, 11.3.3, 11.3.2, 11.5.2, 11.5.3. Remnant vegetation occurs predominately along riparian areas and the south-western boundary of Lot 4 SP248577. These areas are contiguous with a larger tract of remnant vegetation to the south, adjacent to the proposed offset area.

Overgrazing and the invasion of buffel grass in these areas however have suppressed the natural regeneration of native species including native grasses on which the squatter pigeon forages. Weed management, including control of buffel grass, is discussed in section 4.4.

The squatter pigeon also requires access to suitable waterbodies to drink on a daily basis. The offset areas are located within 1 to 3 km of a number of water sources including creeks and farm dams which provide permanent and semi-permanent sources of water for the squatter pigeon, as shown in Figure 3. Based on the definition of squatter pigeon primary habitat under the EPBC Act approval, the offset areas are able to offer the characteristics of high value foraging and breeding squatter pigeon habitat in combination with soil and vegetation attributes described above.

Based on the results of the ecological equivalence assessments undertaken by Anglo American, squatter pigeon habitat within the offset areas is in overall moderately dysfunctional condition (Figure 4). Similar to Brigalow TEC, this condition rating was assessed using the results of the BioCondition assessments presented in Appendix F in accordance with the BioCondition Assessment Methodology. The results of ongoing BioCondition monitoring, in combination with fauna monitoring, will be used to assess the condition and progress of the offset areas in achieving the management objectives for squatter pigeon (see Section 0 for further detail).



Middlemount South Pty Ltd

Location diagram

Figure 4: Vegetation condition mapping

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)
The following datasets are © State of Qld:
- Cadastral Data (2011)

Lot 4 SP248577
Lot 20 SP276924
Foxleigh Plains MLs
Non-project MLs

Offset areas affected by herbicide
Vegetation condition
Moderately dysfunctional condition
Moderately functional condition

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Date: 07-12-2016 Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994 Scale: 1:75,000 @A4

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2.6 OFFSET ASSESSMENT GUIDE

This section describes the inputs and scores used in the Offsets Assessment Guide for the project, in accordance with Condition 5(d) of the EPBC Act approval for the project. The scores that were entered into the offset assessment guides for the Brigalow TEC and squatter pigeon offset areas and how they have been derived are presented in Table 6 and Table 7. Appendix E presents offsets assessment guide outputs. The results show that the offset areas for Brigalow TEC (149.34 ha) and the squatter pigeon (317.32 ha) can acquit 102% and 103% of the project's impacts respectively.

Table 6: Summary of Scores Applied to the Brigalow TEC Offset Assessment Guide

<table>
<tr><th>Input</th><th>Score</th><th>Justification</th></tr>
<tr><td>Quality of impact area</td><td>4</td><td>
The Foxleigh Coal Mine Extension will impact on 87.3 ha of Brigalow TEC. The impact area has been largely cleared of remnant vegetation and the areas of Brigalow TEC exists as fragmented stands (Ecological Survey and Management 2012). The condition of the Brigalow TEC stands varies from heavily degraded as a result of over grazing and the presence of exotic weeds to good health with negligible dieback and a dense ground cover composed of native species.
BioCondition assessments were undertaken in the areas of Brigalow TEC in the impact area as part of the Ecological Equivalence assessment and have been used to inform the quality score for the EPBC Act Offset Assessment Guide. The quality score in the Offset Assessment Guide is a measure of how well a particular site supports a particular threatened species or ecological community and contributes to its ongoing viability. There are three components that contribute to the calculation of the quality score: site condition, site context, and species stocking rate. The weighting given to each component is dependent on the ecological requirements of the threatened species or ecological community. As species stocking rate is not relevant to ecological communities, only site condition and context has been considered for Brigalow TEC.
The BioCondition methodology has been designed to provide a measure of the ecological condition of a vegetation community and the context of that area of vegetation in the surrounding landscape. Therefore BioCondition scores can be used to inform the site condition and the site context components of the quality scores. BioCondition assessments undertaken in wooded ecosystems produce a score out of 100 which can be easily converted to a score out of 10 for use in the Offset Assessment Guide. BioCondition scores for RE within the impact area were calculated as part of equivalence assessments in accordance with the Queensland Government's Ecological Equivalence Methodology (see Appendix C). The BioCondition scores for RE comprising areas of Brigalow TEC in the impact area were averaged and weighted according to the size of the patch to provide an overall combined site condition and context score. The average BioCondition score for Brigalow TEC was 41/100, which when rounded, equates to the score of 4 (Table 4A).
Table 4A: Quality score for Brigalow TEC
<table>
<tr><th>Component</th><th>Component score</th><th>Component Weighting</th><th>Weighted score</th></tr>
<tr><td>Site condition</td><td rowspan="2">4.18</td><td rowspan="2">100%</td><td rowspan="2">4.18</td></tr>
<tr><td>Site context</td></tr>
<tr><td colspan="3">Quality score (rounded to a score out of 10)</td><td>4</td></tr>
</table>
</td></tr>
<tr><td>Quality of offset area</td><td>5</td><td>
The areas of Brigalow TEC within the offset area are dominated by Brigalow (Acacia harpophylla) and poplar box (Eucalyptus populnea). The sub-canopy species composition varied amongst stands and included eucalyptus, yellow and red bauhinia, white wood, yellow wood, currant bush and warrior bush. Understorey diversity is relatively low and buffel grass was present throughout. The condition of the Brigalow TEC offset areas has been impacted by browsing, trampling and erosion as a result of long term cattle grazing.
BioCondition scores for RE within the impact area were calculated as part of equivalence
</td></tr>
</table>

<table>
<tr><th>Input</th><th>Score</th><th>Justification</th></tr>
<tr><td></td><td></td><td>assessments in accordance with the Queensland Government's Ecological Equivalence Methodology (see Appendix C). The BioCondition scores for RE comprising areas of Brigalow TEC in the offset area were averaged and weighted according to the size of the patch to provide an overall combined site condition and context score. The average weighted BioCondition score for Brigalow TEC in the offset area was 48/100, which when rounded, equates to a score of 5 (Table 4B).

Table 4B: Start quality score for the Brigalow TEC offset area.
<table>
<tr><th>Component</th><th>Component score</th><th>Component Weighting</th><th>Weighted score</th></tr>
<tr><td>Site condition</td><td rowspan="2">4.81</td><td rowspan="2">100%</td><td rowspan="2">4.81</td></tr>
<tr><td>Site context</td></tr>
<tr><td colspan="3">Quality score (rounded to a score out of 10)</td><td>5</td></tr>
</table>
</td></tr>
<tr><td>Future quality without offset</td><td>4</td><td>It is anticipated that without a change in land management practices, the quality of the offset area will continue to decline as a result of cattle grazing and weed invasion, in particular exotic grasses such as buffel grass. Areas of Brigalow TEC will continue to be impacted by browsing, trampling and erosion and the natural regeneration of native vegetation will be suppressed. The likelihood of a high intensity fire is also increased without offset management due to the presence of buffel grass. A high-intensity fire can alter the Brigalow vegetation structure (Threatened Species Scientific Committee [TSSC] 2013).</td></tr>
<tr><td>Future quality with offset</td><td>7</td><td>Environmental management strategies that target the ecological improvement of Brigalow TEC in the offset area have been developed in this OMP (see section 3.1.1 and 4). Management strategies have been guided by the actions listed in the national recovery plan for Brigalow (Butler, 2007) and measures and land management practices that have proven to be successful in restoring Brigalow TEC. Strategic grazing regimes will be implemented to minimise livestock access, alleviate grazing pressures and enable natural regeneration and allow vegetation to mature. This OMP details specific control methods to manage exotic weeds such as buffel grass which, in turn, supports fire management by reducing fuel loads. To achieve this future quality score Brigalow TEC must attain a BioCondition score of 70/100 or higher.</td></tr>
<tr><td>Confidence in result – future quality</td><td>70%</td><td>The management actions in this OMP have been developed based on published conservation recommendations, best practice and measures and land management practices that have proven to be successful in restoring Brigalow TEC (Butler 2007; Peeters and Butler 2012). The implementation of site specific management actions to control grazing, weed infestations and fire have been shown to improve the quality of Brigalow TEC over relatively short timeframes (TSSC, 2013). The OMP details the objectives and outcomes to ensure that the ecological condition and viability of the Brigalow TEC offset areas is improved . Monitoring will also be conducted as part of the OMP to measure the progress of the offset area and ensure the offset areas achieve their desired future quality. In addition, the voluntary declaration that will be used to legally secure the offset area on the property title will be supported by this OMP and will be binding on current and future landholders until the offset areas are protected under Queensland Government legislation.</td></tr>
<tr><td>Risk of loss without offset</td><td>35%</td><td>The Brigalow TEC offset areas are not protected under any Queensland Government legislation as these areas are classified as Category X on a property map of assessable vegetation. Category X areas do not contain any assessable vegetation under the VM Act and can be cleared at any time. Additionally, the Brigalow TEC offset areas are subject to a number of mining leases, mining lease applications and exploration permits. Based on the current level of exploration interest surrounding the offset areas, there is potential for resource exploration activities to occur.</td></tr>
<tr><td>Risk of loss with offset</td><td>5%</td><td>The offset areas will be secured in perpetuity through a Voluntary Declaration under the VM Act. The Voluntary Declaration will remain in place until the objectives of this OMP (as outlined in section 3.1) have been achieved. Specifically, the objectives are to improve the vegetation to a point where it classified as remnant vegetation under the VM Act, accepted</td></tr>
</table>

Input	Score	Justification
		by the Queensland Government property map of assessable vegetation and with the Department of Natural Resources and Mines regulated vegetation management mapping accordingly revised. The revision of the VM Act mapping will provide ongoing statutory protection for the offset areas under the VM Act. The Voluntary Declaration will be registered on the land title and will be binding on all current and future owners of the land until the offset areas are protected under Queensland Government legislation. Land use within the offset area will initially be restricted in accordance with the Voluntary Declaration and this OMP, and subsequently under Queensland Government remnant vegetation protection legislation.
Confidence in result – risk of loss	70%	The legally binding mechanism will be registered on the land title and will be binding on all current and future land owners to ensure that Brigalow TEC is protected until such time as it is protected under Queensland Government legislation. Once mapped as remnant vegetation, all future landholders will be bound by the provisions of the VM Act (or subsequent vegetation protection legislation).
Time over which loss is averted (years)	18	The Voluntary Declaration will remain in place until the objectives of this management plan have been achieved and the offset areas are protected under Queensland legislation. These outcomes are planned to be achieved during the period of effect of approval for EPBC 2010/5421, and therefore the time over which loss is averted is considered to be 18 years.
Time until ecological benefit (years)	18	The implementation of site-specific land management actions through the development and application of this OMP will increase the quality of the offset area by reducing potential threats to Brigalow TEC. This has been informed by best practice management measures specifically addressing restoring Brigalow TEC in the shortest possible timeframe (Peeters and Butler 2012). Measurable improvements in the ecological condition of Brigalow TEC in response to management actions have been achieved in relatively short timeframes (TSSC 2013). Desired outcomes for the TEC are planned to be achieved during the period of effect of approval for EPBC 2010/5421, and therefore the time over which loss is averted is considered to be 18 years.

Table 7: Summary of Scores Applied to the Squatter Pigeon Offset Assessment Guide

<table>
<tr><th>Input</th><th>Score</th><th>Justification</th></tr>
<tr><td>Quality of impact area</td><td>5</td><td>
The project will impact on 181 ha of open woodland vegetation that provides primary breeding and foraging habitat for the squatter pigeon. With the exception of the riparian corridor along Cockatoo Creek, the project area has been largely cleared of vegetation and has been subject to moderate to heavy cattle grazing. Consequently, fauna habitat is fragmented and heavily disturbed. However, Cockatoo Creek and a number of farm dams within the project area provide permanent and semi-permanent water sources for fauna, and the squatter pigeon has been recorded in the project area in close proximity to Cockatoo Creek (Ecological Survey and Management, 2012).
The quality score for area of habitat or area of community is a measure of how well a particular site supports a particular threatened species or ecological community and contributes to its ongoing viability. There are three components that contribute to the calculation of habitat quality: site condition, site context, and species stocking rates. The weighting given to each component is dependent on the ecological requirements of the threatened species or ecological community.
BioCondition assessments were undertaken in the areas of breeding and foraging habitat for the squatter pigeon in the impact area as part of the Ecological Equivalence assessments The BioCondition methodology has been designed to provide a measure of the ecological condition of a vegetation community and the context of that area of vegetation in the surrounding landscape and therefore can be used to inform the site condition and the site context components of the quality score. BioCondition assessments undertaken in wooded ecosystems produce a score out of 100 which can be easily converted to a score out of 10 for use in the Offset Assessment Guide. The BioCondition scores for areas of squatter pigeon habitat in the impact area were averaged and weighted according to the size of the patch to provide an overall combined site condition and context score.
The other component of the quality score, species stocking rate, was determined based on a quantitative assessment of three factors; species presence, density of the species utilising the site and the role of site population in regards to the overall species population and was informed by fauna surveys which were undertaken in the impact area by Ecological Survey and Management in 2012. This assessment is presented in Appendix G.
The scores for site condition and site context were given a weighting of 70% of the total score while species stocking rate was given a weighting of 30%, as the presence (stocking rate) of squatter pigeon is likely to be dependent on the site condition and site context. The weighted scores were added together to give an overall quality score of 5 for the impact area (Table 5A).
Table 5A: Quality score for the squatter pigeon in the impact area
<table>
<tr><th>Component</th><th>Component score</th><th>Component Weighting</th><th>Weighted score</th></tr>
<tr><td>Site condition</td><td rowspan="2">4.63</td><td rowspan="2">70%</td><td rowspan="2">3.24</td></tr>
<tr><td>Site context</td></tr>
<tr><td>Species stocking rate</td><td>7.49</td><td>30%</td><td>2.25</td></tr>
<tr><td colspan="3">Quality score (rounded to a score out of 10)</td><td>5</td></tr>
</table>
</td></tr>
<tr><td>Quality of offset area</td><td>6</td><td>
The proposed offset area provides suitable habitat for the squatter pigeon (Cumberland Ecology, 2014) and the species has been recorded nearby the offset areas. A number of permanent and semi-permanent sources of water are located within 1 – 3 km to the proposed offset area and are within the daily flying range of the squatter pigeon (Figure 3; Cumberland Ecology, 2014). However, the properties on which the offset areas are located have been moderately to heavily stocked and exhibit signs of overgrazing by cattle (Cumberland Ecology, 2014). Buffel grass is also prevalent across the properties.
The same methodology that was used to calculate the quality score for the impact area was
</td></tr>
</table>

<table>
<tr><th>Input</th><th>Score</th><th>Justification</th></tr>
<tr><td></td><td></td><td>applied to the offset area. BioCondition assessments were undertaken and the results were used to inform the site condition and site context scores. The species stocking rates score was informed by fauna surveys of the offset area undertaken by Cumberland Ecology in 2014 and the score was determined through a quantitative assessment which is presented in Appendix G. The scores for site condition and site context were given a weighting of 70% of the total score while species stocking rate was given a weighting of 30%, as the presence (stocking rate) of squatter pigeon is likely to be dependent on the site condition and site context. The weighted scores were added together to give an overall quality score of 6 for the offset area (Table 5B).

Table 5B: Quality score for the squatter pigeon in the offset area
<table>
<tr><th>Component</th><th>Component score</th><th>Component Weighting</th><th>Weighted score</th></tr>
<tr><td>Site condition</td><td rowspan="2">5.05</td><td rowspan="2">70%</td><td rowspan="2">3.53</td></tr>
<tr><td>Site context</td></tr>
<tr><td>Species stocking rate</td><td>7.49</td><td>30%</td><td>2.25</td></tr>
<tr><td colspan="3">Quality score (rounded to a score out of 10)</td><td>6</td></tr>
</table>
</td></tr>
<tr><td>Future quality without offset</td><td>5</td><td>Ongoing grazing and the prevalence of buffel grass will continue to decline the quality of squatter pigeon habitat within the offset area. Overgrazing and the spread of invasive weeds are both known threats to squatter pigeon and its habitat (Commonwealth Department of the Environment [DoE] 2014).</td></tr>
<tr><td>Future quality with offset</td><td>8</td><td>Management measures to manage threats to the squatter pigeon and improve squatter pigeon habitat within the offset have been developed in this OMP (see sections 0 and 4). Management measures are based on field surveys of the offset area, published conservation recommendations and best practice measures. The ecological value of squatter pigeon habitat will be improved through the limiting of stock and weed control including the control of buffel grass. This will enable natural regeneration of the understorey and will provide more grass seed for foraging (Cumberland Ecology, 2014). Progress of this regeneration will be tracked through regular BioCondition assessments. Additional actions may include pest animal control and the protection and enhancement of nearby permanent and semi-permanent water sources.

To attain a future condition class of 8 out of 10, squatter pigeon habitat within the offset area must attain a BioCondition score of 83 or higher, accounting for the consideration of species stocking rate remaining constant.</td></tr>
<tr><td>Confidence in result – future quality</td><td>70%</td><td>The management actions detailed in this OMP have been developed based on published conservation recommendations and best practice measures. The OMP also details objectives and outcomes to manage threats to the squatter pigeon and ensure that the quality of habitat is improved over the life of the offset. Monitoring will be conducted as part of the OMP to measure the progress of the offset area and ensure the OMP achieves the future quality target. Management actions will be adapted according to the results of monitoring activities.</td></tr>
<tr><td>Risk of loss without offset</td><td>35%</td><td>The offset areas for the squatter pigeon are not protected under any Queensland Government legislation as these areas are classified as Category X on a property map of assessable vegetation. Category X areas do not contain any assessable vegetation under the VM Act and can be cleared at any time. Additionally, the areas identified as squatter pigeon offset areas are subject to a number of mining leases, mining lease applications and exploration permits. Based on the current level of exploration interest surrounding the offset areas, there is potential for resource exploration activities to occur.</td></tr>
<tr><td>Risk of loss with offset</td><td>5%</td><td>The offset areas will be secured in perpetuity through a Voluntary Declaration under the VM Act. The Voluntary Declaration will remain in place until the objectives of this OMP (as outlined in section 3.1) have been achieved. Specifically, the objectives are to improve the</td></tr>
</table>

Input	Score	Justification
		vegetation to a point where it classified as remnant vegetation under the VM Act, accepted by the Queensland Government property map of assessable vegetation and with the Department of Natural Resources and Mines regulated vegetation management mapping accordingly revised. The revision of the VM Act mapping will provide ongoing statutory protection for the offset areas under the VM Act. The Voluntary Declaration will be registered on the land title and will be binding on all current and future owners of the land until the offset areas are protected under Queensland Government legislation. Land use within the offset area will initially be restricted in accordance with the Voluntary Declaration and this OMP, and subsequently under Queensland Government remnant vegetation protection legislation.
Confidence in result – risk of loss	70%	The legally binding mechanism will be registered on the land title and will be binding on all current and future land owners to ensure that offset areas are protected until such time as it is protected under Queensland Government legislation. Once mapped as remnant vegetation, all future landholders will be bound by the provisions of the VM Act (or subsequent vegetation protection legislation).
Time over which loss is averted (years)	18	The Voluntary Declaration will remain in place until the objectives of this management plan have been achieved and the offset areas are protected under Queensland legislation. These outcomes are planned to be achieved during the period of effect of approval for EPBC 2010/5421, and therefore the time over which loss is averted is considered to be 18 years.
Time until ecological benefit (years)	18	The offset area contains potential breeding and foraging habitat for the squatter pigeon and the species is known to utilise the site. By selecting offsets in areas where current habitat for the species already exists, the time lag between the establishment of the offset area and ecological benefit is reduced. Through implementation of the management measures designed to improve habitat for the squatter pigeon, including the strategic grazing and buffel grass, the ecological benefit for the species is expected to be achieved during the period of effect of approval for EPBC 2010/5421, and therefore the time over which loss is averted is considered to be 18 years.

3 APPROACH TO OFFSET MANAGEMENT

This management plan is based on the principles of adaptive management as illustrated in Figure 5. Management objectives and actions have been developed based on field surveys and in accordance with the key threats and recommended priority actions for each species and community as listed in recovery plans, threat abatement plans, conservation advices and observed during field surveys.

A summary of the management objectives and how they will be achieved is provided in Section 3.1. The proposed management actions are detailed in Section 4. The ongoing suitability of the management actions will be informed by the results of monitoring activities as described in Section 5. This management plan will be updated annually, if required, based on the outcomes achieved and results of monitoring.

The offset site will be managed and monitored until the management objectives of this OMP have been achieved and the offset areas protected under Queensland Government vegetation protection legislation. It is anticipated that the management objectives will be achieved within the management period, ending in 2034, through the implementation of adaptive management; however, the Voluntary Declaration will be continued and additional management will be implemented at the end of the management period should the future quality targets and statutory vegetation protection arrangements not be achieved.

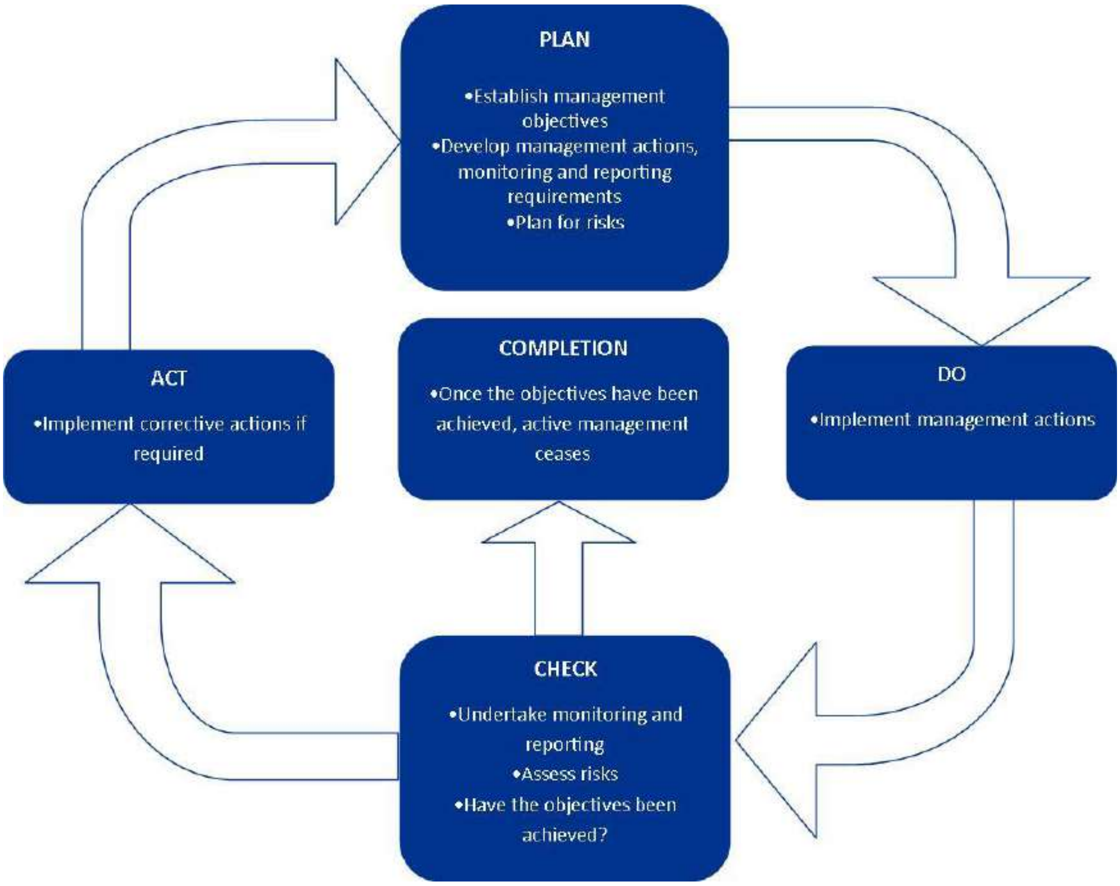


Figure 5: Process for implementation of the OMP

3.1 MANAGEMENT OBJECTIVES

The aim of this OMP is to protect and improve the condition of habitat and vegetation communities for Brigalow TEC and squatter pigeon within the offset areas so as to achieve the desired future condition targetsand protection under Queensland vegetation protection legislation, specifically:

- improve the ecological condition of Brigalow TEC (RE 11.4.9 and RE 11.3.1) within the offset area so that it achieves a BioCondition class score of 1 (Functional Condition), and a minimum 70/100 score (offset calculator quality score of 7), and is mapped as remnant vegetation under the VM Act
- improve the quality of squatter pigeon habitat within the offset area so that a quality score equivalent of 8 is reached based on an assessment of site condition, site context and species stocking rate under the EPBC Act offsets assessment guide principles, and is mapped as remnant vegetation under the VM Act (or its successor).

This OMP is based on the principles of adaptive management which allows for management actions to be adapted to changing conditions (including seasonal variations) and responses observed through monitoring. It is estimated that the objectives of the offset areas will be achieved within 18 years; however, additional management will be considered at the end of the management period should any of the objectives not be met.

The condition targets for Brigalow TEC and squatter pigeon habitat will be achieved through the implementation of management actions within the offset areas including controlled grazing, control of invasive weed species and exotic pasture grasses, fire management, pest animal control, erosion management and maintenance of access tracks. Table 8 presents specific completion criteria for Brigalow TEC and squatter pigeon to assess the progress of the offset areas in achieving the management objectives through the implementation of the proposed management actions further detailed in Table 11 and section 4.

Management actions have been developed in accordance with recommended priority actions listed in recovery plans, threat abatement plans, and conservation advices. Table 10 identifies key threats and recovery actions for Brigalow TEC and squatter pigeon considered in the development of this OMP.

Table 8: Management actions proposed to achieve the completion criteria for Brigalow TEC and squatter pigeon

Offset value	Completion criteria	Relevant management objective	Performance target
Brigalow TEC	Improve the ecological condition to achieve BioCondition class score 1 and offset calculator score of 7 Can be mapped as remnant vegetation under the VM Act Brigalow TEC within the offset area must attain a BioCondition score of 70 or higher	▶ Minimise degradation of Brigalow TEC by pest animals (pigs and rabbits) ▶ Reduce the extent of buffel grass and other weed species to a relative abundance <25% to improve the condition of Brigalow TEC measured as part of future offset condition target monitoring in accordance with the BioCondition methodology. ▶ Control livestock grazing to allow ecological communities to regenerate and minimise soil compaction and erosion to assist in improving the condition of Brigalow TEC. ▶ Implement a strategic grazing regime to control fuel loads and reduce the abundance and extent of exotic pasture grasses (to <25%) in order to reduce the risk of an uncontrolled bushfire and improve the condition of Brigalow TEC. ▶ Areas comprising Brigalow TEC will be fire exclusion zones with fuel loads to be controlled through strategic grazing regimes. The exclusion of fire from Brigalow TEC areas will aim to encourage natural regeneration (as Brigalow is a fire sensitive community) and reduce further degradation of the community from high intensity bushfires.	▶ By 2022, ≥20% of the dominant canopy species present as regeneration. ▶ By 2027, relative abundance of buffel grass and other weed is <25% species in at least 50% of the Brigalow TEC offset area. ▶ By 2027, BioCondition score of 60 achieved across Brigalow offset area. ▶ By 2034, an average BioCondition class of 1 (Functional condition) is reached across all offset area assessment units supporting RE 11.4.9 and RE 11.3.1.
Squatter pigeon	Improve the ecological condition to achieve an offset calculator score of 8, based on the offset area attaining a BioCondition score of 83 or higher Maintenance of a ground layer cover (native, perennial tussock grasses or a mix of	▶ Minimise degradation of squatter pigeon habitat by pest animals (pigs and rabbits) ▶ Minimise predation risk by dogs, foxes and cats on squatter pigeon ▶ Reduce the extent and abundance of buffel grass and other weed species to a relative abundance of <25% in order to reduce	▶ By 2022, ≥20% of the dominant canopy species present as regeneration. ▶ By 2027, relative abundance of buffel grass and other weed is <25% species in at least 50% of the squatter pigeon offset area. ▶ By 2027, BioCondition score

Offset value	Completion criteria	Relevant management objective	Performance target
	perennial tussock grasses and low shrubs or forbs) < 33% (DEE 2015)	competition with native, perennial tussock grasses and shrubs/forbs. Bufflel grass and other weed species will be controlled through strategic grazing and weed control measures. A reduction in weed cover and an increase in native ground layer cover will contribute to an improvement in condition of squatter pigeon habitat to be measured as part of future offset condition target monitoring in accordance with the BioCondition methodology. ▶ Control livestock grazing to allow ecological communities to regenerate and minimise soil compaction and erosion to assist in improving the condition of squatter pigeon habitat. ▶ As part of fire management within squatter pigeon habitat, fuel loads (including exotic pasture grasses) will be controlled through strategic grazing regimes and controlled low intensity burns (excluding areas of Brigalow TEC). This will aim to reduce the risk of high intensity bushfire within the offset area causing further habitat degradation. In addition, low intensity controlled burns within squatter pigeon habitat areas (excluding Brigalow TEC) will aim to promote natural regeneration of relevant vegetation communities to improve the condition of squatter pigeon habitat.	of 70 achieved across squatter pigeon offset area ▶ By 2027, native perennial grass cover is >50% of BioConditoin benchmark score for relevant regional ecosystem (RE 11.3.1, 11.4.9, 11.3.3, 11.3.2, 11.5.2, 11.5.3). ▶ By 2034, an average quality score of 8 is achieved across all offset area assessment units supporting squatter pigeon habitat.

3.1.1 Brigalow TEC

The management objective for the Brigalow TEC offset areas is to improve the ecological condition of the vegetation so that it achieves a BioCondition class score of 1 / offset calculator quality score of 7 and is mapped as remnant vegetation under the VM Act.

The BioCondition Assessment methodology has been developed by the Queensland Herbarium and is a condition assessment framework that provides a measure of how well a terrestrial ecosystem is functioning for biodiversity values. The results of ongoing BioCondition assessments will be compared against RE benchmarks developed by the Queensland Herbarium. Benchmarks are quantitative values derived from reference sites for each site condition attribute assessed in BioCondition, and used as a reference value for comparison purposes. The Queensland Herbarium has established reference sites throughout Queensland, with sites for each RE throughout it geographic distribution. This provides a comprehensive dataset on which to base the condition of RE remnants.

It is proposed that using the BioCondition benchmarks for each of the relevant REs that make up the Brigalow TEC in the offset areas will form the performance criteria against which the ecological condition of the offset areas will be assessed through the monitoring process. This approach will ensure a site-based, quantitative and repeatable assessment procedure can be consistently applied.

The resulting numeric score (given as a score out of 100 for woody ecosystems) can be summarised as a condition rating of 1, 2, 3 or 4, or functional through to dysfunctional condition for biodiversity (Table 9). To achieve a BioCondition class score of 1, the offset area must score at least 80 out of 100.

Baseline BioCondition assessments were undertaken as part of the Ecological Equivalence assessments of the offset areas and the results for the monitoring sites within the Brigalow TEC are provided in Appendix E.

To attain a future condition class of 7 out of 10, Brigalow TEC within the offset area must attain a BioCondition score of 70 or higher.

The results of ongoing BioCondition assessments will also be used to ascertain if Brigalow TEC has achieved remnant status under the VM Act where the dominant canopy is greater than 70% of the height and greater than 50% of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation's undisturbed canopy. This will be determined through comparison of the results to the RE benchmarks.

Table 9: BioCondition class scores

BioCondition class	Ecological condition	BioCondition score (out of 100)
1	Functional	>80
2	Moderately functional	>60 - 80
3	Moderately dysfunctional	40 - 59
4	Dysfunctional	<40

3.1.2 Squatter pigeon

The management objective for the squatter pigeon is to improve the quality of habitat for the species in the offset area. The offset assessment guide results for the Foxleigh Coal Mine Extension (section 2.6) calculated that the future quality of the habitat for the squatter pigeon in the offset area would reach a score of 8. Therefore, the quality of squatter pigeon habitat in the offset area will need to reach a score equivalent of 8 (as described in Table 7). The quality of the squatter pigeon habitat will be assessed based on site condition, site context and species stocking rate. Site condition and site context will be determined based on BioCondition assessments and species stocking rate will be informed by the fauna surveys undertaken as part of the monitoring program and assessed using the quantitative assessment described in Appendix G. All BioCondition monitoring, fauna surveys and habitat assessments will be undertaken by a suitably qualified ecologist to determine when the objectives for squatter pigeon habitat have been achieved. To attain a future condition class of 8 out of 10, squatter pigeon habitat within the offset area must attain a BioCondition score of 83 or higher, accounting for the consideration of species stocking rate remaining constant.

Table 10: Identified threats and recovery actions.

Environmental value	Identified threats	Recovery actions
Squatter pigeon	The squatter pigeon is subject to a number of threats (TSSC, 2015) including: ▶ loss and fragmentation of habitat – clearance of woodland habitat continues to fragment squatter pigeon populations ▶ habitat degradation – overgrazing and weed invasion of habitat brought on by overstocking of habitat by domesticated herbivores, especially sheep and cattle, which often facilitates the proliferation of weeds (e.g. *Cenchrus ciliaris, Parthenium hysterophorus*) and annual pasture grasses at the expense of native perennial grasses. ▶ predation – feral cats and foxes are likely to have the greatest impact, although numerous other avian and terrestrial predators (both native and naturalised) are implicated, including birds of prey, snakes and dingoes.	The Commonwealth Species Profile and Threats Database for the squatter pigeon (DoEE, 2014) identifies a number of recovery and priority actions relating to identified threats, including the following ▶ Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them, if necessary. ▶ Implement appropriate recommendations outlined in the *Threat Abatement Plan for Predation by Feral Cats* and the *Threat Abatement Plan for Predation by the European Red Fox* in areas inhabited by the Squatter Pigeon (southern). ▶ Establish conservation measures to protect grassy woodlands and forests.
Brigalow TEC	The Brigalow TEC is threatened by any activities that continue to reduce its extent, cause a decline in the condition of the vegetation, or impede its recovery. The most important current threats include clearing, fire and pest plant and animal species (DoEE, 2016): ▶ Clearing – while the Brigalow TEC is protected under the EPBC Act (subject to meeting condition thresholds) and the Queensland *Vegetation Management Act 1999* (Qld), the community continues to be illegally cleared, as well as cleared for mining and routine management activities (e.g. clearing for firebreaks, fencing, road construction), all resulting in further loss and fragmentation. ▶ Fire – increasing fuel loads facilitated by invasion of exotic pasture grasses often results in intense fire which has the potential to alter the structure of the Brigalow community and thus limit its capacity to recover. ▶ Pest plant and animals – native and exotic, invasive pasture grasses increase fire risk, while domestic and feral herbivores alter the structure of the Brigalow community by trampling and feeding on seedlings, as well as reducing leaf litter and woody debris for Brigalow-dependent fauna. Weed invasion and overgrazing by native fauna are both promoted by the high levels of fragmentation.	The Commonwealth Species Profile and Threats Database for the Brigalow TEC (DoEE, 2016) identifies a number of recovery actions relating to identified threats, including the following: ▶ Increase the area of the Brigalow ecological community and its representation in conservation reserves ▶ Facilitate the restoration of degraded Brigalow remnants by mitigating key threats such as fire, weeds and animal pests ▶ Avoid further clearing and fragmentation of the Brigalow ecological community ▶ Research the ecology of Brigalow ecosystems, including experimenting with methods to assist advanced regrowth to attain the structural and floristic characteristics of mature remnant Brigalow ▶ Establish regional benchmarks for habitat condition for each of the component vegetation types and regional ecosystems ▶ Establish and implementing pest plans and fire reduction plans for key areas of the ecological community

4 MANAGEMENT ACTIONS

This section details the management and maintenance activities required to be undertaken within the offset areas to improve the condition of the Brigalow TEC and habitat for the squatter pigeon and achieve the management objectives. The management actions have been developed based on published conservation recommendations, best practice, and measures and land management practices that have proven to be successful for each of Brigalow TEC and squatter pigeon (Butler 2007, Peeters and Butler 2012, TSSC 2013, Cumberland Ecology 2014).

For the purposes of this management plan, the offset areas have been divided into two management zones (Figure 6 and Table 11). The management zones have been defined based on ecological values and proposed management actions.

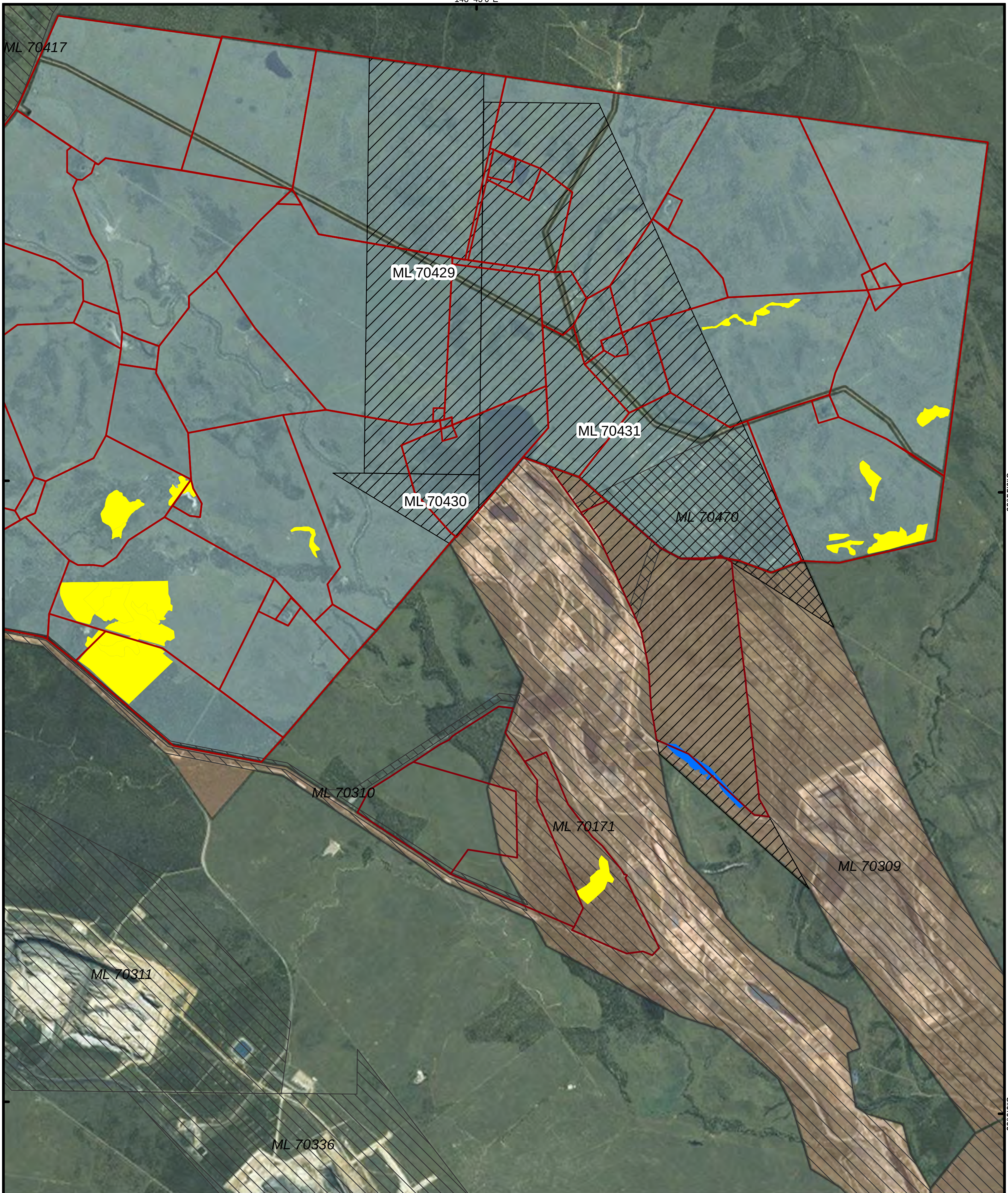
Table 11: Management zones

Management zone	A (302.26 ha)	B (15.07 ha)
Description	▶ a large area of regrowth RE 11.4.9 vegetation located on the south-west boundary of Lot 4 SP248577 as well as a number of smaller fragmented stands in the south-eastern corner of Lot 4 SP248577. ▶ three fragmented stands of regrowth and remnant RE 11.3.1 vegetation on the western portion of Lot 4 SP248577, and an area of riparian vegetation on the eastern portion of Lot 4 SP248577. ▶ an area of remnant RE 11.3.3 located immediately west of the Foxleigh Mine on Lot 20 SP276924. ▶ an area of remnant RE 11.3.1 located immediately east of the Foxleigh Mine on Lot 20 SP276924. ▶ an area of remnant RE 11.5.2/11.5.3 vegetation surrounding patches of regrowth RE 11.4.9 vegetation on the south-west boundary of Lot 4 SP248577.	▶ an area of remnant RE 11.3.2 fringing a watercourse on Lot 20 SP276924.
MNES offset	Brigalow TEC Squatter pigeon habitat	Squatter pigeon habitat
Access restricted	Yes	Yes
Fencing of management zone	Yes	Yes
Target pest animals for control	Dogs, cats, foxes, pigs and rabbits	Dogs, cats, foxes, pigs and rabbits
Primary weed control method	Strategic grazing	Strategic grazing
Fire interval	Not to be burnt	7 years
General livestock excluded	Yes	Yes
Erosion control	Monitoring	Monitoring

4.1 SUMMARY OF MANAGEMENT ACTIONS

Table 12 details management actions that will be undertaken in the management zones and specific performance criteria and desired future condition attributes associated with each action. Trigger levels and corrective actions have also been defined in Table 12. Should the results of ongoing monitoring identify that the management actions have been unsuccessful based on the identified trigger levels, corrective actions will be implemented and the management actions will be reviewed and updated for submission to DEE for approval.

All management actions are applicable to management zone A and B, except for controlled burns for fuel load management which will be excluded from management zone A. The following text discusses each management action in more detail.



Middlemount South Pty Ltd

Figure 6: Management zones

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)
The following datasets are © State of Qld:
- Cadastral Data (2011)

Lot 4 SP248577
Lot 20 SP276924
Foxleigh Plains MLs
Non-project MLs
Existing fencelines

Management zones
Management zone A
Management zone B

0 1 2 3 4
Kilometres

N

Location diagram

© OpenStreetMap (and) contributors, CC-BY-SA

Date: 04-11-2016 Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994 Scale: 1:75,000 @ A4

CO2 Australia

Path: P:\GISData\Projects\Anglo_American\ENV01881926_20160606_offset_map_updates_split_State_Commonwealth\20161104_fig6_mgt_zones_Commonwealth.mxd

Table 12: Management objectives and performance criteria for offset values, outlining management measures, and triggers for corrective action.

Management objectives		Performance criteria	Management action	Corrective action
Minimise predation risk by pest animals in the offset site	Dogs	No increase in numbers of pest animals from baseline counts in offset site	Pest animal management will be undertaken across the offset site in accordance with Section 4.6.	Any increase in the population of pest animal species from baseline scores in the offset areas will trigger the following corrective actions: ▶ Revise current pest animal control activities. ▶ Increase invasive pest animal control efforts in accordance with Queensland DAF guidelines, consistent with the Project Pest Management Plan and in conjunction with neighbouring land owners.
	Foxes			
	Cat			
Minimise habitat degradation caused by pest animals in the offset site	Pigs			
	Rabbits			
Control invasion of offset site by invasive and other weed species		Reduce extent of existing weeds across the offset site to a relative abundance of <25%	Weed management and weed hygiene restrictions will be implemented across the offset site to reduce the extent of existing weeds, (e.g. *Cenchrus ciliaris*), as well as invasive and other weeds as well as controlling the potential introduction of other exotic weed species. Weed management will be undertaken in accordance with Section 4.4 and weed hygiene restrictions will be implemented in accordance with Section 4.2 and 4.4.	Any increase in the relative abundance of invasive or other weed populations from baseline survey or subsequent monitoring events or any new outbreaks of invasive or other weed species will trigger the following corrective actions: ▶ Review adherence to weed hygiene procedures outlined in Section 4.2 (general restrictions) to ensure compliance and update restrictions where required. ▶ Review timing and frequency of weed management measures, and implement alternative weed management timeframes as required. ▶ Investigate alternative weed management control actions (e.g. spot spraying of herbicides) and implement as required.
Minimise impact of livestock grazing on the condition of habitat and vegetation communities for the offset values.		No decrease in native perennial cover BioCondition score of offset area as a consequence of livestock grazing.	Implementation of a strategic grazing regime in accordance with Section 4.3 (grazing management), including completion of a "Dry Season Feed Budget" worksheet to calculate the required stocking rate prior to each grazing event (Section 5.7). Strategic grazing maintains fuel loads at or below 1,500 kg/ha (Section 4.3). Offset areas allowed to spell for 1 - 2 months following strategic grazing events (Section 4.3).	If livestock are located in the offset areas outside of strategic grazing events, fencing will be inspected and repaired and the proponent will explore improvements to stocking management practices or infrastructure to prevent unplanned access by livestock. If there is decrease in the condition of offset areas and/or an increase in area of erosion from baseline surveys and subsequent monitoring attributable to the current strategic grazing regime, the following corrective actions will be considered and implemented where required: ▶ Reduce stocking rates, and/or duration and frequency of strategic grazing events. ▶ Remediation of eroded areas in accordance with the Foxleigh Mine Sediment and Erosion Management Plan.
Improve the condition of habitat and vegetation communities for the offset values across the whole offset site through fire management		No uncontrolled bushfires in offset site	Fire management across the offset areas and in areas owned by Middlemount South surrounding the offset areas will be undertaken in accordance with Section 4.5, namely: ▶ Low intensity controlled burn in management zone B – to manage fuel loads to minimise the risk of high-intensity, uncontrolled bushfires and to improve condition and maintain ecological functioning. ▶ No controlled burns in management zone A. Fuel loads will be monitored through biomass monitoring (Section 5.6), undertaken annually to determine the risk of fire to offset management areas and inform grazing management (Section 4.3) and fire management strategies (Section 4.5). Fuel loads should be maintained at or below 1,500 kg/ha.	If an uncontrolled bushfire has impacted the offset site, review adherence to grazing management and fire management outlined in Section 4.3 and Section 4.5. Take remedial action to ensure compliance with performance criteria, including: ▶ Changes to stocking rates, and/or duration and frequency of strategic grazing events, and/or ▶ Amending fire management measures Should fuel loads exceed the 1,500 kg/ha, the frequency and intensity of grazing regimes will be refined and/or other fuel load control methods will be considered e.g. chemical control. Update Section 4.5 to ensure breach does not re-occur.
Brigalow TEC (RE 11.4.9 and RE 11.3.1) within the offset area achieves a BioCondition class score of 1 (Functional condition) and can be mapped as remnant vegetation under the VM Act.		▶ By 2022, ≥20% of the dominant canopy species present as regeneration. ▶ By 2027, relative abundance of buffel grass and other weed is <25% species in at least 50% of the Brigalow TEC offset area. ▶ By 2027, BioCondition score of 60 achieved across Brigalow offset area. ▶ By 2034, an average BioCondition class of 1 (Functional condition) is reached across all offset area assessment units supporting RE 11.4.9 and RE 11.3.1. ▶ >10% tree mortality in any year.	Implement all relevant management actions and monitoring including assessment of progress of Brigalow TEC offset areas in accordance with Brigalow TEC monitoring (Section 5.4). Middlemount South will establish two control sites located in regrowth Brigalow TEC vegetation located on Lot 4. BioCondition assessments will be undertaken at the same frequency as the offset area. Middlemount South will advise DEE of the location of the control sites as part of annual compliance reporting in 2017.	If there is a change in the mapped distribution of Brigalow TEC in offset areas or there is tree mortality attributable to groundwater drawdown, remediation and/or rehabilitation will be investigated and implemented. If there is <20% of the dominant canopy species present as regeneration by 2022, then options for active regeneration will be assessed and implemented. Active regeneration may include direct seeding and/or planting of tube stock of dominant canopy species.

Management objectives	Performance criteria	Management action	Corrective action
A quality score of 8 is achieved for squatter pigeon habitat within the offset area based on an assessment of site condition, site context and species stocking rate under the EPBC Act offsets assessment guide principles.	▶ By 2022, ≥20% of the dominant canopy species present as regeneration. ▶ By 2027, relative abundance of buffel grass and other weed is <25% species in at least 50% of the squatter pigeon offset area. ▶ By 2027, BioCondition score of 70 achieved across squatter pigeon offset area ▶ By 2027, native perennial grass cover is >50% of BioConditoin benchmark score for relevant regional ecosystem (RE 11.3.1, 11.4.9, 11.3.3, 11.3.2, 11.5.2, 11.5.3). ▶ By 2034, an average quality score of 8 is achieved across all offset area assessment units supporting squatter pigeon habitat.	Implement all relevant management actions and monitoring including fauna monitoring in accordance with Section 5.5.	If there is <20% of the dominant canopy species present as regeneration by 2022, then options for active regeneration will be assessed and implemented if considered viable. Active regeneration may include direct seeding and/or planting of tube stock of dominant canopy species.

4.2 GENERAL RESTRICTIONS

Access into the offset areas will be restricted to authorised personnel only. Existing and new fences will be used to restrict access into offset areas, with locks to be installed on gates. Signs will be installed in prominent locations (i.e. at access points into the offset site) which recognize that the areas are protected for conservation purposes. The signs will advise that access into these areas is restricted to authorised personnel only. All of the offset areas will be demarcated on site plans. All vehicles entering the offset areas will be required to stay on the formed tracks and issued with weed inspection certificates (refer to Section 4.4), with any staff or contractors entering offset areas to be made aware and provided with access to this OMP.

No clearing of native vegetation is permitted within the offset site as part of any management and monitoring activities associated with this OMP, with the exception of clearing that is required for:

- maintenance of access tracks and/or fire breaks (up to 5 m width) (Section 4.5 and 4.8)
- fence construction and maintenance (up to 5 m width on each side of the fence), and
- ensure public safety or as directed by emergency management response personnel in the event of uncontrolled bushfire or other emergency procedure.

Vegetation clearing for the above purposes will be restricted to the use of non-mechanical means or by mechanical means that do not disturb the soil surface. No machinery will be allowed on site after heavy or prolonged rainfall events until the site has dried to allow for safe movement of traffic.

It is also important to note that the offset areas are not located within or near areas subject to forestry rights therefore the risk of widespread vegetation clearing for forestry products is considered very low.

4.3 GRAZING MANAGEMENT

The offset areas are located on properties which have historically been developed for agricultural land use and grazing. There is evidence of grazing throughout the offset areas including browsing on shrubby vegetation, trampling, track formation and grazing on native grasses. In order to optimise vegetation growth, livestock will be controlled in all of the management zones to allow ecological communities to regenerate, minimise soil compaction and erosion and reduce the impact on squatter pigeon habitat. The exception will be strategic grazing events which will be undertaken to manage weeds and fuel-loads and is discussed in more detail below.

Existing fences will be used to manage access to offset areas, including management of strategic grazing activities. In the event that additional fencing is required to be installed, it should ideally be constructed of 1.4 m high, 4-strand barbed-wire fence, with plain wire as the top strand and the bottom wire set 350 mm from the ground to allow easy access by native wildlife. Any constructed fences will include a locked, access gate to allow for entry into the area for management and monitoring activities. Once required fencing has been established, livestock will be mustered and removed from the offset areas.

Livestock will be allowed to graze in all of the management zones under strict controls in order to reduce fuel loads at or below 1,500 kg/ha (the fuel load required to carry a successful fire) and to control exotic pasture grasses, including buffel grass. No grazing will occur during the wet season, being the period of greatest growth. Periods of grazing in the offset area will be followed by spelling for 1 - 2 months to allow for grass to seed and to facilitate recovery of perennial grasses and the herbaceous layer while mitigating wildfire risk by restricting fuel loads. The suitability of conditions for undertaking a grazing event outside of the wet season will be informed by monitoring events as described in Section 5.6. Prior to a strategic grazing event in the offset area, a feed budgeting assessment will be undertaken. A feed budgeting assessment is a recognised method of determining the stocking rate based on the amount of feed available and the amount of feed desired at the end of the grazing event.

The amount of feed available prior to the grazing event will be estimated using the appropriate photo standards available on the Future Beef website[2]. The “Dry Season Feed Budget” worksheet provided in Appendix H will then be used to calculate the required stocking rate for the grazing event.

At the completion of the grazing event, photo standards will be used to assess ground cover and ecosystem biomass. Should the grazing event be required to be extended (e.g. as a result of additional rainfall and resultant grass growth), the feed budget assessment would be recalculated at that time using the “Dry Season Feed Budget” worksheet.

If required, watering points will be established in the offset areas to facilitate strategic grazing in order to deter cattle from grazing within vegetation fringing permanent and semi-permanent water bodies within management zones A and B and degrading the condition of Brigalow and squatter pigeon habitat. The location of the watering points will be determined at the start of management in 2017.

4.4 WEED MANAGEMENT

The presence of buffel grass and other exotic pasture grass species pose the greatest threat to vegetation in the offset areas, in particular areas of Brigalow TEC, as they increase groundcover biomass and the risk of uncontrolled, high intensity fires (Peeters and Butler 2012). A strategic grazing regime will be implemented to reduce the presence of exotic pasture grasses, in particular buffel grass, in the offset areas to less than 25% of the total groundcover. While this will reduce the biomass, it will not be eliminated entirely from the offset areas. To supplement the strategic grazing controls to ensure exotic pasture grass is less than 25% of the total ground cover, strategic spraying of small patches of buffel grass and other non-native grass species will be undertaken. Spraying will occur at the end of the wet season when there is active growth. Follow-up treatment may be required two to four weeks if regrowth is evident. Each treatment event will be mapped to record the change in extent over time.

In addition to exotic pasture grasses, there are isolated occurrences of the following weed species across the offset areas:

- harisia cactus (*Eriocereus martini*)
- westwood pear (*Opuntia streptacantha*)
- prickly pear (*Opuntia inermis*)
- velvety tree pear (*Opuntia tomentosa*)
- fireweed (*Senecio madagascariensis*)
- prickly acacia (*Acacia arabica*)
- guinea grass (*Megathyrsus maximus var maximus*)

Baseline surveys of the offset site will be undertaken in 2017 to determine distribution and abundance of buffel grass and other weeds species outbreaks, including a survey in the dry season and a survey post wet season. Results of baseline surveys of the offset site will be compiled to inform the most appropriate species-specific control measures, location and timing for management activities. These will be summarised and reported to DEE as part of the annual compliance reporting required under the conditions of EPBC approval. Annual inspections will be undertaken to monitor the distribution and abundance of buffel grass

[2] See http://www.business.qld.gov.au/industry/agriculture/crop-growing/grazing-and-pasture-management/sustainable-grazing/monitoring-land-condition

and other the weed species in the offset areas, in accordance with weed monitoring outlined in section 5.8. Information collected during these inspections will be collated in the Foxleigh Weed Register within the Foxleigh GIS database. Weed infestations in the management areas will be controlled and eradicated by preventing seed set and dispersal in accordance with the recommended control measures available on Queensland Department of Agriculture, Fisheries and Forestry website[3] . Control methods include biological control, mechanical removal or chemical applications. Treatment programs will be targeted to occur at the end of the wet season when there is active growth (April to May). Species-specific control measures and timing for control activities will be reviewed on an annual basis based on the results of ongoing weed monitoring in the offset areas.

Weed hygiene measures will also be implemented to prevent the movement of weed material into the offset areas. Prior to entry into the offset areas, all vehicles and equipment will be inspected for weeds, and will only be permitted access if a weed inspection certificate is granted by the Foxleigh environmental department. Additionally, vehicles will be restricted to designated access tracks.

4.5 FIRE MANAGEMENT

High intensity fire is considered a major threat to Brigalow vegetation (Butler, 2007) as well as RE 11.3.3 which provides habitat for the squatter pigeon. Conversely, RE 11.3.2 (located in Management Zone B) which also provides habitat for the squatter pigeon, requires regular burning in order to maintain ecological functioning. Fuel loads in the offset areas, and in the surrounding paddocks, will be controlled through a combination of strategic grazing, weed control measures and fuel reduction burns.

Management zones A will be a fire exclusion zone. Fuel loads in this management zone will be managed through strategic grazing events and weed control measures. To augment this, fuel loads will be managed in the paddocks outside of Management Zone A with cool, low-intensity burns in the late wet to early dry season when there is good soil moisture and the risk of high intensity fires are low. Low intensity burns will be undertaken in management zone B to maintain ecological functioning. The fire management guidelines for RE 11.3.2 recommend that burns be undertaken in the late wet to early dry season when there is good soil moisture. Burns will be undertaken every two to seven years and a fuel load of 1,500 kg/ha is required for a successful burn. Fuel loads will be assessed prior to undertaking a burn using the biomass monitoring method outlined in Section 5.6.

Where fuel loads and conditions are appropriate for a low intensity controlled burn, the Foxleigh Bushfire Management Plan will be implemented in consultation with appropriate authorities such as the Middlemount Emergency Services.

4.6 PEST ANIMAL MANAGEMENT

Native fauna present in the offset areas, including the squatter pigeon, are at risk of predation from wild dogs, foxes, cats and other declared pests, while pigs and rabbits have the potential to lead to erosion of habitat. Pest animals including wild dogs, feral cats, rabbits and pigs have been observed in the vicinity of the mine and in the areas surrounding the offset areas.

Baseline assessments of pest animals in the offset site will be undertaken in 2017, consisting of a survey during the dry season and a survey post wet season, to assess the spatial extent of pest animal impacts to fauna habitat and impacts on vegetation condition for other offset values. Results of baseline pest animal assessments will be compiled to inform the most appropriate species-specific control measures, location and

[3] http://www.daff.qld.gov.au/plants/weeds-pest-animals-ants/weeds

timing for management activities. These will be summarised and reported to the DEE as part of the annual compliance reporting procedures required under the conditions of EPBC approval.

Pest animal control activities will be conducted in accordance with the *Biosecurity Act 2014*. Table 13 provides examples of approved species-specific pest animal control measures recommended by the Queensland and Commonwealth Governments.

Species-specific control measures and timing for control activities will be reviewed on an annual basis based on the results of ongoing pest animal monitoring in the offset site.

Table 13: Species-specific control methods for pest animal species.

Species	Status[a]	Control method
Wild dog (*Canis familiaris*)	Category 3,4,6	To increase the effectiveness of wild dog control, programmes should be coordinated across adjoining properties. The timing of baiting and trapping control techniques should consider seasonal variations and the targeted watering points and are recommended to be undertaken at all time when dogs are active. ▶ Baiting should be used in conjunction with all other control tools and not be relied on as a total control method. Poison baits using 1080 and strychnine and fresh meat baits are the most economic, efficient and effective method of controlling wild dogs and can be laid quickly by hand, from vehicles or aircraft. ▶ Trapping using foot-hold traps should be undertaken in areas of high wild dog activity, and are recommended to be poisoned for humane reasons and to prevent escape. Lures used to attract dogs to the traps include a mixture of dog faeces and urine. ▶ Other control methods include shooting and fencing of specific areas; however shooting is mostly used for control of small populations or individuals. Fencing is expensive to construct and maintain although is an effective method of protecting a small area or particular species population. (DAFF 2014a)
Fox (*Vulpes vulpes*)	Category 3,4,5,6	Control methods for the fox include shooting, trapping, fencing, baiting and livestock guardian dogs combined with land management. Baiting activities should be coordinated among adjoining properties to effectively reduce the impact of foxes. ▶ Poison baits using 1080 and strychnine and fresh meat baits are the most economic, efficient and effective method of controlling foxes and can be laid quickly by hand, from vehicles or aircraft. Baits should be placed along track and fence lines 200−500 m apart, 8−10 cm underground and covered with loose soil. The optimum time to bait is in spring followed by June/July when food demand is highest. ▶ Trapping and shooting are other forms of control methods for foxes; however, are generally ineffective for broad-scale or long term reductions, should be done in conjunction with other control techniques. (DAFF 2015b)
Feral cat (*Felis catus*)	Category 3,4,6	Successful feral cat control programmes generally require the use of multiple control methods including night shooting, poisoning, trapping and fencing in conjunction with land management practices. ▶ Night shooting undertaken with the use of a fox whistle to attract cats. ▶ Poisoning of feral cats using fresh meat baits containing sodium fluoroacetate (1080). ▶ Trapping using rubber-jawed and leg-hold traps work best for true feral cats. Ideal trapping sites include those where territorial markers such as faecal deposits and pole-clawing are present. (DAFF 2015a)
Pig (*Sus scrofa*)	Category 3,4,6	Effective pig control requires an integrated and collaborative approach with surrounding land management. ▶ Poisoning using 1080 baits is the most efficient and effective control method. To maximise effectiveness, free feeding with non-poisoned bait should be performed for several days prior to laying poisoned baits. ▶ Trapping is most effective in populated areas on smaller areas (<500 ha) and is useful in control of remaining individuals from poisoning programmes. ▶ Fencing can successfully reduce pig damage to a specific area; however, is considered an expensive control option. The most effective pig-proof fences use fabricated sheep mesh held close to the ground by plain or barbed wire and supported on steel posts. (DAFF 2014c)

Species	Status[a]	Control method
Rabbit (*Oryctolagus cuniculus*)	Category 3,4,5,6	An integrated control approach, incorporating different control methods in conjunction with land management is the most effective form of control, including destroying rabbit warrens, baiting, rabbit-proof fencing, fumigation, trapping and shooting. (DAFF 2014b)

[a] Status under the *Biosecurity Act 2014*

4.7 EROSION MANAGEMENT

Erosion of creek embankments associated with wet season flood events and historical agricultural practices is present in areas where offset vegetation fringes watercourses. Erosion of embankments caused by cattle is widespread at permanent and semi-permanent water bodies within management zones A and B. With the exception of strategic grazing events, livestock will be excluded from the offset areas in order to minimise incidence of erosion, particularly around permanent and semi-permanent water bodies. It is anticipated that limiting grazing in these area will lead to the reestablishment of vegetation and recovery of these eroded zones. In order to prevent any further erosion, strategic grazing events will be excluded from areas surrounding permanent and semi-permanent water bodies within management zones A and B within the offset areas in the event that rainfall events cause inundated or waterlogged soils to minimise erosion.

Areas of erosion within the offset areas will be monitored and remediated if required, in accordance with the Foxleigh Mine Sediment and Erosion Management Plan (Anglo American, 2011). This may include enhancement of nearby permanent and semi-permanent water sources. Grazing will be excluded from any area where remediation works for erosion and/or erosion or sediment control structures have been installed until vegetation biomass reaches 1,500 kg/ha, when fuel loads need to be managed.

4.8 ACCESS TRACK MANAGEMENT

Existing access tracks will be utilised to facilitate necessary management, maintenance and monitoring activities as part of this OMP. In the event that existing access tracks become impassable (through erosion or vegetation regrowth), maintenance activities of these tracks (e.g. grading) will be prioritised over alternative track alignments. Gully crossings are likely to be subject to periodic, ongoing maintenance as a consequence of erosion following rain events.

Existing and new access tracks will be no wider than 5 m and vegetation disturbance will be minimised wherever possible, in accordance with Section 4.2.

4.9 REHABILITATION

No targeted or active rehabilitation or revegetation is anticipated to be required. Disturbances in the offset areas are primarily due to clearing, grazing and weed invasion. Managing these threatening processes to promote natural regeneration is considered the most viable approach to restoring the offset areas.

Hence it is considered that restricting grazing, controlling weed infestations and reducing fuel loads (to avoid high intensity fires), is the best approach to restoring the condition of the offset areas. Evidence of natural regeneration and recruitment within the offset areas will be monitored through the BioCondition monitoring (Section 5.3). Recruitment is one of the site-based attributes assessed in BioCondition assessments and is measured as the proportion of dominant canopy species[4] present at the site that are regenerating i.e. having

[4] Dominant canopy species for a particular RE are those species listed in the RE benchmark or as identified in the RE description (Queensland Regional Ecosystem Description Database [REDD database]).

individuals with a diameter at breast height (DBH) greater than 5 cm. If after five years from the approval of this OMP, the results of the BioCondition monitoring indicate that less than 20% of the dominant canopy species are present as regeneration then options for active regeneration will be assessed and implemented.

5 OFFSET MONITORING

A monitoring program will be implemented to monitor and report on the effectiveness of the management measures described in Section 4 and measure the progress of the offset areas in achieving future condition obligations. All monitoring activities are to be undertaken by a suitably qualified person.

5.1 DATA MANAGEMENT

Middlemount South will store all files on their computer system in a central location. All spatial data will be stored here:
Z:\ENV\2.0 OPERATIONAL CONTROL\Mapinfo\2 Biodiversity

5.2 PHOTO MONITORING

Photo monitoring is a qualitative analysis technique that provides the opportunity for visual time series analysis of changes in vegetation composition, structure and integrity over time. In areas where active management is being undertaken photo monitoring offers a simple and effective visual means by which to capture the response of the vegetation to management actions.

Photo monitoring guidelines (Hughes et al. 2009) for native plant recovery recommend a minimum of two photo points at a site scale to effectively:

- establish the presence or density of specific priority native species over time
- identify changes in ecological communities.

Photo monitoring is to be undertaken annually to enable visual assessment of changes over time and will consist of the following:

- Nine permanent photo-monitoring sites will be established and marked using a capped stake (Table 14 and Figure 7). The location of each site will be recorded using a GPS in Datum GDA94, Zone 55.
- Photos will be taken in a north, east, south and westerly direction at each photo monitoring site.
- A record of the photographs will be maintained, including GPS co-ordinates, date and time of each photograph, the direction in which the photograph was taken; and the height above the ground at which the photograph was taken.

Photo monitoring will also be used to monitor biomass within the offset management areas (Section 5.6) by comparing to relevant photo standards[5] in order to manage grazing biomass and minimise risk of uncontrolled fire.

[5] See https://futurebeef.com.au/knowledge-centre/pastures-forage-crops/pasture-photo-standards/

Table 14: Photo monitoring sites (Datum GDA94, Zone 55)

Management zone	MNES	Middlemount South internal photo monitoring site name	OMP photo monitoring site name (Figure 7)	Easting	Northing
A	Brigalow TEC and squatter pigeon habitat	OA_PMP_01	PMS 1	673538	7463079
A	Brigalow TEC and squatter pigeon habitat	OA_PMP_02	PMS 2	674250	7464034
A	Brigalow TEC and squatter pigeon habitat	OA_PMP_03	PMS 3	675051	7464506
A	Brigalow TEC and squatter pigeon habitat	OA_PMP_04	PMS 4	677127	7463730
A	Brigalow TEC and squatter pigeon habitat	OA_PMP_05	PMS 5	683740	7467244
A	Brigalow TEC and squatter pigeon habitat	OA_PMP_06	PMS 6	686295	7465713
A	Brigalow TEC and squatter pigeon habitat	OA_PMP_07	PMS 7	685702	7463905
B	Squatter pigeon habitat	OA_PMP_08	PMS 8	682660	7460635
A	Squatter pigeon habitat	OA_PMP_10	PMS 10	681459	7458889

5.3 FUTURE OFFSET CONDITION TARGET MONITORING

The impact and offset sites have been assessed using the BioCondition methodology developed by the Queensland Herbarium. BioCondition assessments provide a measure of how well a terrestrial ecosystem is functioning for biodiversity values. They are a site-based, quantitative and therefore repeatable assessment procedure that can be used in any vegetative state. The resulting scores can also be easily converted into habitat quality scores for use in the EPBC Act Offset Assessment Guides. To attain a future condition class of 7 out of 10, Brigalow TEC within the offset area must attain a BioCondition score of 70 or higher. To attain a future condition class of 8 out of 10, squatter pigeon habitat within the offset area must attain a BioCondition score of 83 or higher, accounting for the consideration of species stocking rate remaining constant. Table 15 presents the BioCondition attributes that will be measured across the offset area and the minimum score that must be achieved for each attribute to meet the future offset condition as well as the related management actions.

Table 15: Minimum BioCondition scores required for each attribute to achieve future offset condition and associated management actions

Attribute	Weighting	Minimum score to achieve future offset condition score	Relevant management actions
Site-based Large trees	15	15	Fire management
Tree canopy height	5	5	Fire management
Recruitment of dominant canopy species	5	5	Grazing restrictions and fire management

Attribute	Weighting	Minimum score to achieve future offset condition score	Relevant management actions
Tree canopy cover (%)	5	5	Grazing restrictions and fire management
Shrub layer cover (%)	5	5	Grazing restrictions and fire management
Coarse woody debris	5	5	Fire management
Native plant species richness Trees Shrubs Grasses Other	 5 5 5 5	 5 5 5 2.5	Grazing restrictions, weed control and fire management
Non-native plant cover	10	5	Grazing restrictions and weed control
Native perennial grass cover (%)	5	5	Grazing restrictions, weed control and fire management
Litter cover	5	5	Fire management
Total site score	**80**	**72.5**	**-**
Landscape Size of patch	10	2	-
Context	5	5	-
Connectivity	5	2	-
Total landscape score	20	9	-
TOTAL BioCondition SCORE	**100**	**81.5**	**-**

To monitor changes in the ecological condition of the offset areas, BioCondition assessments will be undertaken by a suitably qualified person twice in the first five years of management and then every fifth year thereafter until the offset future condition targets are achieved.

BioCondition assessments will be conducted at the permanent monitoring sites listed in Table 16 and Table 17 and shown on Figure 7 in accordance with the BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland, Assessment Manual (Version 2.2; Eyre et. al., 2011; Appendix I). The number and location of sites is based on guidance within the methodology, which states

aim for two to five sites per assessment unit, dependant on the area of each unit (i.e. assessment unit <60 ha, aim for at least two sites, assessment unit >500 ha, aim for five sites). Select a site location that is representative of the unit you are assessing, and at least 50 m from any major disturbance, such as a road or a dam. Also aim to locate sites at least 1 km apart.

In accordance with the methodology, BioCondition assessments will be undertaken at the end of the wet season (i.e. late March to late May) when plant species diversity is the greatest. A copy of the methodology is provided in Appendix I. Baseline BioCondition assessments of these sites have been undertaken by Anglo

American as part of the ecological equivalence assessments. The results of the baseline BioCondition assessments are presented in Appendix F. Future assessments will be undertaken using the same methodology to enable a meaningful comparison between the baseline and monitoring data.

The results of the BioCondition assessments will be compared with the results of previous assessments to ensure the vegetation condition is improving. The results of the BioCondition assessments will also be compared with the benchmark condition scores for the relevant RE in order to determine when the offset areas have achieved the objectives of this management plan (i.e. reached a BioCondition class score of 1).

In addition, annual BioCondition monitoring will be conducted for the first five years in several patches of Brigalow TEC within proposed offset areas that have been impacted by herbicide, including some visual evidence of dieback of regrowth vegetation.

Table 16: BioCondition monitoring sites in Brigalow TEC (Datum GDA94, Zone 55)

Management zone	Monitoring site	Easting	Northing
A	AU1 SS5#	674116	7464259
A	AU4 SS1#	683740	7467244
A	AU5 SS2#	677102	7463940
A	AU10 SS2#	675214	7464589
A	AU2 SS2#	674251	7462798
A	AU2 SS3#	673538	7463079
A	AU8 SS1#	685402	7464812
A	AU8 SS2#	685702	7463905

Same BioCondition monitoring sites as for the squatter pigeon habitat

Table 17: BioCondition monitoring sites in squatter pigeon habitat (Datum GDA94, Zone 55)

Management zone	Monitoring site	Easting	Northing
A	AU1 SS5#	674116	7464259
A	AU4 SS1#	683740	7467244
A	AU5 SS2#	677102	7463940
A	AU10 SS2#	675214	7464589
B	AU7 SS1	682523	7460687
A	AU3 SS1	681328	7458667
A	AU3 SS2	681459	7458889
A	AU2 SS2#	674251	7462798
A	AU2 SS3#	673538	7463079
A	AU8 SS1#	685402	7464812
A	AU8 SS2#	685702	7463905

Same BioCondition monitoring sites as for Brigalow TEC

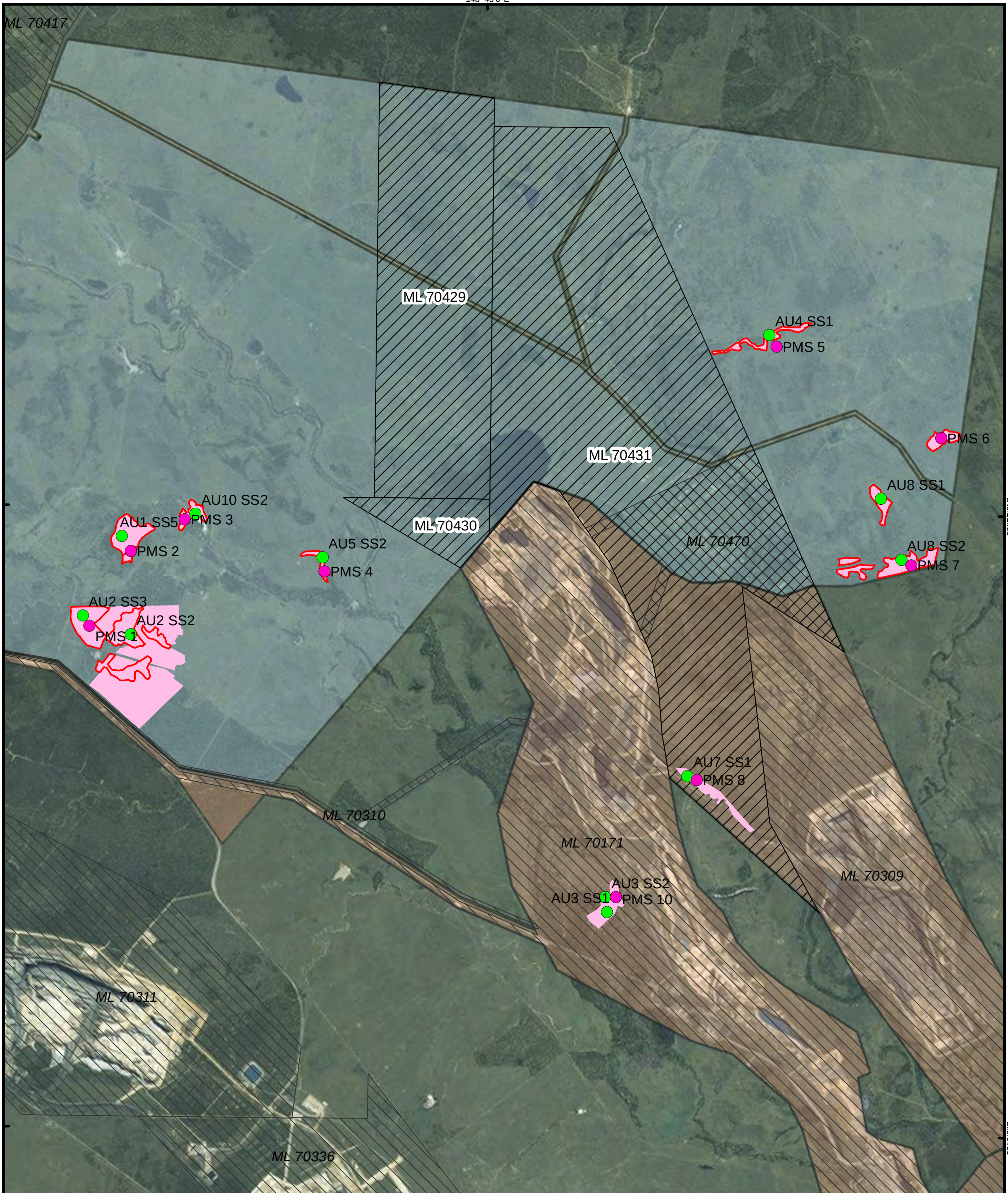


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Figure 7: BioCondition and photo monitoring sites

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)
The following datasets are © State of Qld:
- Cadastral Data (2011)

Lot 4 SP248577
Lot 20 SP276924
Foxleigh Plains MLs
Non-project MLs
Biocondition monitoring sites
Photo monitoring sites

MNES Values
Brigalow TEC
Squatter pigeon

N

0 1 2 3
Kilometres

CO2 Australia

Location diagram

Date: 04-11-2016 Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994 Scale: 1:75,000 @ A4

Path: P:\GISData\Projects\Anglo_American\ENV01881926_20160606_offset_map_updates_split_State_Commonwealth\20161104_fig7_BioCond_Photo_Monitoring_locations_Commonwealth.mxd

5.4 BRIGALOW TEC MONITORING

In addition to the BioCondition assessments that will be undertaken in the Brigalow TEC and other vegetation communities in the offset areas (Section 5.3), Brigalow TEC will also be monitored for signs of water stress that may be ascribed to the development of the adjacent Foxleigh Mine.

Extensive areas of Brigalow TEC on clay plains are not commonly considered groundwater dependent, though this may be the case in some alluvial situations (Butler, pers. comm.). It was advised that there may be potential for groundwater drawdown from the mine to have an adverse impact Brigalow TEC due to the proximity of offset areas to the Foxleigh Mine (Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development, 2013).

In order to ascertain any potential adverse impact of groundwater drawdown on Brigalow TEC condition, weather data (e.g. rainfall) and groundwater data (e.g. groundwater depth) will be collated to compare to Brigalow TEC ecological indicators.

Groundwater monitoring data (including groundwater depth from coal measure formations and/or alluvium) will be collated from data collected as part of existing Queensland Environmental Authority (EA) conditions. Groundwater data will be collected from four groundwater monitoring points (Figure 8), with weather data collected from a weather station located on site (Figure 8).

Groundwater depth and rainfall data will be collated and analysed every two years in conjunction with the ecological indicators discussed below to determine whether any changes observed in the Brigalow ecosystems in the offset areas are attributable to water drawdown attributable to mining activities or to prevailing climatic conditions (e.g. drought).

Water stress can be measured across various temporal and spatial scales including at the individual, population and ecosystem level (Lewis, 2012). The following ecological indicators will be used to monitor the response of Brigalow ecosystems to potential changes in water availability:

- Change in the mapped distribution of Brigalow TEC – changes in distribution of vegetation can indicate a change in groundwater levels (Lewis, 2012; Butler, pers. comm.). The boundaries of Brigalow TEC in the offset areas will be walked and mapped using a hand-held GPS device. The boundaries will then be compared to previous mapped boundaries to determine if there is any change in the distribution of Brigalow TEC.
- Tree mortality as evidenced by decreases in canopy cover – tree canopy cover will be measured using the line intercept method (Greig-Smith, 1964), calculated by measuring the vertical projection of the tree canopy over a 100 m transect. The total length of the projected tree layer is then divided by the total length of the transect to give an estimate of percentage canopy cover. These values will be calculated from the BioCondition monitoring locations outlined in Section 5.3, with changes over time determined by a comparison to the baseline condition.

Middlemount South will establish two control sites located in regrowth Brigalow TEC vegetation located on Lot 4. BioCondition assessments will be undertaken at the same frequency as the offset area. Middlemount South will advise DEE of the location of the control sites as part of annual compliance reporting in 2017.

Middlemount South will assess and implement options for active regeneration if the above monitoring shows that:

- there is a change in the mapped distribution of Brigalow TEC in offset areas or there is tree mortality attributable to groundwater drawdown, and/or;
- there is <20% of the dominant canopy species present as regeneration by 2022.

Middlemount South will engage an expert to determine the most effective approach (based on likelihood of success), including:

- direct seeding
- planting of tube stock of dominant canopy species
- alternative offsets on nearby Middlemount South owned land.

Figure 8: Groundwater monitoring sites and weather station

5.5 FAUNA MONITORING

Fauna monitoring surveys will be undertaken within the Brigalow TEC and squatter pigeon offset areas twice in the first five years (2017 and 2021) of management and then every fifth year thereafter (2025, 2030). Fauna surveys will be undertaken by a suitably qualified person in both the wet and dry seasons of the monitoring years. Permanent monitoring sites located within these areas will be assessed using the same methodology that was applied to conduct the baseline fauna surveys (Cumberland Ecology, 2014; Appendix D). Additional baseline surveys of the offset areas on ML 70309 and ML 70171 will be completed within six months of this plan being approved at fauna monitoring sites (FMS) 12 and 13 (Table 18). The location of the permanent and additional monitoring sites is provided in Table 18 and shown in Figure 9. The objective of these surveys is to assess the capability of the offset areas to provide habitat for a range of vertebrate fauna, in particular the squatter pigeon and Brigalow reptiles. Targeted surveys for the squatter pigeon and Brigalow reptiles will be undertaken consistent with relevant survey guidelines namely:

- Survey Guidelines for Australia's Threatened Birds (DEWHA, 2010), and
- Survey Guidelines for Australia's Threatened Reptiles (DSEWPC, 2011).

The following activities will be undertaken at each of the permanent monitoring sites:

- Targeted bird surveys will involve two people undertaking 30 minute searches within a 2 ha area
- Targeted reptile surveys will be undertaken concurrently with the bird surveys and will consist of a combination of funnel traps and active searches. At each of the permanent monitoring sites, eight funnel traps will be set along a 30 m drift fence. Additionally, active searches of suitable habitat (i.e. under logs, rock and decorticating bark) will also be undertaken at each monitoring site. Active searches for reptiles will be undertaken opportunistically where suitable habitat exists
- Habitat assessments will be conducted at each of the monitoring sites with a particular emphasis on the condition of habitat for the squatter pigeon and Brigalow reptiles. These will involve an assessment of the habitat values present including:
  - density and diversity of understory plant species
  - grass species
  - hollows
  - fallen timber
  - presence of threats (e.g. weeds, evidence of overgrazing or feral animals).

Any other vertebrate fauna species opportunistically observed during the fauna surveys will be recorded.

Table 18: Fauna Monitoring Sites (Datum GDA94, Zone 55)

Management zone	Middlemount South internal fauna monitoring site name	OMP fauna monitoring site name (Figure 9)	Easting	Northing
A	OA_FMS_01	FMS 1	674432	7461983
A	OA_FMS_02	FMS 2	674904	7461508
A	OA_FMS_03	FMS 3	676042	7460965
A	OA_FMS_04	FMS 4	674105	7462855
A	OA_FMS_05	FMS 5	674504	7463513
A	OA_FMS_06	FMS 6	674191	7463975
A	OA_FMS_07	FMS 7	684859	7463723
A	OA_FMS_08	FMS 8	685689	7463812
A	OA_FMS_09	FMS 9	686262	7465708

Management zone	Middlemount South internal fauna monitoring site name	OMP fauna monitoring site name (Figure 9)	Easting	Northing
A	OA_FMS_10	FMS 10	683758	7467241
A	OA_FMS_11	FMS 11	677098	7463754
A	OA_FMS_12	FMS 12	681328	7458667
B	OA_FMS_13	FMS 13	683317	7460049

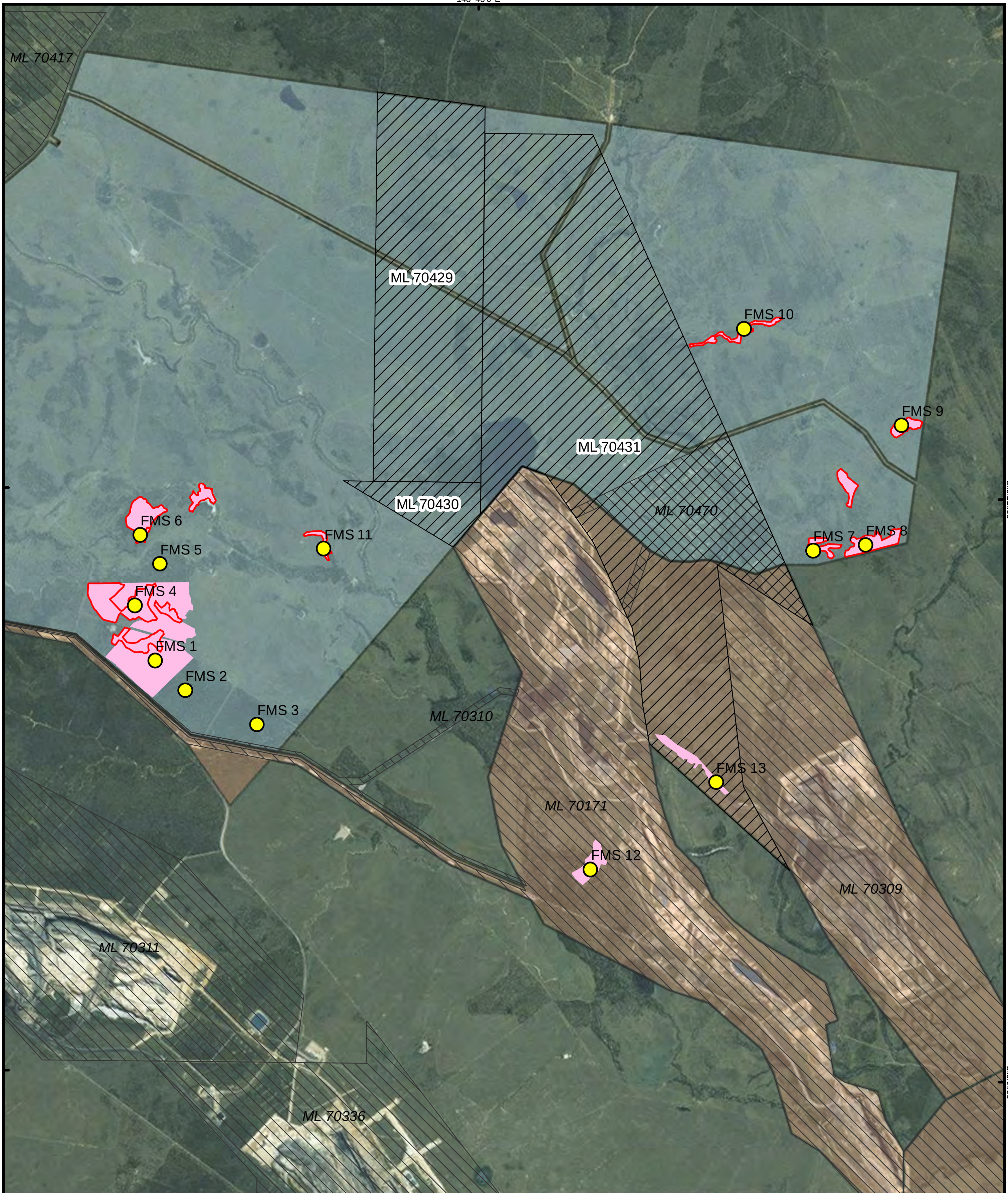

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Figure 9: Fauna monitoring sites

Fauna monitoring sites
Lot 4 SP248577
Lot 20 SP276924
Foxleigh Plains MLs
Non-project MLs

MNES values
Squatter pigeon habitat
Brigalow TEC

0 1 2 3
Kilometres

N

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)
The following datasets are © State of Qld:
- Cadastral Data (2011)

Date: 07-11-2016 Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994 Scale: 1:80,000 @A4

Location diagram

© OpenStreetMap (and) contributors, CC-BY-SA

Path: P:\GIS\Data\Projects\Anglo_American\ENV01881926_20160606_offset_map_updates_split_State_Commonwealth\20161104_fig9_fauna monitoring points_Commonwealth.mxd

5.6 BIOMASS MONITORING

Biomass monitoring is required to be undertaken to determine the risk of fire to the offset area and inform fire management strategies. It will also be used to inform grazing management decisions, including the duration of strategic grazing events and number of cattle grazed in the offset areas.

Biomass is at its greatest at the end of the wet season (around March to April). Consequently biomass will be measured at the end of every wet season to determine the fire risk and inform grazing management decisions. Biomass should be maintained at or below 1,500 kg/ha and will be monitored within the offset areas using appropriate photo standards available on the Future Beef website[6] which can be used to determine dry matter yields.

Should the biomass levels be required to be reduced in the offset areas, a feed budgeting assessment will be undertaken prior to any strategic grazing event. A feed budgeting assessment is a recognised method of determining the stocking rate based on the amount of feed (or biomass) available and the amount of feed (or biomass) that is desired at the end of the grazing event.

The feed budgeting assessment will allow the stocking rate and the duration of grazing to be varied depending on the seasonal conditions. The “Dry Season Feed Budget” worksheet is provided in Appendix H and the method for undertaking a feed budget assessment is summarised as follows:

- Determine the current amount of feed present (kg/ha) using appropriate photo standards available on the Future Beef website.
- Determine the amount of feed desired (kg/ha) at the end of the grazing event.
- Calculate the total useable feed (kg/ha) by subtracting the feed desired from the feed present.
- Determine utilisation (i.e. the proportion of useable feed that livestock can use).
- Determine the feed available for the grazing animal (kg/ha) by multiplying the total useable feed by the utilisation rate.
- Calculate the safe stocking rate by:
  - Determining the feed consumption per day (kg/day).
  - Determining the number of days feed is required (days).
  - Calculating the feed requirement per head (kg/hd) by multiplying the feed consumption per day by the number of days.
  - Calculating the stocking rate (ha/hd) by dividing the feed requirement per head by feed available.
  - Calculate the number of stock (head) by dividing the area of the paddock by the stocking rate.

5.7 EROSION MONITORING

Erosion will be monitored annually throughout the offset areas using the Level 1 monitoring methodology, as described in the ‘Land Manager’s Monitoring Guide – Ground cover indicator’ (DERM, 2010; Appendix J). Level 1 monitoring involves a visual assessment of percentage ground cover by making a number of observations while driving or walking around assessment area. Erosion prone areas will also be monitored during strategic grazing events and following significant weather events (i.e. flooding).

In the event that livestock grazing, fire or other management measures are observed to be contributing to ongoing erosion impacts to environmental values in offset areas, corrective actions (including exclusion of all

[6] Available from http://futurebeef.com.au/topics/pastures-and-forage-crops/pasture-photo-standards/

grazing, targeted remediation – seeding of grass and shrub species - and contouring – to redirect the flow of runoff) will be taken.

5.8 WEED MONITORING

The status of weed infestations in the offset area will be monitored using a range of methods. These include (and are described in further detail in the following sections):

- Each weed treatment event (controlled grazing and herbicide applications) will be mapped to record the change in extent over time.
- Photo monitoring (Section 5.1). The status of weed infestations in the vicinity of the 9 permanent photo monitoring points will be monitored and recorded annually.
- BioCondition assessments (Section 5.3). Non-native plant cover will be recorded during the BioCondition assessments which will be undertaken twice in the first five years of management and then every fifth year thereafter.
- Visual monitoring (Section 5.10). The status of weed infestations will be monitored during visual inspections of the offset area which will be undertaken at a minimum twice every year.

Information collected during these treatment and monitoring events will be collated in the Foxleigh Weed Register within the Foxleigh GIS database.

5.9 PEST ANIMAL MONITORING

The offset areas will be monitored for evidence of pest animals, including an initial baseline survey in year 1 of the distribution and abundance of pest animals.

Ongoing pest animal surveys and assessments of direct impacts on fauna habitat values and vegetation communities (e.g. impact of pigs on vegetation condition) will be undertaken every 3 years as part of ongoing offset area monitoring, and opportunistically during management and monitoring of the offset areas. Monitoring events will consist of a survey during the dry season and a survey post wet season. The results of these pest animal surveys and habitat assessments will be used to inform adaptive pest animal control, targeting specific areas of pest animal outbreaks. Table 13 outlines monitoring for pest animal species.

Table 19: Species-specific monitoring for pest animal species.

Species	Status[a]	Monitoring
Wild dog (*Canis familiaris*)	Category 3,4,6	▶ Incidental observation ▶ Track counts (Sand pad transects) will be established and monitored for three consecutive days to assess the presence/absence of wild dogs. 1080 baiting will be established in areas of high wild dog activity. Bait stations will be monitored once a week for a period of three weeks (or longer if required). The presence/absence of wild dogs will then be reassessed post baiting by monitoring the sand pad transects for a further three consecutive days.
Fox (*Vulpes vulpes*)	Category 3,4,5,6	▶ Incidental observation ▶ Scat count transects ▶ Den counts
Feral cat (*Felis catus*)	Category 3,4,6	▶ Track counts (sand pad transects) ▶ infrared cameras on tracks provide some indication of feral cat distribution and abundance. ▶ Sniffer dogs may be used to assist with cat detection (scent and sign) and control programs.

Species	Status[a]	Monitoring
Pig (*Sus scrofa*)	Category 3,4,6	▶ Incidental observation ▶ Recording the GPS location of traps and baits ▶ Recording details of individuals caught (sex, weight and reproductive status) ▶ Track counts
Rabbit (*Oryctolagus cuniculus*)	Category 3,4,5,6	▶ Incidental observation ▶ Warren counts

[a] Status under the *Biosecurity Act 2014*

5.10 VISUAL MONITORING

In addition to the monitoring outlined in the previous sections, regular opportunistic inspections, a minimum of twice a year, of the offset areas will be undertaken by Middlemount South while implementing management actions. Observations will include:

- condition of fencing
- status of weed infestations in offset area
- incidence of erosion within offset area, particularly around permanent and semi-permanent water bodies
- fuel loads
- damage/degradation resulting from feral animal activity within the offset area
- signs of land degradation and over grazing
- signs of unauthorised access

6 REPORTING AUDITING AND RISK MANAGEMENT

6.1 AUDITS AND INSPECTIONS

The results of monitoring activities will be reviewed annually to ensure the management activities are effective and the offset areas are tracking towards the future condition obligations. In the event that additional management activities are proposed, this OMP will be updated and the actions will be tracked through Middlemount South’s Action Tracking Software Program. Additionally, in the event that future condition targets are unlikely to be achieved management actions will be reviewed and corrective actions implemented to ensure those timebound targets are likely to be achieved.

6.2 RISK MANAGEMENT AND CONTINGENCY MEASURES

Failure to achieve the management objectives and outcomes of this OMP could occur through a range of risks assessed in Appendix K. This risk assessment also identifies corrective actions, should these risks be realised.

6.3 REPORTING

Condition 20 of the EPBC Act approval for the project requires Middlemount South to maintain accurate records substantiating all activities and outcomes associated with or relevant to the conditions of the approval and the measures taken to implement the management plans required by the approval including the OMP. These records will be maintained on the Foxleigh Mine Safety Health and Environment Management System.

In addition, an Offset Area Progress Report will be submitted by June 30 to DoEE every second year (starting from year 1) for the first five years following approval of this management plan. After five years, the reports will be provided every five years until the management outcomes are achieved (implementation updates will be included in annual performance reporting under the project's EPBC approval). As a minimum each report will include:

- departmental reference number
- name and contact details of landholder
- lot on plan property description and postal address
- a general description of climatic conditions that may impact the offset area
- activities undertaken within each management action and the outcomes achieved
- schedule of management actions with progress section completed
- program of action for the next management period
- results of BioCondition assessments
- results of all monitoring including photos, erosion, weeds, biomass, Brigalow TEC monitoring
- results of fauna monitoring
- progress towards the achievement of future condition criteria for the offset area
- problems, issues and impediments to achieving the objectives and outcomes of the management plan

6.4 REVIEW

This plan will be reviewed every 5 years and updated with lessons from the prior management period.

6.5 COMPLIANCE

In accordance with Condition 15 of the EPBC Act approval for the project, any non-compliances with the approval (including this OMP) will be reported to the DoEE and in writing within two business days of Middlemount South becoming aware of the non-compliance

7 MANAGEMENT MONITORING AND REPORTING SCHEDULE

Table 20 provides a schedule of the management, monitoring and reporting activities to be undertaken in the offset areas and these are assigned a frequency for the duration of the OMP. It is expected that the results from the monitoring activities proposed in this OMP will also yield more specific recommendations and/or actions so that improvement in the condition of the vegetation communities can be optimised.

Table 20: Management, Monitoring and Reporting Schedule

Details	Anticipated Timing and frequency	Year
MANAGEMENT ACTIVITIES		
Vegetation Protection		
Apply for Voluntary Declaration to secure the offset area on the property's title.	Upon approval of this OMP	2017
General Restrictions		
Install locks on gates into management zones A and B.	NA	2017
Erect signs on access points into management zones.	NA	2017
Demarcate offset areas on site plans prior to commencement of construction.	NA	2017
Biannually inspect fence, gates and locks to ensure maintained in a serviceable condition.	NA	All
Grazing Management		
Construct additional fencing around management zones A and B if required.	NA	2107
Implement strategic grazing regime.	NA	All
Weed Management		
Implement weed hygiene measures as part of access requirements applicable to the offset areas.	NA	All
Implement strategic grazing regime to reduce the presence of exotic pasture grasses to less than 25% of the total groundcover in the offset areas.	Dry season (March to October)	All
Undertake monitoring to identify any new weed infestations.	NA	All
Undertake spraying of exotic pasture grasses following strategic grazing events.	Late wet season (March to April)	All
Fire Management		
Implement strategic grazing regime to maintain fuel loads at or below 1,500 kg/ha.	Dry season (March to October)	Al
Reduce fuel loads in areas surrounding the offset area using controlled burns if required.	Late wet season to early dry season (February to May)	2017, 2020, 2023, 2026, 2029, 2032
Undertake low intensity burns to maintain ecological functioning (management zone B).	Late wet season to early dry season (February to May)	2017, 2024, 2031
Pest Animal Control		
Baseline assessments of pest animal presence in the offset site, to assess the spatial extent of pest animal impacts to fauna habitat and impacts on vegetation condition.	Survey in dry season and a survey post wet season	2017
Based on the results of ongoing pest animal monitoring in the offset site, review the need for species-specific control measures and timing for control activities in the offset area. Incorporate any control methods.	Annually	All
Erosion Management		
Exclude grazing from any area where remediation works for erosion and/or erosion or sediment control structures have been installed until vegetation biomass reaches 1,500 kg/ha.	Dry season (March to October)	All
Access Track Management		
Construct unsealed access tracks to allow access into the offset areas.	Upon approval of OMP	2017
Maintain unsealed access tracks to no more than 5 m width and in safe condition.	Dry season (March to October)	All
Rehabilitation		
Assess for evidence of natural regeneration and recruitment within the offset areas as part of BioCondition monitoring. If after five years from the approval of this OMP, the results of the	If required after year 5, identify options for active	2021

Details	Anticipated Timing and frequency	Year
BioCondition monitoring indicate that less than 20% of the dominant canopy species are present as regeneration then options for active regeneration will be identified and the OMP reviewed.	regeneration.	
MONITORING		
Photo Monitoring		
Undertaken annually at ten permanent photo monitoring sites.	Annually in late wet season (March to April)	All
BioCondition Assessments		
Conduct BioCondition assessments at monitoring and control sites to assess ecological condition of vegetation and regeneration.	Late wet season (March to April)	2017, 2021, 2026, 2031
Fauna Monitoring		
Conduct fauna monitoring surveys to assess the capability of the offset areas in providing habitat for fauna, in particular the squatter pigeon and Brigalow reptiles.	Late dry season to early wet season (September to November)	2017, 2021, 2026, 2031
Brigalow TEC Monitoring		
Monitor Brigalow TEC for signs of water stress including monitoring weather data (e.g. rainfall) and groundwater data (e.g. groundwater depth) for comparison with Brigalow TEC ecological indicators.	Late dry season (August to October)	2017, 2019, 2021, 2023, 2025, 2027, 2029, 2031, 2033
Biomass Monitoring		
Undertake biomass monitoring to ensure levels do not exceed 1,500kg/ha, to determine the risk of fire to the offset area and inform fire management strategies and strategic grazing decisions.	Late wet season (March to April)	All
Erosion Monitoring		
Undertake annual groundcover assessments using the Level 1 monitoring (as described in the 'Land Manager's Monitoring Guide – Ground cover indicator' (DERM, 2010).	Annually	All
Monitor erosion prone areas during strategic grazing events and following significant weather events (i.e. flooding).	As required	
Weed monitoring		
Monitor the distribution and density of weed infestations through: ▶ Photo monitoring ▶ Recording the nature and location of weed control treatments ▶ BioCondition assessments ▶ Visual monitoring	At least annually	All
Pest animal monitoring		
Survey distribution and abundance of pest animals.	Survey during the dry season and a survey post wet season	2017, 2020, 2023, 2026, 2029, 2032
Visual Monitoring		
Undertake visual monitoring whilst implementing management actions to make observations regarding the condition and state of the offset area.	Will be undertaken at a minimum twice a year (once in the wet season, once in the dry season)	All
Reporting		
Submit annual compliance report to DoEE, including reporting on implementation of this OMP and attainment of offset future quality.	NA	All

8 ROLES AND RESPONSIBILITIES

Table 21 provides details of the Middlemount South departments that will be responsible for implementing the management, monitoring and reporting actions. These actions will be delegated and tracked using Middlemount South's Enablon system.

Table 21: Roles and Responsibilities

Management Activities	Responsible Department				
	Environment Department	Infrastructure Department	Technical Services	Brisbane Corporate Office	Senior Leadership Team
Vegetation Protection					
Apply for Voluntary Declaration to secure the offset area on the property's title. Apply for offset areas to be included on remnant vegetation maps for protection under VM Act or subsequent Queensland vegetation protection legislation	Environmental Superintendent to coordinate in conjunction with Legal and Senior Leadership Team.	-	-	Middlemount South Legal Department to review if required.	Senior Leadership Team (SLT) member to approve OMP and Voluntary Declaration, coordinate with Legal.
General Restriction					
Install locks on gates into management zones A and B.	Project Engineer in consultation with Infrastructure Personnel.	Infrastructure Personnel or external contractor as required.	-	-	-
Erect signs on access points into management zones.	Project Engineer in consultation with Infrastructure Personnel.	Infrastructure Personnel or external contractor as required.	-	-	-
Demarcate offset areas on site plans.	Project Engineer in consultation with Surveyor.	-	Surveyor	-	-
Grazing Management					
Construct additional fencing around management zones A and B	Project Engineer in consultation with Infrastructure Personnel.	Infrastructure Personnel.	-	-	-
Exclude grazing from offset areas (with the exception during strategic grazing events).	Project Engineer carrying out inspections to ensure exclusion of cattle once fences and gates have been installed.	-	-	-	-
Weed Management					

Management Activities	Responsible Department				
	Environment Department	Infrastructure Department	Technical Services	Brisbane Corporate Office	Senior Leadership Team
Implement weed hygiene measures in the offset areas.	Project Engineer managing a contractor when required.	-	-	-	-
Implement strategic grazing regime to reduce the presence of exotic pasture grasses to less than 25% of the total groundcover in the offset areas.	Project Engineer in consultation with Rural Property Manager.	-	-	Rural Property Manager to organise strategic grazing through local cattle owners when required.	-
Undertake spraying of exotic pasture grasses following strategic grazing events.	Project Engineer managing a contractor.	-	-	-	-
Fire Management					
Implement strategic grazing regime to be maintain fuel loads at or below 1,500 kg/ha.	Project Engineer in consultation with Rural Property Manager.	-	-	Rural Property Manager to organise strategic grazing through local cattle owners when required.	-
Reduce fuel loads in areas surrounding the offset area using controlled burns (management zones A, B).	Project Engineer and Environmental Officer to coordinate process in consultation with Infrastructure Personnel or external contractor as required.	-	-	-	-
Undertake regular low intensity burns to maintain ecological functioning (management zone B).	Project Engineer and Environmental Officer to coordinate process in consultation with Infrastructure Personnel or external contractor as required.	-	-	-	-
Pest Animal Management					
Control pest animals if required.	Environmental Superintendent to coordinate as required as part of pest control regime.	-	-	-	-
Erosion Management					
Exclude grazing from	Project Engineer	-	-	-	-

Management Activities	Responsible Department				
	Environment Department	**Infrastructure Department**	**Technical Services**	**Brisbane Corporate Office**	**Senior Leadership Team**
offset areas (with the exception during strategic grazing events).	carrying out inspections to ensure exclusion of cattle once fences and gates have been installed.				
Access Track Management					
Construction of access tracks to allow access into the offset areas.	Project Engineer in consultation with Infrastructure Personnel.	Infrastructure Personnel or external contractor as required.	-	-	-
Maintenance of access tracks in the offset areas.	Project Engineer in consultation with Infrastructure Personnel.	Infrastructure Personnel or external contractor as required.	-	-	-
MONITORING					
Photo Monitoring					
Undertaken annually at nine permanent photo monitoring sites.	Project Engineer / Environmental Officer.	-	-	-	-
BioCondition Assessments					
Conduct BioCondition assessments at monitoring sites to assess ecological condition of vegetation.	Project Engineer in consultation with Environmental Officer or external contractor as required.	-	-	-	-
Fauna Monitoring					
Conduct fauna monitoring surveys to assess the capability of the offset areas in providing habitat for fauna.	Project Engineer managing an external contractor.	-	-	-	-
Brigalow Monitoring					
Undertake monitoring of Brigalow TEC for signs of water stress.	Project Engineer in consultation with Environmental Officer or external contractor as required.	-	-	-	-
Biomass Monitoring					
Undertake biomass monitoring annually to	Project Engineer in consultation with	-	-	-	-

Management Activities	Responsible Department				
	Environment Department	Infrastructure Department	Technical Services	Brisbane Corporate Office	Senior Leadership Team
determine the risk of fire to the offset area and inform fire management strategies and strategic grazing decisions.	Environmental Officer or external contractor as required.				
Erosion Monitoring					
Undertake annual groundcover assessments using the Level 1 monitoring (as described in the 'Land Manager's Monitoring Guide – Ground cover indicator' (DERM, 2010).	Project Engineer in consultation with Environmental Officer or external contractor as required.	-	-	-	-
Visual Monitoring					
Undertaken visual monitoring whilst implementing management actions to make observations regarding the condition and state of the offset area.	Project Engineer.	-	-	-	-
REPORTING					
Report					
Submit a monitoring report by June 30 to DoEE every second year for the first five years and then every five years after that until the management objectives have been achieved.	Project Engineer.	-	-	-	-

9 REFERENCES

Anglo American Metallurgical Coal Pty Ltd (2011) Foxleigh Mine Sediment and Erosion Management Plan.

Anglo American Metallurgical Coal Pty Ltd (2014) Biodiversity Offset and Field Survey Report and Offset Proposal – Foxleigh Plains and Cockatoo Creek Diversions (Draft).

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APPENDIX A REGULATORY REQUIREMENTS

Table A-1: Regulatory Requirements of the Offset Management Plan

Regulatory Requirement	Relevant Section of Offset Management Plan
Condition 4 of EPBC 2010/5421	
4. To compensate for authorised unavoidable impacts on MNES (see condition 3), the approval holder must submit an Offset management plan to the Minister for approval. The approval holder must not impact upon MNES (shown in Attachment B) until the Minister has approved the Offset management plan in writing. The approved Offset management plan must be implemented.	This management plan
5. The Offset management plan must include, but not be limited to, the following information:	
a. details of the offset attributes (including maps in electronic Geographic Information System (GIS) format with accompanying shapefiles), site descriptions, environmental values relevant to MNES, connectivity with other habitat and biodiversity corridors, a rehabilitation program, and conservation and management measures for long-term protection;	Section 2.3, 2.5 and Appendix B
b. a detailed survey and description of the offset site to clearly identify baseline conditions, establish performance indicators and discuss methods for adaptive management. This must include but not be limited to:	
i. a description (prior to any management activities, hence a baseline) of the current condition of the extant vegetation of each offset area, location of survey points (GPS reference);	Section 2.5, Appendix C, Appendix D and Appendix F
ii. the quantity of habitat for EPBC Act listed species or communities (in hectares), found within each offset area;	Section 2.1
iii. the condition class of habitat for EPBC Act listed species or communities found within each offset area	Section 2.5, Appendix C, Appendix D and Appendix F
iv. vegetation condition mapping;	Figure 4
v. photo reference points;	Table 14
vi. tree age class representation;	Appendix F and Appendix C
vii. percentage tree canopy cover;	Appendix F and Appendix C
viii. number of native plant species in ground layer;	Appendix F and Appendix C
ix. percentage of native and foreign grass cover and whether the grass species are annual or perennial;	Appendix F and Appendix C
x. description of fauna habitat including condition, type and connectivity; and	Section 2.5.2 and Appendix D
xi. bird and reptile surveys.	Section 2.5.2 and Appendix D
c. plans to improve upon the baseline condition of squatter pigeon primary habitat and Brigalow listed ecological community consistent with EPBC	

Regulatory Requirement	Relevant Section of Offset Management Plan
listing advice. These plans must include:	
i. a map showing areas to be managed;	Figure 6
ii. management actions for each area and details of methods to be used. These must include:	
a. actions consistent with objectives stated in relevant threat abatement plans; and	Section 3 and Table 10
b. weed control measures to reduce/control the presence of foreign perennial weeds within Brigalow listed ecological community or Squatter Pigeon primary habitat to below 25% of the total groundcover.	Section 4.4
iii. timing of management activity for each area;	Sections 4 and 7
iv. performance criteria for each area;	Sections 3.1 and 4
v. a set of measurable ecological indicators for detecting changes to the Brigalow listed ecological community that may be ascribed to water stress relating to mining activities listed in the offset management plan;	Section 4
vi. a monitoring plan to assess the success of the management activities measured against the baseline condition. The monitoring must be statistically robust and able to quantify change in the condition of the Brigalow listed ecological community or Squatter Pigeon primary habitat. This should include, but not be limited to, control sites and periodic ecological surveys to be undertaken by a qualified ecologist;	Section 5
vii. a description of the potential risks to successful management against the performance criteria, and a description of the contingency measures that would be implemented to mitigate these risks;	Appendix K
viii. a process to report to the Department, the progress of management activities undertaken in the offset areas and the outcome of those activities, including identifying any need for improved management and activities to undertake such improvement; and	Section 6.3
ix. details of the various parties responsible for management, monitoring and implementing the management activities, including their position or status as a separate contractor.	Section 8
d. a completed offset assessment guide for the proposed offsets site and a discussion and a discussion as to how figures used to complete the offsets assessment guide were derived	Section 2.6 and Appendix E

APPENDIX B OFFSET ATTRIBUTES

The following table presents the offset area reference co-ordinates (GDA94), also presented in Figures B1 to B5.

Table B1: Offset area coordinates

Reference co-ordinate	Easting	Northing	Latitude (decimal degrees)	Longitude (decimal degrees)
1	686080	7465639	-22.90691	148.81429
2	686146	7465734	-22.90604	148.81492
3	686177	7465738	-22.90600	148.81522
4	686201	7465803	-22.90541	148.81545
5	686264	7465775	-22.90565	148.81607
6	686318	7465797	-22.90545	148.81659
7	686356	7465840	-22.90506	148.81696
8	686384	7465836	-22.90509	148.81723
9	686419	7465807	-22.90535	148.81757
10	686459	7465806	-22.90535	148.81796
11	686582	7465765	-22.90571	148.81916
12	686554	7465676	-22.90651	148.81890
13	686491	7465654	-22.90672	148.81829
14	686425	7465646	-22.90680	148.81765
15	686386	7465679	-22.90650	148.81726
16	686338	7465622	-22.90703	148.81680
17	686275	7465581	-22.90741	148.81619
18	686175	7465516	-22.90800	148.81522
19	686140	7465534	-22.90785	148.81489
20	686091	7465589	-22.90736	148.81440
21	686252	7464083	-22.92094	148.81615
22	686195	7463836	-22.92317	148.81563
23	685371	7463629	-22.92513	148.80762
24	685351	7463647	-22.92497	148.80742
25	685352	7463677	-22.92470	148.80742
26	685374	7463730	-22.92422	148.80763
27	685436	7463769	-22.92386	148.80824
28	685474	7463790	-22.92367	148.80860
29	685506	7463815	-22.92344	148.80891
30	685506	7463839	-22.92322	148.80891
31	685463	7463859	-22.92305	148.80849
32	685441	7463916	-22.92253	148.80826
33	685458	7463932	-22.92238	148.80843
34	685519	7463934	-22.92236	148.80902
35	685543	7463916	-22.92252	148.80926
36	685596	7463922	-22.92246	148.80978
37	685682	7463968	-22.92203	148.81061
38	685785	7463965	-22.92205	148.81161
39	685823	7463956	-22.92213	148.81199
40	685841	7464036	-22.92140	148.81215

Reference co-ordinate	Easting	Northing	Latitude (decimal degrees)	Longitude (decimal degrees)
41	685927	7463961	-22.92207	148.81300
42	685942	7463891	-22.92270	148.81315
43	686068	7463952	-22.92214	148.81437
44	686091	7464044	-22.92130	148.81458
45	686130	7464065	-22.92111	148.81497
46	685307	7463820	-22.92342	148.80697
47	685282	7463774	-22.92383	148.80673
48	685244	7463762	-22.92395	148.80636
49	685095	7463760	-22.92398	148.80491
50	685095	7463738	-22.92418	148.80491
51	685170	7463682	-22.92467	148.80566
52	685180	7463640	-22.92505	148.80576
53	685172	7463619	-22.92524	148.80568
54	685146	7463604	-22.92538	148.80543
55	685081	7463637	-22.92509	148.80479
56	685080	7463679	-22.92471	148.80477
57	685055	7463717	-22.92437	148.80452
58	684926	7463719	-22.92437	148.80327
59	684905	7463636	-22.92512	148.80307
60	684845	7463648	-22.92502	148.80249
61	684756	7463697	-22.92458	148.80162
62	684745	7463755	-22.92406	148.80151
63	684923	7463784	-22.92378	148.80323
64	685101	7463837	-22.92328	148.80496
65	685114	7463829	-22.92336	148.80509
66	685093	7463899	-22.92272	148.80488
67	684969	7463854	-22.92314	148.80368
68	684769	7463819	-22.92348	148.80173
69	684784	7463841	-22.92329	148.80187
70	684780	7463919	-22.92258	148.80182
71	684888	7463935	-22.92242	148.80288
72	685065	7463930	-22.92245	148.80460
73	685290	7465022	-22.91257	148.80666
74	685391	7464940	-22.91329	148.80765
75	685397	7464897	-22.91368	148.80772
76	685565	7464757	-22.91492	148.80938
77	685491	7464610	-22.91626	148.80867
78	685454	7464409	-22.91808	148.80833
79	685392	7464434	-22.91786	148.80773
80	685381	7464465	-22.91758	148.80762
81	685404	7464482	-22.91742	148.80784
82	685412	7464630	-22.91608	148.80790
83	685281	7464803	-22.91454	148.80660
84	685234	7464900	-22.91367	148.80613
85	685236	7464979	-22.91296	148.80615

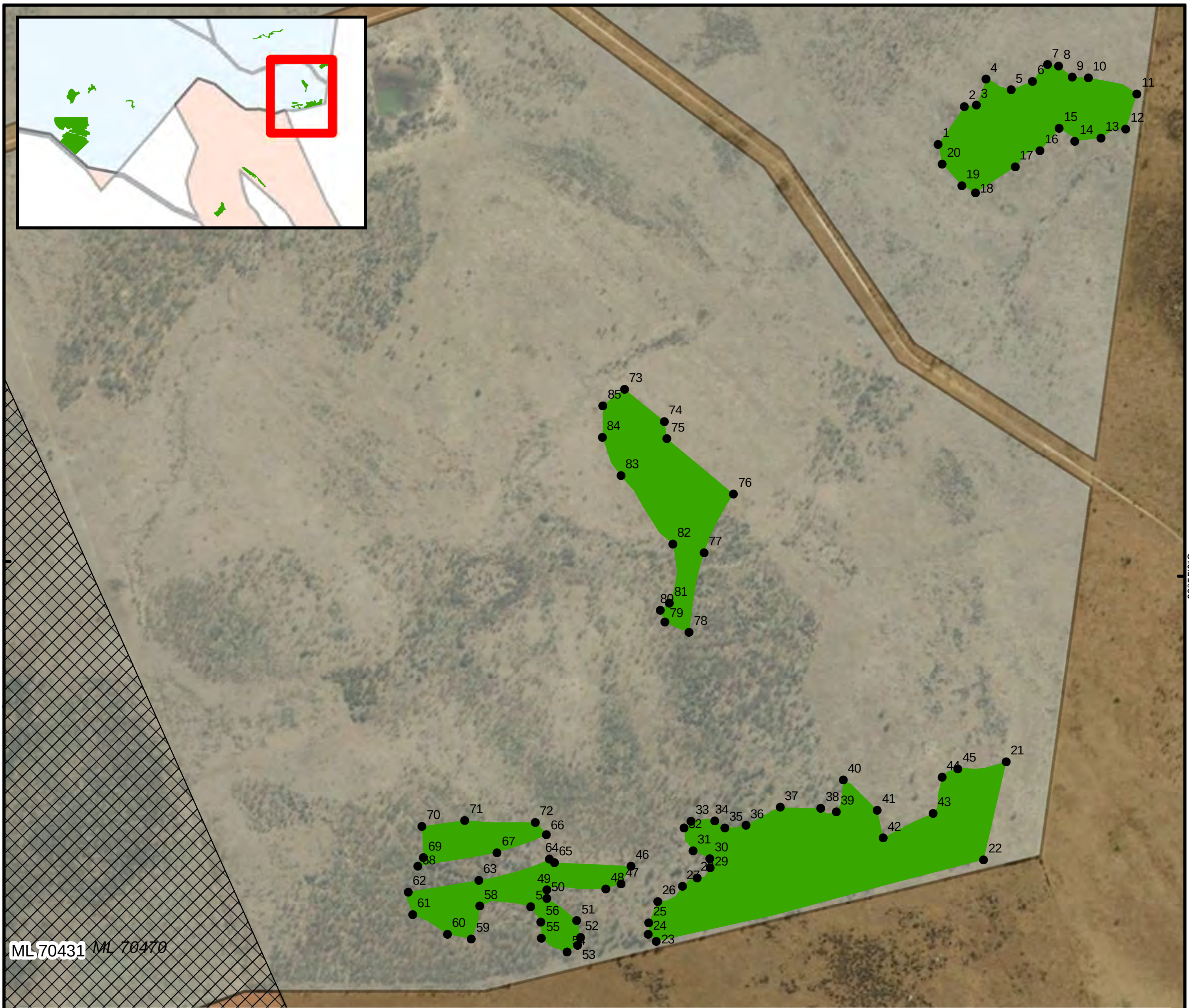
Reference co-ordinate	Easting	Northing	Latitude (decimal degrees)	Longitude (decimal degrees)
86	684367	7467407	-22.89113	148.79739
87	684173	7467284	-22.89226	148.79550
88	683976	7467324	-22.89193	148.79358
89	683918	7467321	-22.89195	148.79302
90	683844	7467282	-22.89232	148.79230
91	683902	7467242	-22.89267	148.79287
92	683902	7467209	-22.89297	148.79288
93	683807	7467171	-22.89332	148.79195
94	683696	7467190	-22.89316	148.79087
95	683709	7467142	-22.89359	148.79100
96	683696	7467017	-22.89473	148.79089
97	683530	7467036	-22.89457	148.78927
98	683368	7467144	-22.89361	148.78768
99	683297	7467109	-22.89394	148.78699
100	683326	7467048	-22.89449	148.78728
101	683298	7467016	-22.89478	148.78701
102	683186	7467033	-22.89464	148.78592
103	683102	7466983	-22.89509	148.78510
104	682906	7466953	-22.89539	148.78320
105	682889	7466997	-22.89499	148.78303
106	683106	7467020	-22.89477	148.78514
107	683252	7467133	-22.89373	148.78655
108	683294	7467135	-22.89370	148.78696
109	683357	7467186	-22.89323	148.78756
110	683419	7467191	-22.89318	148.78817
111	683559	7467071	-22.89426	148.78955
112	683650	7467108	-22.89391	148.79043
113	683667	7467211	-22.89298	148.79058
114	683767	7467284	-22.89231	148.79154
115	683934	7467372	-22.89150	148.79317
116	684192	7467356	-22.89161	148.79568
117	684264	7467420	-22.89103	148.79637
118	683525	7459887	-22.95912	148.79006
119	683454	7459854	-22.95943	148.78938
120	683204	7460106	-22.95718	148.78692
121	683145	7460230	-22.95606	148.78632
122	683085	7460295	-22.95549	148.78573
123	683083	7460341	-22.95507	148.78571
124	683042	7460347	-22.95502	148.78530
125	682981	7460269	-22.95573	148.78471
126	682954	7460286	-22.95558	148.78445
127	682985	7460346	-22.95503	148.78475
128	682925	7460342	-22.95508	148.78416
129	682854	7460392	-22.95463	148.78346
130	682858	7460428	-22.95431	148.78350

Reference co-ordinate	Easting	Northing	Latitude (decimal degrees)	Longitude (decimal degrees)
131	682800	7460412	-22.95446	148.78294
132	682706	7460481	-22.95384	148.78201
133	682694	7460515	-22.95354	148.78189
134	682519	7460632	-22.95251	148.78017
135	682343	7460815	-22.95087	148.77844
136	682507	7460803	-22.95096	148.78003
137	682744	7460628	-22.95252	148.78237
138	683011	7460462	-22.95398	148.78499
139	681402	7459150	-22.96601	148.76946
140	681522	7458889	-22.96835	148.77066
141	681591	7458797	-22.96917	148.77134
142	681563	7458740	-22.96969	148.77107
143	681490	7458757	-22.96955	148.77036
144	681451	7458651	-22.97051	148.76999
145	681199	7458421	-22.97261	148.76756
146	681027	7458599	-22.97102	148.76586
147	681235	7458757	-22.96957	148.76788
148	681230	7458826	-22.96895	148.76781
149	681378	7458944	-22.96787	148.76924
150	681363	7459089	-22.96657	148.76908
151	677221	7463689	-22.92547	148.72816
152	677151	7463670	-22.92566	148.72748
153	677179	7463571	-22.92654	148.72777
154	677154	7463581	-22.92645	148.72753
155	677053	7463745	-22.92498	148.72652
156	677070	7463854	-22.92400	148.72668
157	677095	7463915	-22.92345	148.72691
158	677061	7463964	-22.92301	148.72657
159	676927	7463978	-22.92289	148.72526
160	676794	7463954	-22.92312	148.72397
161	676776	7463980	-22.92289	148.72380
162	676831	7464024	-22.92249	148.72433
163	677046	7464039	-22.92233	148.72642
164	677135	7463994	-22.92273	148.72729
165	677156	7463913	-22.92346	148.72751
166	677133	7463870	-22.92385	148.72728
167	677125	7463809	-22.92440	148.72722
168	675383	7464521	-22.91816	148.71016
169	675341	7464471	-22.91861	148.70975
170	675297	7464510	-22.91826	148.70932
171	675283	7464547	-22.91793	148.70918
172	675249	7464557	-22.91784	148.70885
173	675218	7464535	-22.91805	148.70855
174	675148	7464523	-22.91816	148.70787
175	675113	7464490	-22.91847	148.70753

Reference co-ordinate	Easting	Northing	Latitude (decimal degrees)	Longitude (decimal degrees)
176	675111	7464453	-22.91880	148.70751
177	675080	7464446	-22.91887	148.70721
178	675014	7464342	-22.91981	148.70658
179	674973	7464351	-22.91974	148.70618
180	674963	7464366	-22.91960	148.70608
181	674973	7464427	-22.91905	148.70617
182	675027	7464491	-22.91846	148.70669
183	674976	7464558	-22.91787	148.70618
184	674981	7464587	-22.91760	148.70622
185	675022	7464636	-22.91715	148.70662
186	675015	7464649	-22.91704	148.70655
187	675027	7464668	-22.91686	148.70666
188	675056	7464639	-22.91712	148.70696
189	675077	7464607	-22.91741	148.70716
190	675098	7464607	-22.91741	148.70737
191	675110	7464615	-22.91734	148.70749
192	675100	7464647	-22.91705	148.70738
193	675107	7464658	-22.91695	148.70745
194	675136	7464669	-22.91684	148.70773
195	675142	7464696	-22.91660	148.70779
196	675114	7464765	-22.91598	148.70751
197	675130	7464785	-22.91580	148.70766
198	675181	7464789	-22.91575	148.70815
199	675217	7464753	-22.91608	148.70851
200	675218	7464722	-22.91636	148.70852
201	675283	7464717	-22.91639	148.70915
202	675326	7464702	-22.91652	148.70958
203	675332	7464630	-22.91717	148.70965
204	674610	7464361	-22.91968	148.70264
205	674433	7464241	-22.92078	148.70093
206	674340	7464080	-22.92225	148.70004
207	674264	7463868	-22.92417	148.69932
208	674226	7463887	-22.92400	148.69895
209	674124	7463845	-22.92439	148.69796
210	674128	7463973	-22.92323	148.69799
211	674075	7464053	-22.92252	148.69745
212	673991	7464099	-22.92211	148.69663
213	673959	7464187	-22.92132	148.69631
214	673957	7464228	-22.92095	148.69629
215	674021	7464333	-22.92000	148.69690
216	674059	7464484	-22.91863	148.69726
217	674156	7464572	-22.91782	148.69819
218	674223	7464570	-22.91783	148.69884
219	674279	7464538	-22.91812	148.69939
220	674383	7464407	-22.91929	148.70042

Reference co-ordinate	Easting	Northing	Latitude (decimal degrees)	Longitude (decimal degrees)
221	674463	7464413	-22.91922	148.70120
222	674525	7464446	-22.91892	148.70180
223	674559	7464406	-22.91928	148.70213
224	674380	7461397	-22.94647	148.70073
225	673632	7462045	-22.94070	148.69337
226	673793	7462230	-22.93900	148.69492
227	673730	7462271	-22.93864	148.69429
228	673776	7462404	-22.93744	148.69472
229	673828	7462371	-22.93774	148.69524
230	673940	7462512	-22.93645	148.69632
231	674352	7462387	-22.93753	148.70035
232	674407	7462409	-22.93733	148.70088
233	674020	7462522	-22.93634	148.69710
234	674087	7462586	-22.93576	148.69774
235	674227	7462639	-22.93527	148.69910
236	674162	7462677	-22.93493	148.69846
237	674101	7462636	-22.93531	148.69787
238	674042	7462630	-22.93537	148.69730
239	674007	7462633	-22.93535	148.69695
240	673873	7462742	-22.93438	148.69564
241	673788	7462582	-22.93583	148.69482
242	673589	7462645	-22.93528	148.69288
243	673439	7462833	-22.93360	148.69139
244	673360	7463015	-22.93197	148.69060
245	673367	7463206	-22.93024	148.69065
246	674960	7463229	-22.92987	148.70618
247	674964	7463031	-22.93165	148.70623
248	674994	7462967	-22.93223	148.70654
249	674999	7462884	-22.93297	148.70660
250	675027	7462861	-22.93318	148.70687
251	675020	7462778	-22.93393	148.70681
252	674957	7462769	-22.93402	148.70620
253	674898	7462693	-22.93471	148.70563
254	674920	7462681	-22.93482	148.70585
255	674904	7462649	-22.93511	148.70570
256	674839	7462638	-22.93521	148.70506
257	674846	7462613	-22.93544	148.70513
258	674810	7462585	-22.93570	148.70479
259	674837	7462577	-22.93577	148.70505
260	674857	7462595	-22.93560	148.70525
261	675050	7462490	-22.93653	148.70714
262	675063	7462379	-22.93753	148.70728
263	674991	7462337	-22.93792	148.70658
264	674941	7462346	-22.93784	148.70609
265	674910	7462311	-22.93816	148.70580

Reference co-ordinate	Easting	Northing	Latitude (decimal degrees)	Longitude (decimal degrees)
266	674915	7462266	-22.93857	148.70585
267	674529	7462369	-22.93768	148.70207
268	674511	7462340	-22.93794	148.70190
269	674769	7462281	-22.93845	148.70442
270	674912	7462178	-22.93936	148.70583
271	674883	7462151	-22.93961	148.70555
272	675035	7462030	-22.94068	148.70705



Reference co-ordinates (GDA94, Zone 55 UTM)

Reference	Easting	Northing	Reference	Easting	Northing	Reference	Easting	Northing	Reference	Easting	Northing
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2	686146	7465734	**24**	685351	7463647	**46**	685307	7463820	**68**	684769	7463819
3	686177	7465738	**25**	685352	7463677	**47**	685282	7463774	**69**	684784	7463841
4	686201	7465803	**26**	685374	7463730	**48**	685244	7463762	**70**	684780	7463919
5	686264	7465775	**27**	685436	7463769	**49**	685095	7463760	**71**	684888	7463935
6	686318	7465797	**28**	685474	7463790	**50**	685095	7463738	**72**	685065	7463930
7	686356	7465840	**29**	685506	7463815	**51**	685170	7463682	**73**	685290	7465022
8	686384	7465836	**30**	685506	7463839	**52**	685180	7463640	**74**	685391	7464940
9	686419	7465807	**31**	685463	7463859	**53**	685172	7463619	**75**	685397	7464897
10	686459	7465806	**32**	685441	7463916	**54**	685146	7463604	**76**	685565	7464757
11	686582	7465765	**33**	685458	7463932	**55**	685081	7463637	**77**	685491	7464610
12	686554	7465676	**34**	685519	7463934	**56**	685080	7463679	**78**	685454	7464409
13	686491	7465654	**35**	685543	7463916	**57**	685055	7463717	**79**	685392	7464434
14	686425	7465646	**36**	685596	7463922	**58**	684926	7463719	**80**	685381	7464465
15	686386	7465679	**37**	685682	7463968	**59**	684905	7463636	**81**	685404	7464482
16	686338	7465622	**38**	685785	7463965	**60**	684845	7463648	**82**	685412	7464630
17	686275	7465581	**39**	685823	7463956	**61**	684756	7463697	**83**	685281	7464803
18	686175	7465516	**40**	685841	7464036	**62**	684745	7463755	**84**	685234	7464900
19	686140	7465534	**41**	685927	7463961	**63**	684923	7463784	**85**	685236	7464979
20	686091	7465589	**42**	685942	7463891	**64**	685101	7463837			
21	686252	7464083	**43**	686068	7463952	**65**	685114	7463829			
22	686195	7463836	**44**	686091	7464044	**66**	685093	7463899			

Middlemount South Pty Ltd

Location diagram

Figure B-1: Offset area boundary

- Lot 4 SP248577
- Lot 20 SP276924
- Foxleigh Plains MLs
- Non-project MLs
- Offset areas
- Reference co-ordinates

N

0 0.2 0.4 0.6
Kilometres

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)
The following datasets are © State of Qld:
- Cadastral Data (2011)

CO2 Australia

Date: 04-11-2016 Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994 Scale: 1:15,000 @ A4

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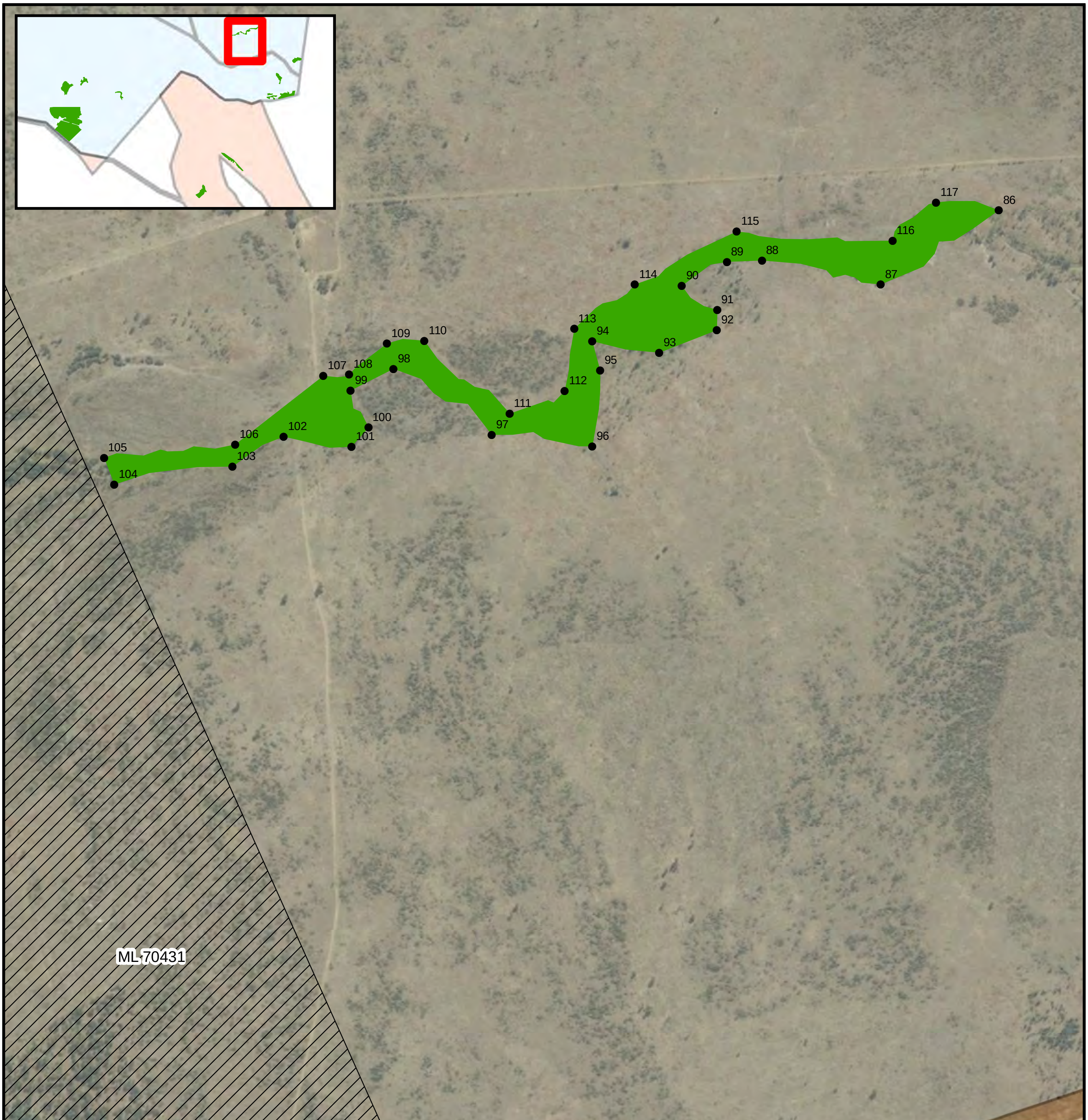

Reference co-ordinates (GDA94, Zone 55 UTM)

Reference	Easting	Northing	Reference	Easting	Northing	Reference	Easting	Northing	Reference	Easting	Northing
86	684367	7467407	**94**	683696	7467190	**102**	683186	7467033	**110**	683419	7467191
87	684173	7467284	**95**	683709	7467142	**103**	683102	7466983	**111**	683559	7467071
88	683976	7467324	**96**	683696	7467017	**104**	682906	7466953	**112**	683650	7467108
89	683918	7467321	**97**	683530	7467036	**105**	682889	7466997	**113**	683667	7467211
90	683844	7467282	**98**	683368	7467144	**106**	683106	7467020	**114**	683767	7467284
91	683902	7467242	**99**	683297	7467109	**107**	683252	7467133	**115**	683934	7467372
92	683902	7467209	**100**	683326	7467048	**108**	683294	7467135	**116**	684192	7467356
93	683807	7467171	**101**	683298	7467016	**109**	683357	7467186	**117**	684264	7467420

Middlemount South Pty Ltd

Figure B-2: Offset area boundary

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)
The following datasets are © State of Qld:
- Cadastral Data (2011)

Lot 4 SP248577
Lot 20 SP276924
Foxleigh Plains MLs
Non-project MLs
Offset areas
Reference co-ordinates

0 0.1 0.2 0.3
Kilometres

N

CO2 Australia

Location diagram

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Date: 04-11-2016 Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994 Scale: 1:9,000 @ A4

Path: P:\GIS\Data\Projects\Anglo_American\ENV01881926_20160606_offest_map_updates_split_State_Commonwealth\20161102_figB-2_offsetareas_outline.mxd

Reference co-ordinates (GDA94, Zone 55 UTM)

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118	683525	7459887	**127**	682985	7460346	**136**	682507	7460803	**145**	681199	7458421
119	683454	7459854	**128**	682925	7460342	**137**	682744	7460628	**146**	681027	7458599
120	683204	7460106	**129**	682854	7460392	**138**	683011	7460462	**147**	681235	7458757
121	683145	7460230	**130**	682858	7460428	**139**	681402	7459150	**148**	681230	7458826
122	683085	7460295	**131**	682800	7460412	**140**	681522	7458889	**149**	681378	7458944
123	683083	7460341	**132**	682706	7460481	**141**	681591	7458797	**150**	681363	7459089
124	683042	7460347	**133**	682694	7460515	**142**	681563	7458740			
125	682981	7460269	**134**	682519	7460632	**143**	681490	7458757			
126	682954	7460286	**135**	682343	7460815	**144**	681451	7458651			

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Figure B-3: Offset area boundary

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)

The following datasets are © State of Qld:
- Cadastral Data (2011)

Lot 4 SP248577
Lot 20 SP276924
Foxleigh Plains MLs
Non-project MLs
Offset areas
Reference co-ordinates

N

0 0.2 0.4 0.6
Kilometres

Location diagram

CO2 Australia

Date: 07-11-2016 Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994 Scale: 1:15,000 @ A4

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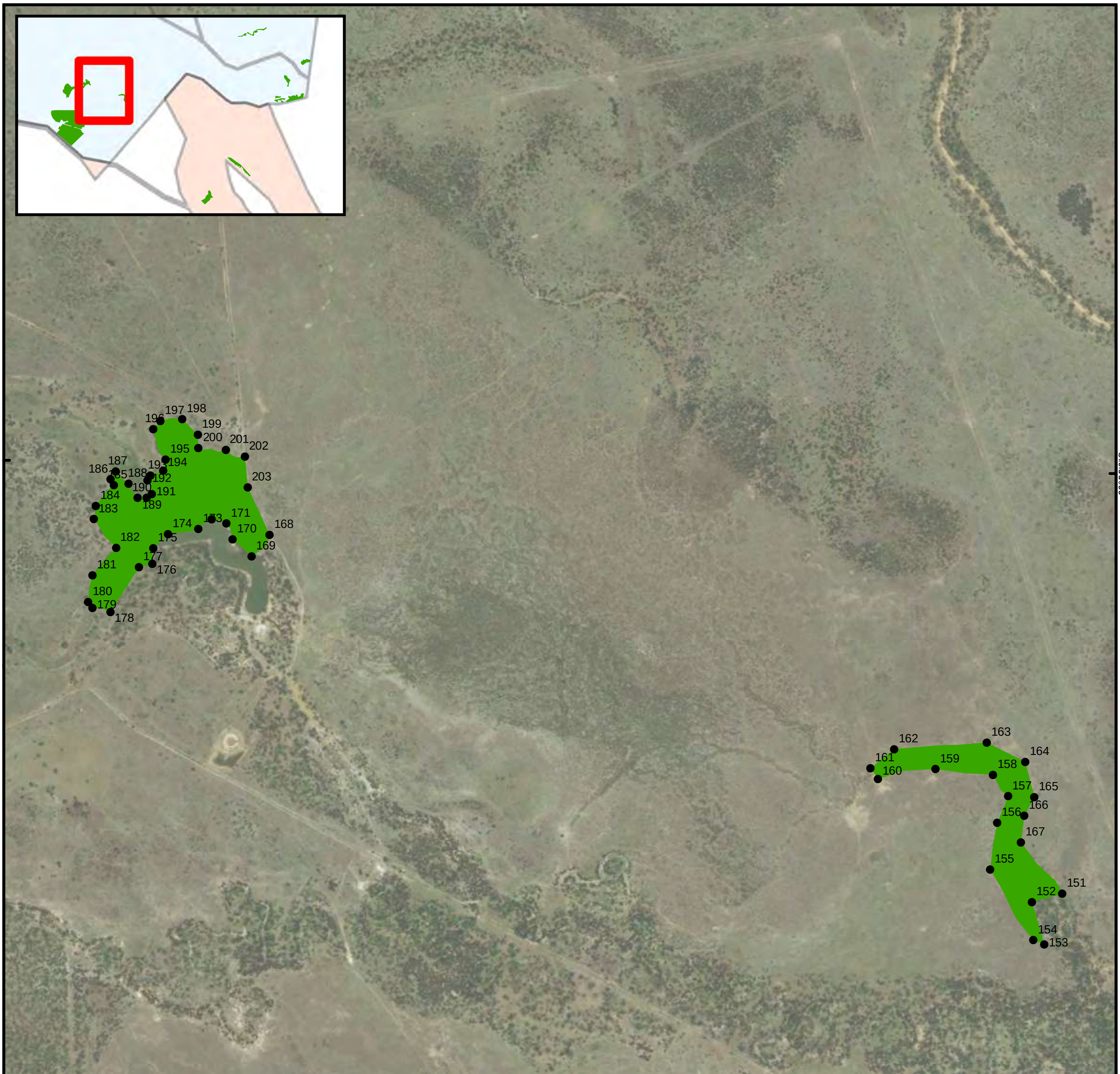

Reference co-ordinates (GDA94, Zone 55 UTM)

Reference	Easting	Northing	Reference	Easting	Northing	Reference	Easting	Northing	Reference	Easting	Northing
151	677221	7463689	**165**	677156	7463913	**179**	674973	7464351	**193**	675107	7464658
152	677151	7463670	**166**	677133	7463870	**180**	674963	7464366	**194**	675136	7464669
153	677179	7463571	**167**	677125	7463809	**181**	674973	7464427	**195**	675142	7464696
154	677154	7463581	**168**	675383	7464521	**182**	675027	7464491	**196**	675114	7464765
155	677053	7463745	**169**	675341	7464471	**183**	674976	7464558	**197**	675130	7464785
156	677070	7463854	**170**	675297	7464510	**184**	674981	7464587	**198**	675181	7464789
157	677095	7463915	**171**	675283	7464547	**185**	675022	7464636	**199**	675217	7464753
158	677061	7463964	**172**	675249	7464557	**186**	675015	7464649	**200**	675218	7464722
159	676927	7463978	**173**	675218	7464535	**187**	675027	7464668	**201**	675283	7464717
160	676794	7463954	**174**	675148	7464523	**188**	675056	7464639	**202**	675326	7464702
161	676776	7463980	**175**	675113	7464490	**189**	675077	7464607	**203**	675332	7464630
162	676831	7464024	**176**	675111	7464453	**190**	675098	7464607			
163	677046	7464039	**177**	675080	7464446	**191**	675110	7464615			
164	677135	7463994	**178**	675014	7464342	**192**	675100	7464647			

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Figure B-4: Offset area boundary

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)
The following datasets are © State of Qld:
- Cadastral Data (2011)

Lot 4 SP248577
Lot 20 SP276924
Foxleigh Plains MLs
Non-project MLs
Offset areas
Reference co-ordinates

N

0 0.2 0.4 0.6
Kilometres

Location diagram

Date: 04-11-2016 Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994 Scale: 1:13,000 @ A4

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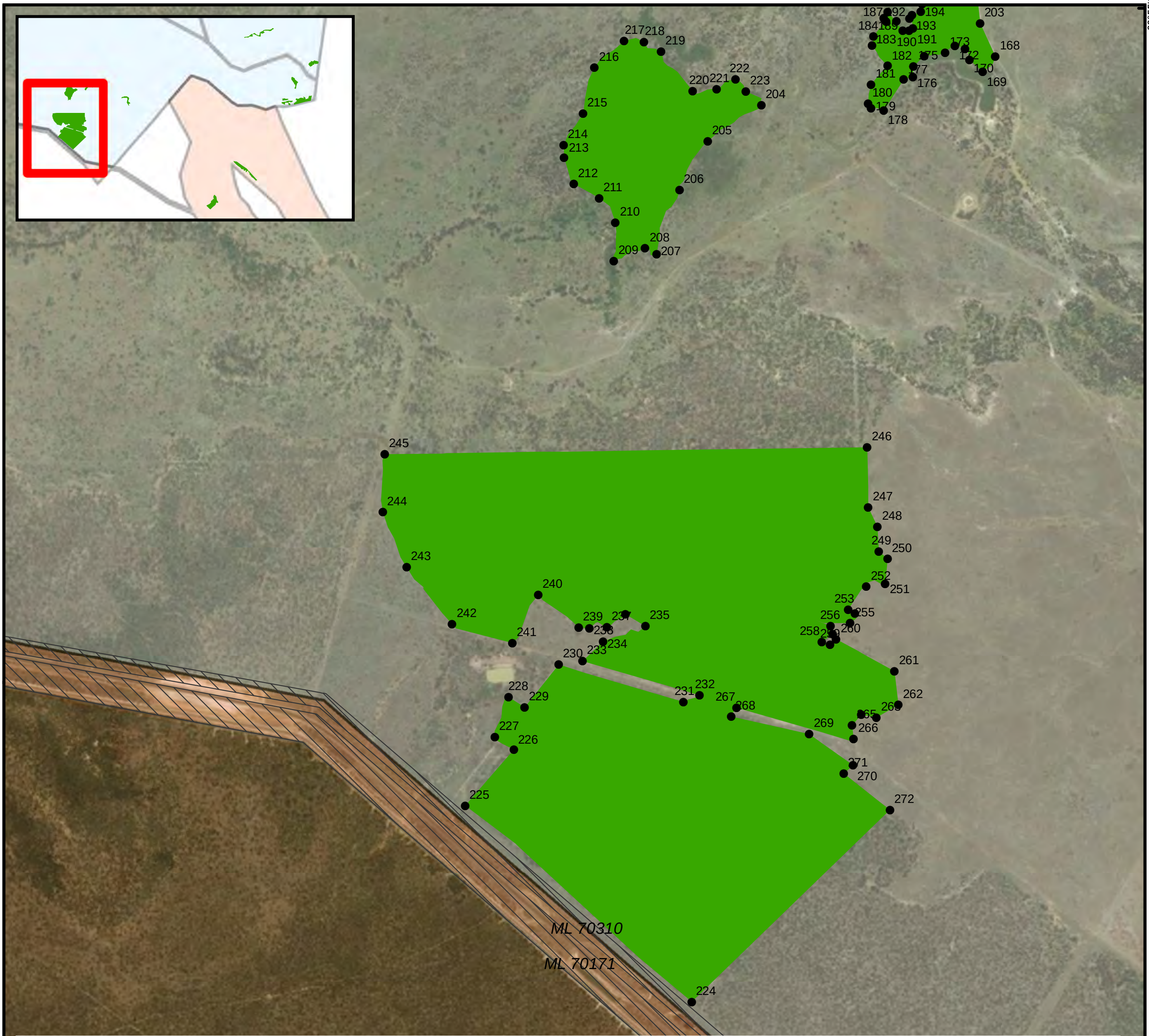

Reference co-ordinates (GDA94, Zone 55 UTM)

Reference	Easting	Northing	Reference	Easting	Northing	Reference	Easting	Northing	Reference	Easting	Northing
204	674610	7464361	**222**	674525	7464446	**240**	673873	7462742	**258**	674810	7462585
205	674433	7464241	**223**	674559	7464406	**241**	673788	7462582	**259**	674837	7462577
206	674340	7464080	**224**	674380	7461397	**242**	673589	7462645	**260**	674857	7462595
207	674264	7463868	**225**	673632	7462045	**243**	673439	7462833	**261**	675050	7462490
208	674226	7463887	**226**	673793	7462230	**244**	673360	7463015	**262**	675063	7462379
209	674124	7463845	**227**	673730	7462271	**245**	673367	7463206	**263**	674991	7462337
210	674128	7463973	**228**	673776	7462404	**246**	674960	7463229	**264**	674941	7462346
211	674075	7464053	**229**	673828	7462371	**247**	674964	7463031	**265**	674910	7462311
212	673991	7464099	**230**	673940	7462512	**248**	674994	7462967	**266**	674915	7462266
213	673959	7464187	**231**	674352	7462387	**249**	674999	7462884	**267**	674529	7462369
214	673957	7464228	**232**	674407	7462409	**250**	675027	7462861	**268**	674511	7462340
215	674021	7464333	**233**	674020	7462522	**251**	675020	7462778	**269**	674769	7462281
216	674059	7464484	**234**	674087	7462586	**252**	674957	7462769	**270**	674912	7462178
217	674156	7464572	**235**	674227	7462639	**253**	674898	7462693	**271**	674883	7462151
218	674223	7464570	**236**	674162	7462677	**254**	674920	7462681	**272**	675035	7462030
219	674279	7464538	**237**	674101	7462636	**255**	674904	7462649			
220	674383	7464407	**238**	674042	7462630	**256**	674839	7462638			
221	674463	7464413	**239**	674007	7462633	**257**	674846	7462613			

Middlemount South Pty Ltd

Figure B-5: Offset area boundary

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)

The following datasets are © State of Qld:
- Cadastral Data (2011)

Lot 4 SP248577
Lot 20 SP276924
Foxleigh Plains MLs
Non-project MLs
Offset areas
Reference co-ordinates

N

0 0.2 0.4 0.6
Kilometres

CO2 Australia

Location diagram

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Date: 04-11-2016 Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994 Scale: 1:19,000 @ A4

Path: P:\GIS\Data\Projects\Anglo_American\ENV01881\926_20160606_offest_map_updates_split_State_Commonwealth\20161102_figB-5_offsetareas_outline.mxd

APPENDIX C BIODIVERSITY OFFSET FIELD SURVEY REPORT & OFFSET PROPOSAL

INTERNAL

BIODIVERSITY OFFSET FIELD SURVEY REPORT & OFFSET PROPOSAL

FOXLEIGH PLAINS & COCKATOO CREEK DIVERSIONS

Revision

Revision	Author	Reviewed	Approved	Date
1.0	Shaun Collins	Ben Saunders Steven Leighton Layla Howe Owain Davies Skye Davis Elise Luscombe		

Contents

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Abbreviations and Acronyms

Abbreviation	Description
AU	Assessment Unit
BOS	Biodiversity Offset Strategy
BVG	Broad Vegetation Group
DoE	Department of the Environment (Commonwealth)
DSEWPAC	Department of Sustainability, Environment, Water, Population and Communities (Former title of Commonwealth regulatory agency)
DSITIA	Department of Science, information Technology, Innovation and the Arts
EC	Ecological Condition
EE	Ecological Equivalence
EEM	Ecological Equivalence Methodology(Oct 2011)
EIS	Environmental Impact Statement
EHP	Department of Environment and Heritage Protection (Queensland)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPBC EOP	Environment Protection and Biodiversity Conservation Environmental Offset Policy
GPS	Global Positioning System
HVR	High Value Regrowth
ML	Mining Lease
MLA	Mining Lease Application
MNES	Matters of National Environmental Significance
OAG	Offset Assessment Guide
QLD	Queensland
QBOP	Queensland Biodiversity Offset Policy (January 2014)
QGEOP	Queensland Government Environmental Offsets Policy (Month Year)
QPVMO	Queensland Policy for Vegetation Management Offsets (Month Year)
RE	Regional Ecosystem
REDD	Regional Ecosystem Description Database
SF	Special Feature
SO	Stream Order
TEC	Threatened Ecological Community
VM Act	Vegetation Management Act 1999 (Queensland)

1 EXECUTIVE SUMMARY

Anglo American is proposing to develop activities associated with the operations of their Foxleigh coal mine which is located in the Bowen Basin in Central Queensland, 12 km south-west of Middlemount. These developments include the expansion of the existing open-cut Foxleigh Mine and the two staged diversion of Cockatoo Creek. These activities will require the clearing of a number of state significant biodiversity values that will require offsetting,

The projects offset requirements were addressed in two separate biodiversity offset strategies which were prepared by Ecofund. Each document was submitted to the Department of Environment and Heritage Protection to outline the required offsets and the proposed approach to delivering the necessary offset requirements. The combined total impact areas required to be offset are shown in Table ES1 below. A number of potential offset properties were identified within these strategies and adjacent two properties owned by Anglo American were chosen to demonstrate the ecological equivalence of proposed offset areas.

Table ES1: Summary of combined Foxleigh project offset requirements

State Significant Biodiversity Values			Combined Clearing Areas (Stage One, Stage Two & Fox Plains)
Environmental Value	Species/community	VM Class	Impact (ha)
Threatened RE listed under the VM Act	RE 11.3.1 (BVG 25a)	Endangered	26.29
	RE 11.3.2 (BVG 17a)	Of concern	14.17
	RE 11.3.3 (BVG 16c)	Of concern	2.36
	RE 11.3.4 (BVG 16c)	Of concern	1.50
High Value Regrowth	RE 11.3.1, 11.4.9, 11.9.5 (BVG 25a)	Endangered	94.63
Watercourse vegetation listed under the VM Act	Stream order 3 watercourse	NA	109.37

Section 3 details the methodology used to demonstrate the ecological equivalence of the proposed offset areas, including detailed field-based and desktop assessments. Both the ecological condition and special features of the clearing and offset areas were determined by evaluating a series of 14 indicators for each criterion. The clearing and offset areas were then scored for each indicator and an overall ecological condition score and an overall special features score was calculated for the clearing area and the offset area.

Through detailed assessment of both the impacted area and the proposed offset areas it has been concluded that the ecological condition and special features are deemed to be ecologically equivalent. This is summarised in table ES2 below. Further detail describing the scoring associated with the criteria for the two impact areas and the proposed offset areas is outlined in Section 4.

Table ES2: Ecological Equivalence Summary

State Significant Biodiversity Values			Combined Clearing Areas (Stage One, Stage Two & Fox Plains)			Foxleigh Proposed Offset Area			Special feature adjacency score trial
Environmental Value	Species/community	VM Class	Impact (ha)	EC Score	SF Score	(ha)	EC Score	SF Score	
Threatened RE listed under the VM Act	RE 11.3.1 (BVG 25a)	Endangered	26.29	11.84	9.85	30.73	18.40	4.60	19.36
	RE 11.3.2 (BVG 17a)	Of concern	14.17	7.69	6.87	15.11	8.65	1.54	14.57
	RE 11.3.3 (BVG 16c)	Of concern	2.36	1.40	0.31	16.11	10.47	3.33	
	RE 11.3.4 (BVG 16c)	Of concern	1.50	1.07	0.56				
High Value Regrowth	RE 11.3.1, 11.4.9, 11.9.5 (BVG 25a)	Endangered	94.63	36.35	35.92	124.55	56.21	78.37	
Watercourse vegetation listed under the VM Act	Stream order 3 watercourse	NA	109.37	22.06	50.227	144.07	73.44	78.37	

Completing the required ecological equivalence work across both the clearing areas and the proposed offset area has assisted in reducing the subjectivity in the proposed offset selection. It has also provided a transparency and clarity in the approach taken to compare ecological attributes between the impact area and the proposed offset area.

The results of this detailed ecological equivalence assessment demonstrates that the offset area ecological condition and special features scores exceed the clearing area ecological condition and special features score. As such it is therefore proposed that the suggested offset areas are more than suitable to fulfil the offset requirements for the Foxleigh Plains mine expansion project and the Cockatoo Creek Stage One and Stage Two Diversion projects.

2 INTRODUCTION

2.1 Purpose of document

Anglo American's Australian coal business has developed this document in accordance with the Queensland Biodiversity Offset Policy (QBOP) for the construction of the Foxleigh Plains (FL Plains) mine expansion project and the Cockatoo Creek Stage One and Stage Two Diversion projects.

This document aims to:

- Provide an overview of the FL Plains, Cockatoo Creek Stage One and Stage Two Diversion projects that require offsetting under the QBOP.
- Detail the State Significant Biodiversity Values (SSBV's) anticipated to be impacted by each project.
- Identify the proposed areas to offset the residual impacts on SSBV's, which will be incorporated into the offset management plan for each project.
- Describe the steps taken by Anglo American to assess the Ecological Equivalence of the proposed offset area against the combined clearing areas of these projects; and
- Serve as an offset proposal to be submitted to relevant regulatory agencies demonstrating that Ecological Equivalence has been met.

It is important to note this document only addresses offset requirements under Queensland policies, however it may be used to support any documents developed to meet Federal offset policy requirements and legal obligations.

2.2 Project Background

Anglo American is proposing to develop activities associated with the existing operations of the Foxleigh coal mine located in the Bowen Basin. EPML00744813 (formerly MIN100734308) contains mining leases ML 70171, ML 70309, ML70470 and ML70310 and is more generally known as the Foxleigh Project. In regional terms the mine is located in Central Queensland on the eastern flank of the Bowen Basin approximately 12 km south of Middlemount and 230 km south west of Mackay. The mine's location is shown in the regional locality plan (Figure 1). The Foxleigh Project is located approximately 17 km east of Anglo American's existing German Creek Mining complex.

Currently works are underway to extend Foxleigh mining operations through the development of the FL Plains Project, ensuring current production levels are maintained for at least an additional fifteen years. The FL Plains project covers an area of approximately 3400 ha and is located to the north of ML70470 and ML70171 and the area between ML70171 and ML70309 (refer to Figure 3). An EIS process was undertaken to obtain the requisite state environmental approvals for the FL Plains project with a draft Environmental Authority issued for the project in December 2013.

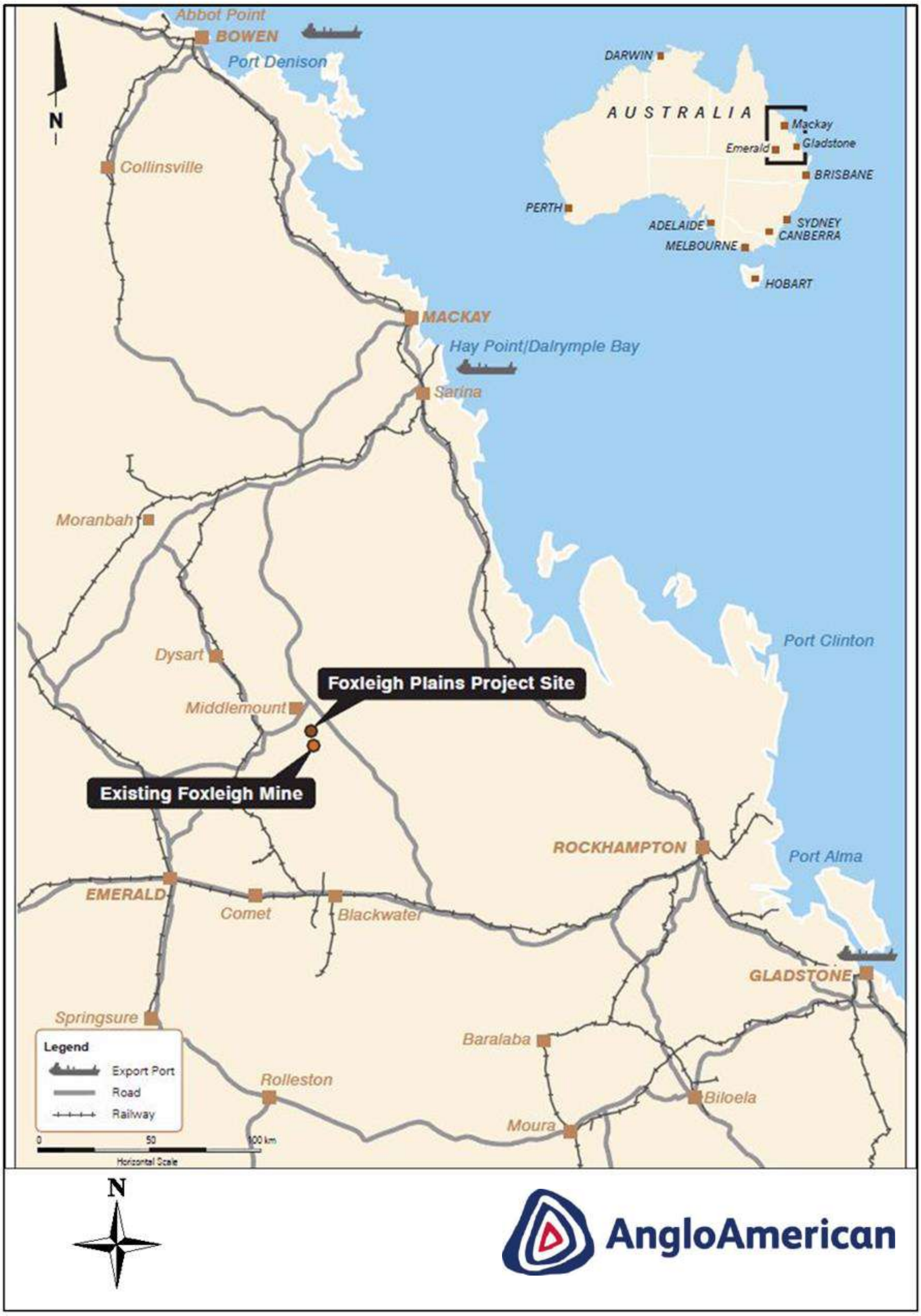

Figure 1: Foxleigh Mine Location

2.2.1 **Cockatoo Creek Stage One and Stage Two Diversions**

Anglo American has proposed the on lease two staged diversion of Cockatoo Creek to allow for the expansion of One Tree Pit and Pipeline Pit North at Foxleigh Mine. The project is located within Anglo American's existing mining Leases (ML70309 and ML71071) on Lot 6 SP189240.

Stage One involves the construction of a 2.7 km diversion channel and a 3.5 km levee (that mitigates risk of flooding of pits and associated infrastructure) to allow for the expansion of the One Tree Pit. The diversion channels have been designed to have a similar bed grade to the reaches being replaced. The levee will parallel the diversion; however it will be a little longer, tying into high ground east of the diversion. The levee will be located between the diversion channel and open cut pits to contain flows up to the Q2000 event, with a 0.5 m freeboard. The levee bank will also be used to form a diversion plug at each end of the diversion to prevent stream flows from entering the abandoned section of creek.

The Stage Two diversion channel, to allow for the expansion of Pipeline Pit North, is proposed to extend the Stage One diversion and levee. The Stage Two diversion channel is designed to be 2.28km along with a 1.7m levee. The Stage Two diversion and Pipeline Pit North expansion is still subject to exploration drill analysis, feasibility studies and the alignment of timing for this project with current operational schedules. The Stage Two levee will be located beside the diversion and has been designed into the Stage One levee. At the completion of the Stage Two, the entire creek diversion would be 4.98 km and the levee 5.2 km in length (Figure 2).

2.2.2 **Foxleigh Plains**

FL Plains involves the expansion of the existing open-cut Foxleigh Mine into the FL Plains site. Anglo American has applied for three mining leases; MLA 70429, MLA 70430 and MLA 70431 adjacent to, and north of, the existing Foxleigh Mine (ML70171 and ML70309). The anticipated grant of these MLAs is by mid-2014.

The project site is flat to gently undulating and traversed by Roper Creek in the south-west, and Cockatoo Creek, which runs in a north to south direction in the eastern portion of the site. The project site is currently used for cattle grazing and has been largely cleared of vegetation with the exception of riparian areas associated with Cockatoo Creek.

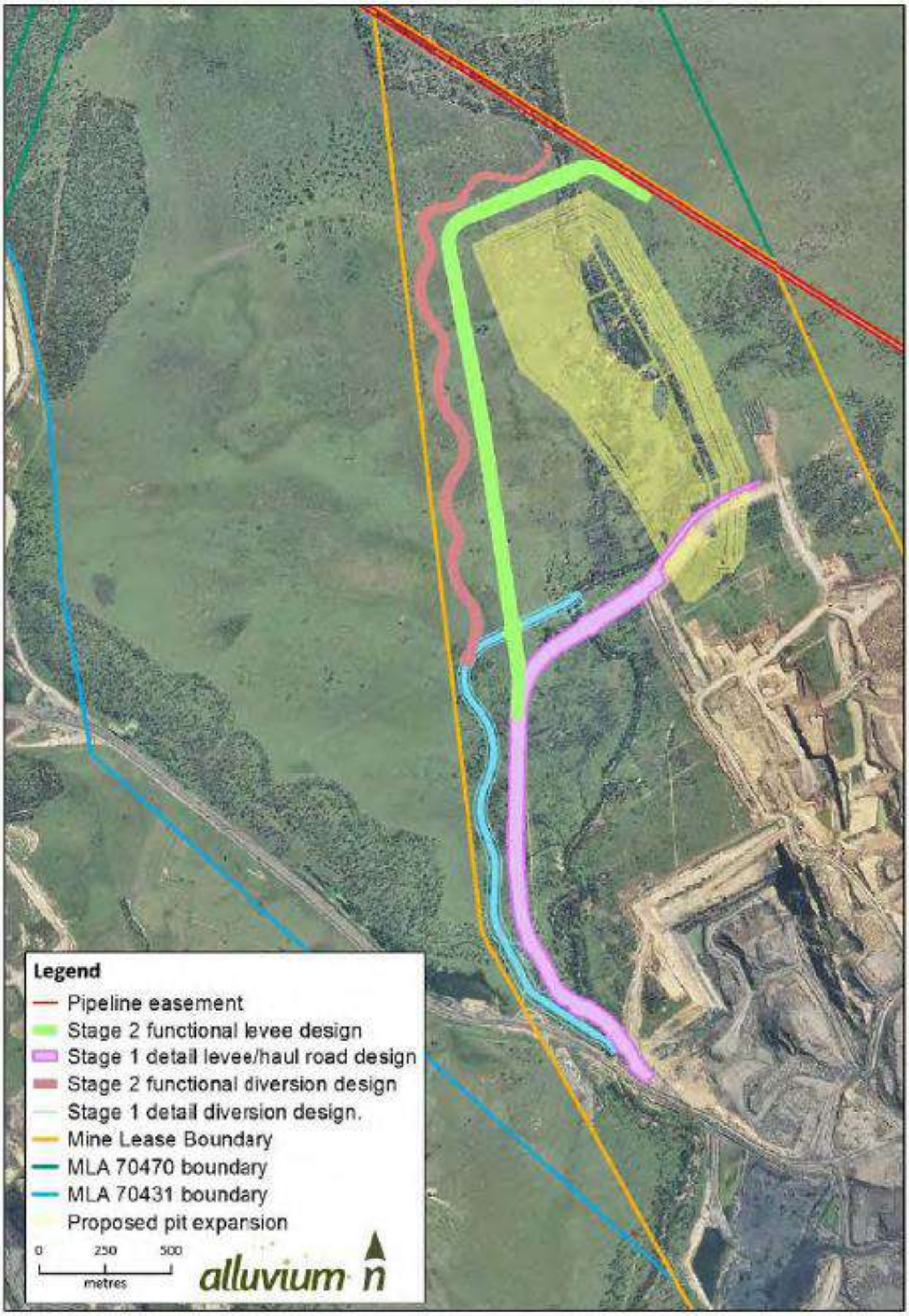

Figure 2: Cockatoo Creek Stage One and Stage Two levee design

2.3 Offset policies and Assessment Methods

In order to satisfy State approval requirements, significant impacts to environmental values must be offset. It must however be demonstrated that all efforts have been taken to firstly avoid and then minimise any impact to these values. When this has been demonstrated and there remains a residual impact, efforts must be taken to offset the impact. The purpose of the Queensland offset policies is to provide a systematic approach that aims to increase the long-term protection and viability of a set of environmental values.

The development of the environmental offsets strategy for the Cockatoo Creek Stage One and Stage Two Diversions and the FL Plains project has progressed over a number of years. During this time the Queensland Government has undertaken a major review of the State's approach of environmental offsets. As such works to date to satisfy the offset requirements have been managed under the previous Queensland Governmental Environmental Offset Policy and the Queensland Biodiversity Offset Policy. This report details how the offset strategies to date reflect these requirements.

2.3.1 Queensland Government Environmental Offsets Policy (QGEOP) and Queensland Biodiversity Offset Policy (QBOP)

The Queensland Government Environmental Offsets Policy (QGEOP) establishes a strategic framework for using and applying environmental offsets in Queensland. The QGEOP is based on seven principles that guide the use of offsets to achieve ecologically sustainable development:

- Offsets will not replace or undermine existing environmental standards or regulatory requirements, or be used to allow development in areas otherwise prohibited through legislation or policy
- Environmental impacts must first be avoided, then minimised, before considering the use of offsets for any remaining impact
- Offsets must achieve an equivalent or better outcome
- Offsets must provide environmental values as similar as possible to those being lost
- Offset provision should minimise lag time between the impact and the offset delivery
- Offsets must provide additional protection to environmental values at risk, or additional management actions to improve environmental values
- Offsets must be legally secured for the duration of the offset requirement.

The *Vegetation Management Act 1999* (VM Act) regulates vegetation clearing in Queensland. Given the exemptions under the VM act the for the clearing of vegetation in project areas that are subject to a mining lease, the Queensland Policy for Vegetation Management Offsets, (QPVMO) doesn't apply to these projects. Any clearing outside of a ML or MLA will trigger the provisions of this policy.

The Queensland Biodiversity Offset Policy (QBOP) applies to activities associated with a ML. The purpose of the QBOP is to increase the long term protection and viability of the state's biodiversity where residual impacts from a development on an area possessing State Significant Biodiversity Values SSBV's cannot be avoided. The QBOP provides the framework to ensure that there is no net loss of biodiversity.

2.3.2 Biodiversity Offset Strategy

CO_2 Australia (formerly Ecofund) was contracted to develop a separate Biodiversity Offset Strategy (BOS) for each of these projects. The BOS for the Cockatoo Creek State One and Stage Two Diversion project was developed in September 2013 and the BOS for the FL Plains project was developed in July 2013.

These strategies were compiled and submitted to the Department of Environment and Heritage Protection (EHP) in accordance with the QBOP. The documents outlined the SSBV's that were proposed to be impacted by each project and how Anglo American intended on meeting and delivering the necessary offset requirements.

2.4 Ecological equivalence method and criterion indicators

The Ecological Equivalence Methodology (EEM) was developed by EHP and the Queensland Herbarium. First published in October 2011, it provides a standardized approach that allows for vegetation within a proposed clearing area and offset area to be adequately assessed, scored and compared across a variety of features.

Implementation of the EEM underpins the QBOP and facilitates a broad vegetation assessment to determine whether vegetation in a proposed offset area is of a condition suitable to actually offset the values that will be impacted and ensure the offset will deliver equivalent or improved ecological outcomes.

Ecological Equivalence assessments are undertaken by assessing the Ecological Condition and the Special Features across the proposed clearing area and offset area. The first criterion, Ecological Condition (EC), is assessed using a standard set of 14 indicators. Ten of these indicators are field based and four are GIS based. The ten field based indicators require the collection of a range of data which characterise the structure and composition of plant arrangements. The four GIS based indicators are assessed by undertaking spatial analyses on spatial data and detailed aerial photography.

Prior to assessing any of the EEM indicators, the vegetation within the clearing and offset area must be field verified. Following this, it needs to be confirmed that the proposed offset areas are not located within category B areas outlined on the regulated vegetation map provided by EHP. In order to assess both the impacted areas and the offset areas to determine their equivalence a number of smaller areas called assessment units (AU) are allocated to each area. These areas form the basis for further assessment to determine if the areas are of the same RE type and in the same condition. The Ecological Equivalence assessments of these separate AUs can then be conducted.

The second criterion, Special Features (SF), is assessed by undertaking a desktop spatial analysis using GIS data available from EHP. The process undertaken by Anglo American in identifying the offset requirements and available offset areas is listed in more detailed in section 3.

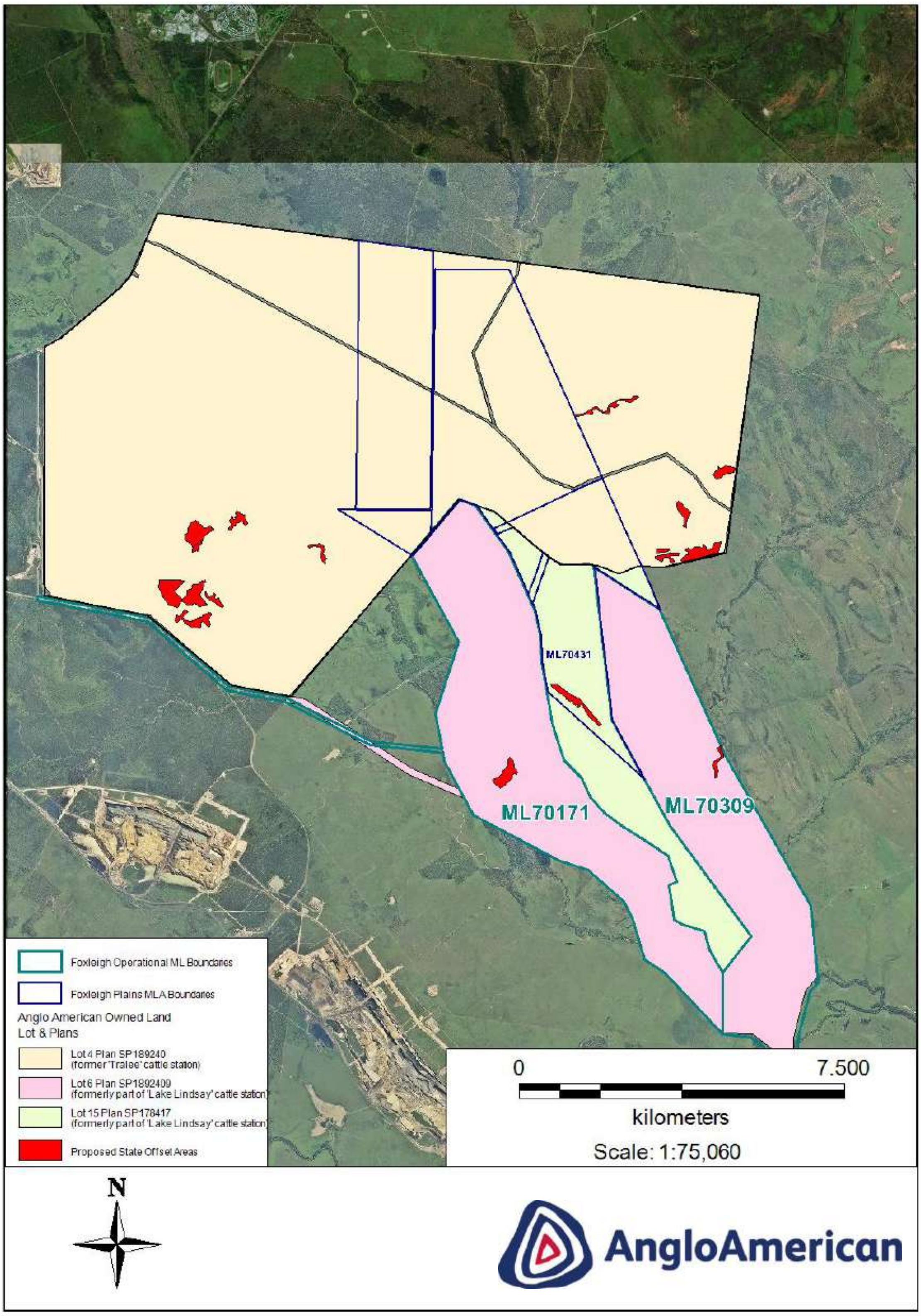

Figure 3: Anglo American owned land and proposed offset areas

3 METHODOLOGY

3.1 Offset requirements

Offset requirements under the QBOP are primarily focused on providing a land based offset where an ecological equivalence can be achieved between the impacted area and the proposed offset area. Fauna values were not included in the scope of work largely because the proposed offset areas provide a suitable, protected habitat for any affected species. Two approaches were taken to assess the offset requirements for FL Plains and the Cockatoo Creek Stage One and Stage Two Diversion.

Desktop analysis and field verification surveys were conducted to assess the offset requirements for FL Plains. This involved an analysis of the FL Plains EIS information and field surveys conducted in May 2011. These were then compared with field surveys conducted by Anglo American between October 2012 and December 2012.

The offset requirements for Cockatoo Creek Stage One & Stage Two Diversion project were determined by field surveys of both potential impact and offset areas (discussed further in section 4). This survey was carried out by Anglo American between January 2013 and April 2013. On ground vegetation was cross checked against Regional Ecosystem maps provided by the Queensland Herbarium and the Regional Ecosystem Description Database (REDD).

During this process both CO_2 Australia and the Queensland Herbarium, were regularly consulted for interpretation of QBOP guidelines and scenario specific offset requirements with these projects.

3.1.1 **Offset area identification & field verification**

Criteria outlined within the the EEM and QBOP was used to guide Anglo American with the identification of potential offset options. The aim was to match offset values located on Anglo American owned land. This primarily includes:

- Lot4 on Plan SP189249: the former 'Tralee' cattle station that was purchased as part of the land acquisition for the development of FL Plains;
- Lot 6 Plan SP189240 and Lot 15 Plan SP178417: these land parcels were a portion of the 'Lake Lindsay' cattle station and were purchased as part of the land acquisition for Foxleigh mine operations..

Detailed studies of potential coal resources within the region have been undertaken and it has been determined that the mining of coal in these areas would be un economical. As a result no mining activities are forecast for these areas. The proposed offset area locations are shown in relation to land tenure and Foxleigh operation features in Figure 3.

The proposed offset areas are not mapped as remnant vegetation under Queensland Herbarium and REDD. Identifying the potential offset areas involved Anglo American undertaking a number of desktop studies and field identification processes. These are detailed further in the following sections.

3.1.2 **Desktop study**

All available parcels of land were mapped using the most current Queensland Herbarium RE mapping layer (version 8) in conjunction with the most recent aerial photography of the Foxleigh mining area (December 2013). This analysis of the aerial photography was undertaken to identify all potentially suitable vegetation area outside the ‘remnant’ vegetation as shown on the Queensland Herbarium RE mapping layer

Potentially suitable vegetation was then compared to three data sets;

- Surface geology mapping – to determine the most likely equivalent land zone.
- Queensland Herbariums pre - clear mapping layer - to identify which RE’s were believed to present before European clearing; and
- Queensland Herbarium RE mapping layer - to locate remnant RE’s.

The potential RE’s outside of these areas were identified to assist with field verification. The polygons were then uploaded onto a handheld GPS in preparation for field verification.

3.1.3 **Field Verification**

Following the spatial analysis, each outlying vegetation area was surveyed in the field to verify the desktop findings. The field verification was made up of three components which included;

- The land zone and subsurface material was compared against surface geology resources.
- The composition of flora species in each area of vegetation was compared against that of the identified RE descriptions and in some cases involved extensive cross checking with the Queensland Herbarium REDD for accurate RE identification
- Vegetation structure was compared with corresponding Queensland herbarium RE Benchmark data to determine the status (i.e. regrowth or remnant)

An assessment of existing vegetation mapping was compared with field verified information and new maps were developed incorporating this field verified vegetation.

3.1.4 **Plant identification**

During field surveys all plants were identified using a range of field guides and online resources. Any plant species that could not be identified to a species level were then identified to a genus level. In circumstances were plants could not be identified at all, they were assumed to be native so as not to unfairly affect the equivalency scoring. This approach was completed for both the clearing and offset areas. Resources used for plant identification included:

- Anderson, E.R. (2003). *Plants of central Queensland; their identification and uses*. Department of Primary Industries, QLD.
- Milson, J (2002). *Pasture Plants of north-west Queensland*. Department of Primary Industries, QLD.
- Milson, J (2000). *Trees and Shrubs of north-west Queensland*. Department of Primary Industries, QLD.
- Holliday, I. (2010). *A Field Guide to Australian Trees*. Reed Holland, Australia.
- Eddie. C. (2012) Santos Field Guide to Trees and Shrubs of Eastern Queensland Oil and Gas Fields. Santos, Australia.

3.1.5 **Offset Identification**

Based on locations of proposed impacts, offset requirements were identified following the field verification and plant identification. An understanding of the locations of field verified remnant and High Value Regrowth (HVR) RE’s allowed a comparison with impacted SSBV’s to be made. Where offset areas could not be matched on a like for like basis (in accordance with

QBOP), they were matched to a Broad Vegetation Group (BVG) level. Knowledge of the areas being impacted assisted in the preparation of the Ecological Equivalence (EE) scoring process.

3.2 Ecological Equivalence Methodology

3.2.1 **Site stratification/Assessment Unit selection**

The vegetation within the respective project areas (FL Plains, Cockatoo Creek Stage One and Stage Two Diversion) were grouped together to form Assessment Units (AU). This grouping was based upon RE type, condition and geographic isolation. In some situations patches of vegetation that were the same RE type and in similar condition were treated as separated AU's. This was largely due to their high level of fragmentation and the large distances between these "islands" of vegetation.

Within each AU a number of multiple sample sites were chosen. In accordance with the EEM, sample sites were chosen in areas of each AU where the vegetation was representative of the AU as whole. In addition, the size of the AU also determined the number of sample sites that were chosen within the AU.

This process of AU selection and the location of sample sites was the same method that was carried out to select AUs within the proposed offset areas. This ensured the same process was used across both impact area and offset area. The locations of selected AUs are shown in Figures 6, 7, and 8.

3.2.2 **Ecological Equivalence Scoring**

The process for conducting an ecological equivalence analysis is outlined in the Ecological Equivalence Methodology Guideline. Both the field based EC assessment and the desktop analysis of EC and SF scoring was carried out on the impacted areas and offset areas in accordance with the methodology. These completed scoring tables are available in Appendix 3. The specific dates generally occurred between September 2012 and May 2014. Examples of completed field assessment sheets have been provided in Appendix 4.

Throughout the EEM process certain scoring scenarios arose that were not accounted for in the EEM. Detailed discussions between Anglo American and the Queensland Herbarium allowed an appropriate approach to be developed to effectively score these scenarios. These discussions with the Queensland Herbarium were maintained from September 2012 through to January 2013 and any additional questions were addressed throughout the remainder of 2013.

Once scores were obtained for each AU, they were then combined on a SSBV level to give a complete Ecological Equivalence score for that SSBV (matching BVG and VM class). This allowed these scores to be combined across both of the proposed clearing areas (all AU's that contained RE's of the same BVG and had the same Vegetation Management (VM) class (or higher) were combined across the clearing areas). This allowed for a clear conclusion to be reached in that Ecological Equivalence was demonstrated by the proposed offset area across the entirety of the proposed Foxleigh clearing area.

In March 2014, CO_2 Australia was contracted by Anglo American to specifically provide support, guidance and assistance with the interpretation of the QBOP & EEM during the final stages of the Ecological Equivalence scoring process.

3.2.3 **Bio-condition Benchmark data**

The values for the field based EC indicators were scored by comparing these values against the bio condition benchmark data for that RE. These bio condition benchmark datasets were obtained from the Bio condition Benchmarks for Regional Ecosystem Condition Assessment document (DSITIA). For obtaining RE data that was not printed in this publication, the Queensland Herbarium was contacted and draft sets were made available. These additional datasets were needed for the assessment of RE's 11.3.25, 11.3.3, 11.4.9.

3.2.4 **Special Feature (SF) scoring scenario**

During the assessment several special feature scoring scenarios arose that were not accounted for in the EEM. These scenarios were discussed further with the Queensland Herbarium and an approach to the assessment of these scenarios was developed. Examples of these scenarios are summarised below.

1. Remnant vegetation with multiple special features:

    Some remnant patches of vegetation that had different SF's overlapping different portions of it were encountered. For example, within a 10 ha AU, 6 ha were overlapped by one feature and 4 ha by another feature. With guidance from the Queensland Herbarium, a score was allocated to each portion (e.g. 6 ha portion and 4 ha portion) for overlapping features. Each portion was then weighted by the area that overlaps it. These scores were then added to give a total score for that AU.

2. HVR with overlapping special features:

    The EEM prescribes an 'adjacency calculation' method for scoring SF for HVR. The EEM claims this process is aimed at quantifying and qualifying the proximity of an area to nearby remnant vegetation with special features. During the offset area survey, AU's containing HVR vegetation that had SF's overlapping them were encountered.

The Queensland Herbarium advised that the adjacency calculation method should be conducted for the entirety of the AU, which meant treating the portion that is overlapped by the SF and the portion that isn't, as one. The portion that is overlapped by a SF is scored as per the remnant vegetation but is weighted by the percentage of area containing the SF, not the entirety of the AU. These separate scores were then combined to give a total SF score for that AU. In some instances multiple portions of the HVR AU had varying SFs overlapping it. These cases were treated the same and each portion with overlapping SFs was scored separately.

3.2.5 **Special Feature shortfall Scenario**

Two situations have arisen where the SF score of two SSBVs within the offset area are less than the SF score of the clearing area. This has occurred even though the offset area is larger and the EC scores are greater. To address this issue CO_2 Australia was consulted and an alternative proposal was developed using an adjacency calculation as outlined in the EEM.

The SF shortfall arose from there being limited to no SFs mapped across remnant vegetation that exists outside the boundaries of the Qld Herbarium remnant RE mapping layers. Although the shortfall existed for remnant vegetation, the adjacency calculation method was undertaken to assess the SFs of the AU's in question. This undertaking subsequently raised the SF score of the concerned SSBV's AU to being greater than the clearing area. CO_2 advised that this approach was acceptable by EHP as long as the EC score was greater. Following the use of this calculation the shortfall was addressed and both the EC and SF scores for the entirety of the offset area (across all SSBV's) are greater than the clearing area.

3.2.6 **Watercourse Vegetation**

The SF and EC scores for all the AU's were combined to determine the watercourse vegetation Ecological Equivalence scores. The approach to scoring FL Plains was slightly different as the only vegetation within the watercourse buffers displayed these watercourse vegetation characteristics.

At the instruction of CO_2 Australia, the entirety of a watercourse AU was assessed but the score was weighted by the area of the AU that was overlapped by the watercourse buffer (e.g. for a 10 ha patch of RE that has 6 ha within a watercourse the whole 10 ha is treated as an AU but the scoring is weighted by the 6 ha that overlaps with the watercourse buffer). The SF scores for all AU's that intersected with a watercourse buffer are then added together and then divided by the number of AU hectares. This provides a SF score per hectare value. This value was then multiplied by the area (in ha) of the AUs that sits within the watercourse buffers.

Once calculated for each area, the EC and SF scores of the watercourse vegetation within clearing areas were combined and compared against the watercourse vegetation scores of the proposed offset area.

4 OFFSET REQUIREMENTS

The disturbance remaining across the project areas after all efforts had been made to avoid and minimise the expected project disturbance has left a number of residual impacts to SSBVs that require offsetting. This offset requirement is outlined within the QBOP.

A summary of the expected impacts for each project that will require offsets is detailed below. In addition an overall combined impact table is provided to show the total impact across the two projects.

4.1 Cockatoo Creek Stage One and Stage Two Diversion

Offset requirements for the Cockatoo Creek Stage One and Stage Two Diversion projects are identified in Table 1. Due to the nature of this project the disturbance predominantly impacts watercourse vegetation with over 57% being an impact to vegetation associated within the buffer of a stream order three watercourse. Ground truthed vegetation and the impact areas within the projects disturbance footprint are shown in Figure 4.

Table 1: Summary of Cockatoo Creek Stage One and Stage Two Diversion Offset requirements

Regulatory Framework	Environmental Value	Species/community	VM Class	Stage 1 Impact (ha)	Stage 2 Impact (ha)	TOTAL Impact (ha)
Queensland Biodiversity Offsets Policy	Threatened RE listed under the VM Act - Remnant	RE 11.3.1 (BVG 25a)	Endangered	7.03	14.32	21.35
		RE 11.3.2 (BVG 17a)	Of concern	-	4.34	4.34
	Threatened RE listed under the VM Act - High Value Regrowth	RE 11.3.1, 11.9.5 (BVG 25a)	Endangered	-	11.49	11.49
	Watercourse vegetation listed under the VM Act (all vegetation including Least concern RE 11.3.25)	Stream order 3 watercourse	NA	18.13	31.55	49.68

***Please note that 11.46 ha of RE 11.3.3, was surveyed in the North of the project but subsequently removed from this table. Due to changes in diversion design and the resulting disturbance footprint, this RE will not be impacted and therefore not needed to be offset.

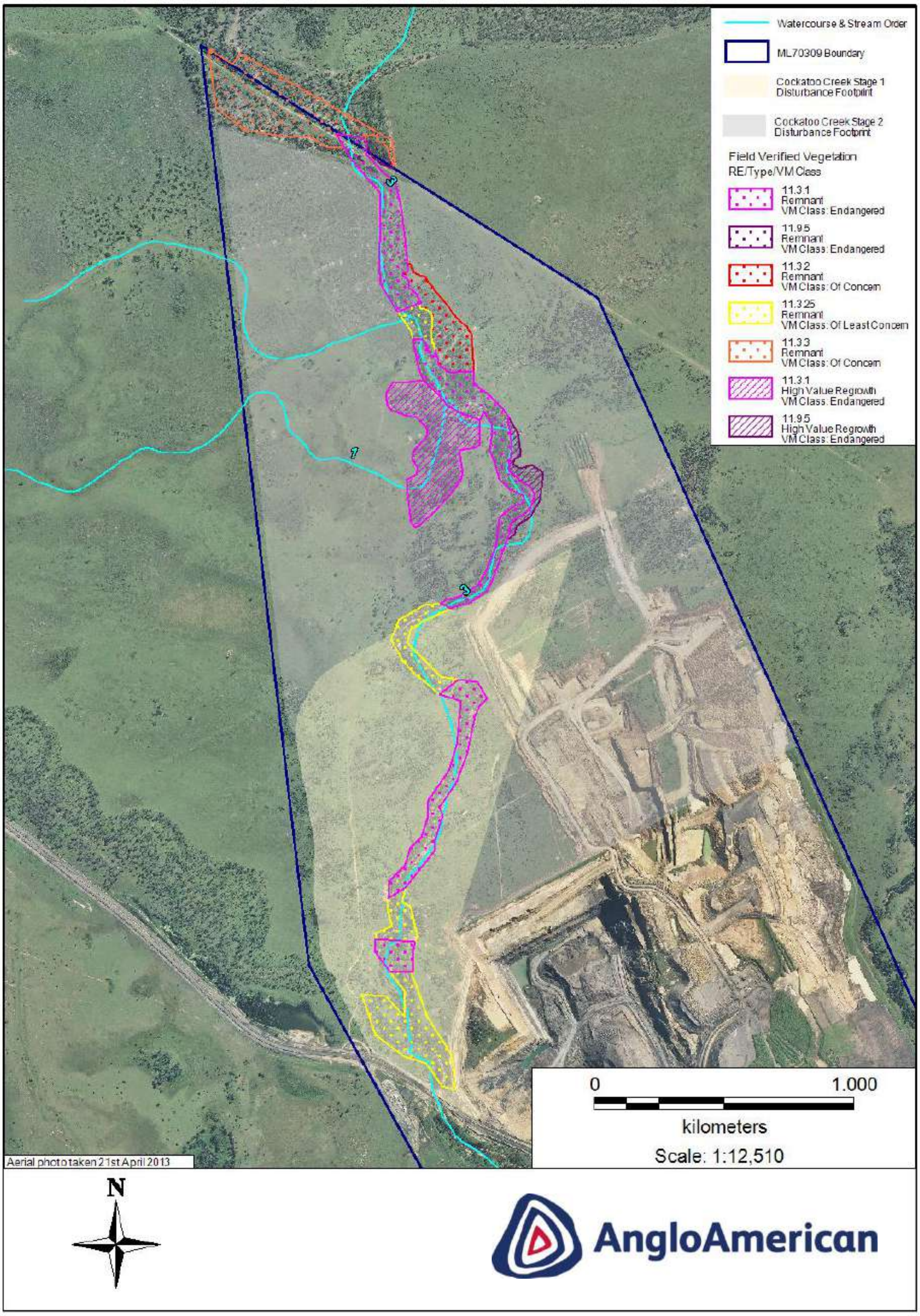

Figure 4: Cockatoo Creek Stage One and Stage Two Diversion SSBV's within disturbance footprint

4.2 Foxleigh Plains

Offset requirements for the FL Plains Project are identified in Table 2. Impacts to high value regrowth and water course vegetation contribute to almost 90% of the disturbance associated with this project. Ground truthed vegetation and the impact areas within the projects disturbance footprint are shown in Figure 5.

Table 2: Summary of Foxleigh Plains Offset requirements

Regulatory Framework	Environmental Value	Species/community	VM Class	TOTAL Impact (ha)
Queensland Biodiversity Offsets Policy	Threatened RE listed under the VM Act	RE 11.3.1 (BVG 25a)	Endangered	4.9
		RE 11.3.2 (BVG 17a)	Of concern	9.82
		RE 11.3.3 (BVG 16c)	Of concern	2.36
		RE 11.3.4 (BVG 16c)	Of concern	1.5
	High Value Regrowth	RE 11.3.1, 11.4.9 11.9.5 (BVG 25a)	Endangered	83.14
	Watercourse vegetation listed under the VM Act (includes Least concern RE 11.3.25 & 11.5.3)	Stream order 3 watercourse (all vegetation including Least concern RE's)	NA	59.68

The initial design for the FL Plains EIS identified 7.33 ha of endangered regional ecosystem (11.5.17 – *Eucalyptus tereticornis* woodland in depressions on Cainozoic sand plains/remnant surfaces), as being disturbed. This RE triggered both the threatened RE and significant wetlands SSBV under the QBOP. However, a review of the mine plan was subsequently undertaken to further refine the mine plan design so that this will not be disturbed and therefore will not require offsetting.

4.3 Combined Offset Requirements

The cumulative offset requirements for both the Cockatoo Creek Stage One and Stage Two Diversion and FL Plains projects are shown below in Table 3.

Table 3: Summary of combined Foxleigh project offset requirements

State Significant Biodiversity Values			**Combined Clearing Areas (Stage One, Stage Two & Fox Plains)**
Environmental Value	Species/community	VM Class	Impact (ha)
Threatened RE listed under the VM Act	RE 11.3.1 (BVG 25a)	Endangered	26.29
	RE 11.3.2 (BVG 17a)	Of concern	14.17
	RE 11.3.3 (BVG 16c)	Of concern	2.36
	RE 11.3.4 (BVG 16c)	Of concern	1.50
High Value Regrowth	RE 11.3.1, 11.4.9, 11.9.5 (BVG 25a)	Endangered	94.63
Watercourse vegetation listed under the VM Act	Stream order 3 watercourse	NA	109.37

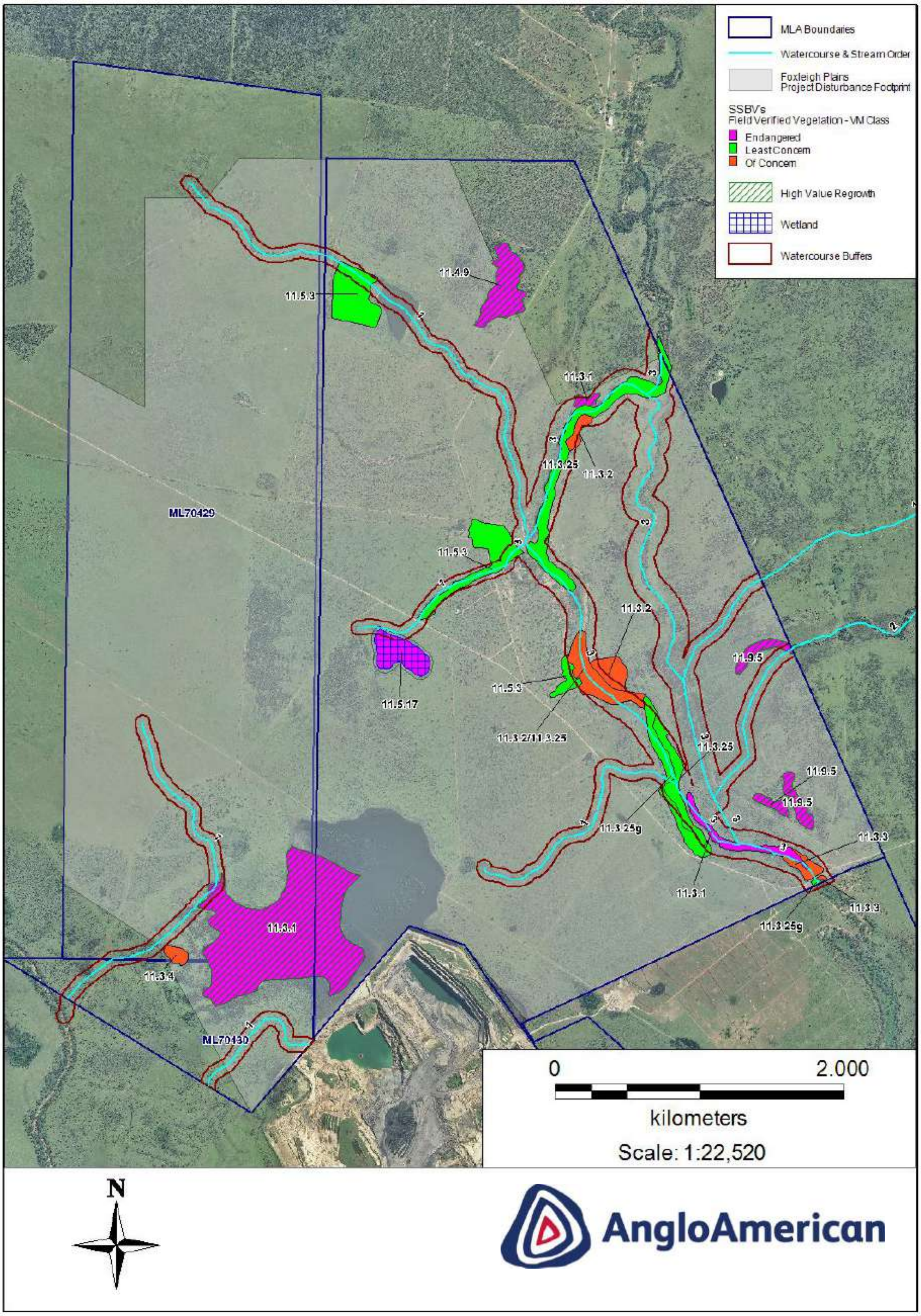

Figure 5: Foxleigh Plains SSBV within disturbance footprint

4 ECOLOGICAL EQUIVALENCE SCORING

The QBOP requires Ecological Equivalence to be demonstrated between the offset area and the clearing area. Conducting this process for the two Cockatoo Creek diversions and the FL Plains projects involved determining a score for each of two ecological criteria (ecological condition and special features). This then allowed a transparent and repeatable scoring process for the comparison of the clearing area and the offset area.

The following information aims to give an Ecological Equivalence overview of the proposed clearing areas and offset areas by providing a detailed summary of the Ecological Equivalence scoring results for each assessment unit across each proposed impact and offset area. In addition a description of the vegetation communities recorded *within* each impact and offset area is also provided.

4.1 Cockatoo Creek Stage One and Stage Two Diversion Impact Area

4.1.1 Ecological Equivalence Summary

An EE assessment was carried out across the locations proposed to be impacted by the Cockatoo diversion areas. All 14 indicators of the two criterion, ecological condition and special features, were assessed to produce an overall score for each criteria. The EC and SF scores provide the basis for demonstrating ecological equivalence between the clearing area and the proposed offset area. The EE scores from the Cockatoo Creek impact areas are summarised in Table 4 below.

Table 4: Summary of Ecological Conditions and Special Feature scores for the SSBV's across the Cockatoo Creek Stage One and Stage Two Diversion project

SSBV	RE / BVG / VM Class	Assessment Unit	Area (ha)	Ecological Equivalence Score	
				Ecological Condition	Special Features
Threatened RE listed under the VM Act - Remnant	RE 11.3.1 (BVG 25a) Endangered	CC AU2	21.35	9.65	8.14
	RE 11.3.2 (BVG 17a) Of concern	CC AU4	4.34	2.86	1.88
Threatened RE listed under the VM Act - High Value Regrowth	RE 11.3.1 (BVG 25a) Endangered	CC AU5	9.78	3.912	13.208
	RE 11.9.5 (BVG 25a) Endangered	CC AU6	1.708	0.24	2.66
Watercourse vegetation	All watercourse vegetation including least concern ecosystems 11.3.25 (CC AU1)	CC AU1, 2, 4, 5 & 6	49.68	23.69	31.13

*** Please note that 11.46 ha of RE 11.3.3, CC AU 3, was surveyed but subsequently removed from this table. Due to changes in diversion design and the resulting disturbance footprint, this RE is no longer going to be impacted and will not need to be offset.

4.1.2 Assessment Unit

A description of the assessment units which make up each SSBV sampled across the Cockatoo Creek Stage One and Stage Two Diversion clearing area are detailed below. The site location for each assessment unit is shown in Figure 6. Photos representative of each assessment unit are presented below in Photo Plate 1.

CC AU2 - Endangered

11.3.1 – Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on alluvial plains Broad Vegetation Group (BVG) 25a.

The canopy layer was dominated by Brigalow (*Acacia harpophylla*) and possessed an average height of approximately 8 m. This SSBV had a narrow, linear distribution along the potential impact area of Cockatoo Creek. Associated species included Yellowwood (*Terminalia oblongata*), infrequent Queensland Blue Gum (*Eucalyptus tereticornis*) in the southern reaches only and emergent Coolabah (*Eucalyptus coolabah*) with the southern portion dominated by Belah (*Casuarina cristata*). However, in some areas the Coolabah was the ecologically dominant layer. Less than 1% of the Brigalow had a Diameter at Breast Height (DBH) greater than 29 cm (the benchmark data for 11.3.1 for large non-eucalypt trees) whereas the majority of the Coolabah had a DBH greater than 49 cm (the benchmark data for 11.3.1 for large non-eucalypt trees).

The sub-canopy and shrub layers were similarly composed of juvenile canopy species. Red Bauhinia (*Lysiphyllum carronii*), False Sandalwood (*Eremophila mitchellii*) and Currant Bush (*Carissa ovata*) were also found. The occurrence of these species was inconsistent across the vegetation, ranging from co-dominant to not apparent.

The ground cover layers of this vegetation ranged from a dense cover of leaf litter through to a dense cover of exotic pastoral grasses with a large amount of coarse woody debris. Infrequent occurrences of native grasses such as Couch (*Cynodon dactylon*), Umbrella Cane grass (*Leptochloa digitata*) and Creek Windmill grass (*Enteropogon ramosus*) were recorded. Declared pest species Harisia cactus (*Eriocereus martini*) was commonly distributed throughout this vegetation in areas above the high flow channel of the creek.

CC AU4 – Of Concern

11.3.2 Poplar Box (*Eucalyptus populnea*) woodland on alluvial plains – BVG 17a.

The field validated distribution of this vegetation type possessed a similar structure and composition, particularly with the upper strata of EHP's description of 11.3.2 and consisted mostly of mature Poplar Box (*Eucalyptus populnea*) ranging from 18 to 22 m in height with Yellowwood (*Terminalia oblongata*). The sub canopy consisted of juvenile canopy species alongside Leichhardt Bean (*Cassia brewsteri*) and *Acacia ostwaldii*.

The ground layer varied from a high dominance of exotic grass species such as; Guinea grass (*Megathyrsus maximus*), Nut grass/Nut sedge (*Cyperus rotundus*), Sabi grass (*Urochloria mosambisciens*) and various varieties of Buffel grass (*Cenchrus ciliaris var.*). Infrequent occurrences of native species Couch (*Cynodon dactylon*) and Umbrella Cane grass (*Leptochloa digitata*) were also recorded.

CC AU5 – High Value Regrowth	11.3.1 - Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on alluvial plains - BVG 25a. The canopy of this Southern distribution of HVR 11.3.1 was dominated entirely of juvenile even-aged Brigalow (*Acacia harpophylla*) regrowth and Red Bauhinia (*Lysiphyllum carronii*) which possessed an average height ranging from approximately 5 to 7m. There were also several large emergent Red Bauhinia (*Lysiphyllum carronii*) individuals present The dense groundcover of grass was dominated by the native Button grass (*Dactyloctenium radulans* and to a lesser extent, other exotic pastoral species. According to Anderson (2003), Button grass is an early pioneer of disturbed and trampled sites, commonly increasing under heavy stocking and can indicate overgrazing. Infrequent occurrences of native grasses Couch (*Cynodon dactylon*), Fairy grass (*Sporobolus caroli*), and Brigalow grass (*Paspalidium caespitosum*) were also recorded.
CC AU6 – High Value Regrowth	11.9.5 - Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on fine-grained sedimentary rocks - BVG 25a. The canopy of this southern distribution of HVR 11.9.5 was dominated entirely of juvenile even-aged Brigalow (*Acacia harpophylla*) regrowth with the occasional Yellowwood (*Terminalia oblongata*) of which the Brigalow and Yellowwood possessed a median height of approximately 3 m. The ground cover layer of this vegetation was dominated by a dense cover of exotic pastoral grasses Sabi grass (*Urochloa mosambiciensis*) and Buffel Grass (*Cenchrus ciliaris var.*). Large sections of this distribution had succumbed to extensive erosion with significant gullies during recent flow events
CC AU1 - Watercourse	11.3.25 - Queensland Blue Gum (*Eucalyptus tereticornis*) or River Red Gum (*E. camuldulensis*) woodland fringing drainage lines – BVG 16a In general the overall canopy layer of this vegetation type was composed of various species. The dominant species were Coolabah (*Euclayptus coolabah*), Blue Gum (*Eucalyptus tereticornis*) with less frequent occurrences of Moreton Bay Ash (*Corymbia tessellaris*) and Poplar Box (*Eucalyptus populnea*). The sub canopy and low tree layer was dominated by very large Yellowwood (*Terminalia oblongata*) and juvenile canopy species. Commonly encountered species included River Oak (*Casuarina cunninghamiana*), Red Bauhinia (*Lysiphyllum carronii*), and Leichhardt Bean (*Cassia brewsteri*). One Ghost Gum (*Corymbia dallachyana*) was also recorded. The shrub layer was generally dominated by False Sandalwood (*Eremophila mitchelli*), Currant Bush (*Carissa ovata*) and Red Bauhinia (*Lysiphyllum carronii*). The composition and density of the groundcover layer was highly variable and dependant on bank incision and proximity to water. Although scarce in comparison to the abundance of exotic pastoral grasses, native Umbrella Cane grass (*Leptochloa*

digitata) appeared to be more abundant closer to the centre of the watercourse, Creek Windmill grass (*Enteropogon ramosus*) was the opposite with *Arundinella nepalensis*.

Watercourse Vegetation

All the vegetation within the disturbance footprint of the Cockatoo Creek Stage One and Stage Two Diversion projects described in AUs 2-6 also form the watercourse vegetation AU's. The watercourse vegetation also contains RE 11.3.25 classified under the VM Act as 'least concern'. The description of CCAU1 relates to the additional vegetation not already described in other AUs.

Connectivity

The Cockatoo Creek Stage One and Stage Two Diversion project areas are mapped within a state significant corridor (Appendix 2). Remnant vegetation within this area is considered to provide important connectivity for biodiversity values.

4.1.3 Ecological Condition scoring

The EC indicator scores for each AU within the Cockatoo Creek Stage One and Stage Two Diversion project are outlined in Appendix 3 – Tables 1 and 2.

CC AU2 11.3.1

CC AU4 11.3.2

CC AU5 11.3.1 HVR

CC AU6 11.9.5 HVR

CC AU1 11.3.25

Plate 1: Examples of Cockatoo Creek Stage One and Stage Two Diversion Assessment Units

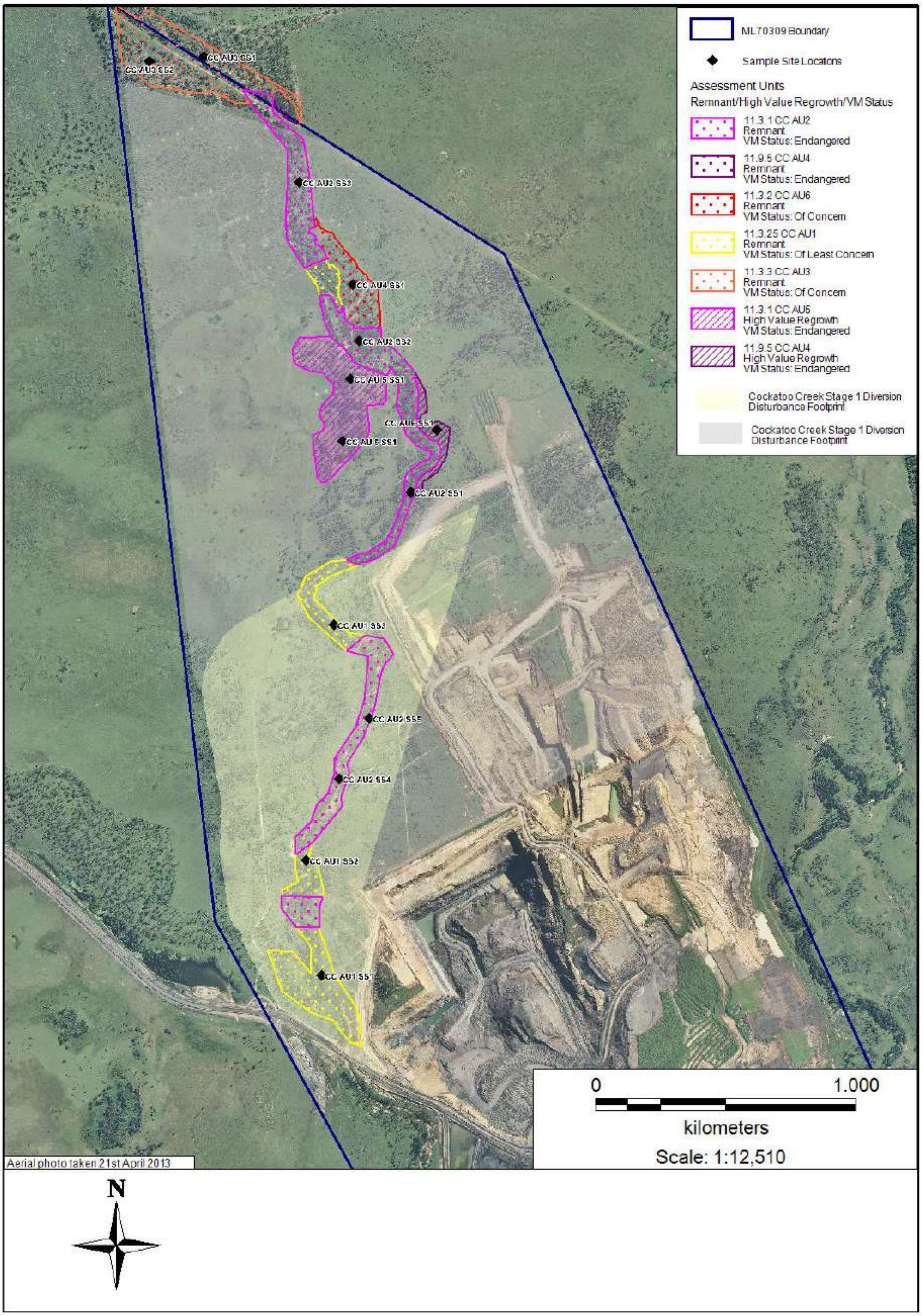

Figure 6: Cockatoo Creek Stage One and Stage Two Diversion Assessment Units & Sample Sites

4.2 Foxleigh Plains Impact Area

4.2.1 Ecological Equivalence Score

An EE assessment was carried out across the locations proposed to be impacted by the FL Plains Project. All 14 indicators of the two criterion, ecological condition and special features, were assessed to produce an overall score for each criteria. The EC and SF scores provide the basis for demonstrating ecological equivalence between this clearing area and the proposed offset area. The EE scores from the FL Plains impact areas are summarised in Table 5 below.

Table 5: Summary of Ecological Conditions and Special Feature scores for the SSBV's across the Foxleigh Plains project

SSBV	Species / community	Assessment Unit	Area (ha)	Ecological Equivalence Score		Area (ha)	SSBV EE Score Total	
				Ecological Condition	Special Features		Ecological Condition	Special Features
Threatened RE listed under the VM Act - Remnant	RE 11.3.1 (BVG 25a) Endangered	FP AU 2	4.9	2.18	1.7	4.9	2.18	1.7
	RE 11.3.2 (BVG 17a) Of concern	FP AU 8,9 &11	9.82	4.8	4.98	9.82	4.8	4.98
	RE 11.3.3 (BVG 16c) Of concern	FP AU 13	2.36	1.4	0.31	3.86	2.46	0.87
	RE 11.3.4 (BVG 16c) Of Concern	FP AU 14	1.5	1.06	0.56			
Threatened RE listed under the VM Act - High Value Regrowth	RE 11.3.1 (BVG 25a) Endangered	FP AU 1 & 6	73.05	27.73	14.10	83.14	32.19	20.03
	RE 11.4.9 (BVG 25a) Endangered	FP AU 3	1.99	0.44	0.97			
	RE 11.9.5 (BVG 25a) Endangered	FP AU 5	8.1	3.84	4.96			
Watercourse vegetation	All portions of vegetation overlapping watercourse buffers. Includes least concern ecosystems 11.3.25 (FP AU 4 & 10) 11.3.25g (FP AU7) 11.5.3 (FP AU 15)	FP AU 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, & 14	59.68	33.61	19.097	59.68	33.61	19.097

***Please note that 7.3ha of RE 11.5.17, FP AU 12, was surveyed but subsequently removed from this table. Due to changes in the mine layout plan and resulting project disturbance footprint, this RE is no longer going to be impacted and will not need to be offset.

4.2.2 Assessment Unit

The below vegetation descriptions have been adapted largely from a report compiled by Ecological Survey and Management for the FL Plains Project EIS. Further input from Anglo American field validation and Ecological Equivalence assessment work assisted with these descriptions. The locations of these assessment units are shown in Figure 7. Photos representative of each assessment unit are presented below in Plate 2.

FP AU2 - Endangered	11.3.1 - Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on alluvial plains Broad Vegetation Group - BVG 25a. Narrowly fringing Cockatoo Creek in the south of the disturbance footprint, the canopy layer of this vegetation is dominated by Belah (*Casuarina cristata*) possessing a median height of approximately 16m. Associated species include Brigalow, Yellowwood and infrequent emergent Coolabah and Poplar Box. Sparsely distributed sub canopy and shrub layers are present. The ground layer was mainly dominated by organic leaf litter with sparse occurrences of Brigalow Grass, Blue Trumpet and Lesser Joyweed.
FP AU8, 9, & 11 - Of Concern	11.3.2 Poplar Box (*Eucalyptus populnea*) woodland on alluvial plains – BVG 17a. Residual distributions of this vegetation type were identified at various locations along the project site. There was minimal variability between the different portions and this description represents them equally. The canopy layer within these areas was dominated by Poplar Box (median height 15m). Associated species such as Queensland Blue Gum and Sally Wattle were infrequently encountered. The thinly distributed sub canopy cover was similarly dominated by Poplar Box. Other encountered species in the sub-canopy included Yellowwood, Red Bauhinia, Ostwald's Wattle and Scrub Leopardwood. The shrub layer varied from not present to dense stands of Currant Bush that covered large areas. The ground cover layer was the most diverse in composition across this vegetation type. Overall the exotic pastoral species Buffel grass dominated, but areas where native grasses dominated did occur. These species included Tall Chloris and Twirly Windmill grass.
FP AU13 - Of Concern	11.3.3 – Coolabah (*Eucalyptus coolabah*) woodland on alluvial plains – BVG 16c. This vegetation was recorded at the southern extent of the disturbance footprint, North of ML70470. The canopy layer was dominated by Coolabah averaging 19m in height. The thinly scattered sub canopy layer was generally dominated by Coolabah, Yellowwood, Brigalow and Belah. The shrub layers were similarly composed with infrequent occurrences of Ostwalds Wattle and False Sandalwood.
FP AU14 - Of Concern	11.3.4 – Queensland Blue Gum (*Eucalyptus tereticornis*) and/or Eucalyptus spp. Tall woodland on alluvial plains - BVG 16c A small pocket of this vegetation was recorded in the south western corner of the FL Plains project. The canopy later was dominated by Moreton Bay Ash, Queensland Blue Gum and Long Fruited Bloodwood with a median height of 25m. The very sparse to sparse sub canopy was dominated by Poplar Box and Sally Wattle. The very sparse shrub layer was dominated by juvenile canopy species and associated Currant Bush. The ground cover layer was dominated by Buffel grass, Sabi grass and associated Bunched Speargrass

FP AU1, 6 – High Value Regrowth	11.3.1 - Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on alluvial plains - BVG 25a. This large patch of regrowth vegetation was located directly north of current Foxleigh mining operations on the south west of the proposed disturbance area. The canopy layer was heavily dominated by Brigalow possessing a median height of 2.5m. The shrub layer consisted entirely of shorter more juvenile Brigalow. The ground cover layer was largely un-vegetated, consisting mainly of low to medium amounts of organic litter and exposed areas.
FPAU3 - High Value Regrowth	11.4.9 – Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) on Cainozoic clay plains. BVG 25a This vegetation was recorded to the east of a large farm dam in the north of the project site. The low canopy layer of 2.5m was dominated by Brigalow with occasionally Yellowwood. The shrub layer was dominated by Brigalow. This groundcover layer was diversely composed but mainly dominated by a low to moderate cover of Sabi grass, Weeping Love grass and Tall Chloris.
FP AU5 - High Value Regrowth	11.9.5 - Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on fine-grained sedimentary rocks - BVG 25a This regrowth vegetation was recorded in three fragmented patches along the eastern boundary of the Mining lease west of Cockatoo Creek. The canopy layer of these three distributions of regrowth is dominated by Brigalow with infrequent Yellowwood. This layer possessed a median height of around 5m.The shrub layer was composed of shorter juvenile canopy species. The groundcover layer was variously composed but generally dominated by Buffel grass. Patches of native Brigalow grass, Slender Chloris, and Twirly Windmill grass were commonly identified.
FP AU4, 10 - Watercourse	11.3.25 – Queensland Blue Gum (*Eucalyptus tereticornis*) or River Red Gum (*E. camuldulensis*) woodland fringing drainage lines- BVG 16a This vegetation type was the predominant vegetative cover along Cockatoo creek to the north of the Tralee homestead. The canopy layer of this ecosystem was heavily dominated by Queensland Blue Gum with Moreton Bay Ash and Poplar box lightly distributed throughout. This canopy layer possessed a median height ranging from 18 to 27m. The sub canopy layer composition varied with species such as juvenile canopy species; Belah, Sally Wattle, Brigalow and Yellowwood were commonly encountered. The sparse shrub layer was generally dominated by Yellowwood, Brush Cassia, Red Bauhinia, Sally wattle and Ostwald’s Wattle. The ground cover ranged from a dense cover of Buffel grass to Guinea grass and Sabi grass.

FP AU7 - Watercourse	11.3.25g – Sedgeland in broad alluvial drainage basins - BVG 16a This vegetation occurred along Cockatoo Creek south of the 'Tralee' homestead where the creek channel becomes a broad alluvial basin. This vegetation largely lacked any woody vegetation. However isolated Queensland Blue Gum were thinly littered across sections where it meets RE 11.3.25. The ground cover consisted of a mosaic of different water associated species including Flat Spike sedge, Giant sedge, Common Nardoo, Swamp Rice grass and Wavy Marshwort.
FPAU15 - Watercourse	11.5.3 - *Eucalyptus populnea* ± *E. melanophloia* ± *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces – BVG 17a This vegetation was recorded in disjoint populations fringing remnant vegetation on the western side of Cockatoo Creek and relatively large intact residual woodland fringing the western side of a large farm dam in the northern portion of the project. The canopy layer was dominated by Poplar Box, with infrequent Moreton Bay Ash. It possessed a median height ranging from 16m to 19m. The sub canopy layer was dominated by Poplar box with infrequently occurring Sally Wattle and Whitewood. The shrub layer was variously composed and included species such as Brush Cassia, False Sandalwood, Emu Apple, and Whitewood. The ground cover was generally dominated by a dense cover of Buffel grass. Other species such as Wiregrass, Sabi grass and Bunched Speargrass were often suppressed but still evident

Watercourse Vegetation

The watercourse vegetation within the FL Plains disturbance footprint included portions of all the AU's listed above that make up the threatened RE's but also encompassed a portion of the VM Class 'least concern' ecosystems that occurred within the FL Plains disturbance footprint as follows.

Significant Wetlands

Initial studies conducted as a part of the FL Plains EIS identified that a 7.33 ha patch of RE 11.5.17 is also a significant wetland. Subsequent mine plan changes means that this area is no longer an area for potential impact and therefore no longer required to be offset.

Connectivity

A large portion of the site is mapped within a state significant corridor (Appendix 2). Remnant vegetation within this area is considered to provide important connectivity for biodiversity.

4.2.3 Ecological Condition scoring

The EC indicator scores for each AU within the FL Plains Project are outlined in Appendix 3 – Tables 3, 4, 5 and 6.

FP AU1 11.3.1 HVR

FP AU3 11.4.9

FP AU4 11.3.25 Watercourse

FP AU5 11.9.5

FP AU13 11.3.3

FP AU14 11.3.4

Plate 2: Examples of Foxleigh Plains Assessment Units

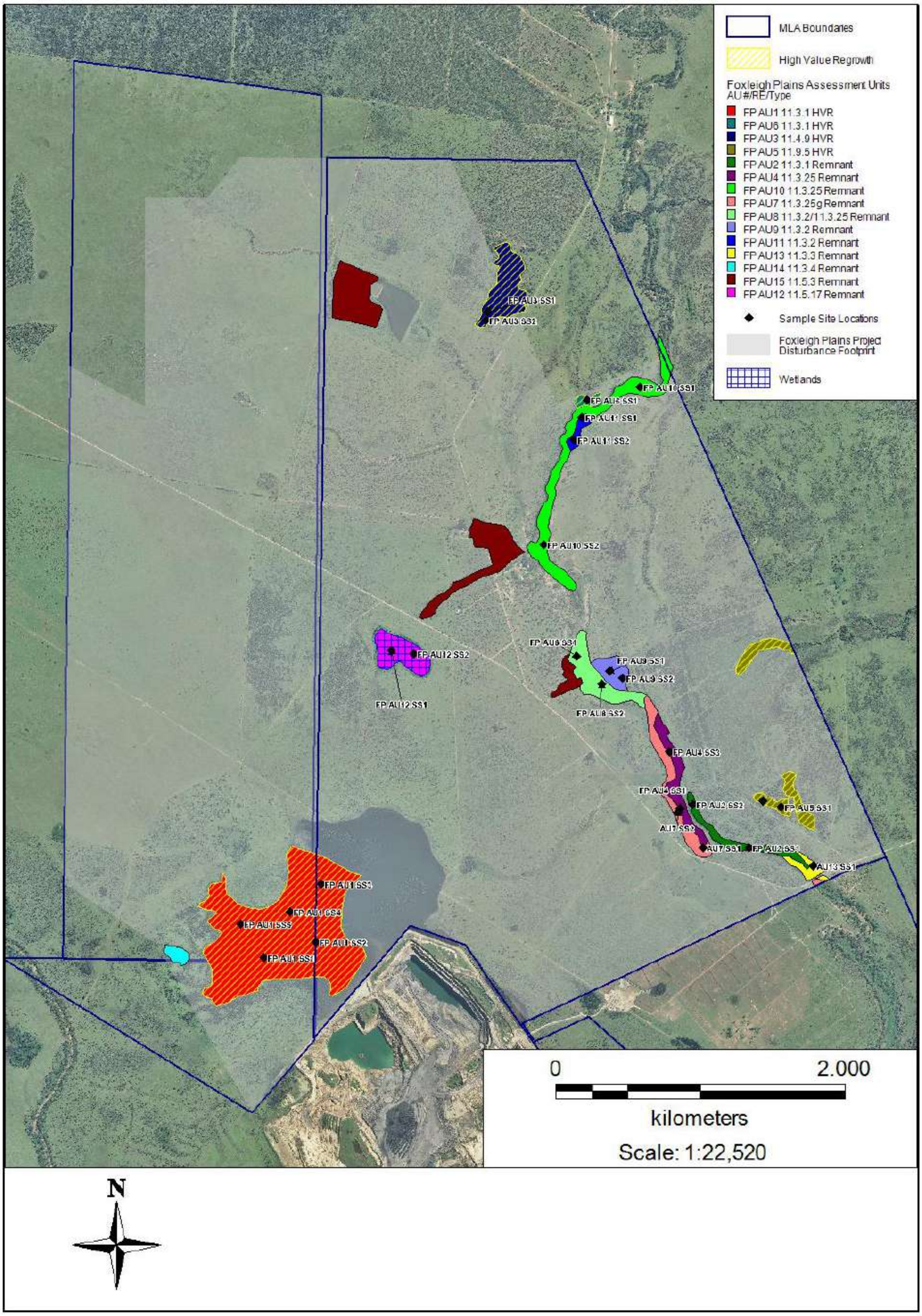

Figure 7: Foxleigh Plains project Assessment Units

4.3 Offset Area

Anglo American's strategy for locating offset requirements has been to locate offset areas primarily on land owned by Anglo American. This offsetting strategy includes utilising land within two existing cattle grazing properties (Tralee and Lake Lindsay), and parcels of land within the current operating Foxleigh mining lease. This is shown in Figure 3.

These proposed offset areas are located specifically in locations where no forecasted mining activities will be scheduled. This is supported by a number of factors. In particular, a review of potential mining reserves and geological conditions shows that the proposed offset areas are highly unlikely to yield economical coal reserves. Viable coal deposits have been fully extracted within the existing ML necessitating the current requirement to extend the Foxleigh Mine into new areas to the north. In addition the offset areas, particularly those locations located within the mining lease, are found where strip-ratios (overburden removed compared to coal recovered) are uneconomical, all mining within the area ceased more than 5 years ago, and rehabilitation has been undertaken.

4.3.1 Ecological Equivalence Score

In order to enable a comparison of EC and SF to be made between the clearing areas and the intended offset area, EE scoring was also carried out on the offset area, Table 6 provides a summary of the EC and SF scores for the assessment units across offset areas. The location of these AU's is displayed in Figure 8.

Table 6: Summary of Ecological Condition and special feature scores for the SSBV's across the proposed offset area

SSBV	Species / community	Assessment Unit	Area (ha)	Ecological Equivalence Score	
				Ecological Condition	Special Features
Threatened RE listed under the VM Act - Remnant	RE 11.3.1 (BVG 25a) Endangered	OA AU4,5,6, 9 & 10	30.73	18.4	4.6 (non adjacency calculation) 19.36 (adjacency calculation)
	RE 11.3.2 (BVG 17a) Of concern	OA AU7	15.11	8.65	1.54 (non adjacency calculation) 19.36 (adjacency calculation)
	RE 11.3.3 (BVG 16c) Of concern	OA AU3	16.11	10.47	3.33
Threatened RE listed under the VM Act - High Value Regrowth	RE 11.3.1 (BVG25a) Endangered	OA AU1 & 6	20.84	9.33	10.58
	RE 11.4.9 (BVG25a) Endangered	OA AU2 & 8	103.71	46.87	67.8
Watercourse vegetation	All portions of vegetation overlapping watercourse buffers. Includes least concern ecosystems -11.3.25 (FP AU 4 & 10) -11.3.25g (FP AU7) -11.5.3 (FP AU 15)	ALL Offset Area AU's OA AU1 - 10	186.50	93.74	87.84 (non adjacency calculation) 115.63 (adjacency calculation)

As described in the methodology, for RE's 11.3.1 and 11.3.2, the SF score displays the SF score when strictly applying the EEM and also the adjacency calculation score. The water course vegetation displays the SF score for both these scenarios also.

4.3.2 Assessment Units

A description of the assessment units which make up each area sampled across the proposed offset location are detailed below. The site location for each assessment unit is shown in Figure 8. Photos representative of each assessment unit are presented in Plate 3.

OA AU4, 5, 6, 9 & 10 - Endangered

11.3.1 - Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on alluvial plains Broad Vegetation Group - BVG 25a.

Remnant Brigalow and Belah dominated ecosystems were very scarce throughout the areas searched for available offset vegetation. Various small fragmented remnant patches however were identified. Each of these patches fringes a watercourse and serves a role in stabilising the embankments. Their canopies were mainly similarly composed in terms of species, with only two patches having slightly more occurrences of Belah than the others. The median height of these various distributions ranged from 9m through to 16m. Other tree species recorded included Poplar Box, Yellowwood and Red Bauhinia. The sub canopy layers were sparse to very sparse. This layer was generally composed of juvenile canopy species, with occurrences of False Sandalwood, Wilga, Leichhardt Bean and various wattle species. Sparse like the sub-canopy, the shrub layer consisted of Currant Bush and juvenile canopy and sub-canopy species. The ground cover was the most diverse; ranging from a dense mat of organic litter to infestations of exotic Buffel grass. Areas of exposed soils and pockets of native grass were not uncommon. These native grasses included Umbrella Cane grass and Brigalow grass. Generally these areas appeared to have undergone water inundation in past months

OA AU7 – Of Concern

11.3.2 - Poplar Box (*Eucalyptus populnea*) woodland on alluvial plains – BVG 17a.

Situated next to a Foxleigh mine haul road on ML70431, mining in this area of the ML has ceased and no further disturbance or mining activities are planned. This vegetation fringes a watercourse. Poplar Box (*Eucalyptus populnea*) dominates the woodland canopy, with Leichhardt Bean and False Sandalwood occasionally present. The sparse low tree layer was similarly composed with occurrences of False Sandalwood, Beefwood and Acacia species. Although the coverage is predominantly Buffel grass, the ground layer is rich in native grass species, particularly Chloris sp, with regular occurrences of Twirly Windmill grass and Native Millet.

OA AU3 – Of Concern	11.3.3 – Coolabah (*Eucalyptus coolabah*) woodland on alluvial plains – BVG 16c. This stand of vegetation is situated on ML70170, on alluvial flood plains between two main watercourses. Mining in this area of the ML has ceased and no further disturbance or mining activities are planned. It connects with a large extensive stand of Queensland Herbarium mapped ‘remnant’ vegetation of the same ecosystem. Coolabah (*Eucalyptus coolabah*) can be predominantly found in the woodland canopy where Leichhardt Bean and Black Tea Tree can also be found. The low tree layer was similarly composed of False Sandalwood and Red Bauhinia. Native Couch and exotic Buffel grass dominated the ground layer.
OA AU1 & 6 – High Value Regrowth	11.3.1 - Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on alluvial plains Broad Vegetation Group (BVG) 25a. Dense stands of this regrowth vegetation were encountered throughout the offset area. These stands occur in alluvial clay plains associated with watercourses. The low canopy/tree layer which dominated this vegetation was comprised almost entirely of Brigalow. Uncommon and less frequent occurrences of Yellowwood and Red Bauhinia were also encountered. The ground layer was largely varied. Areas of exposed soil, dense mats of organic litter, pockets of native grass and large expanses of exotic Buffel grass are all commonly encountered.
OA AU2 & 8 – High Value Regrowth	11.4.9 – Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) on Cainozoic clay plains. Dense stands of this regrowth vegetation were encountered throughout the offset area. Mainly occurring in sandy-clay plains associated with watercourses. The low canopy layer of this vegetation was dominated by Brigalow between 2.5 to 7m. Yellowwood, Poplar Box, Red Bauhinia and Yapunyah were commonly encountered. Brigalow dominated the shrub/lower layers of these regrowth areas with Currant bush sporadically distributed. The ground layer was largely varied. Areas of exposed soil, dense mats of organic litter, pockets of native grass and large expanses of exotic Buffel grass were all commonly encountered.

Watercourse Vegetation

Watercourse vegetation encompasses remnant and HVR vegetation of all VM Classes and Biodiversity status. In the case of the Foxleigh proposed offset area, vegetation planned to offset the threatened RE SSBVs will also cover the requirements to offset watercourse vegetation offsets. These areas are all associated with watercourses and display the characteristics required by the QBOP in maintaining bank stability, water quality, and aquatic and terrestrial habitat values. Section 3.2.6 details how these AUs meet the watercourse vegetation offset requirements.

Connectivity

A large portion of the site is mapped within a state significant corridor (Appendix 2). Remnant vegetation within this area is considered to provide important connectivity for biodiversity.

4.3.3 **Ecological Condition scoring**

The EC indicator scores for each AU within the Offset Areas are outlined in Appendix 3 – Tables 7, 8, 9 and 10.

OA AU1 11.3.1 HVR

OA AU2 11.4.9 HVR

OA AU3 11.3.3

OA AU6 11.3.1 HVR

OA AU8 11.4.9 HVR

OA AU10 11.3.1

Plate 3: Examples of field surveyed Offset Area (proposed) Assessment Units

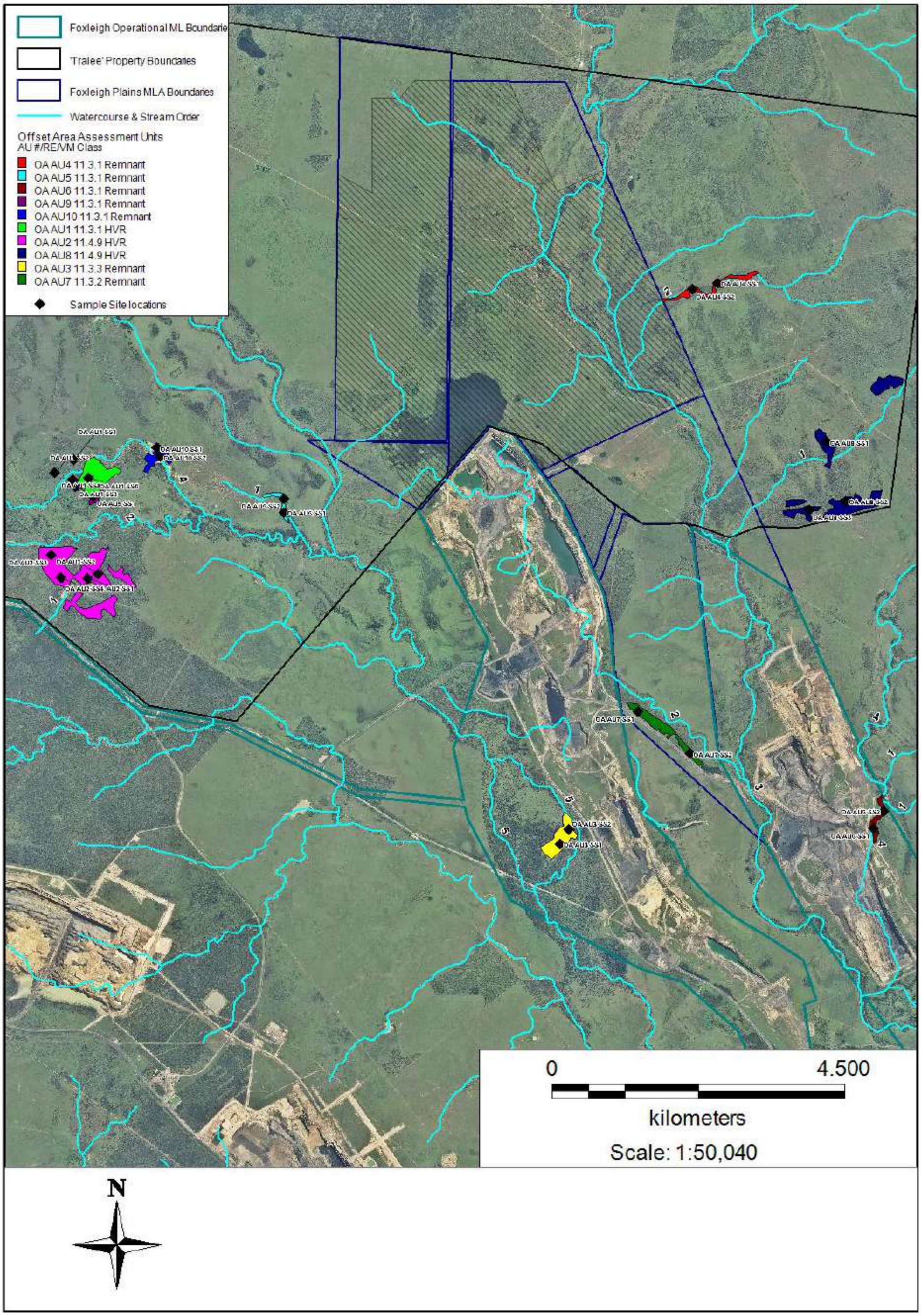

Figure 8: Proposed Offset Area Assessment Units for Cockatoo Creek Stages One and Two and sample sites

5 ECOLOGICAL EQUIVALENCE DETERMINATION

The Ecological Equivalence scores calculated for the Cockatoo Creek Stage One and Stage Two diversions and the FL Plains Project are the main outputs required for an Ecological Equivalence assessment of the clearing areas. The outputs of the clearing areas assessments are then compared against Ecological Equivalence scores calculated for the proposed offset areas.

For both projects areas and the proposed offset area an Ecological Equivalence score has been calculated for each individual assessment unit where SSBVs have been impacted or alternatively where offsets are proposed.

For the offset area to be ecologically equivalent to the clearing area, and therefore meet Ecological Equivalence requirements under QBOP, the offset area must obtain:

- an overall EC score equal to or greater than the overall EC score for the clearing areas;
- an overall special features score equal to or greater than the overall special features score for the clearing areas; and
- a minimum score for EC indicator 1 (recruitment of woody perennial species) must have a minimum score of three (i.e. >20 of overstorey species present as regeneration) and EC indicator 4 (tree canopy cover) must have a minimum score of two (i.e. >10% and less than 50% benchmark) on offset areas.

In order for Ecological Equivalence to be met the overall EC and SF scores for the offset areas must be equal to or greater than those derived on the clearing sites.

5.4 Discussion of Ecological Equivalence Scoring of SSBVs

The Ecological Equivalence scores of the offset and clearing areas were first compared on a SSBV/BVG level. The scores were then compared to the entire offset area and against the entire combined clearing areas. This was facilitated by adding together the EC scores and the SF scores of the assessment units for each SSBV for the combined clearing areas and comparing them with the offset area. This section examines these score comparisons.

In accordance with the EEM and QBOP, the proposed offset area successfully demonstrates Ecological Equivalence with the combined clearing areas of Cockatoo Creek Stage One and Stage Two Diversion and FL Plains.

A comparison of the overall EC score and SF score for each SSBV impacted in both clearing areas against the offset areas is outlined in Table 7 below.

Table 7: Ecological Equivalence Summary

State Significant Biodiversity Values			Combined Clearing Areas (Stage One, Stage Two & Fox Plains)			Foxleigh Proposed Offset Area			Special feature adjacency score trial
Environmental Value	Ecosystem / community	VM Class	Impact (ha)	EC Score	SF Score	(ha)	EC Score	SF Score	
Threatened RE listed under the VM Act	RE 11.3.1 (BVG 25a)	Endangered	26.29	11.84	9.85	30.73	18.40	4.60	19.36
	RE 11.3.2 (BVG 17a)	Of concern	14.17	7.69	6.87	15.11	8.65	1.54	14.57
	RE 11.3.3 (BVG 16c)	Of concern	2.36	1.40	0.31	16.11	10.47	3.33	
	RE 11.3.4 (BVG 16c)	Of concern	1.50	1.07	0.56				
High Value Regrowth	RE 11.3.1, 11.4.9, 11.9.5 (BVG 25a)	Endangered	94.63	36.35	35.92	124.55	56.21	78.37	
Watercourse vegetation listed under the VM Act	Stream order 3 watercourse	NA	109.37	22.06	50.227	144.07	73.44	78.37	
Totals			248.32	80.41	134.87	373	187.48	175.69	

As the above table shows the impacts of the combined clearing areas can be successfully offset as the EC of the proposed offset area meets and exceeds the requirements under the EEM and QBOP. To further explain this finding, the impacted SSBVs are outlined below with a description of how the offset area is Ecologically Equivalent.

5.4.1 **Threatened Regional Ecosystems listed under the VM Act.**

Impacts to threatened regional Ecosystems have been limited to one 'Endangered' ecosystem and three 'Of Concern' ecosystems. A discussion on how these impacts have been offset by the proposed offset area is detailed below.

1. <u>'Endangered' Regional Ecosystems – Remnant</u>

11.3.1 - Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on alluvial plains - Broad Vegetation Group (BVG25a).

The clearing areas have a combined 26.29 ha area of remnant regional ecosystem 11.3.1 fringing the respective stretches of Cockatoo Creek. Within the FL Plains clearing area there is 4.9 ha of RE 11.3.1 dominated by Belah. In comparison the Cockatoo Creek Stage One and Stage Two Diversion's 21.35 ha area is dominated by shorter more juvenile Brigalow. Although both distributions are exposed to edge effects of encroaching clearing area of cattle pastures, the FL Plains distribution is generally in better condition than the Cockatoo Creek Stage One and Stage Two Diversion distribution. The latter lacks mature vegetation, contains established exotic pastoral and invasive grass species and has heavily eroded or partially collapsed the embankments in some sections of the watercourse.

The offset area has a mosaic of available watercourse fringing patches of RE 11.3.1 and combined, these patches equate to 30.73 ha. The AU's which comprise this RE are largely similar in condition, with Brigalow being the dominant species. OA AU4 in the eastern portion of the 'Tralee' property is the exception. Like the FL Plains distribution of RE 11.3.1, large Belah dominates here. These AUs are distributed across both western and eastern areas of 'Tralee' and one AU, OA AU6, is situated on ML70309 upstream of the Carlo Creek diversion.

When combined, the AUs with RE 11.3.1 in the proposed offset area have an EC score and area greater than that of the matching RE AU's in the combined clearing areas. The SF score, when strictly applying the EEM, does not produce a score greater than the clearing area as required. This occurs because the remnant vegetation in the offset area is not mapped as category B and therefore is lacking special features as defined by the layer. Advice from CO_2 Australia, suggested that using the adjacency calculation method for these patches would be appropriate. This method produced a SF score greater than that of the clearing area demonstrating that being located in close proximity to areas containing special features makes it suitable to achieve the required EE.

2. 'Of Concern' Regional Ecosystems – Remnant

11.3.2 Poplar Box (*Eucalyptus populnea*) woodland on alluvial plains – BVG 17a.

When combined, all projects have a total clearing area of 14.67 ha of remnant RE 11.3.2, fringing the respective stretches of Cockatoo Creek. The RE is very similar in condition and composition across all clearing areas. The proposed offset area has one large 15.11 ha patch fringing a drainage line that interconnects with Cockatoo Creek. This area is located on ML70431 outside of the mine planning areas.

This distribution of RE 11.3.2 in the proposed offset has an EC score and area greater than that of the clearing area. The SF score, when strictly applying the EEM, does not render a score greater than the clearing area. In a similar approach to that utilised for the endangered vegetation the adjacency calculation was used to achieve a SF score greater than that of the clearing area and therefor demonstrate a suitable ecological equivalence.

11.3.3 – Coolabah (*Eucalyptus coolabah*) woodland on alluvial plains 11.3.4 – Queensland Blue Gum (*Eucalyptus tereticornis*) and/or Eucalyptus spp. Tall woodland on alluvial plains (BVG 16c).

The requirement to clear two small separate pockets of RE's on FL Plains was identified. A 1.5 ha of 11.3.4 in the southwest corner of FL Plains and 2.36 ha of 11.3.3 fringing Cockatoo Creek. These RE's both belong to broad vegetation group 16c:

> Woodlands and open woodlands dominated by *Eucalyptus coolabah* (coolabah) or *E. microtheca* (coolabah) or *E. largiflorens* (black box) or *E. tereticornis* (blue gum) or E. chlorophylla on floodplains.

As stated in the QBOP, an offset area for an 'of concern' RE must be of the same broad vegetation management group and be a regional ecosystem that has the same or higher, VM class as the area proposed for clearing.

The 16 ha patch of RE 11.3.3, OA AU3, situated between Horse Creek and Roper Creek on ML70430 satisfies these offset criteria. After combining the EC and SF scores of the clearing area (RE's 11.3.3 and 11.3.4), the specific AU within the offset area has a greater EC and SF score than the clearing area.

This OA AU3 will also be used to offset watercourse vegetation in the clearing areas. The score of this AU greatly exceeds that of the corresponding AUs in the clearing area.

5.4.2 'Endangered' Regional Ecosystems – High Value Regrowth

The clearing area has a combined 94.63 ha of HVR Brigalow dominated vegetation. This vegetation is comprised of three different regional ecosystems.

11.3.1 - Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on alluvial plains (BVG25a). 11.4.9 – Brigalow (*Acacia harpophylla)* shrubby woodland with Rosewood (*Terminalia oblongata)* on Cainozoic clay plains (BVG25a). 11.9.5 - Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on fine-grained sedimentary rocks (BVG25a).

All of these HVR RE's belong to the same Broad Vegetation Group (BVG25a) which covers:

> Open forests to woodlands dominated by *Acacia harpophylla* (Brigalow) sometimes with *Casuarina cristata* (Belah) on heavy clay soils. Includes areas co-dominated with *A. cambagei* (gidgee) and/or emergent eucalypts.

As stated in the QBOP, an offset area for an 'endangered' RE must be of the same broad vegetation group and also be a regional ecosystem that has the same or higher VM class as the area proposed for clearing.

The combined 124 ha of HVR Brigalow dominated vegetation on the offset area is comprised of regional ecosystems 11.3.1 (20.84 ha) and 11.4.9 (103.71 ha). After combining the EC and SF scores of the assessment units which make up the endangered HVR of BVG 25a, the equivalent combined AU scores in the offset area had a greater EC and SF score than the clearing area

5.4.3 **Watercourses**

Watercourses on the clearing areas are associated with various woodlands dominated by Coolabah, Poplar Box, Queensland Blue Gum, Brigalow, and Belah. All of which occur along Cockatoo Creek (Stream Order (SO) 3) and smaller drainage lines running across clay and sandy plains. Cockatoo Creek supports distinctive riparian vegetation whereas the smaller drainage lines feeding into Cockatoo Creek support minimal riparian vegetation.

The habitats associated with watercourses within FL Plains are generally in better condition than those of the Cockatoo Creek Stage One and Stage Two Diversion project areas. However evidence of the impacts of high grazing pressures and the spread of weeds, are distinctively more evident in the Cockatoo Creek Stage One and Stage Two Diversion project areas than FL Plains.

Each AU in the offset area chosen to offset the watercourse vegetation is associated with a watercourse of an equal or higher stream order. Offsetting this vegetation also contributes to maintaining bank stability, better water quality, and increased aquatic and terrestrial habitat. A description of each offset area is provided below.

OA AU1 directly fringes SO4 Parrot Creek and extends into the adjacent flood plains. The dominant HVR Brigalow vegetation plays a role maintaining bank stability, and preventing run off and erosion forming impacts in adjacent flood plains. The Gilgai and vegetation itself are important for aquatic and terrestrial habitat.

OA AU2 fringes a SO1 tributary that directly feeds into SO4 Parrot Creek. This AU is 2 km upstream and only separated by 500 m from Parrot Creek. In view of its proximity it has the attributes to consider it as being associated with Parrot Creek. This HVR Brigalow vegetation provides bank stabilising root systems, assists in controlling turbidity levels and aluminium levels from associated run off. In terms of terrestrial habitat, this distribution plays an important role in linking remnant expanses of adjacent category B mapped watercourse vegetation. In regards to aquatic habitat, the root systems and patchy clay lenses can provide Gilgai and temporary waterholes when water flow ceases.

OA AU3 is situated in a small flood plain between Roper and Horse Creeks (both SO5 watercourses). It directly fringes Horse Creek and expands into the plain between them. It is only 400 m from Roper Creek. During large flow events it is not uncommon for this area to be inundated with water. This remnant woodland is dominated by very large mature Coolabah whose extensive root systems play a vital role in maintaining bank stability, subsequently preventing bank erosion and impacts associated with water quality and turbidity. These marginally exposed root systems assist in providing aquatic habitat. In addition large hollow bearing Coolabah serve as important habitat trees for terrestrial fauna in the area and links adjacent category B mapped vegetation together. Long standing ponds of water can be found throughout this woodland long after rain and flow events cease.

OA AU4 fringes a SO2 drainage line that directly feeds into SO3 Cockatoo Creek. This AU is 400 m upstream of SO3 Cockatoo Creek and is the last remaining distribution of remnant vegetation (also riparian vegetation) in the eastern portion of the Cockatoo Creek flood plain. This remnant vegetation is dominated by large mature Belah whose extensive root systems play a vital role in maintaining bank stability, subsequently preventing bank erosion and impacts associated with water quality and turbidity. Being surrounded by a grazing land and a mining operation this remnant vegetation serves as a 'refuge' for wildlife. The vegetation also supports some temporary aquatic habitats that can exist after flow and rain events cease.

OA AU5 fringes a SO1 watercourse that directly feeds into SO4 Parrot Creek. This unnamed watercourse runs parallel with Parrot Creek and then joins with Parrot Creek 200 m downstream from its location. This remnant Brigalow dominated vegetation plays an important role in maintaining bank stability, subsequently preventing bank erosion and impacts associated water quality and turbidity. This closely confined riparian vegetation provides and unbroken riparian corridor which is important in providing for terrestrial and aquatic habitat.

OA AU6 fringes SO4 Carlo Creek upstream of the Foxleigh mine operation. This vegetation is dominated by remnant Brigalow which plays an important role in maintaining bank stability and preventing impacts to bank erosion and impacts associated water quality and turbidity. Being surrounded by a grazing land and a mining operation this remnant vegetation serves as a 'refuge' for wildlife. The vegetation also supports some temporary waterhole habitats that can exist long after flow and rain events cease.

OA AU7 fringes a SO2 watercourse that directly feeds into SO4 Cockatoo Creek 400 m away. This Poplar Box dominated woodland plays a role in maintaining bank stability. Regular inundation by flood waters and heavy rain events sees it supporting some temporary shallow ponds that last long after flow and rain events cease. The woodland itself is capable of providing terrestrial habitat for fauna.

OA AU8 consists of a mosaic of dense stands of Brigalow dominated HVR vegetation, that is surrounded by Poplar Box regrowth. This vegetation partially fringes a SO1 watercourse that directly feeds into SO3 Cockatoo Creek 500 m away. The remainder of the AU is in the sandy/clay flood plain associated with this watercourse.

OA AU9 fringes the high flow channel of SO4 Parrot Creek. This AU dominated by remnant Brigalow and Belah vegetation is adjacent to a permanent waterhole/dam. The mature vegetation plays a role in maintaining this permanent water source and provides terrestrial habitat for fauna.

OA AU10 fringes SO4 Parrot Creek. This remnant vegetation is dominated by Brigalow and is also located adjacent to a permanent waterhole/dam. The mature vegetation plays a role in maintaining this permanent water source and provides terrestrial habitat for fauna.

After combining the EC and SF scores of the AU's which make up the watercourse vegetation, the equivalent combined AU scores in the offset area have a greater EC and SF score than the clearing area.

6 CONCLUSION

Under the Queensland Biodiversity Offset Policy an Ecological Equivalence Assessment must be conducted to assist in determining if ecological equivalence has been achieved between the offset area and the clearing area. This is a critical step in determining if a proposed offset area is suitable to mitigate the impacts and fulfil the offset requirements.

This comparison requires the ecological condition and special feature scores of the proposed offset area to exceed the scores of the clearing areas associated with the Cockatoo Creek Stage One and Two diversions and also the FL Plains Project.

As demonstrated within this report the proposed offset area successfully meets the requirements of an offset area as defined by the Queensland Biodiversity Offsets Policy. The proposed offset area has:

- an overall ecological condition score equal to or greater than the overall ecological condition score for the clearing areas;
- an overall special features score equal to or greater than the overall special features score for the clearing areas; and
- a minimum score for ecological condition indicator 1 (recruitment of woody perennial species) must have a minimum score of three (i.e. >20 of overstorey species present as regeneration) and ecological condition indicator 4 (tree canopy cover) must have a minimum score of two (i.e. >10% and less than 50% benchmark) on offset areas.

Where the SFs score for two specific threatened RE's, was not obtained, the adjacency calculation was used to determine the proximity of these areas location to special features. Even without the adjacency calculation scores for these remnant RE's, when strictly applying the EEM's special feature scoring for remnant RE's, the entire offset area has an overall SF score greater than that of the entire clearing area.

Ecological equivalence is only part of an offsets requirement. Anglo American also intends to demonstrate how the area will be legally secured and how the management and monitoring of the area will be conducted within a future Offset Area Management Plan.

This report has aimed to provide the confidence required to demonstrate that through comprehensive field verification and desktop analysis the residual impacts associated with the Cockatoo Creek diversions and the FL Plains Project can be successfully offset. The proposed offset area meets and exceeds the ecological condition assessments and demonstrates ecological equivalence with the impacted areas and SSBVs.

7 RESOURCES

Anderson, E.R. (2003). *Plants of central Queensland; their identification and uses*. Department of Primary Industries, QLD.

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Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. 2011. *BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.1*. Department of Environment and Resource Management (DERM), Biodiversity and Ecosystem Sciences, Brisbane.

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Expert Industry Guidance

- Daniel Creevey – Biodiversity Officer, Queensland Herbarium.
- Christopher Ewing – Project Manager, CO2 Australia.

8 APPENDICES

Appendix 1: Field verified vegetation mapping

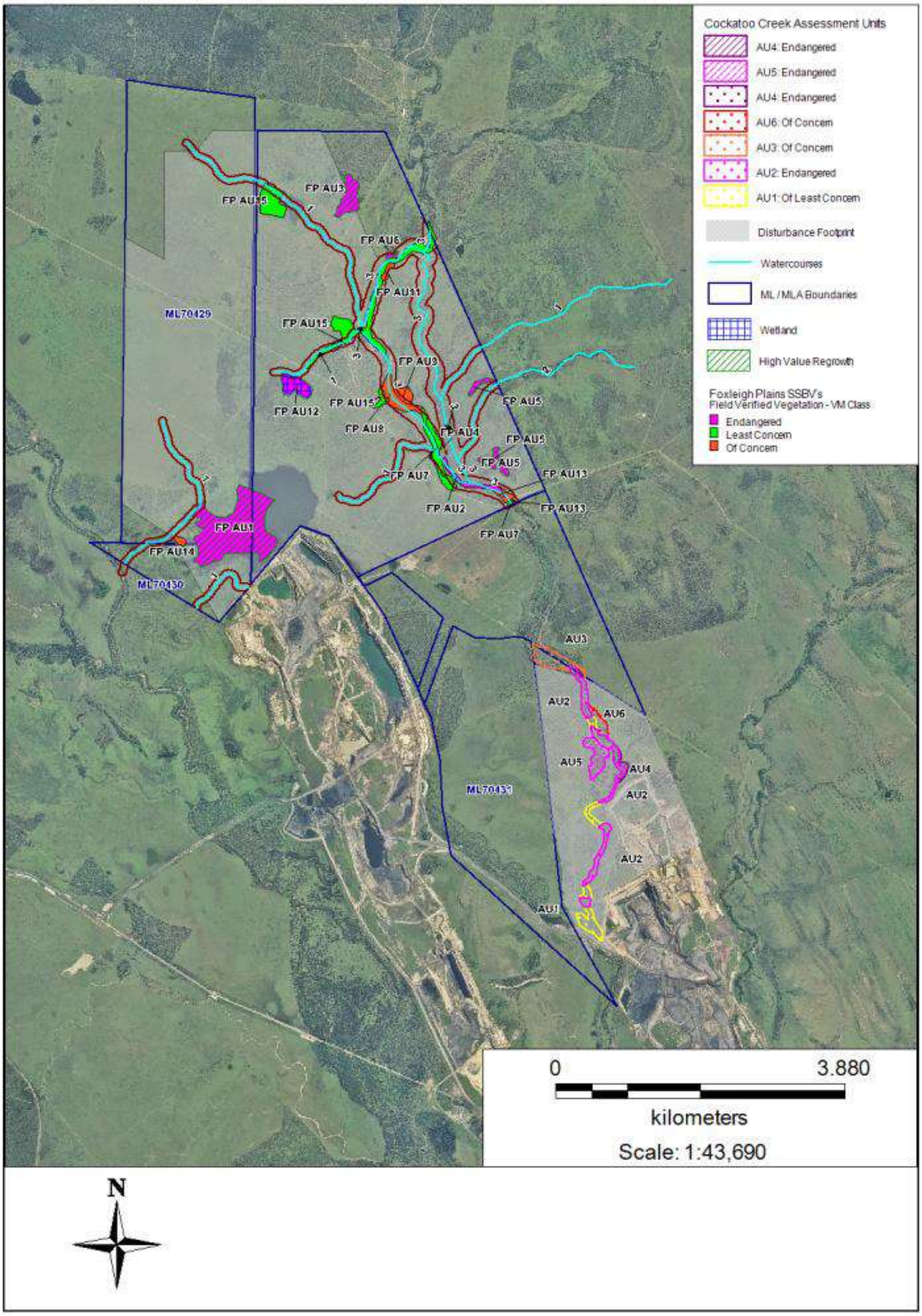
Appendix 2: Maps of SSBVs within impacts areas and offset areas

Appendix 3: Ecological Equivalence Scoring Summaries for clearing areas and offset area

Appendix 4: Examples of completed ecological condition field assessment sheets

Appendix 1

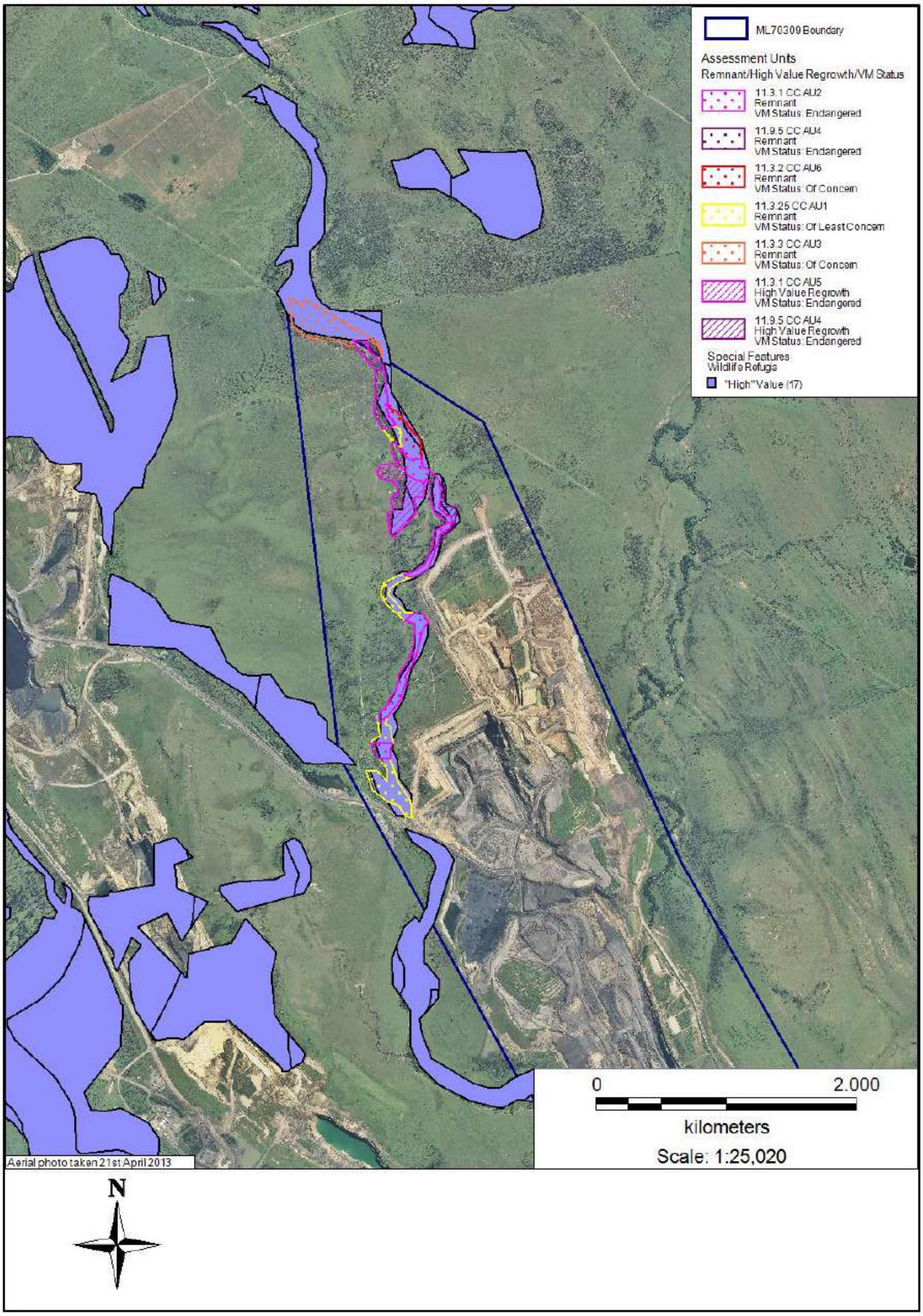
Field verified vegetation mapping



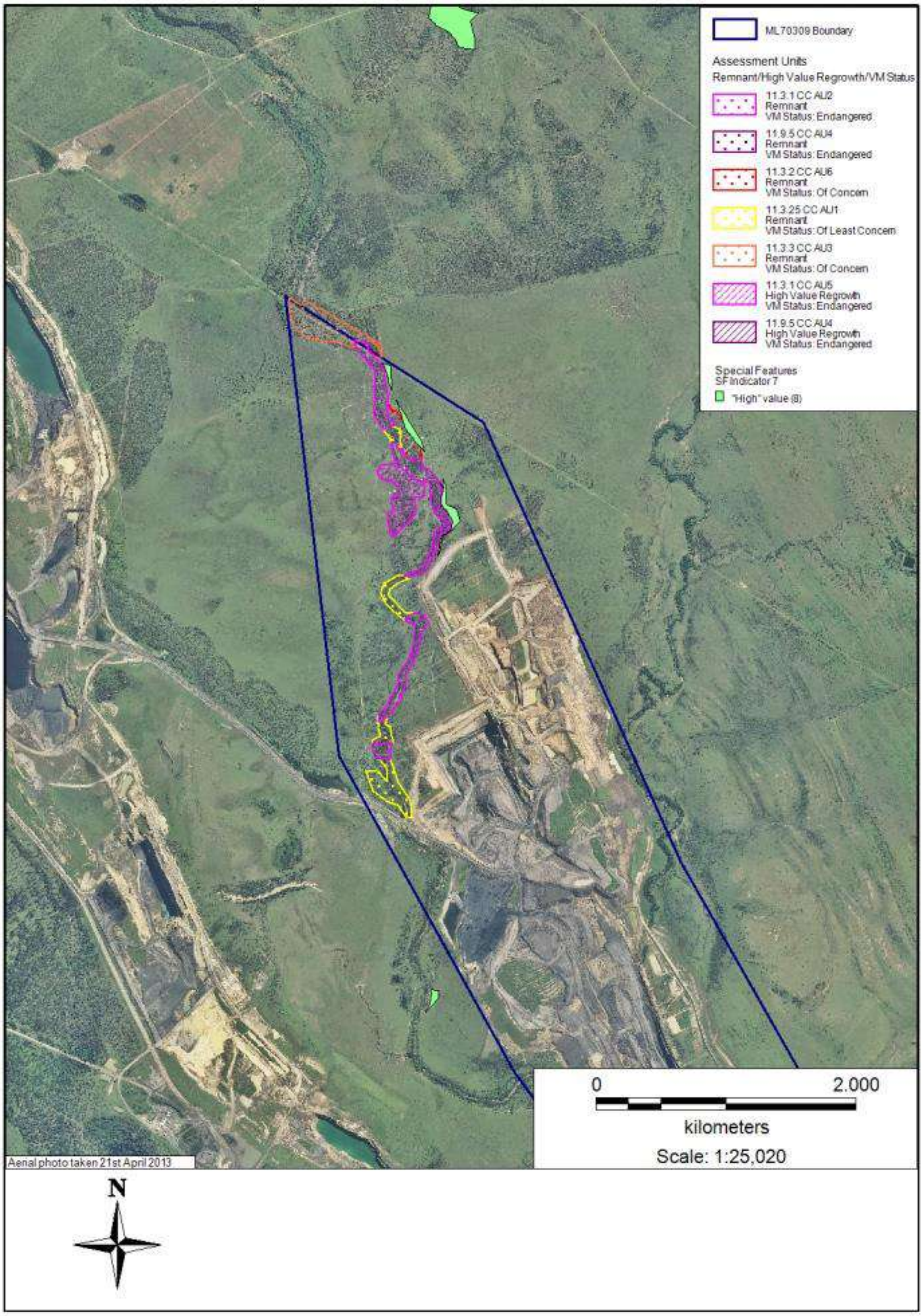
A1: Field verified vegetation mapping

Appendix 2

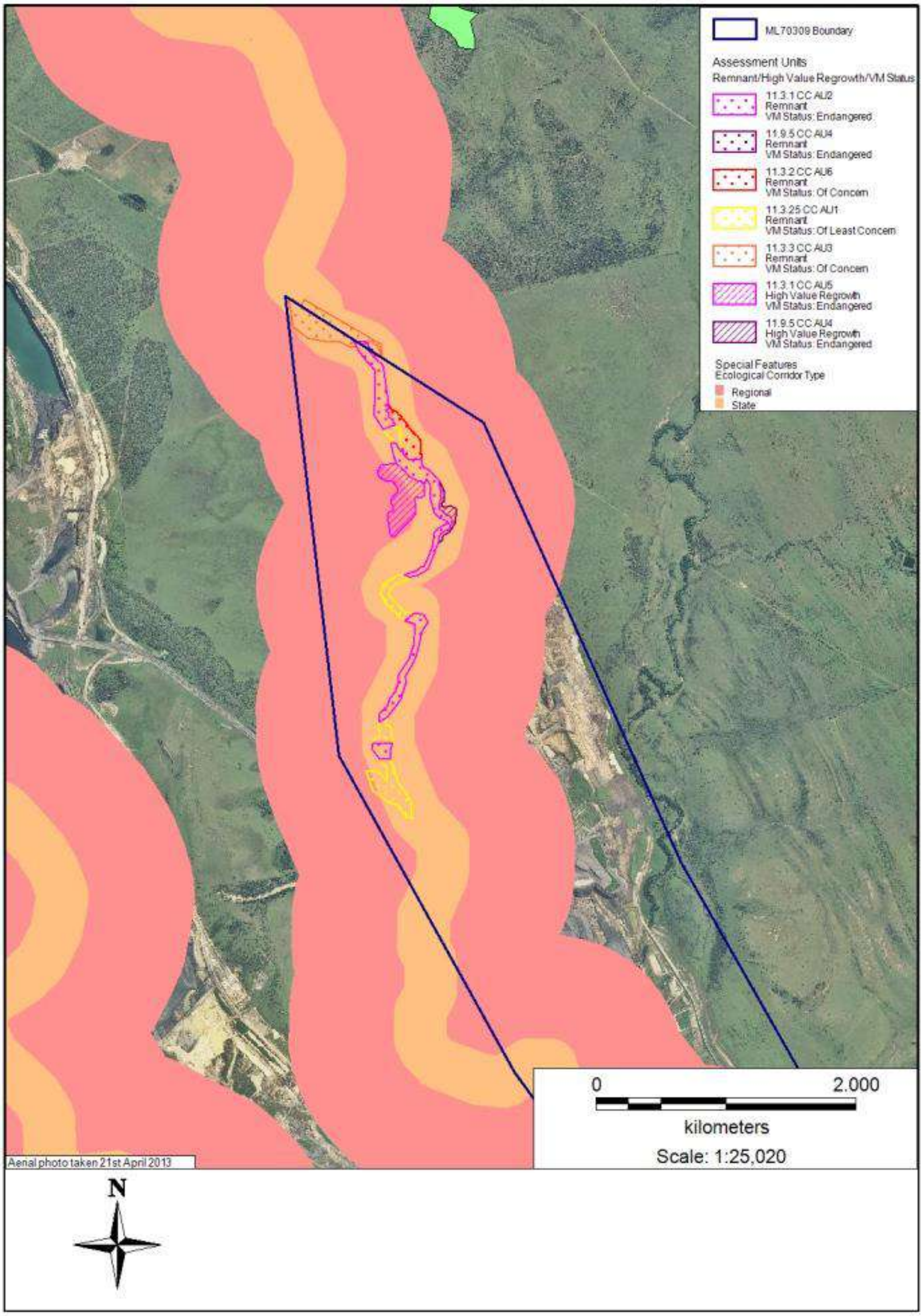
Maps of SSBVs within impacts areas and offset areas.



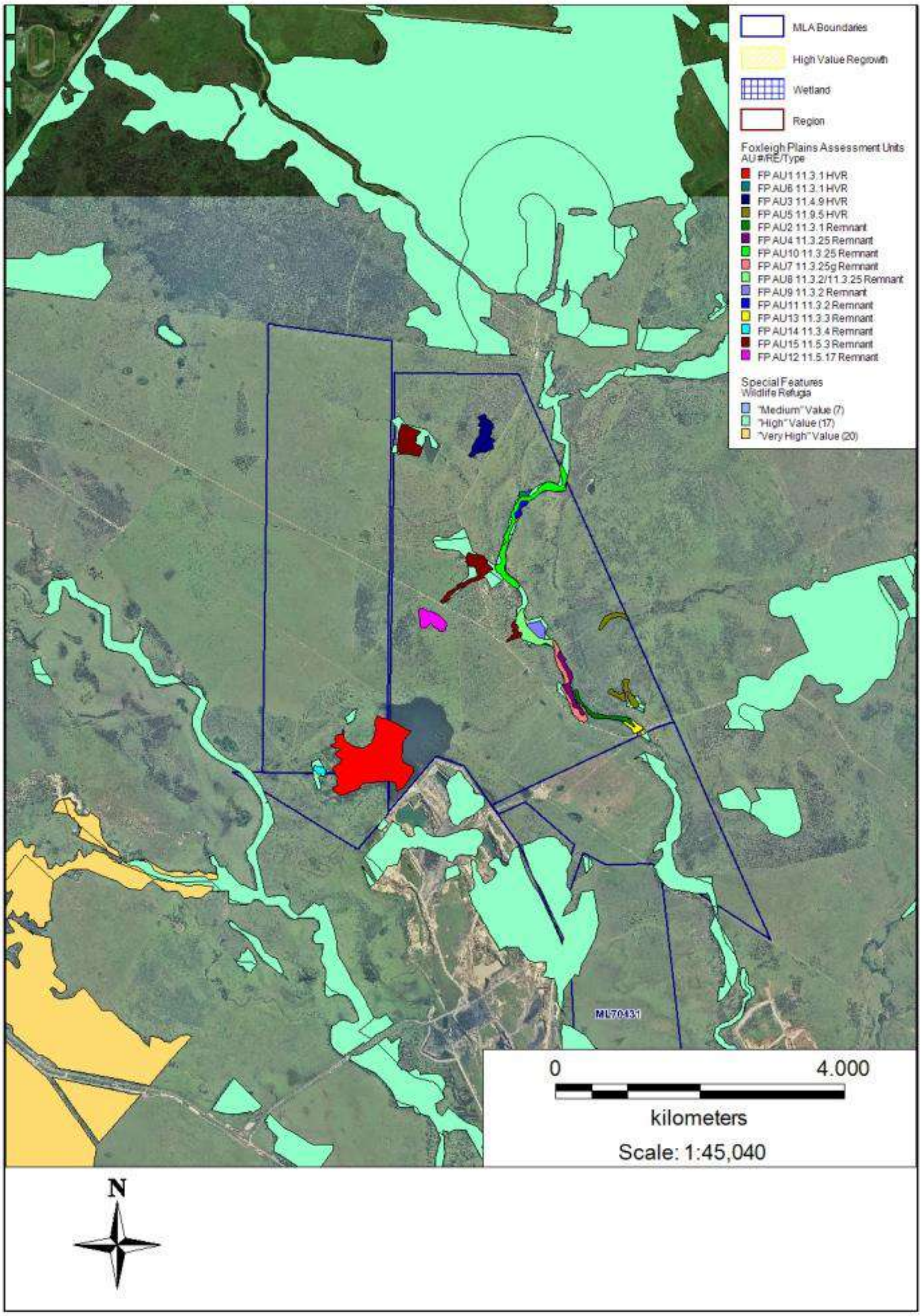
A2 Figure 1: Cockatoo Creek Stage One and Stage Two Diversion SF indicator 2 Wildlife Refugia proximity to project area



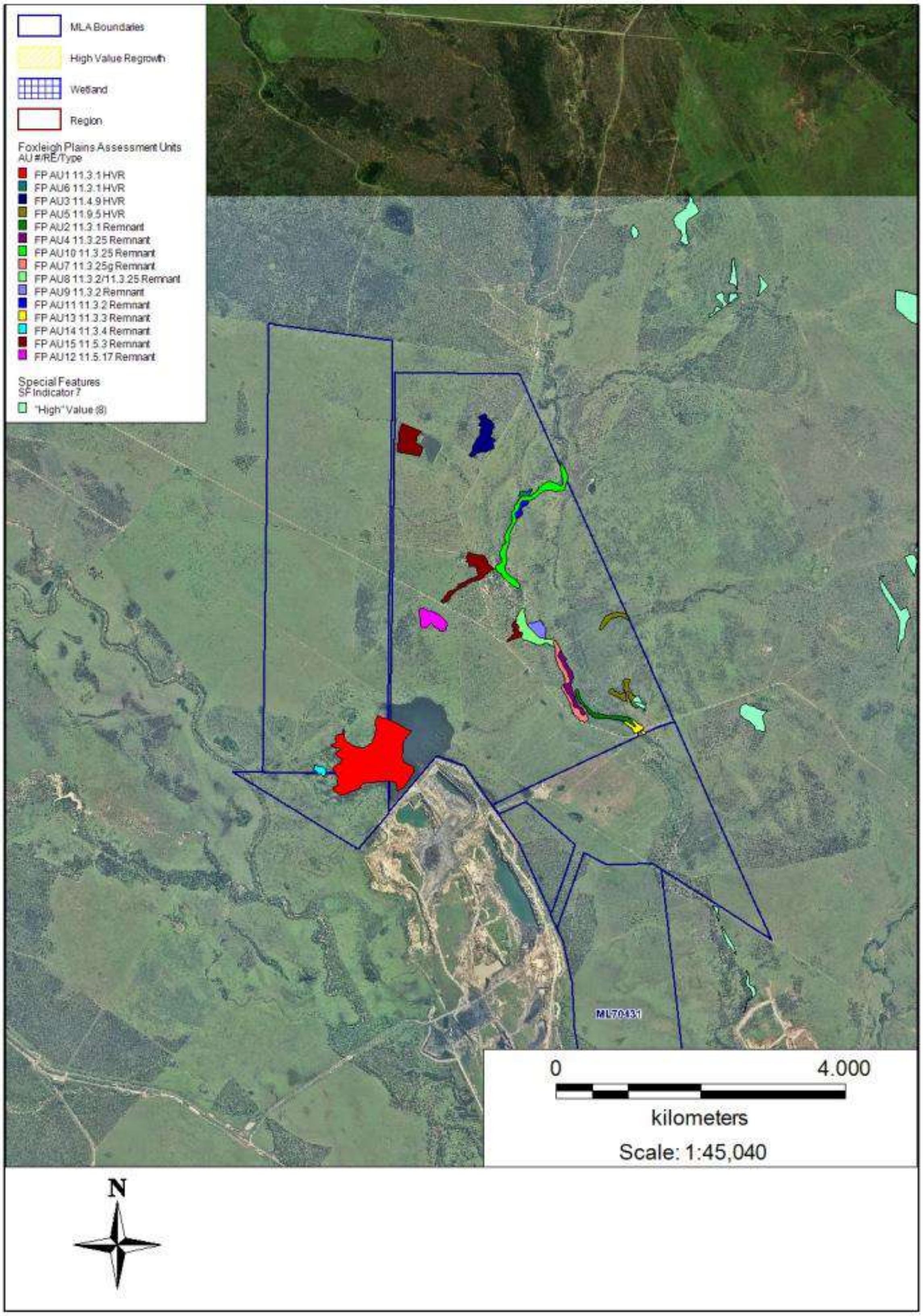
A2 Figure 2: Cockatoo Creek Stage One and Stage Two Diversion SF indicator 7 proximity to project area



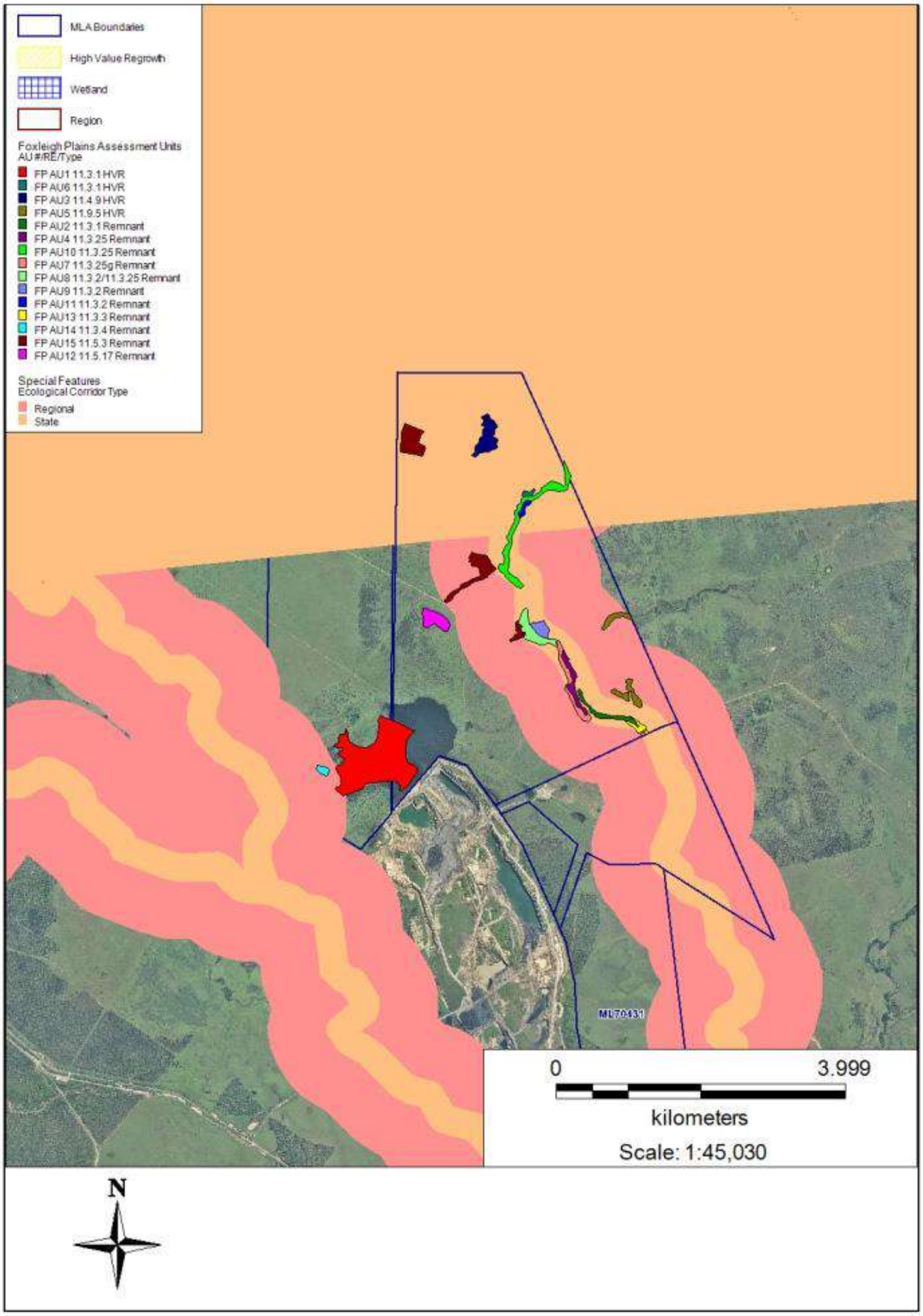
A2 Figure 3: Cockatoo Creek Stage One and Stage Two Diversion SF indicator 11 ecological corridor



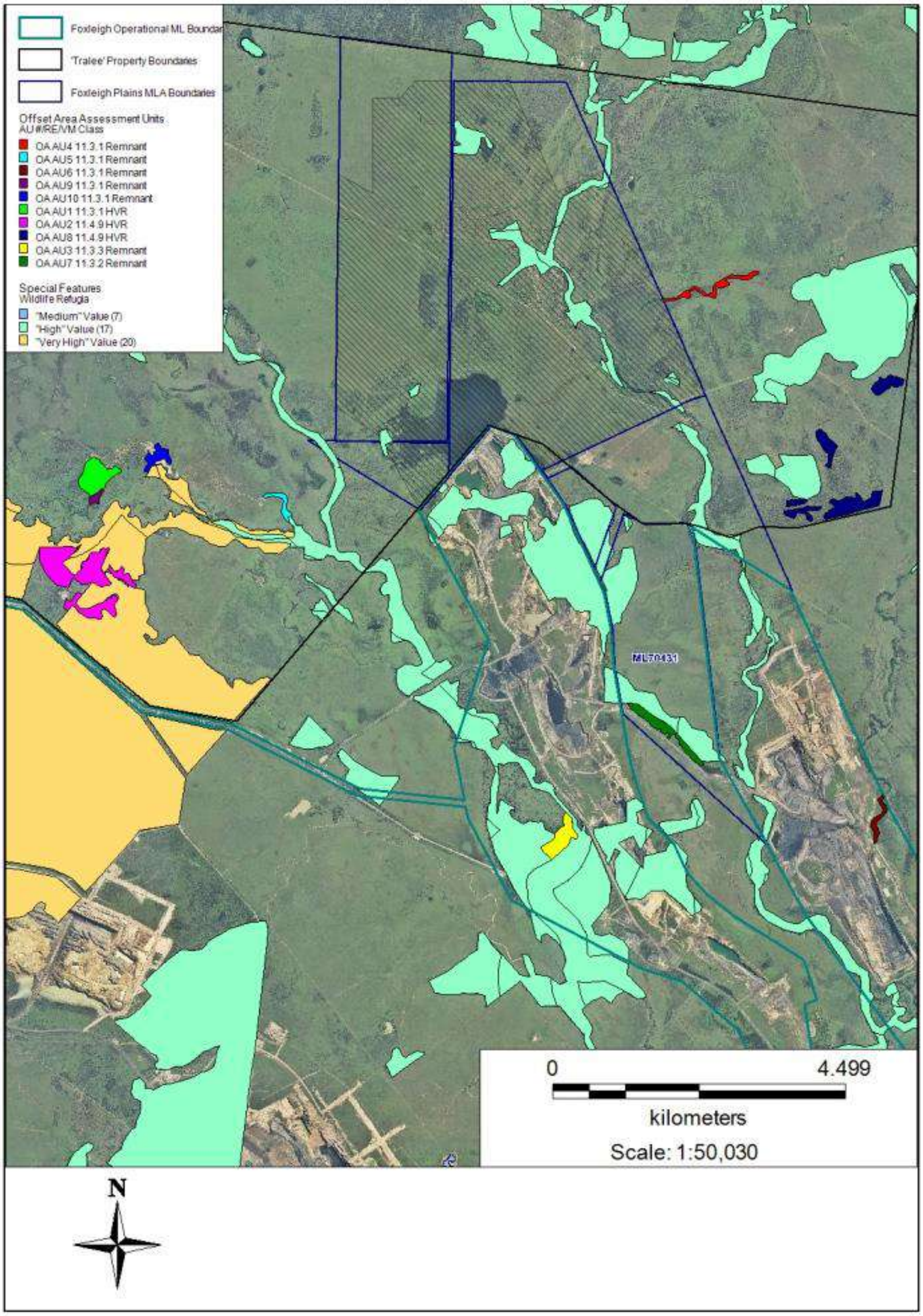
A2 Figure 4: Foxleigh Plains - SF indicator 2 Wildlife Refugia proximity



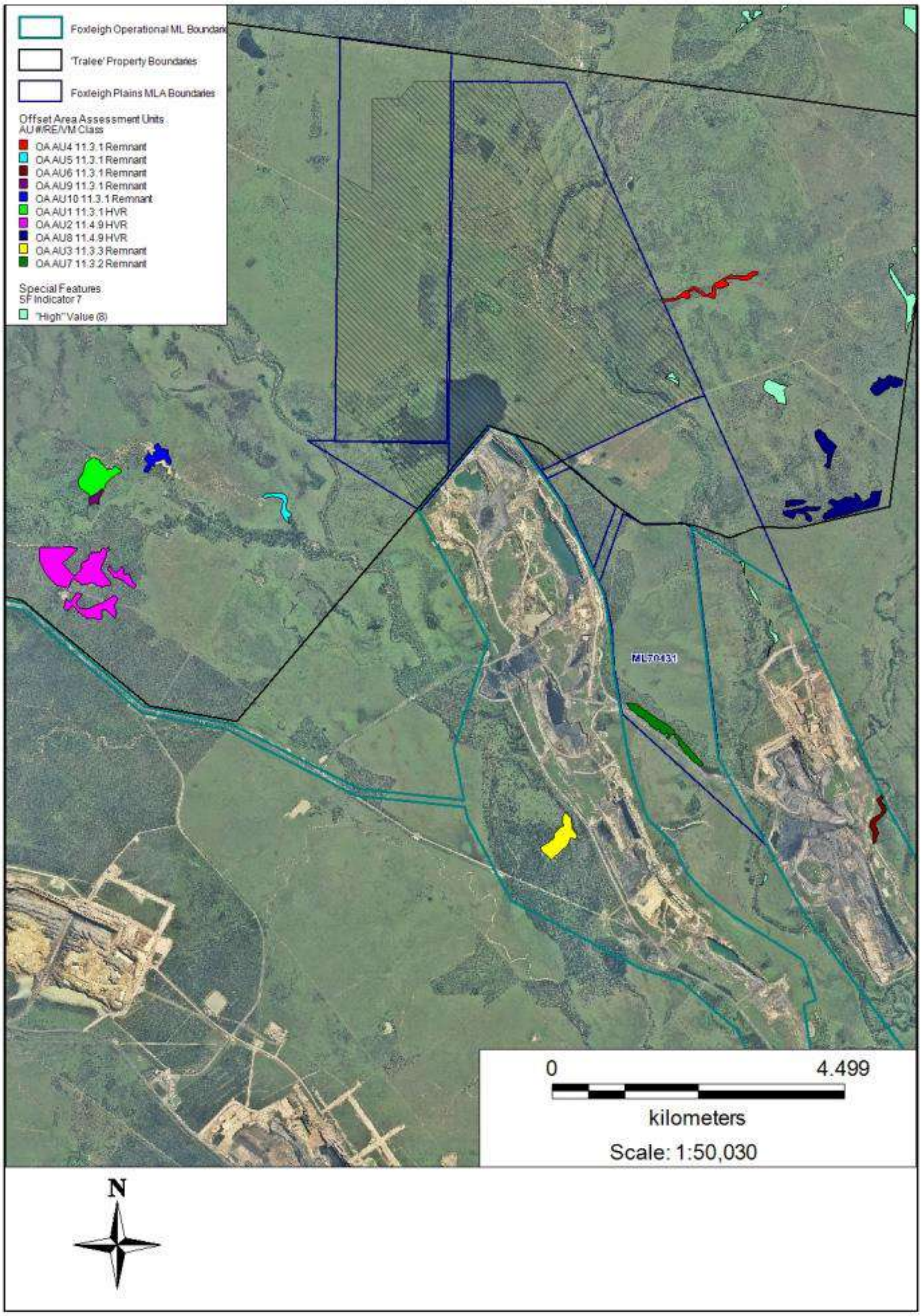
A2 Figure 5: Foxleigh Plains - SF indicator 7 proximity



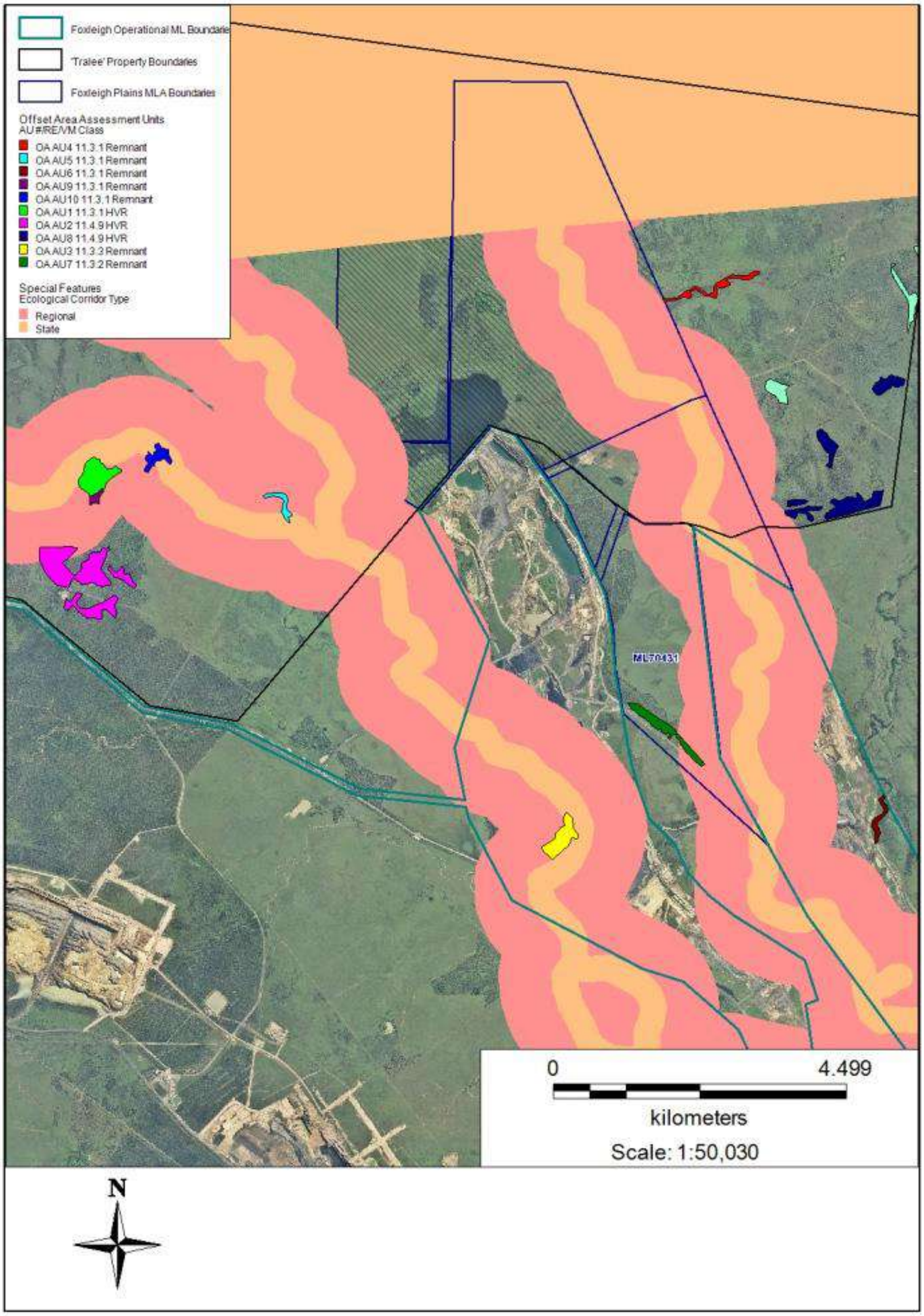
A2 Figure 6: Foxleigh Plains - SF indicator 11 Ecological corridor



A2 Figure 7: Proposed Offset Area for Cockatoo Creek Stages One and Two - SF indicator 2 Wildlife Refugia proximity



A2 Figure 8: Cockatoo Creek Stages One and Two Offset Area --SF indicator 7 proximity



A2 Figure 9: Cockatoo Creek Stages One and Two Offset Area - SF indicator 11 ecological corridor

Appendix 3

Ecological Equivalence Scoring Summaries for clearing areas and offset area

A3 Table 1: Cockatoo Creek Stage 1 and Stage 2 Diversions - Ecological Condition Indicator Scores

Ecological Condition indicators	11.3.25	11.3.1 Remnant	11.9.5 HVR	11.3.2 Remnant	11.3.1 HVR
	CC AU 1	CC AU 2	CC AU 6	CC AU 4	CC AU 5
Field Based indicators					
Number of sample sites					
Recruitment of canopy species	4.33	4.20	5.00	3.00	3.00
Native plant species richness for 4 life forms	14.17	15.70	0.00	15.00	12.50
Tree canopy height	5.00	5.00	0.00	5.00	3.00
Tree canopy cover (%)	5.00	4.40	5.00	5.00	5.00
Shrub layer cover (%)	2.67	3.80	0.00	3.00	0.00
Native perennial grass cover (%)	1.00	2.80	0.00	1.00	5.00
Litter cover	3.00	3.80	2.00	3.00	0.00
Large trees	10.00	5.00	0.00	15.00	2.50
Coarse woody debris	4.00	3.80	0.00	5.00	2.00
Non-native plant cover	0.00	4.60	0.00	0.00	0.00
Total Field based indicators	**49.17**	**53.1**	**12**	**55**	**33**
GIS Based Indicators					
Patch size	5	5	0	5	5
Connectivity	2	2	2	4	2
Context	0	0	0	2	0
Distance to water	ONLY MEASURED IN INTACT LANDSCAPES, BRIGALOW BELT IS CONSIDERED FRAGMENTED				
Landscape Score (Lc)	7	7	2	11	7
Total BioCondition Score	56.17	59.70	14.00	66.00	40.00
Area (ha)	12.50	21.35	1.71	4.35	9.78
Assessment unit Ecological Condition score	7.02	9.65	0.24	2.87	3.91

A3 Table 2: Cockatoo Creek Stage 1 and Stage 2 Diversions - Special Features Indicator Scores

Attribute	AU1 11.3.25				CCS AU2 11.3.1		AU3 11.3.3				AU4 11.3.2		AU5 11.3.1 HVR					AU6 11.9.5 HVR			
	AU1 Portion 1	AU1 portion 2	AU1 Portion 3	AU1 Portion 4	AU2 Portion 1	AU2 Portion 2	AU3 Portion 1	AU3 Portion 2	AU3 Portion 3	AU3 Portion 4	AU4 Portion 1	AU4 Portion 2	AU5 Portion 1	AU5 Portion 2	AU5 Portion 3	AU5 Portion 4	AU5 WHOLE adjacency calculations	AU6 Portion 1	AU6 Portion 2	AU6 Portion 3	AU6 WHOLE adjacency calculations
1																	ADJACENCY CALCUCLATIONS ARE COMPLETED FOR THE ENTIRETY OF EACH HVR PATCH				ADJACENCY CALCUCLATIONS ARE COMPLETED FOR THE ENTIRETY OF EACH HVR PATCH
2	17		17		17		17		17		17	17		17	17			17	17		
3																					
4																					
5																					
6																					
7												8									
8																			8		
9																					
10																					
11	20	20	17	17	20	20	20	20	17	17	20	20	20	20	17	17		20	20	20	
12																					
13	5	10	5	5	5	5	2.5	2.5	5	5	5	5		5	5	5		10	10	10	
14																					
sum of score	42	30	39	22	42	25	39.5	22.5	39	22	42	50	20	42	39	22		47	55	30	
Area (ha)	11.32	0.86	0.49	0.13	14.863	7.6032	10.0949	2.5634	0.038	0.04	3.681	0.67	1.01219	1.992	3.07	3.7		0.6604	1.044	0.01213	
Special features score = sum of scores x area / 100	4.7544	0.258	0.1911	0.0286	6.2425	1.9008	3.98749	0.57677	0.01482	0.0088	1.54602	0.335	0.202438	0.83664	1.1973	0.814	10.157997	0.31039	0.5742	0.00364	1.7740142
TOTAL SPECIAL FEATURES SCORE	5.2321				8.14326		4.5878705				1.88102		13.208375					2.6622412			

A3 Table 3: Foxleigh Plains Project - Ecological Condition Indicator Scores

Ecological Condition indicators	11.3.1 HVR	11.3.1 Remnant	11.4.9 HVR	11.3.25 Remnant	11.9.5 HVR	11.3.1 HVR	11.3.25g Remnant	11.3.2/11.3.25 Remnant	11.3.2 Remnant	11.3.25 Remnant	11.3.2 Remnant	11.5.17**	11.3.3 Remnant	11.3.4 Remnant	11.5.3 Remnant
	FP AU 1	FP AU 2	FP AU 3	FP AU 4	FP AU 5	FP AU 6	FP AU 7	FP AU 8	FP AU 9	FP AU 10	FP AU 11	FP AU 12	FP AU 13	FP AU14	FPAU15
Field Based indicators															
Recruitment of canopy species	5.00	5.00	0.00	3.00	5.00	5.00	na	5.00	3.00	5.00	5.00	THIS RE IS OUTSIDE OF THE REVISED MINE DISTURBANCE FOOTRPINT AND DOES NOT REQUIRE OFFSETTING	5.00	5.00	5.00
Native plant species richness for 4 life forms	8.00	13.75	5.00	8.75	12.50	7.50	10	11.25	10.00	13.75	11.25		12.50	20.00	20.00
Tree canopy height	0.00	5.00	0.00	5.00	0.00	3.00	na	5.00	3.00	5.00	2.75		5.00	5.00	5.00
Tree canopy cover (%)	1.50	4.00	5.00	5.00	5.00	5.00	na	3.50	5.00	4.00	2.00		5.00	5.00	5.00
Shrub layer cover (%)	0.00	0.00	0.00	0.00	0.00	0.00	na	0.00	0.00	0.00	4.00		5.00	5.00	5.00
Native perennial grass cover (%)	0.40	0.00	0.00	5.00	5.00	1.00	0	0.00	2.00	1.50	0.00		3.00	3.00	3.00
Litter cover	5.00	3.00	4.00	5.00	5.00	3.00	0	5.00	5.00	3.00	5.00		5.00	5.00	5.00
Large trees	10.00	5.00	0.00	12.50	2.50	0.00	na	5.00	5.00	15.00	5.00		5.00	10.00	10.00
Coarse woody debris	1.60	2.00	0.00	3.50	0.00	0.00	na	3.50	3.50	3.50	3.50		5.00	5.00	5.00
Non-native plant cover	0.00	10.00	5.00	10.00	10.00	5.00	10	5.00	5.00	5.00	0.00		5.00	3.00	5.00
Total Field based indicators	31.50	47.75	19	57.75	45	29.5	20	43.25	41.5	55.75	38.5		55.5	66	68
GIS Based Indicators															
Patch size	5	2	0	5	0	5	5	5	5	2	5		2	0	2
Connectivity	2	2	0	4	0	2	2	2	2	0	4		2	0	2
Context	0	0	0	5	0	0	5	0	0	0	0		0	5	0
Distance to water	ONLY MEASURED IN INTACT LANDSCAPES, BRIGALOW BELT IS CONSIDERED FRAGMENTED												ONLY MEASURED IN INTACT LANDSCAPES, BRIGALOW BELT IS CONSIDERED FRAGMENTED		
Landscape Score (	7	4	0	14	0	7	12	7	7	2	9		4	5	4
Total BioCondition Score	38.50	51.75	19.00	71.75	45.00	36.50	32	50.25	48.50	57.75	47.50		59.50	71.00	72.00
Area (ha)	72.05	4.94	1.99	5.90	8.10	1.00	7.01	4.2*	3.85	16.50	1.77		2.36	1.50	10.95
AU EC SCORE	27.74	2.19	0.45	4.23	3.85	0.37	3.61	2.11	1.87	9.53	0.84		1.40	1.07	17.22

A3 Table 4: Foxleigh Plains Project - Special Features Indicator Scores

Attribute	11.3.1 HVR		11.3.1 RE		11.4.9 HVR		11.3.25 Remnant		11.9.5 HVR			**11.3.1 HVR**			11.3.25g Remnant				11.3.2 / 11.3.25 Remnant		11.3.2 Remnant	11.3.25 Remnant		11.3.2 Remnant		AU12 11.5.17	11.3.3 Remnant			11.3.4 Remnant		11.5.3 Remnant				
	AU1 area 1 (non adj)	AU1 area 2 (adj)	AU2 area 1	AU2 area 2	AU3 (non adj)	AU3 (adj)	AU4 area 1	AU4 area 2	AU5 area 1 (non adj)	AU5 area 2 (non adj)	AU5 (adj)	AU6 area 1 (non adj)	AU6 area 2 (non adj)	AU6 (adj)	AU7 area 1	AU7 area 2	AU7 area 3	AU7 area 4	AU8 area 1	AU8 area 2	AU9	AU10 area 1	AU10 area 2	AU11 area 1	AU11 area 2	AU12	AU13 area 1	AU13 area 2	AU13 area 2	AU14 area 1	AU14 area 2	AU15 area 1	AU15 area 2	AU15 area 3	AU15 area 4	AU15 Portion 5
1		ADJACENCY CALCUCLATIONS ARE COMPLETED FOR THE ENTIRETY OF EACH HVR PATCH, NOT THE PORTIONS THAT ARE NOT VOERLAPPED BY SPECIAL FEATURES				ADJACENCY CALCUCLATIONS ARE COMPLETED FOR THE ENTIRETY OF EACH HVR PATCH, NOT THE PORTIONS THAT ARE NOT VOERLAPPED BY SPECIAL FEATURES					ADJACENCY CALCUCLATIONS ARE COMPLETED FOR THE ENTIRETY OF EACH HVR PATCH, NOT THE PORTIONS THAT ARE NOT VOERLAPPED BY SPECIAL FEATURES			ADJACENCY CALCUCLATIONS ARE COMPLETED FOR THE ENTIRETY OF EACH HVR PATCH, NOT THE PORTIONS THAT ARE NOT VOERLAPPED BY SPECIAL FEATURES																						
2			17				17						17		17	17			17		17	17		17			17			17			17	17		17
3																																				
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5																																				
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11	17		20	20	20		20	20	20	17		20	20		20	17	20	17	20	20	20	20	20	20	20		20	20	17	17	17	17	17	20	20	20
12																																				
13	5		10	10	10		10	10	5	5		5	5		10	10	10	10	5	5	10	5	5	5	5	10	10	10	10	2.5	2.5	10	10	10	10	10
14																																				
Sum of Score	22.00	18.62	47.00	30.00	30.00		47.00	30.00	25.00	22.00	42.00	25.00	42.00	29.07	47.00	44.00	30.00	27.00	42.00	25.00	47.00	42.00	25.00	42.00	25.00	10.00	47.00	30.00	27.00	36.50	19.50	27	44	47	30	47
Area (ha)	1.96	70.10	1.35	3.59	2.00		4.25	1.69	0.05	7.07	8.10	0.91	0.31	0.91	3.39	0.38	2.48	0.88	2.03	6.70	3.85	14.78	2.02	1.20	0.57	7.33	0.05	0.67	0.33	1.51	0.04	2.294	8.81	0.599	1.585	10.43
SF Score	0.43	13.05	0.63	1.08	0.60	0.38	2.00	0.51	0.01	1.55	3.40	0.23	0.13	0.27	1.59	0.17	0.74	0.24	0.85	1.68	1.81	6.21	0.50	0.50	0.14	0.73	0.02	0.20	0.09	0.55	0.01	0.61	3.87	0.28	0.47	4.90
TOTAL	**13.48**		**1.71**		**0.98**		**2.51**		**4.96**			**0.63**			**2.74**				**2.53**		**1.81**	**6.71**		**0.64**		**0.73**	**0.31**			**0.56**		**10.15**				

A3 Table 5: Foxleigh Plains - Adjacency Calculation special feature scoring

	AU1 11.3.1 HVR NE levee					AU3 11.4.9 HVR North of Kenny household				
	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)
Attribute:	AU1 adj calc	AU1 adj calc	AU1 adj calc	AU1 adj calc	AU1 adj calc	AU2 adj calc	AU2 adj calc	AU2 adj calc	AU2 adj calc	AU2 adj calc
1. Centres of endemism										
2. Wildlife refugia (1)	17	0.8	1	0.8	13.6	17	0.5	0.5	0.25	4.25
Wildlife refugia (2)	17	0.8	0.25	0.2	3.4	17	0.1	1	0.1	1.7
Wildlife refugia (3)	17	0.1	0.25	0.025	0.425	17	0.1	1	0.1	1.7
Wildlife refugia (4)	17	0.1	0.5	0.05	0.85	17	0.1	0.75	0.075	1.275
Wildlife refugia (5)	17	0.1	0.1	0.01	0.17	17	0.1	0.75	0.075	1.275
Wildlife refugia (6)	17	0.1	0.1	0.01	0.17	17	0.25	0.75	0.1875	3.1875
Wildlife refugia (7)						17	0.1	0.75	0.075	1.275
Wildlife refugia (8)						17	0.1	0.75	0.075	1.275
Wildlife refugia (9)						17	0.1	0	0	0
Wildlife refugia (10)						17	0.25	0.1	0.025	0.425
Wildlife refugia (11)						17	0.1	0.75	0.075	1.275
Wildlife refugia (12)						17	0.1	0.75	0.075	1.275
3. Areas with conentrations of disjunct populations										
4. Areas with taxa at limits of geographic range										
5. Areas with high species richness										
6. Areas considered to be important for maintaining populations of ancient and primitive taxt										
7. Geomorphology (1)										
Geomorphology (2)										
8. Artificially created waterbodies of ecological significance										
9. Areas considered to be important because of high relative density of hollow bearing trees										
10. Breeding or roosting sites used by a significant number of individuals										
11. Ecological corridors		[redacted]					[redacted]			
12. Priority species										
13. Significance of patch within a 1km buffer										
14. Protected area estate buffer										
sum of score					18.615					18.9125
Area (ha)					70.1					1.999
Special features score = sum of scores x area / 100					13.049115					0.378060875

	AU5 11.9.5 HVR East of Cockatoo Creek					AU6 11.3.1 HVR North Reaches Cockatoo Creek				
	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)
Attribute:	AU5 adj calc	AU5 adj calc	AU5 adj calc	AU5 adj calc	AU5 adj calc	AU6 portion 1 (Nth)	AU6 portion 1	AU6 portion 1 (Nth) adj	AU6 portion 1 (Nth)	AU6 portion 1 (Nth) adj
1. Centres of endemism										
2. Wildlife refugia (1)	17	0.25	0.75	0.1875	3.1875	17	0.1	0.75	0.075	1.275
Wildlife refugia (2)	17	0.8	0.1	0.08	1.36	17	0.1	0.75	0.075	1.275
Wildlife refugia (3)	17	0.8	0.1	0.08	1.36	17	0.8	1	0.8	13.6
Wildlife refugia (4)	17	0.8	1	0.8	13.6	17	0.5	1	0.5	8.5
Wildlife refugia (5)	17	0.25	0.75	0.1875	3.1875	17	0.1	1	0.1	1.7
Wildlife refugia (6)	17	0.1	0.5	0.05	0.85	17	0.1	0.75	0.075	1.275
Wildlife refugia (7)	17	0.1	0.75	0.075	1.275	17	0.1	0.75	0.075	1.275
Wildlife refugia (8)	17	0.8	0.1	0.08	1.36	17	0.1	0.1	0.01	0.17
Wildlife refugia (9)	17	0.8	0.1	0.08	1.36					
Wildlife refugia (10)	17	0.25	0.5	0.125	2.125					
Wildlife refugia (11)	17	0.25	0.75	0.1875	3.1875					
Wildlife refugia (12)	17	0.1	0.75	0.075	1.275					
3. Areas with conentrations of disjunct populations	17	0.1	0.75	0.075	1.275					
4. Areas with taxa at limits of geographic range										
5. Areas with high species richness										
6. Areas considered to be important for maintaining populations of ancient and primitive taxt										
7. Geomorphology (1)	8	0.8	1	0.8	6.4					
Geomorphology (2)	8	0.1	0.25	0.025	0.2					
8. Artificially created waterbodies of ecological significance										
9. Areas considered to be important because of high relative density of hollow bearing trees										
10. Breeding or roosting sites used by a significant number of individuals										
11. Ecological corridors		[redacted]					[redacted]			
12. Priority species										
13. Significance of patch within a 1km buffer										
14. Protected area estate buffer										
sum of score					42.0025					29.07
Area (ha)					8.1					0.9129
Special features score = sum of scores x area / 100					3.4022025					0.26538003

A3 Table 6: Foxleigh Plains - Watercourse Vegetation AU Ecological Condition scoring

Ecological Condition indicators	11.3.1 HVR	11.3.1 Remnant	11.3.25 Remnant	11.9.5 HVR	11.3.1 HVR	11.3.25g Remnant	11.3.2/11.3.25 Remnant	11.3.2 Remnant	11.3.25 Remnant	11.3.2 Remnant	11.3.3 Remnant	11.5.3 Remnant
	FP AU 1	FP AU 2	FP AU 4	FP AU 5	FP AU 6	FP AU 7	FP AU 8	FP AU 9	FP AU 10	FP AU 11	FP AU 13	FPAU15
Field Based indicators												
Recruitment of canopy species	5.00	5.00	3.00	5.00	5.00	na	5.00	3.00	5.00	5.00	5.00	5.00
Native plant species richness for 4 life forms	8.00	13.75	8.75	12.50	7.50	10	11.25	10.00	13.75	11.25	12.50	20.00
Tree canopy height	0.00	5.00	5.00	0.00	3.00	na	5.00	3.00	5.00	2.75	5.00	5.00
Tree canopy cover (%)	1.50	4.00	5.00	5.00	5.00	na	3.50	5.00	4.00	2.00	5.00	5.00
Shrub layer cover (%)	0.00	0.00	0.00	0.00	0.00	na	0.00	0.00	0.00	4.00	5.00	5.00
Native perennial grass cover (%)	0.40	0.00	5.00	5.00	1.00	0	0.00	2.00	1.50	0.00	3.00	3.00
Litter cover	5.00	3.00	5.00	5.00	3.00	0	5.00	5.00	3.00	5.00	5.00	5.00
Large trees	10.00	5.00	12.50	2.50	0.00	na	5.00	5.00	15.00	5.00	5.00	10.00
Coarse woody debris	1.60	2.00	3.50	0.00	0.00	na	3.50	3.50	3.50	3.50	5.00	5.00
Non-native plant cover	0.00	10.00	10.00	10.00	5.00	10	5.00	5.00	5.00	0.00	5.00	5.00
Total Field based indicators	31.50	47.75	57.75	45	29.5	20	43.25	41.5	55.75	38.5	55.5	68
GIS Based Indicators												
Patch size	5	2	5	0	5	5	5	5	2	5	2	2
Connectivity	2	2	4	0	2	2	2	2	0	4	2	2
Context	0	0	5	0	0	5	0	0	0	0	0	0
Distance to water	ONLY MEASURED IN INTACT LANDSCAPES, BRIGALOW BELT IS CONSIDERED FRAGMENTED											
Landscape Score (	7	4	14	0	7	12	7	7	2	9	4	4
Total BioCondition Score	38.50	51.75	71.75	45.00	36.50	32	50.25	48.50	57.75	47.50	59.50	72.00
Area (ha)	1.297	4.94	5.57	3.33	1	5.95	8.225	1.24	16.44	1.56	2.36	7.77
Assessment unit ecological condition score	0.5	2.19	3.99	1.5	0.37	3.06	4.13	0.6	9.49	0.74	1.40	5.62

A3 Table 7: Offset Area - Ecological Condition Indicator Scores

Ecological Condition indicators	11.3.1 HVR	11.4.9 HVR	11.3.3 Remnant	11.3.1 Remnant	11.3.1 Remnant	11.3.1 Remnant	11.3.2 Remnant	11.4.9 HVR	11.3.1 Remnant	11.3.1 Remnant
	OA AU 1	OA AU 2	OA AU 3	OA AU 4	OA AU 5	OA AU6	OA AU7	OA AU8	OA AU9	OA AU10
Field Based indicators										
Recruitment of canopy species	4.60	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Native plant species richness for 4 life forms	11.00	5.63	12.50	18.75	17.50	15.00	16.25	13.33	20.00	13.75
Tree canopy height	3.00	1.50	5.00	5.00	5.00	5.00	5.00	3.00	5.00	5.00
Tree canopy cover (%)	5.00	2.50	4.50	3.25	5.00	4.50	5.00	3.17	5.00	5.00
Shrub layer cover (%)	1.60	0.75	0.00	3.00	4.00	1.50	3.00	3.00	5.00	2.50
Native perennial grass cover (%)	1.60	1.25	2.00	2.00	4.00	3.00	3.00	1.33	3.00	5.00
Litter cover	4.20	5.00	3.00	4.00	5.00	4.00	5.00	5.00	5.00	4.00
Large trees	0.00	0.00	15.00	5.00	5.00	5.00	0.00	0.00	10.00	5.00
Coarse woody debris	2.60	0.50	2.00	2.00	3.50	2.00	4.00	0.00	5.00	3.50
Non-native plant cover	4.20	3.25	2.00	4.00	3.00	2.50	4.00	5.00	5.00	5.00
Total Field based indicators	37.80	25.375	51	52	57	47.5	50.25	38.83333333	68	53.75
GIS Based Indicators										
Patch size	7	10	10	2	10	2	5	7	2	10
Connectivity	0	4	2	0	0	0	0	0	0	0
Context	0	4	4	0	2	0	2	2	2	2
Distance to water	ONLY MEASURED IN INTACT LANDSCAPES, BRIGALOW BELT IS CONSIDERED FRAGMENTED									
Landscape Score (Lc)	7	18	16	2	12	2	7	9	4	12
Total BioCondition Score	44.80	43.38	67.00	54.00	69.00	49.50	57.25	47.83	72.00	65.75
Area (ha)	20.84	61.28	16.11	9.75	4.89	5.59	15.11	42.43	2.48	8.02
Assessment unit ecological condition score	9.34	26.58	10.79	5.26	3.37	2.77	8.65	20.43	1.78	5.21

A3 Table 8: Offset Area - Special Features Indicator Scores

Attribute	11.3.1 HVR			11.4.9 HVR			11.3.3		11.3.1 Remnant	11.3.1 Remnant		11.3.1 Remnant	11.3.2 Remnant		11.4.9 HVR		11.3.1 Remnant	11.3.1 Remnant	
	OA AU1 Area 1	OA AU1 Area 2	OA AU1 Adj calc	OA AU2 Area 1	OA AU2 Area 2	OA AU2 (Adj calc)	OA AU3 Area 1	OA AU3 Area 2	OA AU4	OA AU5	OA AU5	OA AU6	OA AU7	OA AU7	OA AU8 Area 1	OA AU8 (Adj calc)	OA AU9	OA AU10 Area 1	OA AU10 Area 2
1			ADJACENCY CALCUCLATIONS ARE COMPLETED FOR THE ENTIRETY OF EACH HVR PATCH, NOT THE PORTIONS THAT ARE NOT VOERLAPPED BY SPECIAL FEATURES			ADJACENCY CALCUCLATIONS ARE COMPLETED FOR THE ENTIRETY OF EACH HVR PATCH, NOT THE PORTIONS THAT ARE NOT VOERLAPPED BY SPECIAL FEATURES										ADJACENCY CALCUCLATIONS ARE COMPLETED FOR THE ENTIRETY OF EACH HVR PATCH, NOT THE PORTIONS THAT ARE NOT VOERLAPPED BY SPECIAL FEATURES			
2				20.00	20.00														
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11	20.00	17.00			17.00		17.00	20.00	0.00	17.00	20.00	0.00		17.00	17.00		17.00	20.00	17.00
12																			
13	2.50	2.50		0.00	0.00		2.50	2.50	10.00	5.00	5.00	10.00	5.00	5.00	10.00		2.50	5.00	5.00
14																			
sum of score	22.50	19.50		20.00	37.00		19.50	22.50	10.00	22.00	25.00	10.00	5.00	22.00	27.00		19.50	25.00	22.00
Area (ha)	5.37	15.47		4.57	0.15		9.84	6.28	9.75	3.77	1.12	5.59	10.49	4.62	4.62		2.48	6.34	1.68
SF Score	1.21	3.02	6.36	0.91	0.05	42.53	1.92	1.41	0.97	0.83	0.28	0.56	0.52	1.02	1.25	23.05	0.48	1.58	0.37
SF TOTAL	10.58			43.50			3.33		0.97	1.11		0.56	1.54		24.30		0.48	1.95	

A3 Table 9: Offset Area - Adjacency Calculation scores for the remnant AU's with a low Special features score

Attribute	OAU AU1 11.3.1 HVR					OA AU2 11.3.1 HVR					OAU3 11.4.9 HVR					OAU AU8 11.4.9 HVR				
	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)
1. Centres of endemism																				
2. Wildlife refugia (1)	17	0.5	0.1	0.05	0.85	17	0.1	0.75	0.075	1.275	20	0.8	1	0.8	16	17	0.25	0.1	0.025	0.425
Wildlife refugia (2)	17	0.1	0.5	0.05	0.85	17	0.1	0.1	0.01	0.17	20	0.25	1	0.25	5	17	0.25	0.5	0.125	2.125
Wildlife refugia (3)	17	0.1	0.75	0.075	1.275	20	0.1	0.75	0.075	1.5	20	0.1	1	0.1	2	17	0.25	0.5	0.125	2.125
Wildlife refugia (4)	17	0.25	0.25	0.0625	1.0625	20	0.1	0.75	0.075	1.5	20	0.1	0.75	0.075	1.5	17	0.1	0.1	0.01	0.17
Wildlife refugia (5)	20	0.1	0.75	0.075	1.5	20	0.1	0.75	0.075	1.5	20	0.1	0.75	0.075	1.5	17	0.1	0.25	0.025	0.425
Wildlife refugia (6)	20	0.1	0.75	0.075	1.5	20	0.25	0.75	0.1875	3.75	20	0.1	0.75	0.075	1.5	17	0.1	0.25	0.025	0.425
Wildlife refugia (7)	20	0.1	0.75	0.075	1.5	20	0.8	0.1	0.08	1.6	20	0.1	0.75	0.075	1.5	17	0.1	0.5	0.05	0.85
Wildlife refugia (8)	17	0.5	0.1	0.05	0.85	20	0.1	0.75	0.075	1.5	17	0.1	1	0.1	1.7	17	0.1	0.5	0.05	0.85
Wildlife refugia (9)	17	0.5	0.1	0.05	0.85	17	0.1	0.75	0.075	1.275	20	0.1	0.75	0.075	1.5	17	0.1	0.5	0.05	0.85
Wildlife refugia (10)	17	0.1	0.75	0.075	1.275	17	0.1	0.75	0.075	1.275	20	0.8	1	0.8	16	17	0.1	0.1	0.01	0.17
Wildlife refugia (11)	20	0.1	0.75	0.075	1.5	17	0.25	0.75	0.1875	3.1875	20	0.1	1	0.1	2	17	0.1	0.1	0.01	0.17
Wildlife refugia (12)	17	0.8	0.1	0.08	1.36	17	0.1	0.75	0.075	1.275	17	0.1	1	0.1	1.7	17	0.25	0.1	0.025	0.425
Wildlife refugia (13)	20	0.1	0.75	0.075	1.5	17	0.1	0.5	0.05	0.85	20	0.8	1	0.8	16	17	0.1	0.75	0.075	1.275
Wildlife refugia (14)	20	0.1	0.75	0.075	1.5	17	0.1	0.75	0.075	1.275	20	0.1	0.75	0.075	1.5	17	0.1	0.75	0.075	1.275
Wildlife refugia (15)						20	0.8	0.1	0.08	1.6						17	0.1	0.75	0.075	1.275
Wildlife refugia (16)						20	0.1	0.1	0.01	0.2						17	0.1	0.5	0.05	0.85
Wildlife refugia (17)						17	0.1	0.75	0.075	1.275						17	0.25	0.5	0.125	2.125
Wildlife refugia (18)						20	0.1	0.75	0.075	1.5						17	0.5	0.1	0.05	0.85
Wildlife refugia (19)						20	0.1	0.75	0.075	1.5						17	0.5	0.1	0.05	0.85
Wildlife refugia (20)																17	0.1	0.25	0.025	0.425
Wildlife refugia (21)																17	0.1	0.25	0.025	0.425
Wildlife refugia (22)																17	0.1	0.5	0.05	0.85
Wildlife refugia (23)																17	0.1	0.5	0.05	0.85
Wildlife refugia (24)																17	0.8	1	0.8	13.6
Wildlife refugia (25)																17	0.8	1	0.8	13.6
3. Areas with conentrations of disjunct populations																				
4. Areas with taxa at limits of geographic range																				
5. Areas with high species richness																				
6. Areas considered to be important for maintaining populations of ancient and primitive taxt																				
7. Geomorphology (1)																8	0.25	0.1	0.025	0.2
Geomorphology (2)																8	0.1	0.1	0.01	0.08
Geomorphology (3)																8	0.1	0.1	0.01	0.08
Geomorphology (4)																8	0.1	0.25	0.025	0.2
Geomorphology (5)																8	0.25	0.25	0.0625	0.5
Geomorphology (6)																8	0.1	0.5	0.05	0.4
Geomorphology (7)																8	0.1	0.75	0.075	0.6
8. Artificially created waterbodies of ecological significance																				
9. Areas considered to be important because of high relative density of hollow bearing trees																				
10. Breeding or roosting sites used by a significant number of individuals																				
11. Ecological corridors	17	[redacted]			PRESENT	20	[redacted]			PRESENT	17	[redacted]			PRESENT	20	[redacted]			PRESENT
12. Priority species		[redacted]					[redacted]					[redacted]					[redacted]			
13. Significance of patch within a 1km buffer	5	[redacted]			5	2.5	[redacted]			2.5	0	[redacted]			0	10-30% native veg remaining: 13.9%	[redacted]			5
14. Protected area estate buffer																				
sum of score					22.3725					30.5075					69.4					54.32
Area (ha)					9.66					20.84					61.28					42.43
SF SCORE					2.1611835					6.357763					42.52832					23.047976

A3 Table 10: Offset Area - Adjacency Calculation special feature scoring for proposed offset area

Attribute	OA AU4 11.3.1 Remnant adjacency score method					OA AU5 11.3.1 Remnant adjacency score method				
	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)
1. Centres of endemism										
2. Wildlife refugia (1)	17	0.1	0.75	0.075	1.275	20	0.1	1	0.1	2
Wildlife refugia (2)	17	0.1	0.75	0.075	1.275	20	0.1	1	0.1	2
Wildlife refugia (3)	17	0.1	0.5	0.05	0.85	20	0.5	1	0.5	10
Wildlife refugia (4)	17	0.1	0.25	0.025	0.425	20	0.1	1	0.1	2
Wildlife refugia (5)	17	0.1	0.25	0.025	0.425	20	0.1	1	0.1	2
Wildlife refugia (6)	17	0.1	0.25	0.025	0.425	20	0.1	1	0.1	2
Wildlife refugia (7)	17	0.1	0.1	0.01	0.17	20	0.8	1	0.8	16
Wildlife refugia (8)	17	0.1	0.25	0.025	0.425	17	0.5	1	0.5	8.5
Wildlife refugia (9)	17	0.1	0.5	0.05	0.85	17	0.5	1	0.5	8.5
Wildlife refugia (10)	17	0.1	0.5	0.05	0.85	17	0.8	1	0.8	13.6
Wildlife refugia (11)	17	0.1	0.5	0.05	0.85	17	0.25	0.5	0.125	2.125
Wildlife refugia (12)	17	0.1	0.5	0.05	0.85	17	0.1	0.5	0.05	0.85
Wildlife refugia (13)	17	0.1	0.5	0.05	0.85	17	0.1	0.5	0.05	0.85
Wildlife refugia (14)	17	0.25	0.1	0.025	0.425	17	0.1	0.8	0.08	1.36
Wildlife refugia (15)	17	0.1	0.5	0.05	0.85					
Wildlife refugia (16)	17	0.1	0.75	0.075	1.275					
Wildlife refugia (17)										
Wildlife refugia (18)										
Wildlife refugia (19)										
Wildlife refugia (20)										
Wildlife refugia (21)										
Wildlife refugia (22)										
Wildlife refugia (23)										
Wildlife refugia (24)										
Wildlife refugia (25)										
3. Areas with conentrations of disjunct populations										
4. Areas with taxa at limits of geographic range										
5. Areas with high species richness										
6. Areas considered to be important for maintaining populations of ancient and primitive taxt										
7. Geomorphology (1)	8	0.1	0.5	0.05	0.4					
Geomorphology (2)	8	0.1	0.5	0.05	0.4					
Geomorphology (3)	8	0.1	0.75	0.075	0.6					
Geomorphology (4)										
Geomorphology (5)										
Geomorphology (6)										
Geomorphology (7)										
8. Artificially created waterbodies of ecological significance										
9. Areas considered to be important because of high relative density of hollow bearing trees										
10. Breeding or roosting sites used by a significant number of individuals										
11. Ecological corridors	20	[redacted]			PRESEN	20	[redacted]			PRESENT
12. Priority species										
13. Significance of patch within a 1km buffer	10-30% native veg remaining: 13.9%				10	10-30% native veg remaining: 13.9%				5
14. Protected area estate buffer										
sum of score					23.47					76.79
Area (ha)					9.75					4.90
SF SCORE					2.29					3.76

Attribute	OA AU6 11.3.1 Remnant adjacency score method					OA AU17 11.3.2 Remnant adjacency method				
	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)
1. Centres of endemism										
2. Wildlife refugia (1)	17	0.1	0.75	0.075	1.275	17	0.25	0.75	0.1875	3.1875
Wildlife refugia (2)	17	0.1	0.5	0.05	0.85	17	0.8	1	0.8	13.6
Wildlife refugia (3)	17	0.1	0.5	0.05	0.85	17	0.8	1	0.8	13.6
Wildlife refugia (4)	17	0.1	0.5	0.05	0.85	17	0.1	0.75	0.075	1.275
Wildlife refugia (5)	17	0.1	0.5	0.05	0.85	17	0.1	0.75	0.075	1.275
Wildlife refugia (6)	17	0.1	0.5	0.05	0.85	17	0.1	0.75	0.075	1.275
Wildlife refugia (7)						17	0.5	0.75	0.375	6.375
Wildlife refugia (8)						17	0.5	0.75	0.375	6.375
Wildlife refugia (9)						17	0.5	0.75	0.375	6.375
Wildlife refugia (10)						17	0.5	0.75	0.375	6.375
Wildlife refugia (11)						17	0.5	0.75	0.375	6.375
Wildlife refugia (12)						17	0.5	0.1	0.05	0.85
Wildlife refugia (13)						17	0.5	0.1	0.05	0.85
Wildlife refugia (14)						17	0.1	0.5	0.05	0.85
Wildlife refugia (15)						17	0.1	0.5	0.05	0.85
Wildlife refugia (16)						17	0.1	0.75	0.075	1.275
Wildlife refugia (17)						17	0.1	0.75	0.075	1.275
Wildlife refugia (18)						17	0.1	0.75	0.075	1.275
Wildlife refugia (19)						17	0.1	0.5	0.05	0.85
Wildlife refugia (20)						17	0.1	0.5	0.05	0.85
Wildlife refugia (21)										
Wildlife refugia (22)										
Wildlife refugia (23)										
Wildlife refugia (24)										
Wildlife refugia (25)										
3. Areas with conentrations of disjunct populations										
4. Areas with taxa at limits of geographic range										
5. Areas with high species richness										
6. Areas considered to be important for maintaining populations of ancient and primitive taxt										
7. Geomorphology (1)	8	0.1	0.5	0.05	0.4	8	0.1	0.75	0.075	0.6
Geomorphology (2)						8	0.1	0.75	0.075	0.6
Geomorphology (3)										
Geomorphology (4)										
Geomorphology (5)										
Geomorphology (6)										
Geomorphology (7)										
8. Artificially created waterbodies of ecological significance										
9. Areas considered to be important because of high relative density of hollow bearing trees										
10. Breeding or roosting sites used by a significant number of individuals										
11. Ecological corridors	20	[redacted]			PRESENT	20	[redacted]			PRESENT
12. Priority species										
13. Significance of patch within a 1km buffer	10-30% native veg remainin g: 13.9%				10	10-30% native veg remaining: 13.9%				10
14. Protected area estate buffer										
sum of score					15.93					86.21
Area (ha)					5.59					15.11
SF SCORE					0.89					13.03

Attribute	OA AU 9 11.3.1 Remnant adjacency score method					OA AU10 11.3.1 Remnant adjacency score method				
	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplier (BxC)=D	Score (AxD)	SF Score (A)	Distance to SF multiplier(B)	% native woody veg multiplier (C)	Adj. multiplie r (BxC)=D	Score (AxD)
1. Centres of endemism										
2. Wildlife refugia (1)	20	0.1	0.75	0.075	1.5	20	0.1	1	0.1	2
Wildlife refugia (2)	20	0.1	0.75	0.075	1.5	20	0.1	1	0.1	2
Wildlife refugia (3)	20	0.1	0.75	0.075	1.5	20	0.1	1	0.1	2
Wildlife refugia (4)	20	0.5	0.5	0.25	5	20	0.25	1	0.25	5
Wildlife refugia (5)	20	0.1	0.75	0.075	1.5	20	0.1	1	0.1	2
Wildlife refugia (6)	20	0.1	0.75	0.075	1.5	20	0.1	1	0.1	2
Wildlife refugia (7)	20	0.8	0.1	0.08	1.6	20	0.5	1	0.5	10
Wildlife refugia (8)	20	0.1	0.75	0.075	1.5	20	0.8	1	0.8	16
Wildlife refugia (9)	20	0.1	0.75	0.075	1.5	20	0.8	1	0.8	16
Wildlife refugia (10)	20	0.1	0.75	0.075	1.5	17	0.1	1	0.1	1.7
Wildlife refugia (11)	20	0.1	0.75	0.075	1.5	17	0.1	1	0.1	1.7
Wildlife refugia (12)	17	0.1	0.75	0.075	1.275	17	0.1	1	0.1	1.7
Wildlife refugia (13)						17	0.1	1	0.1	1.7
Wildlife refugia (14)						17	0.1	1	0.1	1.7
Wildlife refugia (15)						17	0.1	1	0.1	1.7
Wildlife refugia (16)						17	0.1	0.75	0.075	1.275
Wildlife refugia (17)						17	0.1	0.75	0.075	1.275
Wildlife refugia (18)										
Wildlife refugia (19)										
Wildlife refugia (20)										
Wildlife refugia (21)										
Wildlife refugia (22)										
Wildlife refugia (23)										
Wildlife refugia (24)										
Wildlife refugia (25)										
3. Areas with conentrations of disjunct populations										
4. Areas with taxa at limits of geographic range										
5. Areas with high species richness										
6. Areas considered to be important for maintaining populations of ancient and primitive taxt										
7. Geomorphology (1)										
Geomorphology (2)										
Geomorphology (3)										
Geomorphology (4)										
Geomorphology (5)										
Geomorphology (6)										
Geomorphology (7)										
8. Artificially created waterbodies of ecological significance										
9. Areas considered to be important because of high relative density of hollow bearing trees										
10. Breeding or roosting sites used by a significant number of individuals										
11. Ecological corridors	PRESENT	[redacted]			20	PRESENT	[redacted]			17
12. Priority species										
13. Significance of patch within a 1km buffer	10-30% native veg remaining : 13.9%				10	10-30% native veg remaining: 13.9%				10
14. Protected area estate buffer										
sum of score					51.38					96.75
Area (ha)					2.48					8.02
SF SCORE					1.27					7.76

Appendix 4

Examples of completed ecological condition field assessment sheets

A4 sheet 1: Field assessment sheet OA AU1 SS2

Ecological Equivalence Methodology—Version 1.0 October 2011

Ecological condition field assessment sheet

For assessment of ecological equivalence under the Queensland Biodiversity Offset Policy and the Policy for Vegetation Management Offsets. Version 1.0, 2011. Page 1 of 2.

Project title:	DERM reference:
Lot plan/s:	Bioregion:

Area: 11.3.25	**RE/land type/assessment unit:** OA 1 SS2	**Bioregion:** Ripe Ck NW near dam	**Property:**
Date: 31/10/2012	**Photos** (optional) **N:** 693 694	**S:** 695 696 **E:** 699 708	**W:** 697 698
Landscape photo(s):		**Spot photo (s):**	
Datum: WGS84 or GDA94 Zone: 679768 7466636	**0 m mark AMGE:**		**AMGN:**
Transect bearing:	**50 m mark AMGE:**		**AMGN:**
General description: 11.3.25 creek line, 11.3.2 on flat. Dominated by buffel. Abt of smaller diameter eucs			

100 x 50 m area: * Ecologically dominant layer (EDL); ecological condition indicator (ECI)

Eucalypt large tree DBH 40 (from benchmark doc.): Number of large eucalypt trees: 16	Non-Eucalypt large tree DBH 0 (from benchmark doc.): Number of large non-eucalypt trees:
Total large trees (ECI 8): 16	
Tree canopy (EDL) height (ECI 3):	
Subcanopy and/or emergent height (where relevant): S:	E: PB, BG
Proportion of dominant canopy (EDL) species with evidence of recruitment (ECI 1):	
Total tree species richness (ECI 2a) includes all tree (i.e. single stemmed > 2 m height) species in the 100x50m, not just EDL species: False sandalwood, BG, PB, MBA, LB, Bloodwood, Tree - 709, 710 - sally wattle 711 - 714 - tree	

50 x 10 m area: *list species if known or count if unknown

Shrub species richness (ECI 2b) (defined as single stemmed below 2 m or multi-stemmed from base or below 20 cm) *: currant bush
Grass species richness (ECI 2c): 717.
Forbs and others (non-grass ground) species richness (ECI 2d):
Non-native plant (weed) cover (ECI 10): buffelgrass Wait a while weed photo 716, 718

50 x 20 m area: Coarse woody debris (ECI 9) CWD; >10 cm, >0.5 m, measured to the plot boundary:

	CWD length:		CWD length:		CWD length:		CWD length:		CWD length:		CWD length:
1	3m x 40cm	8		15		22		29		36	
2	4m x 17cm	9		16		23		30		37	
3	3m x 15cm	10		17		24		31		38	
4		11		18		25		32		39	
5		12		19		26		33		40	
6		13		20		27		34		41	
7		14		21		28		35		Total: 10	

creek photos 707 - 708

Page 2 of 2

Five 1x1 m plots * attributes used in scoring

Ground cover:	1 (701)	2 (702)	3 (703)	4 (704)	5 (70k)	Mean	
Native perennial grass cover (ECI 6)*	0 20	10 20	0 40	0 40 total	10 0	4	24
Organic litter cover (ECI 7) *	5 90 dead grass	10 60 dead grass	10 60	10 40 dead	10 50	9	52
Forbs and other	100 bc		90 buffel	0	0		
Total	=100%	=100%	=100%	=100%	=100%		

100 m transect

Tree canopy cover (ECI 4): Only assess Emergent (E) or Subcanopy (S) layers if the benchmark document stipulates that these layers should be present; otherwise Canopy (C) *trees in the same layer and continuous along the transect can be grouped

Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total
C	16-18	7									
C	31-34	3									
E	37-40	3									
C	62-64	4									
C	72-74	4									
C	84-88	4									
										Total C: 20 Total S: Total E:	

Shrub canopy cover (ECI 5): *denote as native or exotic. Only native shrub cover used in scoring

Shrubs*	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total
												Total native: 0		
												Total exotic:		

A4 sheet 2: Field assessment sheet OA AU2 SS2

Ecological Equivalence Methodology—Version 1.0 October 2011

Ecological condition field assessment sheet

For assessment of ecological equivalence under the Queensland Biodiversity Offset Policy and the Policy for Vegetation Management Offsets. Version 1.0, 2011. Page 1 of 2.

Project title:	DERM reference:
Lot plan/s:	Bioregion:

Area: 11.5.17	**RE/land type/assessment unit:** OA2 SS2	**Bioregion:**	**Property:**
Date: 31/10/12	**Photos** (optional) **N:** 682 683 683 684	**S:** 680 681 681 682 **E:** 678 679 679 680	**W:** 676 677 677 678
Landscape photo(s):		**Spot photo (s):**	
Datum: WGS84 or GDA94 677424 7469485 **Zone:**	**0 m mark AMGE:** **50 m mark AMGE:**	**AMGN:** **AMGN:**	
Transect bearing:			
General description: same as OA2 SS1			

100 x 50 m area: * Ecologically dominant layer (EDL); ecological condition indicator (ECI)

Eucalypt large tree DBH 40 (from benchmark doc.): Number of large eucalypt trees: 10	Non-Eucalypt large tree DBH 27 **(from benchmark doc.):** Number of large non-eucalypt trees: 0
Total large trees (ECI 8): 10	
Tree canopy (EDL) height (ECI 3): 12 15m 16m	
Subcanopy and/or emergent height **(where relevant)**: S:	E:
Proportion of dominant canopy (EDL) species with evidence of recruitment (ECI 1):	
Total tree species richness (ECI 2a) includes all tree (i.e. single stemmed > 2 m height) species in the 100x50m, not just EDL species: 6	

50 x 10 m area: *list species if known or count if unknown

Shrub species richness (ECI 2b) (defined as single stemmed below 2 m or multi-stemmed from base or below 20 cm) *: -
Grass species richness (ECI 2c): Grass 2 sedge, couch 686, 687
Forbs and others (non-grass ground) species richness (ECI 2d):
Non-native plant (weed) cover (ECI 10):

50 x 20 m area: Coarse woody debris (ECI 9) CWD; >10 cm, >0.5 m, measured to the plot boundary:

CWD length:		CWD length:		CWD length:		CWD length:		CWD length:		CWD length:	
1	6m x 40cm	8		15		22		29		36	
2	3m x 15?	9		16		23		30		37	
3		10		17		24		31		38	
4		11		18		25		32		39	
5		12		19		26		33		40	
6		13		20		27		34		41	
7		14		21		28		35		Total:	

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Five 1x1 m plots * attributes used in scoring

	684	689	690	691	692	
Ground cover:	**1**	**2**	**3**	**4**	**5**	**Mean**
Native perennial grass cover (ECI 6)*	100	100	70	60	50	47.2
Organic litter cover (ECI 7) *				0	0	
Forbs and other				0	0	
Total	=100%	=100%	=100%	=100%	=100%	

100 m transect

Tree canopy cover (ECI 4): Only assess Emergent (E) or Subcanopy (S) layers if the benchmark document stipulates that these layers should be present; otherwise Canopy (C) *trees in the same layer and continuous along the transect can be grouped

Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total
C	5-9	4									
C	44-47	3									
C	96-98	2									
										Total C: Total S: Total E:	

Shrub canopy cover (ECI 5): *denote as native or exotic. Only native shrub cover used in scoring

Shrubs*	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total
	0													
												Total native:		
												Total exotic:		

A4 sheet 2: Field assessment sheet OA AU2 SS2

Ecological Equivalence Methodology—Version 1.0 October 2011

Ecological condition field assessment sheet

For assessment of ecological equivalence under the Queensland Biodiversity Offset Policy and the Policy for Vegetation Management Offsets. Version 1.0, 2011. Page 1 of 2.

Project title: ______ DERM reference: ______
Lot plan/s: ______ Bioregion: ______

Area: 11.3.1/11.3.2 mix
RE/land type/assessment unit: OAB SS1
Bioregion:
Property:

Date: 2/11/17
Photos (optional) **N:** 888 889 **S:** 892 893 **E:** 890 891 **W:** 894 895

Landscape photo(s): **Spot photo (s):**

Datum: WGS84 or GDA94 Zone: 675702 7463571
0 m mark AMGE: **AMGN:**
50 m mark AMGE: **AMGN:**
Transect bearing: S-5

General description: riparian veg PB creekline south - into thick brigalow 11.3.1 lots of awnless

100 x 50 m area: * Ecologically dominant layer (EDL); ecological condition indicator (ECI)

Eucalypt large tree DBH 40
(from benchmark doc.):
Number of large eucalypt trees: 9+8 (17)

Non-Eucalypt large tree DBH 29
(from benchmark doc.):
Number of large non-eucalypt trees: (Brig) 5

Total large trees (ECI 8): 22

Tree canopy (EDL) height (ECI 3):
Subcanopy and/or emergent height (where relevant): S: – E: 100 PB

Proportion of dominant canopy (EDL) species with evidence of recruitment (ECI 1):

Total tree species richness (ECI 2a) includes all tree (i.e. single stemmed >2 m height) species in the 100x50m, not just EDL species: Brig, PB, YW, false sandalwood, LB, unknown trees photos

50 x 10 m area: *list species if known or count if unknown

Shrub species richness (ECI 2b) (defined as single stemmed below 2 m or multi-stemmed from base or below 20 cm) *: Gvata

Grass species richness (ECI 2c): umbrella cane grass

Forbs and others (non-grass ground) species richness (ECI 2d): purple flower

Non-native plant (weed) cover (ECI 10): Buffel, fennel weed, prickly pear

50 x 20 m area: Coarse woody debris (ECI 9) CWD: >10 cm, >0.5 m, measured to the plot boundary:

	CWD length		CWD length:		CWD length:		CWD length:		CWD length		CWD length
1	3m x 10	8	4 x 10	15		22		29		36	
2	2 x 10	9	3 x 15	16		23		30		37	
3	2 x 10	10	3 x 13	17		24		31		38	
4	3 x 12	11	4 x 10	18		25		32		39	
5	5 x 15	12	2 x 10	19		26		33		40	
6	6 x 12	13	3 x 15	20		27		34		41	
7	4 x 10	14	10 x 60	21		28		35		Total:	52

TH 12

Five 1x1 m plots * attributes used in scoring buffel

Ground cover:	1	2	3	4	5	Mean
Native perennial grass cover (ECI 6)*	100	-	-	400	0	0
Organic litter cover (ECI 7) *	0	30	100	~~4~~ 20	60	646
Forbs and other	0	50 buff	-	60 buff	0	
Total	=100%	=100%	=100%	=100%	=100%	

100 m transect

Tree canopy cover (ECI 4): Only assess Emergent (E) or Subcanopy (S) layers if the benchmark document stipulates that these layers should be present; otherwise Canopy (C) *trees in the same layer and continuous along the transect can be grouped

Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total
[illegible]	20	20									
C(8)	25-27	2									
C(6)	48-55	7									
C(7)	62-64	2									
C(8)	65-80	15									
C(8)	85-92	7									
									Total C: 61 Total S: Total E:		

Shrub canopy cover (ECI 5): *denote as native or exotic. Only native shrub cover used in scoring

Shrubs*	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total
N	49-50	1												
N	65-68	3												
												Total native: 4		
												Total exotic:		

APPENDIX D BASELINE FAUNA MONITORING

Page 2 of 2

Five 1x1 m plots * attributes used in scoring

Ground cover:	1 (701)	2 (702)	3 (703)	4 (704)	5 (705)	Mean	
Native perennial grass cover (ECI 6)*	0 20	10 20	0 40	0 40 total	10 0	4	24
Organic litter cover (ECI 7) *	5 90 dead grass	0 60 dead grass	10 [illegible]	10 40 dead	10 50	9	52
Forbs and other	100 bc		90 buffel	0	0		
Total	=100%	=100%	=100%	=100%	=100%		

100 m transect

Tree canopy cover (ECI 4): Only assess Emergent (E) or Subcanopy (S) layers if the benchmark document stipulates that these layers should be present; otherwise Canopy (C) *trees in the same layer and continuous along the transect can be grouped

Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total
C	16-18	2									
C	31-34	3									
E	37-40	3									
C	62-64	4									
C	72-74	4									
C	84-86	4									
									Total C: 20 Total S: Total E:		

Shrub canopy cover (ECI 5): *denote as native or exotic. Only native shrub cover used in scoring

Shrubs*	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total
											Total native: 0			
											Total exotic:			

A4 sheet 2: Field assessment sheet OA AU2 SS2

Ecological condition field assessment sheet

For assessment of ecological equivalence under the Queensland Biodiversity Offset Policy and the Policy for Vegetation Management Offsets. Version 1.0, 2011. Page 1 of 2.

Project title:	DERM reference:
Lot plan/s:	Bioregion:

Area: 11.5.17	**RE/land type/assessment unit:** OA2 SS2	**Bioregion:**	**Property:**	
Date: 31/10/12	**Photos** (optional) **N:** 682 683 683 684	**S:** 680 681 681 682	**E:** 678 679 679 680	**W:** 676 677 677 678
Landscape photo(s):			**Spot photo (s):**	
Datum: WGS84 or GDA94 677424 7469185	**Zone:**	**0 m mark AMGE:**	**AMGN:**	
		50 m mark AMGE:	**AMGN:**	
Transect bearing:				
General description: same as OA2 SS1				

100 x 50 m area: * Ecologically dominant layer (EDL); ecological condition indicator (ECI)

Eucalypt large tree DBH 40 (from benchmark doc.): Number of large eucalypt trees: 10	Non-Eucalypt large tree DBH 27 **(from benchmark doc.):** Number of large non-eucalypt trees: 0
Total large trees (ECI 8): 10	
Tree canopy (EDL) height (ECI 3): 12-15m [illegible] 16m	
Subcanopy and/or emergent height **(where relevant)**: S:	E:
Proportion of dominant canopy (EDL) species with evidence of recruitment (ECI 1):	
Total tree species richness (ECI 2a) includes all tree (i.e. single stemmed > 2 m height) species in the 100x50m, not just EDL species: 6	

50 x 10 m area: *list species if known or count if unknown

Shrub species richness (ECI 2b) (defined as single stemmed below 2 m or multi-stemmed from base or below 20 cm) *: -
Grass species richness (ECI 2c): Grass 2 sedge, couch 686, 687
Forbs and others (non-grass ground) species richness (ECI 2d):
Non-native plant (weed) cover (ECI 10):

50 x 20 m area: Coarse woody debris (ECI 9) CWD; >10 cm, >0.5 m, measured to the plot boundary:

CWD length:		CWD length:		CWD length:		CWD length:		CWD length:		CWD length:	
1	6m x 40cm	8		15		22		29		36	
2	3m x 15m	9		16		23		30		37	
3		10		17		24		31		38	
4		11		18		25		32		39	
5		12		19		26		33		40	
6		13		20		27		34		41	
7		14		21		28		35		Total:	

Page 2 of 2

Five 1x1 m plots * attributes used in scoring 684 689 690 691 692

Ground cover:	1	2	3	4	5	Mean
Native perennial grass cover (ECI 6)*	100	100	20	60	50	47.2
Organic litter cover (ECI 7) *				0	0	
Forbs and other				0	0	
Total	=100%	=100%	=100%	=100%	=100%	

100 m transect

Tree canopy cover (ECI 4): Only assess Emergent (E) or Subcanopy (S) layers if the benchmark document stipulates that these layers should be present; otherwise Canopy (C) *trees in the same layer and continuous along the transect can be grouped

Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total
C	5-9	4									
C	44-47	3									
C	96-98	2									
										Total C: Total S: Total E:	

Shrub canopy cover (ECI 5): *denote as native or exotic. Only native shrub cover used in scoring

Shrubs*	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total
	0													
												Total native:		
												Total exotic:		

A4 sheet 2: Field assessment sheet OA AU2 SS2

Ecological Equivalence Methodology—Version 1.0 October 2011

Ecological condition field assessment sheet

For assessment of ecological equivalence under the Queensland Biodiversity Offset Policy and the Policy for Vegetation Management Offsets. Version 1.0, 2011. Page 1 of 2.

Project title:	DERM reference:
Lot plan/s:	Bioregion:

Area: 11.3.1/11.3.2 mix	**RE/land type/assessment unit:** OAB SSi	**Bioregion:**	**Property:**
Date: 2/11/17	**Photos** (optional) **N:** 888 889	**S:** 892 893 **E:** 890 891	**W:** 894 895
Landscape photo(s):		**Spot photo (s):**	
Datum: WGS84 or GDA94 Zone: 675702 7463571	**0 m mark AMGE:** **50 m mark AMGE:**	**AMGN:** **AMGN:**	
Transect bearing: S-5			
General description: riparian veg PB creekline south - into thick brigalow 11.3.1 lots of acacia			

100 x 50 m area: * Ecologically dominant layer (EDL); ecological condition indicator (ECI)

Eucalypt large tree DBH 40 (from benchmark doc.): Number of large eucalypt trees: 9+8 (17)	Non-Eucalypt large tree DBH 29 (from benchmark doc.): Number of large non-eucalypt trees: (Brig) 5
Total large trees (ECI 8): 22	
Tree canopy (EDL) height (ECI 3):	
Subcanopy and/or emergent height (where relevant): S: —	E: 100 PB
Proportion of dominant canopy (EDL) species with evidence of recruitment (ECI 1):	
Total tree species richness (ECI 2a) includes all tree (i.e. single stemmed >2 m height) species in the 100x50m, not just EDL species: Brig, PB, YW, false sandalwood, LB, unknown trees photos	

50 x 10 m area: *list species if known or count if unknown

Shrub species richness (ECI 2b) (defined as single stemmed below 2 m or multi-stemmed from base or below 20 cm) *: Gvata
Grass species richness (ECI 2c): umbrella canegrass
Forbs and others (non-grass ground) species richness (ECI 2d): purple flower
Non-native plant (weed) cover (ECI 10): Buffel, fennel weed, prickly pear

50 x 20 m area: Coarse woody debris (ECI 9) CWD: >10 cm, >0.5 m, measured to the plot boundary:

CWD length		CWD length:		CWD length:		CWD length:		CWD length:		CWD length:	
1	3 x 10	8	4 x 10	15		22		29		36	
2	2 x 10	9	3 x 15	16		23		30		37	
3	2 x 10	10	3 x 13	17		24		31		38	
4	3 x 12	11	4 x 10	18		25		32		39	
5	5 x 15	12	2 x 10	19		26		33		40	
6	6 x 12	13	3 x 15	20		27		34		41	
7	4 x 10	14	10 x 60	21		28		35		Total: 52	

TH 12

Page 2 of 2

Five 1x1 m plots * attributes used in scoring   buffel

Ground cover:	1	2	3	4	5	Mean
Native perennial grass cover (ECI 6)*	100	-	-	100	0	0
Organic litter cover (ECI 7) *	0	30	100	20	60	64.6
Forbs and other	0	50 blt	-	60 blf	0	
Total	=100%	=100%	=100%	=100%	=100%	

100 m transect

Tree canopy cover (ECI 4): Only assess Emergent (E) or Subcanopy (S) layers if the benchmark document stipulates that these layers should be present; otherwise Canopy (C) *trees in the same layer and continuous along the transect can be grouped

Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total	Tree or group* (C or S or E)	Distance (m)	Total
~~0~~	20	20									
C(8)	25-27	2									
C(6)	48-55	7									
C(7)	62-64	2									
C(8)	65-80	15									
C(8)	85-92	7									
										Total C: 53 Total S: Total E:	

Shrub canopy cover (ECI 5): *denote as native or exotic. Only native shrub cover used in scoring

Shrubs*	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total	Shrubs	Distance (m)	Total
N	49-50	1												
N	85-88	3												
												Total native: 4		
												Total exotic:		

APPENDIX D BASELINE FAUNA MONITORING

FOXLEIGH PLAINS PROJECT OFFSET AREAS

Bird, Reptile, and Fauna Habitat Survey

For:

Anglo American Coal

December 2014

Final

CUMBERLAND ECOLOGY

PO Box 2474
Carlingford Court 2118

CUMBERLAND ECOLOGY

Report No. Q14010RP1

The preparation of this report has been in accordance with the brief provided by the Client and has relied upon the data and results collected at or under the times and conditions specified in the report. All findings, conclusions or recommendations contained within the report are based only on the aforementioned circumstances. The report has been prepared for use by the Client and no responsibility for its use by other parties is accepted by Cumberland Ecology.

Revision	Date Issued	Reviewed by	Approved by	Date Approved	Revision Type
1	14/11/14	LH	LH	14/11/14	Draft
2	14/11/14	DR	DR	14/11/14	Draft
3	14/11/14	AP	AP	14/11/14	Submitted Draft
4	3/12/14	TP	TP	3/12/14	Final

Approved by: David Robertson

Position: Director

Signed: David Robertson

Date: *3 December, 2014*

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Glossary of Terms

Anglo American:	Anglo American Metallurgical Coal Pty Ltd
DotE:	Commonwealth Department of the Environment
TEC:	Threatened Ecological Community under the EPBC Act
EPBC Act:	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FPP:	Foxleigh Plains Project
LGA	Local Government Area
MNES:	Matters of National Environmental Significance under the EPBC Act
Monitoring Site	refers to a geographic location within a discrete parcel of land defined by a single vegetation type
NC Act:	Queensland *Nature Conservation Act 1992*
OAMP:	Offset Area Management Plan
Proposed Offset Areas	Areas identified in **Figure 1.2** that will be managed for biodiversity outcomes to compensate for clearing of vegetation
Site	refers to the location where data was collected. Each site includes bird census, reptile census, photograph points, and a fauna habitat assessment
Study Area:	refers to the parcel of land bounded by the Foxleigh Plains mining leases and within the Tralee Property
Threatened species	refers to those flora and fauna species listed as vulnerable, endangered or critically endangered under the NC Act or EPBC Act;
Tralee Property	refers to a parcel of land owned by Anglo American in which the proposed Offset Areas are located

Executive Summary

Cumberland Ecology has been engaged by Anglo American Metallurgical Coal Pty Ltd (Anglo American) to conduct baseline bird, reptile, and threatened fauna habitat assessment surveys for the Foxleigh Plains Project (ML 70429, ML 70430, and ML 70431) Proposed Offset Areas.

In compliance with Conditions 5.b.x and 5.b.xi issued under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) referral Approval Notice (EPBC 2010/5421), initial baseline surveys were conducted to be used in the Offset Area Management Plan (OAMP) to provide:

- Description of threatened fauna habitat including condition, type, and connectivity; and
- Bird and reptile surveys.

The objectives for the offset areas described within the OAMP as a whole is to:

- Protect all vegetation from future clearing; and
- Improve the ecological condition of vegetation to the point that it resembles a mature and relatively undisturbed ecosystem.

S1 Background

The Foxleigh Plains Project (FPP) has been approved as an open cut coal mine in the Bowen Basin, near Middlemount, Queensland. The FPP has been granted approval to clear areas of remnant and regrowth Brigalow woodland, as well as habitat for Squatter Pigeons (Southern) (*Geophaps scripta scripta*).

The approved project will have an impact upon flora and fauna that are listed as Matters of National Environmental Significance (MNES) under the EPBC Act, including one Threatened Ecological Community (TEC). To offset the impacts of clearing on MNES, EPBC Approval conditions require the protection of:

- 103.7 ha of Brigalow TEC; and
- 286.9 ha of Squatter Pigeon Primary Habitat.

The offsets for the FPP have been acquired and are all located within the Tralee Property. The offset areas are to be managed under an OAMP for the site. A key condition of the OAMP is to describe fauna habitat including condition, type and connectivity, and conduct bird and reptile surveys.

S2 Methodology

Baseline surveys were conducted for birds, reptiles, and fauna habitat across the proposed offset areas. Surveys were conducted in at eight permanent monitoring sites, as well as at 14 opportunistic sites. Permanent monitoring sites were conducted across the proposed Offset Areas, and involved a bird survey, a reptile survey using funnel traps and active searches, and a fauna habitat assessment. Opportunistic surveys were also carried out in areas with noteworthy habitat features (such as permanent water sources), or in patches of Offset Area lacking in a permanent monitoring site.

Bird surveys involved a 30 minute search in a search area of approximately 2 ha by two observers. All birds heard or observed within the search area were recorded.

Reptile surveys involved a 0.3m x 30m drift fence dug into the earth. Four pairs of reptile funnels (8 total) were set along the drift fence. In addition active searches for reptiles were undertaken within the 2 ha area by overturning logs and lifting rocks. Drift fences and reptile funnels were only used at permanent monitoring sites.

Habitat assessment was undertaken at all sites. Habitat assessment involved scoring the frequency of specific habitat features such as logs, permanent water, and decorticating bark within the 2ha search area.

S3 Key Findings

Baseline surveys of the Offset Areas were conducted in two survey seasons:

- Post-wet (May 2014); and
- Pre-wet (October 2014).

Diurnal bird surveys showed the proposed Offset Areas supported a moderate diversity of birds with 85 species recorded across Tralee Property between both survey periods.

Reptile diversity and abundance was low across all areas, and this is likely attributed to the historical grazing undertaken across Tralee Property.

Fauna habitat condition across the Offset Areas was variable, with moderate quality habitat focussed about permanent water sources and remnant woodland communities. Lower quality fauna habitat was located within regenerating Brigalow TEC, where a dense shrub layer of Brigalow sp. dominated the habitat.

One Squatter Pigeon was sighted during the pre-wet surveys. The presence of the Squatter Pigeon supports the suitability of the nearby Offset Areas as Squatter Pigeon habitat. The sighting of the Squatter Pigeon was outside the Offset Areas, but within a contiguous patch of vegetation with the Offset Areas.

S4 Conclusion

The information gathered in this baseline survey of birds, reptiles, and fauna habitat can be used to measure the effectiveness of management actions proposed in the Offset Management Plan. The data will primarily be able to compare against the objective of improving the ecological condition of vegetation to the point that it resembles a mature and relatively undisturbed ecosystem.

This baseline information can be used in conjunction with BioCondition monitoring (as described in the OAMP) to guide management actions to improve outcomes on Foxleigh for Brigalow TEC and MNES such as Squatter Pigeons.

Introduction

1.1 Background

The Foxleigh Plains Project (FPP) has been approved as an open cut coal mine in the Bowen Basin, near Middlemount, Queensland (QLD). The FPP has been granted Commonwealth approval to clear approximately 406 ha of native vegetation of which 83 ha comprises of Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community and 181 hectares are classified as Squatter Pigeon primary habitat.

The approved project will have an impact upon flora and fauna that are listed as Matters of National Environmental Significance (MNES) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); and listed as vulnerable under the Queensland *Nature Conservation Act 1992* (NC Act), including TEC:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC (referred to hereafter as Brigalow TEC); and
- Squatter Pigeon (Southern) (*Geophaps scripta scripta*).

To offset the impacts on MNES, approval conditions require the protection of 286.9 ha of similar ecological communities and habitats in the region. The offsets for the FPP have been acquired and are located within Tralee property. All proposed Offset Areas are within the Tralee property and have been used for agriculture including cattle farming prior to acquisition by the FPP.

An Offset Management Plan (OAMP) has been prepared by CO2 Australia Limited in conjunction with Anglo American Metallurgical Coal Pty Ltd (Anglo American) for the management of the offsets for the FPP (CO_2 Australia, 2014). The OAMP is to be submitted to the Federal Department of the Environment (DotE) for approval by the Minister.

A condition of the approval of the FPP was to conduct surveys to gather baseline data on birds, reptiles, and fauna habitat to assess the future effectiveness of ongoing management of the Offset Areas.

The location of the FFP Project Site is shown on **Figure 1.1**.

1.2 Purpose

The Purpose of this report is to describe the establishment of permanent monitoring sites, for the continued monitoring of the proposed Offset Areas within the FPP, and to provide analysis of the baseline data collected from these sites during May and October 2014.

In compliance with **Condition 5.b.x** and **5.b.xi** of the DotE Conditions of Approval 2010-5421, initial baseline surveys were conducted to describe:

- Description of threatened fauna habitat including condition, type, and connectivity; and
- Baseline bird and reptile survey data.

1.3 Foxleigh Plains Project Proposed Offset Areas

Proposed Offset Areas are located within Tralee Property approximately 8km south west of Middlemount, QLD (see **Figure 1.2**). Tralee Property is a 12,140 ha freehold cattle farm within the Isaac Regional Council Local Government Area (LGA). Historically the property has been used for cattle farming and mixed agriculture, and is currently predominantly cleared of native vegetation. Within Tralee Property are 286 ha are proposed for use as offsets for the FPP.

Available vegetation will be utilised as offsets for the FPP to offset as:

- 103.7 ha Brigalow TEC; and
- 286.8 ha of Squatter Pigeon primary habitat.

1.3.1 Brigalow TEC Offset Areas

Brigalow TEC Offset Areas currently exist as eight isolated patches of vegetation across Tralee Property. The sum of the eight patches will provide an offset area of 103.7 ha. The vegetation of these patches comprises of Regional Ecosystem (RE) 11.4.9*: Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains (SEWPaC, 2012).

The Brigalow TEC Offset Areas exists in both remnant woodland, and high value regenerating vegetation forms.

1.3.2 Squatter Pigeon Offset Areas

Squatter Pigeon primary habitat Offset Areas currently exist as 10 isolated patches of vegetation across Tralee Property. The sum of these 10 patches will provide an offset area of 286.9 ha. The vegetation of these patches comprises:

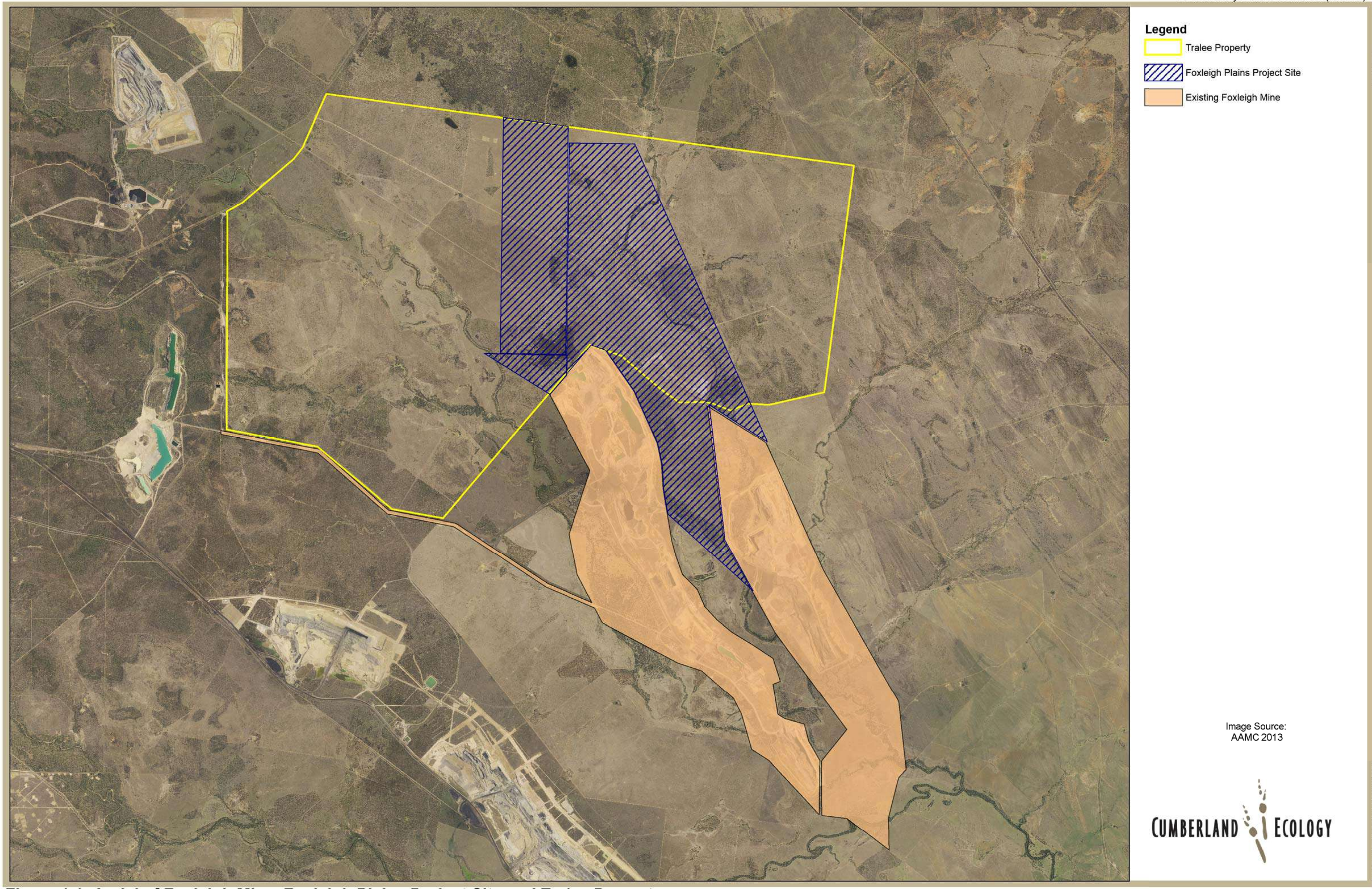
- RE11.3.1: *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains, in both woodland and high value regenerating forms;

- RE 11.4.9: *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains;
- RE 11.5.2: *Eucalyptus crebra*, *Corymbia* spp., with *E. moluccana* on lower slopes of Cainozoic sand plains and/or remnant surfaces; and
- RE 11.5.3: *Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* on Cainozoic sand plains and/or remnant surfaces.

Squatter Pigeon primary habitat Offset Areas are located within areas of suitable habitat as described in the EPBC referral 2010-5421 Approval notice:

- Foraging Habitat – Gravelly, sandy, or loamy soils, open-forest to woodland communities (dominated by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* species), within 3 kilometres of a permanent or seasonal water body; or
- Breeding Habitat – Well-draining, gravelly, sandy or loamy soils, open-forest to woodland communities with patchy, tussock-grassy understories, within 1 kilometre of a permanent water body.

Coordinate System: MGA Zone 55 (GDA 94)



I:\...\Q14010\Figures\RP1\20141113\Figure 1.1. Aerial of Tralee and Foxleigh

Figure 1.1. Aerial of Foxleigh Mine, Foxleigh Plains Project Site and Tralee Property

1000 0 1000 2000 3000 4000m

Coordinate System: MGA Zone 55 (GDA 94)

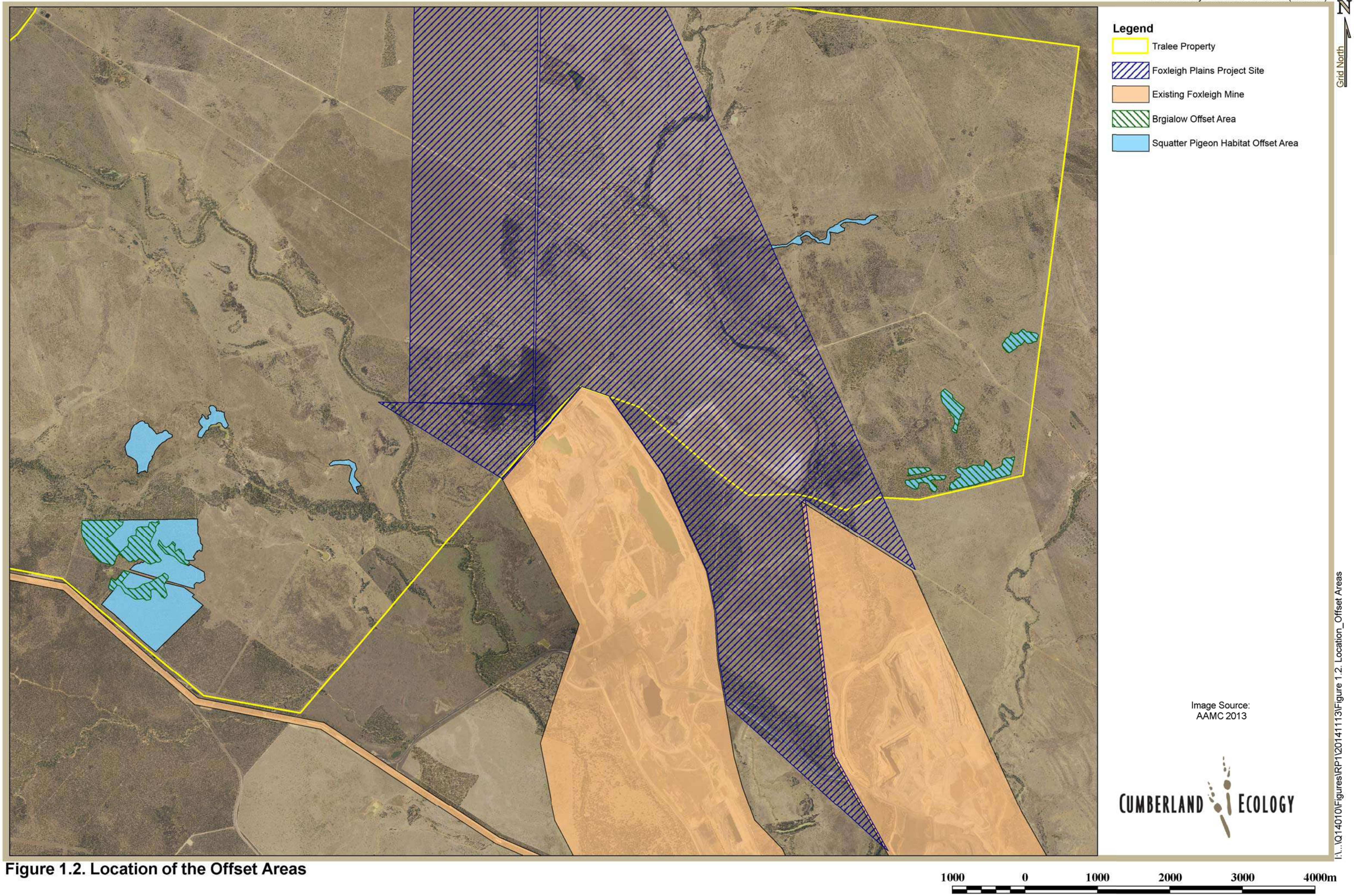


Figure 1.2. Location of the Offset Areas

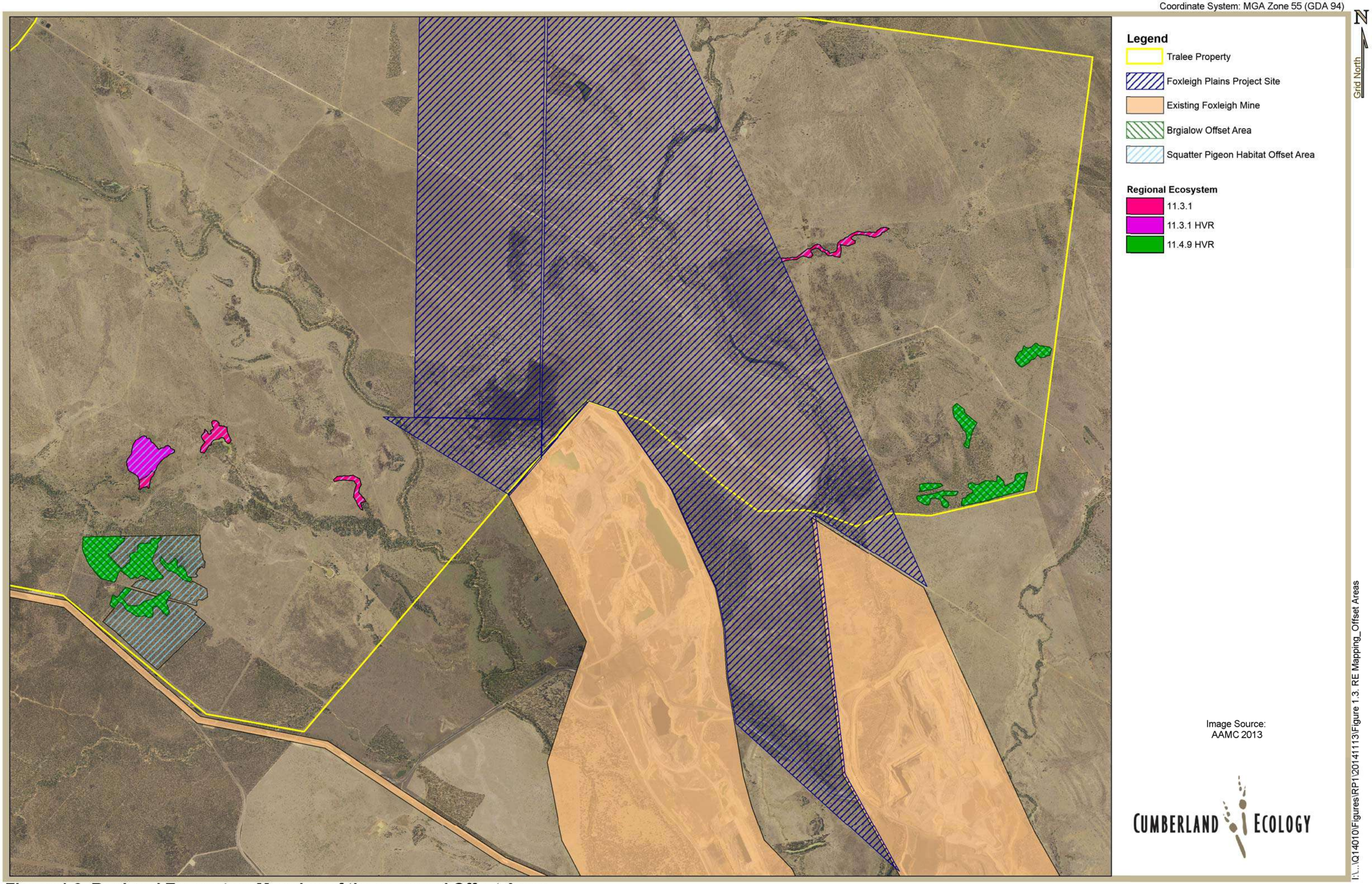


Figure 1.3. Regional Ecosystem Mapping of the surveyed Offset Areas

Chapter 2

Methods

2.1 Ecological Monitoring Methods

i. Permanent monitoring sites

Eight permanent monitoring sites were established across the proposed Offset Areas.The quantum of permanent sites was determined considering relevant guidelines (minimum 3 sites per study category; Eyre et al., 2013), spatial separation of offset area patches, logistics and site access, and animal welfare requirements to check traps before temperatures rose too high. Permanent monitoring sites were distributed to gain a suitable coverage of all of the patches, and all vegetation types across the Offset Areas. Permanent monitoring sites consisted of the following surveys:

- Diurnal bird survey;
- Reptile survey involving funnel traps and active searches; and
- Fauna habitat assessment.

ii. Opportunistic searches for birds, and reptiles

In addition to permanent monitoring sites, opportunistic searches were carried across the Offset Areas for the purpose of gaining a thorough dataset across all Offset Areas, especially in areas where permanent monitoring sites were not situated. Opportunistic searches were undertaken across the Offset Areas to capture greater coverage of survey effort. Opportunistic searches generally involved the same methodologies as permanent monitoring plots (Section 2.1.i); however, no reptile funnels or drift fencing was used.

Site selection for opportunistic searches was based on the following criteria:

- No closer than 100 metres to/ from permanent monitoring sites;
- At least one opportunistic search within each Offset Area patch that did not contain a permanent monitoring site; and
- No closer than 50 metres to roadways and edges of the patch; or
- 50 metres within proximity to a unique habitat feature such as a dam or waterway;

2.1.2 Diurnal bird Survey

Diurnal searches were undertaken at each monitoring site within the first four hours of light. The surveys consisted of a 2 ha search about the monitoring site by two experienced ecologists for a period of 30 minutes. Birds identified by visual observation, call, or general impression of size and shape (GISS) were recorded as within the survey area. Birds seen flying through the survey area, or calls heard at a distance (that were clearly not within the immediate survey area) were not included within the site data. Any birds heard at a distance were included as incidental species. Bird survey methodology was adopted considering the Survey Guidelines for Australia's Threatened Birds (DotE, 2010), the Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (Eyre et al., 2013), and the Birdlife Australia Atlas Search Guidelines (BirdLife Australia, 2013).

2.1.3 Reptile Survey

Reptile surveys were undertaken at each monitoring site. Reptile surveys involved the installation of a 0.3m x 30m drift fence in a straight line or "t" shape where practical. The drift fence was dug into the soil to prevent reptiles from passing underneath the fence. Along the drift fence, four pairs of reptile funnels (8 total) were set out flush with the fenceline. Bark and timber was placed on top of the reptile funnels to provide shading for captured reptiles and to prevent the funnels from being disturbed by wind or animals. Funnel traps were set out for a minimum of three nights, and checked each morning for presence of reptiles.

In addition to funnel traps, active searches for reptiles were undertaken within a 2 ha area about each site. Active searches involved turning over rocks and logs, peeling off decorticating bark from trees and looking in areas where reptiles may be sheltering.

2.1.4 Fauna Habitat Assessment

Fauna habitat assessment was undertaken at each monitoring site. Habitat assessment involved scoring the frequency of habitat attributes within the visible area from the site. Scoring was undertaken as a measure of the area surrounding the site to capture the overall fauna habitat qualities of the entire vegetation patch. Habitat values were scored using the following thresholds:

- Frequent = > 40% of the site;
- Occasional = 10-14% of the site;
- Rare =< 10% site; and
- Absent = 0% of the site.

At each monitoring site, the frequency of the following habitat features was estimated:

- Hollows (small-medium);
- Hollows (large);

- Fallen logs (>10cm diameter);
- Decorticating bark;
- Leaf litter;
- Bare ground;
- Grass;
- Shrubs;
- Boulders;
- Rock crevices;
- Termite mounds;
- Permanent water; and
- Ephemeral water.

An assessment of site disturbance was also undertaken using the same abundance thresholds. The following disturbance features were estimated within each site:

- Fire;
- Grazing;
- Cropping;
- Clearing;
- Erosion; and
- Weeds.

Permanent monitoring sites were selected within a contiguous patch of vegetation, and location recoded with a handheld GPS unit. Locations of the survey sites are shown in **Table 2.1**.

Site selection for permanent monitoring sites was based on the following criteria:

- Representative vegetation community of the larger patch;
- Away from roadways and edges of the patch; and
- Within an area with suitable space to install the drift fencing.

i. Site locations and timing

Site locations were selected to evenly survey both Brigalow TEC and Squatter Pigeon habitats across the Offset Areas. The proposed Offset Areas were changed between the post-wet and pre-wet surveys. As a result some locations were removed, and some sites were added to the survey, to complete the eight sites per survey session.

A full list of site locations is shown in **Table 2.1**, and details of survey dates are shown in **Table 2.2**

Table 2.1 Descriptions and locations of permanent monitoring sites

Site Number	Site Description	Post-wet Survey – May 2014	Pre-wet Survey – October 2014	Vegetation type	Easting	Northing
Site 1	Squatter Pigeon Habitat	Yes	Yes	Dry Eucalypt Woodland	674432	7461983
Site 2	Squatter Pigeon Habitat	Yes	No – outside final Offset Areas	Dry Eucalypt Woodland	674904	7461508
Site 3	Squatter Pigeon Habitat	Yes	No – outside final Offset Areas	Dry Eucalypt Woodland	676042	7460965
Site 4	Brigalow TEC	Yes	Yes	Brigalow TEC High value regrowth	674105	7462855
Site 5	Squatter Pigeon Habitat	Yes	No – outside final Offset Areas	Dry Eucalypt Woodland	674504	7463513
Site 6	Brigalow TEC	Yes	Yes	Brigalow TEC	674191	7463975
Site 7	Brigalow TEC	Yes	No – outside final Offset Areas	Brigalow TEC High value regrowth	684988	7463637
Site 7 (new)	Brigalow TEC	--	Yes (replaced Site 7)	Brigalow TEC High value regrowth	684859	7463723
Site 8	Brigalow TEC	Yes	Yes	Brigalow TEC High value regrowth	685689	7463812
Site 9	Brigalow TEC	--	Yes – replaced site 2	Brigalow TEC High value regrowth	686262	7465708
Site 10	Squatter Pigeon Habitat	--	Yes – replaced site 3	Dry Eucalypt Woodland	683758	7467241
Site 11	Squatter Pigeon Habitat	--	Yes – replaced site 5	Dry Eucalypt Woodland	677098	7463754

Table 2.2 Survey dates for Post-wet (May 2014) and Pre-wet (October 2014) Surveys

Survey Period	Site Name	Treatment	Replicate	Date set out	Date collected
Post-wet survey	Site 1	Squatter Pigeon Habitat	1	7th May 2014	10th May 2014
	Site 2	Squatter Pigeon Habitat	2	7th May 2014	10th May 2014
	Site 3	Squatter Pigeon Habitat	3	7th May 2014	10th May 2014
	Site 4	Brigalow TEC	1	7th May 2014	10th May 2014
	Site 5	Squatter Pigeon Habitat	4	10th May 2014	13th May 2014
	Site 6	Brigalow TEC	2	10th May 2014	13th May 2014
	Site 7a	Brigalow TEC	3	10th May 2014	13th May 2014
	Site 8	Brigalow TEC	4	10th May 2014	13th May 2014
Pre-wet Surveys	Site 1	Squatter Pigeon Habitat	1	18th October 2014	21st October 2014
	Site 4	Brigalow TEC	1	18th October 2014	21st October 2014
	Site 6	Squatter Pigeon Habitat	2	18th October 2014	21st October 2014
	Site 7b	Brigalow TEC	2	15th October 2014	18th October 2014
	Site 8	Brigalow TEC	3	15th October 2014	18th October 2014
	Site 9	Brigalow TEC	4	15th October 2014	18th October 2014
	Site 10	Squatter Pigeon Habitat	3	15th October 2014	18th October 2014
	Site 11	Squatter Pigeon Habitat	4	18th October 2014	21st October 2014

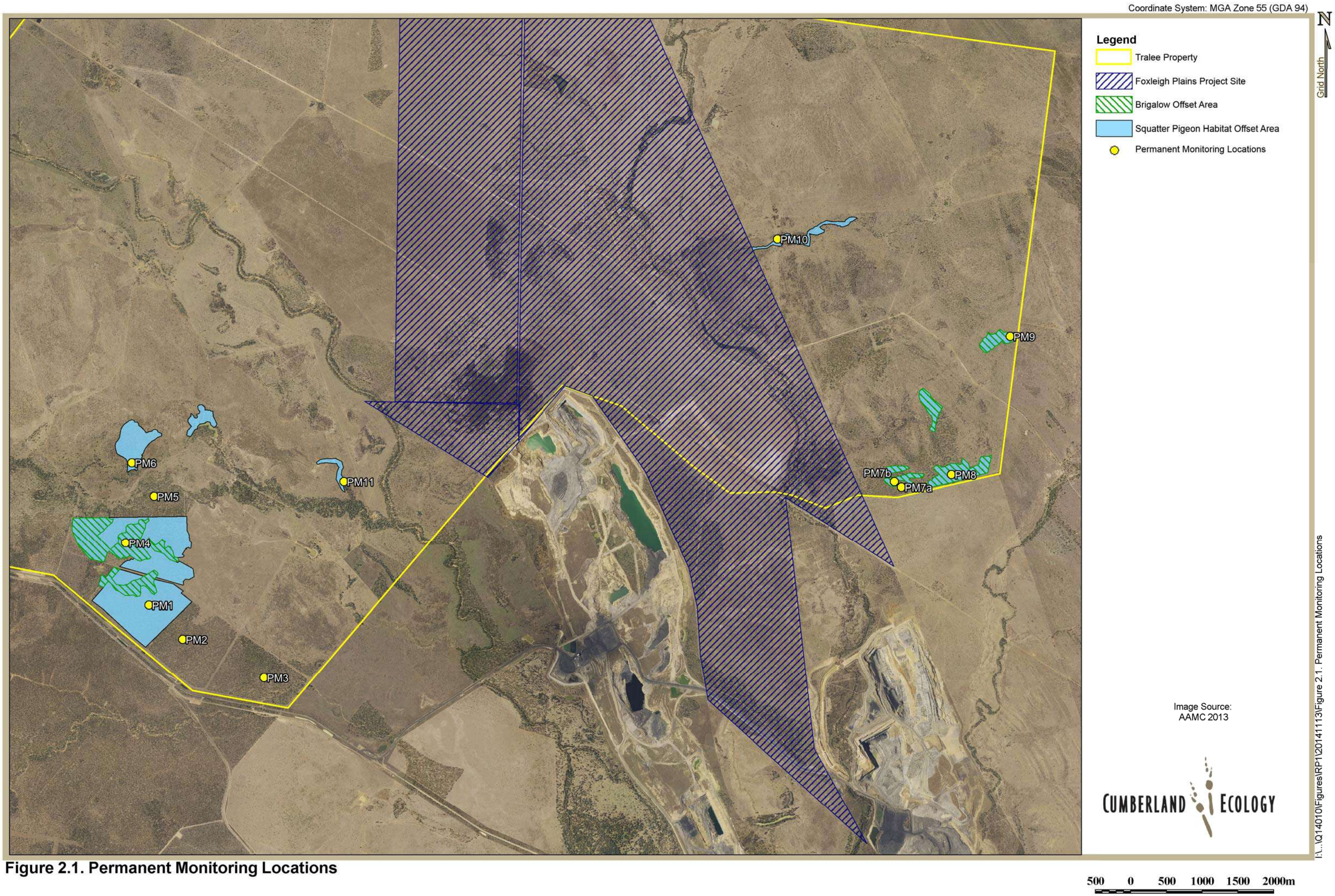


Figure 2.1. Permanent Monitoring Locations

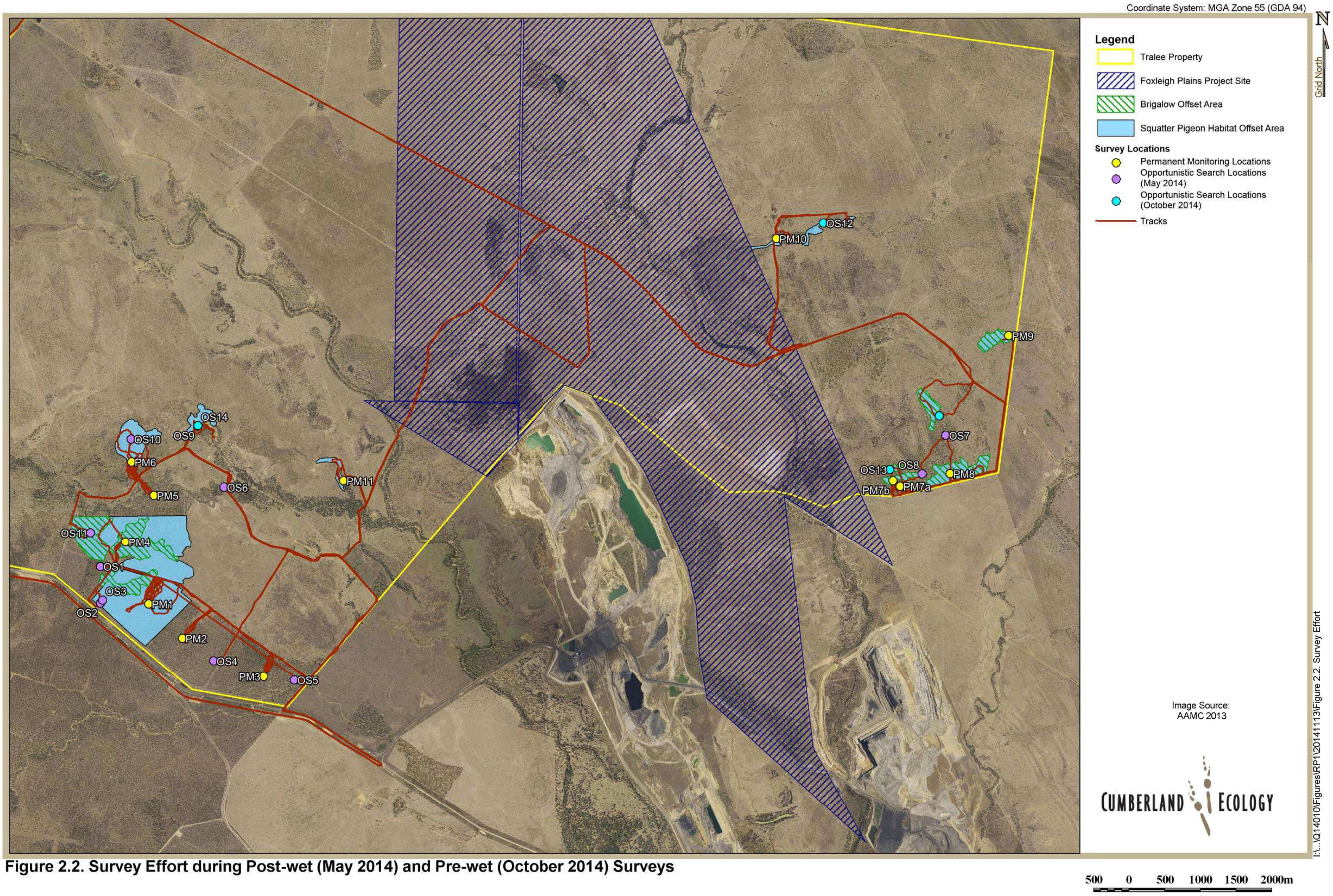


Figure 2.2. Survey Effort during Post-wet (May 2014) and Pre-wet (October 2014) Surveys

Chapter 3

Results

3.1 Field Survey Conditions

Weather conditions during both post-wet and pre-wet surveys were dry, with no rainfall during either survey session. Despite the dry conditions permanent water sources were still present on the Offset Areas (**Photograph 3.1**)

Daily weather statistics are shown below for the nearest weather station to the study area. The nearest data was available from the Bureau of Meteorology (BOM) from Blackwater Airport (Station 035134), approximately 88km from the study area. Daily weather statistics during the survey periods is shown in **Table 3.1** below.

Table 3.1 Survey conditions during Post-wet (May 2014) and Pre-wet (October 2014) Surveys

Survey period	Date	Maximum Temperature °C	Minimum Temperature °C	Rainfall mm
Post-wet Surveys	7th May 2014	11.2	26.7	0
	8th May 2014	7.6	26.7	0
	9th May 2014	11.2	27.4	0
	10th May 2014	16.1	27.9	0
	11th May 2014	16.9	27.9	0
	12th May 2014	16.6	28.2	0
	13th May 2014	19.5	27.8	0
Pre-wet Surveys	15th October 2014	10.2	26.6	0
	16th October 2014	10.4	29.2	0
	17th October 2014	11.1	30.7	0
	18th October 2014	14.5	30.7	0
	19th October 2014	17.9	29.9	0
	20th October 2014	16.1	31.5	0
	21st October 2014	16.9	30.5	0

Photograph 3.1 Permanent wetland adjacent to a proposed Offset Area (near Opportunistic Site OS14)

3.2 Ecological Monitoring

3.2.1 Bird Survey

A total of 85 bird species were identified across Tralee Property and the proposed Offset Areas. A complete list of birds observed during surveys is provided in **Appendix A** in **Table A.1**.

The most diverse site was Site 6 with 37 species of birds identified between the two survey periods. This is likely due to the remnant woodland vegetation at the site, and the presence of a permanent waterbody nearby to the site. Bird surveys at Opportunistic Site 14 identified 35 species of birds, which is likely due to habitat abundance at the site with large trees with hollows, and permanent water present at the site.

The least abundant site was Site 9, with only ten species of bird identified at the site. Habitat conditions at Site 9 were dense *Acacia* sp. regrowth with little ground cover and no shrub later. Given the habitat type available at Site 9, the low diversity of birds is not unexpected.

The most frequently observed birds were Torresian Crow (*Corvus orru)*, Singing Honeyeater (*Lichenostomus virescens*), and Grey Butcherbird (*Cracticus torquatus*), which were observed at 10, 9, and 11 sites respectively. These three species are distributed across eastern and northern Australia, and are common to the region.

One Squatter Pigeon (Geophaps scripta scripta), listed as Vulnerable under the Commonwealth EPBC Act and the QLD NC Act 1994 and a target species of the monitoring surveys, was identified during the surveys. This individual (shown in Photograph 3.2) was observed outside the proposed Offset Areas, but within the Tralee Property boundary. Although the location of the Squatter Pigeon is outside of the proposed Offset Areas, the vegetation at the observed location forms a contiguous patch of vegetation with Site 1 and Site 4 (Figures 1.2 & 2.1). The presence of Squatter Pigeons within this vegetation supports the assessment that suitable habitat for Squatter Pigeons is present within the proposed Offset Areas. Habitat suitability is discussed further in Section 3.2.3.

Photograph 3.2 Squatter Pigeon (southern) (*Geophaps scripta scripta*) observed nearby the proposed Offset Areas

Coordinate System: MGA Zone 55 (GDA 94)

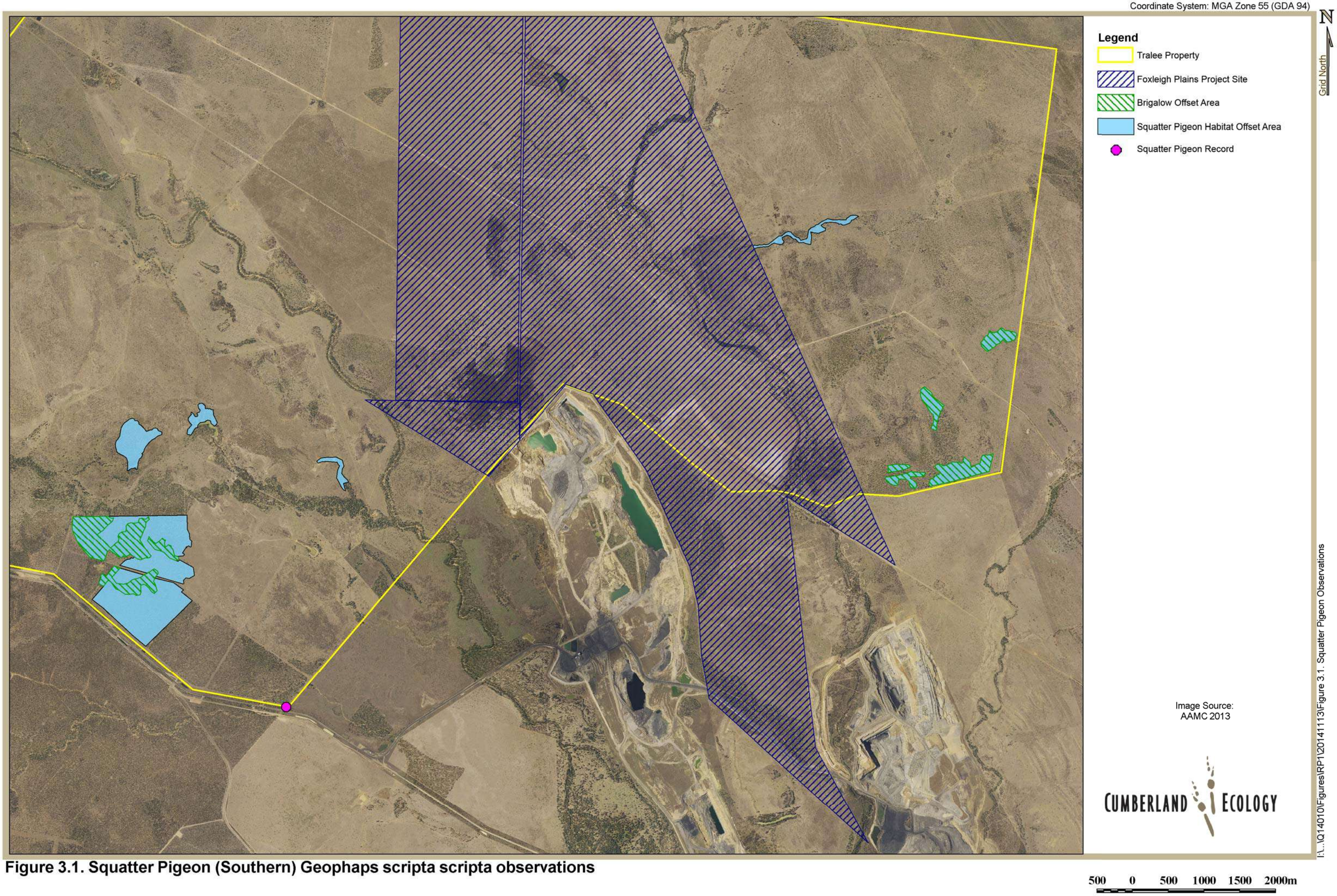


Figure 3.1. Squatter Pigeon (Southern) Geophaps scripta scripta observations

3.2.2 Reptile Survey

A total of nine reptile species were observed during both survey periods on Tralee Property, and of these nine species seven were observed at permanent sites within the proposed Offset Areas. A list of reptile species observed during the surveys is found in Table 3.2.

The most diverse site was Site 1 with three species of reptiles identified between the two survey periods. Sites 2, 3, 4, 7b, 9, 10, and 11, did not have any reptiles. No terrestrial reptiles were identified during active searches.

The most frequently observed reptile was Bynoe's Prickly Gecko (*Heteronotia binoei*), which is distributed throughout continental Australia excepting the more humid regions of the south-east and south-west of the continent.

Incidental observations included three conspicuous species common to QLD and eastern Australia; Eastern Bearded Dragon (*Pogona barbarta*) (Photograph 3.4), Eastern Brown Snake (*Pseudonaja textilis*), and Eastern Snake-necked Turtle (*Chelodina longicollis*).

No reptiles listed under the Commonwealth EPBC Act or the QLD NC Act 1994 were encountered during the surveys.

Table 3.2 Reptile species observed during surveys

		Site 1		Site 5	Site 6	Site 7	Site 8	Incidental	
Scientific Name	**Common Name**	**Post-wet**	**Pre-wet**	**Post-wet**	**Pre-wet**	**Pre-wet**	**Pre-wet**	**Post-wet**	**Pre-wet**
Heteronotia binoei	Bynoe's Prickly Gecko	X			X		X		
Strophurus williamsi	Eastern Spiny Tailed Gecko					X			
Carlia pectoralis	Open-Litter Rainbow Skink				X				
Cryptoblepharus pulcher	Péron's snake-eyed skink		X						
Lygisaurus laevis	Iridescent litter-skink		X						
Lialis burtonis	Burton's Snake-lizard			X					
Pogona barbata	Eastern Bearded Dragon							X	X
Pseudonaja textilis	Eastern Brown Snake								X
Chelodina (Chelodina) longicollis	Eastern Snake-necked Turtle							X	X

Photograph 3.3 Eastern Spiny-tailed Gecko *Strophurus williamsi* at Site PM7

Photograph 3.4 Eastern Bearded Dragon *Pogona barbata*, nearby to Site PM1

3.2.3 Fauna Habitat Assessment

Habitat across the proposed offsets has been subjected to systematic clearing for grazing for an excess of 50 years. As a result the majority of habitats within the proposed Offset Areas are degraded and show signs of ongoing grazing such as erosion, trampling of aquatic vegetation, and lack of shrub layers. There are only limited areas of remnant woodland remaining on the whole of Tralee Property as a result of its historic use for grazing and cropping. The majority of vegetation is regrowth between an estimated 5 to 25 years old.

Habitat types across Tralee Property are typical of the Brigalow Belt Bioregion. Generally, habitat types consisted of:

- Riparian woodland;
- Eucalypt grassy open woodland;
- Remnant Brigalow TEC woodland;
- Shrubby regrowth Brigalow TEC; and
- Cleared grassland or pasturelands.

Key habitat features present within the proposed Offset Areas habitat types included:

- Hollows for arboreal fauna;
- Permanent and ephemeral water sources;
- Grasses; and
- Shrubs.

A description of the condition and connectivity of the fauna habitat types is provided below:

i. Riparian Woodland

a. Condition

The highest quality areas of habitat are located about the permanent water sources, which is where the highest abundance of bird species were located. These areas also had multiple old trees with many hollows and dead wood on the ground (Photographs 3.5 & 3.6). However, these areas do suffer from frequent usage by cattle and, as such, disturbance and trampling is predominant in riparian woodlands.

b. Connectivity

Areas of riparian woodland are not connected to other areas of woodland. Riparian Woodlands are found at Site 6, Site 10, and Site 11. These sites are located > 2km from each other.

Photograph 3.5 Ephemeral water at Site PM11

Photograph 3.6 Permanent water body (farm dam) at opportunistic site OS14.

ii. Eucalypt grassy open woodland

a. Condition

Open woodland areas in the south-west of the proposed Offset Areas are the most intact habitat types. The large patch of woodland which contains Sites 1-4 (**Figure 1.2** and **2.1**) is comprised of relatively intact Eucalyptus open grassy woodland, which contains a true canopy layer, some shrubs, and relatively broad ground cover of grasses. These areas provide suitable habitat for species such as Squatter Pigeon, and the area has ample refuge habitats.

This area is comprised predominately of:

- RE 11.5.2: *Eucalyptus crebra*, *Corymbia* spp., with *E. moluccana* on lower slopes of Cainozoic sand plains and/or remnant surfaces; and

- RE 11.5.3: *Eucalyptus populnea*, *E. melanophloia*, and *Corymbia clarksoniana* on Cainozoic sand plains and/or remnant surfaces (**Photograph 3.7** & **3.8**).

b. Connectivity

Areas of open woodland are concentrated in the south-western regions of the property. These areas are bound in the north by cleared pasture-lands, but have connectivity to other woodlands in the south as can be seen on the aerial photograph of the site (**Figure 1.1**).

Photograph 3.7 *Eucalyptus populnea* woodland near Squatter Pigeon sighting

Photograph 3.8 *Eucalyptus populnea* woodland at Site PM1

iii. Remnant Brigalow TEC woodland

a. Condition

Remnant Brigalow TEC was confined to two small patches across the proposed Offset Areas, at Site 6 and at Opportunistic Search 14. These areas are in reasonable condition although they have undergone similar disturbance by cattle, given their proximity to the few available permanent water sources within the proposed Offset Areas. There are large areas of erosion and large areas with little to no ground cover.

b. Connectivity

Remnant Brigalow TEC woodlands are isolated to two small patches. The area of Remnant Brigalow TEC nearby Site 6 is connected to a larger area of regrowth Brigalow TEC. The second patch of Remnant Brigalow TEC is approximately 500m away. This area of vegetation is also isolated from other areas of vegetation.

Photograph 3.9 Fauna Habitat in Remnant Brigalow TEC at Site PM6

iv. Shrubby regrowth Brigalow TEC

a. Condition

Shrubby regrowth Brigalow TEC is the most depauperate of the fauna habitats throughout the proposed Offset Areas. The majority of these areas are located within depressions within the landscape and likely hold water long after rain. These areas are devoid of ground cover, and a true shrub layer due to the dense shading effects of the regrowth form of *Acacia* sp. within the vegetation patch.

b. Connectivity

Shrubby regrowth brigalow is represented in nearly all patches of the Proposed Offset Areas. The occurrence of this habitat type is prevalent throughout all Proposed Brigalow TEC Offset Areas, and is extensive within the south-eastern patches of the Offset Areas. The habitat type shows similar connectivity to that of other habitat types across Tralee Property, with considerable distances between patches of habitat.

Photograph 3.10 Dense *Acacia* regrowth at site PM4

Chapter 4

Conclusion

Bird, reptile and fauna habitat assessment surveys have now been conducted across the proposed Offset Areas for the Foxleigh Plains Project. This includes eight permanent monitoring sites spread across the Offset Areas for Brigalow TEC & Squatter Pigeon (Four sites) and Squatter Pigeon Only (Four sites). The monitoring sites were set out to capture information on bird and reptile abundances and diversity, as well as fauna habitat features at all sites. Sites were set out in locations that best represented the habitat type and Regional Ecosystem mapping, as provided in the Offset Management Plan.

Data was collected at all permanent monitoring sites, as well as at 14 Opportunistic Search sites, and this can be used as baseline data for future years monitoring studies. Data was collected in two survey periods, an eight day survey during the post-wet season (May 2014), and an eight day survey during the pre-wet season (October 2014).

Analysis of the baseline data showed a moderate diversity of bird species, with 85 species observed across the proposed Offset Areas between two survey periods. Bird species most commonly observed were Torresian Crow (*Corvus orru*), Singing Honeyeater (*Lichenostomus virescens*), and Grey Butcherbird (*Cracticus torquatus*). These species are common to disturbed habitats and are reflective of the farming history of the site. A shift towards higher abundances of bird species more sensitive to disturbance would be expected under appropriate management of the Offset Areas. A single Squatter Pigeon (Southern) (*Geophaps scripta scripta*) was observed during the surveys across Tralee Property.

Reptile diversity was low, with only nine species recorded across proposed Offset Areas. All reptile species encountered are common to the region and no threatened reptiles were observed.

Fauna habitats across the proposed Offset Areas included riparian woodland, Eucalypt grassy open woodland, remnant Brigalow TEC woodland, shrubby regrowth Brigalow TEC, and cleared grassland or pasturelands.

Data collected during the baseline survey is comparable to previous studies undertaken on Tralee Propoerty. An impact assessment of the Foxleigh Plains Project Site (see **Figure 1.2**) by Ecological Survey & Management (2012) identified 94 species of birds and 11 species of reptiles within a larger study area than the proposed Offset Areas. This suggests that the condition of the Offset Areas, and diversity of birds and reptiles is consistent with other areas within the locality, and reflective of disturbance activities (such as grazing) common to the locality.

A summary table outlining the species counts for recent studies is shown below:

Table 4.1 Summary of bird and reptile species counts for studies conducted on Tralee Property

Study Area	Bird Species	Reptile Species
Foxleigh Plains Project Site (Ecological Survey & Management, 2012)	94	11
Offset Area Baseline Fauna Survey (Cumberland Ecology , 2014)	85	9

Data collected within this baseline study can now be used for future monitoring studies to assess the effectiveness of the Offset Management Plan, and provide recommendations to management practices.

Data from this baseline study can be used to monitor the effectiveness of the OAMP against the management objectives of the OAMP. Primarily the data will be used to determine whether management actions will improve the ecological condition of vegetation to the point that it resembles a mature and relatively undisturbed ecosystem. Information gathered during the post-wet surveys outside the Offset Areas can be used as a reference site where management actions will not apply.

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Appendix A

Survey Results

Table 4.2 **Bird observations during Post-wet (May 2014) and Pre-wet (October 2014) surveys at Foxleigh Plains proposed Offset Areas**

Scientific Name	Common Name	Permanent Monitoring Sites											Opportunistic Searches														Incidentals
		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
		Post Wet	Post Wet	Post Wet	Post Wet	Post Wet	Post Wet	Post Wet	Post Wet	Pre Wet	Pre Wet	Pre Wet	Post Wet	Post Wet	Post Wet	Post Wet	Post Wet	Post Wet	Post Wet	Post Wet	Post Wet	Post Wet	Pre Wet	Pre Wet	Pre Wet	Pre Wet	
Struthidea cinerea	Apostlebird			X							X				X									X		X	
Ardeotis australis	Australian Bustard		X																								
Cracticus tibicen	Australian Magpie	X	X	X		X	X	X			X		X							X	X						
Pelecanus conspicillatus	Australian Pelican																			X						X	
Acrocephalus australis	Australian Reedwarbler						X																			X	
Geopelia humeralis	Bar-shouldered Dove				X		X				X										X					X	
Coracina novaehollandiae	Black-faced Cuckoo-shrike	X	X	X		X	X	X			X		X													X	
Entomyzon cyanotis	Blue-faced Honeyeater						X						X				X			X						X	
Elseyornis melanops	Black-fronted Dotterel																									X	
Dacelo leachii	Blue-winged Kookaburra									X	X																
Falco berigora	Brown Falcon						X					X	X														
Lichmera indistincta	Brown Honeyeater							X	X		X														X		
Coturnix ypsilophora	Brown Quail												X														
Acanthiza pusilla	Brown Thornbill		X						X																X		
Scythrops novaehollandiae	Channel-billed Cuckoo							X																			
Accipiter cirrocephalus	Collared Sparrowhawk			X																							
Phaps chalcoptera	Common Bronzewing									X	X																
Ocyphaps lophotes	Crested Pigeon																									X	
Eurystomus orientalis	Dollarbird				X																					X	
Taeniopygia bichenovii	Double-barred Finch	X					X		X																X		
Ardea modesta	Eastern Great Egret						X						X							X						X	
Cacomantis flabelliformis	Fan-tailed Cuckoo																									X	
Todiramphus macleayii	Forest Kingfisher						X																				
Cracticus torquatus	Grey Butcherbird	X	X	X	X	X	X				X	X	X		X					X			X	X			
Rhipidura albiscapa	Grey Fantail	X	X			X	X		X				X	X					X	X	X	X					
Colluricincla harmonica	Grey Shrike-thrush	X		X	X		X				X		X														
Anas gracilis	Grey Teal																			X							

Table 4.2 Bird observations during Post-wet (May 2014) and Pre-wet (October 2014) surveys at Foxleigh Plains proposed Offset Areas

Scientific Name	Common Name	Permanent Monitoring Sites											Opportunistic Searches														Incidentals
		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Pomatostomus temporalis	Grey-crowned Babbler		X					X	X		X				X									X			
Chalcites basalis	Horsfield's Bronze-Cuckoo			X	X		X	X	X		X	X															
Eudynamys orientalis	Eastern Koel											X														X	
Dacelo novaeguineae	Laughing Kookaburra				X		X																				
Myiagra rubecula	Leaden Flycatcher	X			X		X																				
Phalacrocorax sulcirostris	Little Black Cormorant																			X							
Philemon citreogularis	Little Friarbird	X			X				X																	X	
Microcarbo melanoleucos	Little Pied Cormorant																			X							
Grallina cyanoleuca	Magpie-lark		X	X					X		X	X	X				X			X						X	
Artamus personatus	Masked Woodswallow																							X		X	
Dicaeum hirundinaceum	Mistletoebird	X			X		X		X				X						X	X					X		
Falco cenchroides	Nankeen Kestrel																			X							
Nycticorax caledonicus	Nankeen Night-Heron																									X	
Philemon corniculatus	Noisy Friarbird	X			X		X	X		X	X												X			X	
Manorina melanocephala	Noisy Miner	X		X			X		X						X	X				X						X	
Oriolus sagittatus	Olive-backed Oriole	X									X												X	X		X	
Platycercus adscitus	Pale-headed Rosella		X				X					X				X							X			X	
Cacomantis pallidus	Pallid Cuckoo	X			X		X	X		X	X	X											X			X	
Geopelia striata	Peaceful Dove						X																				
Centropus phasianinus	Pheasant Coucal						X					X								X						X	
Cracticus nigrogularis	Pied Butcherbird			X			X	X	X	X	X	X	X				X									X	
Trichoglossus haematodus	Rainbow Lorikeet	X			X	X	X					X	X							X						X	
Malurus melanocephalus	Red-backed Fairy-wren	X			X							X							X							X	
Aprosmictus erythropterus	Red-winged Parrot													X												X	
Myiagra inquieta	Restless Flycatcher						X																				
Platalea regia	Royal Spoonbill												X													X	
Cincloramphus mathewsi	Rufous Songlark												X											X			
Pachycephala rufiventris	Rufous Whistler	X	X	X	X		X	X	X	X	X		X									X	X	X	X		
Todiramphus sanctus	Sacred Kingfisher								X																		
Myiagra cyanoleuca	Satin Flycatcher								X		X																

Table 4.2 Bird observations during Post-wet (May 2014) and Pre-wet (October 2014) surveys at Foxleigh Plains proposed Offset Areas

Scientific Name	Common Name	Permanent Monitoring Sites											Opportunistic Searches														Incidentals
		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Lichenostomus virescens	Singing Honeyeater	X		X		X	X	X	X	X	X	X	X					X		X	X	X					
Chthonicola sagittata	Speckled Warbler																		X		X						
Geophaps scripta	Squatter Pigeon																										X
Threskiornis spinicollis	Straw-necked Ibis						X																				
Pardalotus striatus	Striated Pardalote	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X		X					
Acanthiza lineata	Striated Thornbill								X																		
Plectorhyncha lanceolata	Striped Honeyeater		X			X					X									X						X	
Cacatua galerita	Sulphur-crested Cockatoo						X					X														X	
Corvus orru	Torresian Crow	X	X	X	X	X	X	X		X	X	X	X							X	X	X				X	
Malurus lamberti	Variegated Fairy-wren	X			X	X	X	X																			
Aquila audax	Wedge-tailed Eagle												X									X		X			
Smicrornis brevirostris	Weebill	X	X	X	X	X	X												X	X		X					
Haliastur sphenurus	Whistling Kite						X					X									X	X				X	
Coracina papuensis	White-bellied Cuckoo-shrike			X									X														
Egretta novaehollandiae	White-faced Heron																			X						X	
Melithreptus lunatus	White-naped Honeyeater					X																					
Gerygone albogularis	White-throated Gerygone	X	X		X	X	X																				
Lalage sueurii	White-winged Triller				X		X				X	X												X			
Rhipidura leucophrys	Willie Wagtail	X		X					X	X	X		X											X		X	
Platalea flavipes	Yellow-billed Spoonbill																			2							
Lichenostomus chrysops	Yellow-faced Honeyeater					X									X												
Acanthiza nana	Yellow Thornbill	X																									
Anas superciliosa	Pacific Black Duck						X																			X	
Vanellus miles	Masked Lapwing										X															X	
Anthus novaeseelandiae	Australasian Pipit											X											X				
Eolophus roseicapillus	Galah																										X
Grus rubicunda	Brolga								X	X																	X
Neochmia temporalis	Red-browed Finch																										X

Table 4.3 Fauna habitat characteristics at permanent monitoring locations

Habitat Characteristic	Monitoring Site Location										
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Hollows (small-medium)	O	A	A	A	R	O	A	A	A	R	O
Hollows (large)	R	A	A	A	A	A	A	A	A	A	O
Fallen logs (>10cm diameter)	O	R	O	A	R	O	A	A	R	F	O
Decorticating bark	R	R	R	A	A	O	A	A	A	R	R
Litter	O	A	R	O	R	R	R	R	O	F	R
Bare ground	O	O	O	F	O	F	F	F	F	R	F
Grass	F	F	O	R	F	O	O	O	O	O	O
Shrub	O	R	R	F	O	O	R	O	O	A	R
Boulders	A	A	A	A	A	A	A	A	A	A	A
Rock Crevices	A	A	A	A	A	A	A	A	A	A	A
Termite mounds	A	A	A	A	A	A	A	A	A	A	A
Permanent water	A	A	A	A	A	F	A	A	A	A	F
Ephemeral water	A	A	A	A	R	A	A	A	A	R	F

F = frequent (>40% site), O = Occasional (10-40% site), R = Rare (<10% site), A = Absent (0% site)

Table 4.4 Disturbance type and frequency at permanent monitoring locations

	Monitoring Site Location										
Disturbance Type	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**	**Site 11**
Fire	A	R	A	A	A	A	A	A	A	A	A
Grazing	O	F	F	F	F	F	O	O	F	F	F
Cropping	A	A	A	A	A	A	A	A	A	A	A
Clearing	A	R	R	A	A	A	A	A	O	A	F
Erosion	A	A	A	A	A	O	A	A	O	A	F
Weeds	O	O	O	R	R	O	A	A	O	A	O

F = frequent (>40% site), O = Occasional (10-40% site), R = Rare (<10% site), A = Absent (0% site)

Table 4.5 Fauna habitat characteristics at opportunistic search locations

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
HABITAT Characteristics														
Hollows (small-medium)	A	R	R	O	O	A	A	O	A	A	A	R	A	R
Hollows (large)	A	A	A	O	O	A	A	O	A	A	A	R	A	R
Fallen logs (>10cm diameter)	A	R	R	O	O	A	A	R	A	A	O	R	R	R
Decorticating bark	A	R	A	R	O	A	A	R	A	A	R	R	R	R
Litter	R	R	R	R	R	R	R	R	A	R	R	F	O	R
Bare ground	F	O	O	O	F	F	F	O	F	F	F	F	F	O
Grass	R	O	O	O	R	R	O	O	R	R	R	R	O	O
Shrub	R	O	O	R	R	R	O	O	R	A	R	A	R	O
Boulders	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Rock Crevices	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Termite mounds	A	A	R	A	A	A	R	A	A	A	A	A	R	A
Permanent water	F	A	A	A	R	A	A	F	A	A	A	A	A	F
Ephemeral water	A	A	A	F	F	A	A	F	A	A	R	R	A	R

F = frequent (>40% site), O = Occasional (10-40% site), R = Rare (<10% site), A = Absent (0% site)

Table 4.6 Disturbance type and frequency at opportunistic search locations

DISTURBANCE	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
Fire	A	R	A	A	A	A	A	A	A	A	A	A	A	A
Grazing	F	O	F	O	F	F	F	F	F	F	F	F	F	F
Cropping	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Clearing	F	R	A	R	F	F	R	O	F	O	A	R	A	A
Erosion	F	R	A	R	F	F	A	O	A	F	R	F	F	R
Weeds	O	R	R	R	R	R	R	O	R	O	R	R	R	R

F = frequent (>40% site), O = Occasional (10-40% site), R = Rare (<10% site), A = Absent (0% site)

APPENDIX E OFFSETS ASSESSMENT GUIDES

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012
This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Brigalow TEC
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	**1.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	Yes	Brigalow TEC	**Area**	83.7	Hectares	
			Quality	4	Scale 0-10	
			Total quantum of impact	33.48	Adjusted hectares	
Threatened species habitat						
Area of habitat	No		**Area**			
			Quality			
			Total quantum of impact	0.00		

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source
Number of features e.g. Nest hollows, habitat trees	No				
Condition of habitat Change in habitat condition, but no change in extent	No				
Threatened species					
Birth rate e.g. Change in nest success	No				
Mortality rate e.g Change in number of road kills per year	No				
Number of individuals e.g. Individual plants/animals	No				

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	Yes	33.48	Adjusted hectares	Tralee	**Risk-related time horizon (max. 20 years)**	18	**Start area (hectares)**	149.34	**Risk of loss (%) without offset**	35%	**Risk of loss (%) with offset**	5%	44.80	70%	31.36	25.30	34.16	102.02%	Yes		
									Future area without offset (adjusted hectares)	97.1	**Future area with offset (adjusted hectares)**	141.9									
					Time until ecological benefit	18	**Start quality (scale of 0-10)**	5	**Future quality without offset (scale of 0-10)**	4	**Future quality with offset (scale of 0-10)**	7	3.00	70%	2.10	1.69					
Threatened species habitat																					
Area of habitat	No				**Time over which loss is averted (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**										
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0									
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**										

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Number of features e.g. Nest hollows, habitat trees	No															
Condition of habitat Change in habitat condition, but no change in extent	No															
Threatened species																
Birth rate e.g. Change in nest success	No															
Mortality rate e.g Change in number of road kills per year	No															
Number of individuals e.g. Individual plants/animals	No															

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	0				$0.00		$0.00
Area of community	33.48	34.16	102.02%	Yes	$0.00	N/A	$0.00
					$0.00	**$0.00**	**$0.00**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Squatter pigeon
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Squatter Pigeon	Area	181	Hectares	
			Quality	5	Scale 0-10	
			Total quantum of impact	90.50	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	No				Risk-related time horizon (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset										
									Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0									
					Time until ecological benefit		Start quality (scale of 0-10)		Future quality without offset (scale of 0-10)		Future quality with offset (scale of 0-10)										
Threatened species habitat																					
Area of habitat	Yes	90.50	Adjusted hectares	Tralee West	Time over which loss is averted (max. 20 years)	18	Start area (hectares)	317	Risk of loss (%) without offset	35%	Risk of loss (%) with offset	5%	95.20	70%	66.64	64.28	93.21	103.00%	Yes		
									Future area without offset (adjusted hectares)	206.3	Future area with offset (adjusted hectares)	301.5									
					Time until ecological benefit	18	Start quality (scale of 0-10)	6	Future quality without offset (scale of 0-10)	5	Future quality with offset (scale of 0-10)	8	3.00	70%	2.10	2.03					
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**		**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																				
Condition of habitat Change in habitat condition, but no change in extent	No																				
Threatened species																					
Birth rate e.g. Change in nest success	No																				
Mortality rate e.g Change in number of road kills per year	No																				
Number of individuals e.g. Individual plants/animals	No																				

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($): Direct offset ($)	Cost ($): Other compensatory measures ($)	Cost ($): Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	90.5	93.21	103.00%	Yes	$0.00	N/A	$0.00
Area of community	0				$0.00		$0.00
					$0.00	**$0.00**	**$0.00**

APPENDIX F BASELINE BIOCONDITION SCORES

Anglo American conducted ecological equivalence assessments of Foxleigh Coal Mine Extension site and the offset areas over a period from October 2012 to April 2013 (see Appendix C). The baseline BioCondition scores for the offset areas are presented in this section.

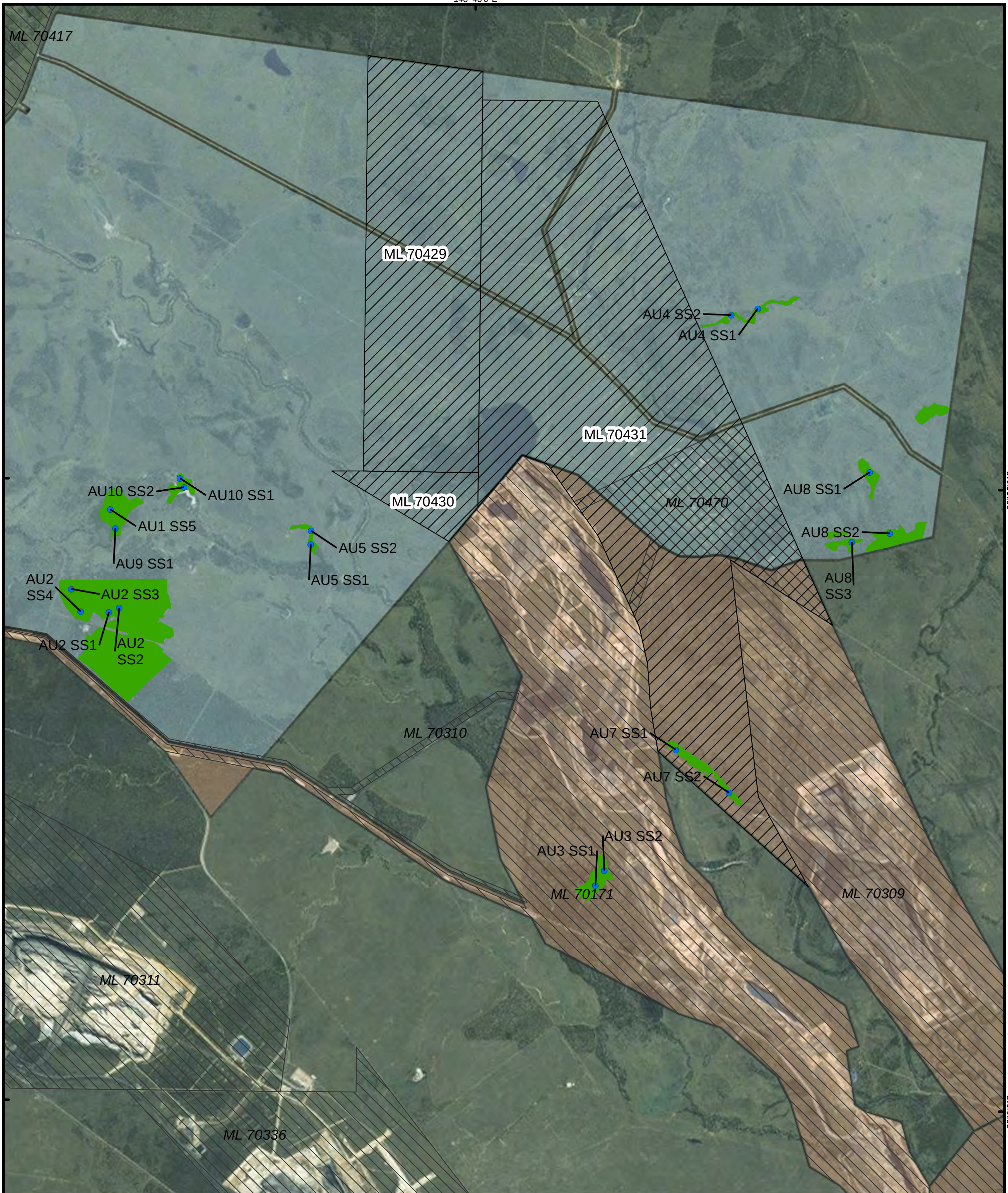
Vegetation within the offset areas was grouped together based on RE, condition and geographic location to form assessment units (AU). Within each AU, sample sites were chosen where the vegetation was considered to be representative of the AU as a whole. The locations of the sample sites within the AUs are provided in Table F-1.

At each of the sample sites, a BioCondition assessment was undertaken to assess the ecological condition of the vegetation. Table F-2 provides the baseline BioCondition data for all sample sites within the offset areas. The BioCondition scores and equivalent BioCondition classes are also provided Table F-2. Note that sample sites that are shaded will continue to be monitored as part of the monitoring program.

Table F-1: Location of BioCondition sample sites within the offset areas (Datum GDA94, Zone 55)

Assessment Unit	Sample Site	RE	Easting	Northing
AU1	SS5	RE11.3.1	674116	7464259
AU2	SS1	RE11.4.9	674096	7462733
AU2	SS2	RE11.4.9	674251	7462798
AU2	SS3	RE11.4.9	673538	7463079
AU2	SS4	RE11.4.9	673681	7462742
AU3	SS1	RE11.3.3	681328	7458667
AU3	SS2	RE11.3.3	681459	7458889
AU4	SS1	RE11.3.1	683740	7467244
AU4	SS2	RE11.3.1	683347	7467151
AU5	SS1	RE11.3.1	677098	7463738
AU5	SS2	RE11.3.1	677102	7463940
AU6	SS2	RE11.3.1	686279	7459171
AU7	SS1	RE11.3.2	682523	7460687
AU7	SS2	RE11.3.2	683317	7460049
AU8	SS1	RE11.4.9	685402	7464812
AU8	SS2	RE11.4.9	685702	7463905
AU8	SS3	RE11.4.9	685139	7463775
AU9	SS1	RE11.3.1	674196	7463979
AU10	SS1	RE11.3.1	675153	7464720
AU10	SS2	RE11.3.1	675214	7464589

Note: Sample sites that are shaded will continue to be monitored as part of monitoring program.



Middlemount South Pty Ltd

Figure F-1:
Baseline BioCondition sites

DATA SOURCE:
The following datasets were provided by Anglo American Metallurgical Coal Pty Ltd:
- Brigalow TEC offset area (Sept 2014)
- Offset vegetation (state) (Sept 2014)
- Squatter pigeon habitat (Sept 2014)
- Mining Lease (June 2014)
- Cockatoo Creek Diversion (Feb 2013)
The following datasets are © State of Qld:
- Cadastral Data (2011)

Lot 4 SP248577
Lot 20 SP276924
Foxleigh Plains MLs
Non-project MLs
Offset areas
Baseline BioCondition sites

N

0 1 2 3
Kilometres

CO2 Australia

Location diagram

© OpenStreetMap (and) contributors, CC-BY-SA

Date: 04-11-2016 Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994 Scale: 1:75,000 @ A4

Path: P:\GISData\Projects\Anglo_American\ENV01881926_20160606_offset_map_updates_split_State_Commonwealth\20161102_figF-1_Biocondition_points_Commonwealth.mxd

Table F-2: Baseline BioCondition data

Ecological Condition Indicators	AU1	AU2				AU3		AU4		AU5		AU7		AU8			AU9	AU10	
	SS5	SS1	SS2	SS3	SS4	SS1	SS2	SS1	SS2	SS1	SS2	SS1	SS2	SS1	SS2	SS3	SS1	SS1	SS2
Number of large trees per ha	0	0	0	0	0	18	12	52	32	44	8	0	6	0	0	0	138	24	26
Recruitment of canopy species (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Tree canopy height (m)																			
Canopy	5	3.5	3.5	3.5	3	19	21	13	10	9.9	10	13	15	4.5	4.5	4.5	17	11	15
Sub-canopy						10	10	5	4	4.5	4	6	5	2.5	-	2.7	7	7	7.5
Tree canopy cover (%)																			
Canopy	49	47	43	50	34	44	38	80.5	33.5	47.5	35	37.8	49.4	26	48.6	24.3	56	52.5	50
Sub-canopy	-	-	-	-	-	7	4	4.5	45	11.7	17.5	9.7	4.1	4	0	3.6	10	7	13
Shrub cover (%)	0	0	0	1	0	0	0	4	2	14.2	16.5	5.3	2.6	10.3	0.6	18	9.2	0	12
Course woody debris (m)	850	25	21.5	250	0	800	500	320.2	850	1615	-	418	860	115	112	118	1410	2187	335
Native plant species richness																			
Trees	2	1	3	4	3	4	6	11	9	6	4	6	5	7	3	4	9	2	8
Shrubs	2	1	2	5	3	2	3	5	5	5	6	6	4	6	4	4	8	3	2
Grasses	6	3	3	4	4	8	7	7	6	5	4	9	7	7	5	9	6	4	9
Forbs and others	0	0	0	0	0	9	7	7	5	4	5	2	5	7	5	3	7	1	9
Organic litter cover (%)	21	80	63	73	54	30	30	54	66	60	42	35	44	63	66	41.4	68	79	32.8
Native perennial	61	0	0	4	0	40	20	6.2	2.2	7.4	6	12.2	0	11	1.4	7	4.8	15	32.8

Ecological Condition Indicators	AU1	AU2				AU3		AU4		AU5		AU7		AU8			AU9	AU10	
	SS5	SS1	SS2	SS3	SS4	SS1	SS2	SS1	SS2	SS1	SS2	SS1	SS2	SS1	SS2	SS3	SS1	SS1	SS2
grass cover (%)																			
Non-native plant cover (%)	5 – 25	25 – 50	5	5 – 25	5 – 25	5 – 25	5 – 25	5 – 25	25 – 50	25 – 50	25 – 50	25 – 50	5 – 25	5 – 25	5 – 10	5 – 25	5 –10	<5	50
Litter cover (%)	21	80	63	73	54	30	30	54	66	60	42	35	44	63	66	41.4	68	79	32.8
BioCondition score (%)	44.80	43.38				67.00		54.00		69.00		57.25		47.83			72.00	65.75	
BioCondition class	3	3				2		3		2		3		3			2	2	

APPENDIX G SQUATTER PIGEON SPECIES STOCKING RATE – QUANTITATIVE ASSESSMENT

Table G-1 Squatter pigeon species stocking rate – impact area

Criteria	Score	Impact Area Score	Justification for score	Weighting	Weighted Score
Species presence					
Confirmed – species or community observed or recorded from the site	4	4	The squatter pigeon was recorded in 2009 within the impact area for the Foxleigh Mine (Ecological Survey and Management 2012).	33.33%	3.33
Likely - site contains known or potential habitat for the species or community and species or community recorded in similar habitat in locality of the site	3				
Possible - site contains known or potential habitat for the species or community, however the species or community has not been recorded from locality of the site, or vice versa	2				
Unlikely - site contains habitat of limited value for the species or community and/or species or community not recorded from locality of the site	1				
Density of the species utilising the site					
Density of species on the site known, and consistent or greater than density known for the species from the literature/anecdotal evidence	4	3	As there has been limited surveys undertaken, the density of squatter pigeons is inferred from the presence of suitable habitat within the impact area. The habitat in the impact area is likely to support density consistent with literature/anecdotal evidence.	33.33%	2.50
Density of species inferred from confirmed presence of appropriate habitat, with evidence to suggest it is likely to support density consistent with literature/anecdotal evidence	3				
Density of the species very sparse, with likelihood that site is suboptimal, potentially indicative of relictual population	2				
Species not confirmed on site, with no evidence of appropriate habitat	1				

Criteria	Score	Offset area score	Justification for score	Weighting	Weighted Score
Role of site population in regards to the overall species population					
Site supports a key source species population for breeding and/or dispersal or community at the state to national scale, necessary for maintaining genetic diversity AND/OR the population is outside or near the geographical limit of the species/community range OR is critical stopover habitat for migratory species at the national or state scale.	4	2	The species is regularly recorded in the Middlemount area and the species is noted as remaining common north of the Carnarvon Ranges (DoE 2016). The impact area has not been identified as containing an important species population for breeding or dispersal, or a community that is a contiguous or functional link between known, important or key source species populations or communities at the landscape to regional scale.	33.33%	1.67
Site supports an important species population for breeding or dispersal, or a community that is a contiguous or functional link between known, important or key source species populations or communities at the landscape to regional scale, OR is an important stopover habitat for migratory species.	3				
Site supports a species population/community that is not contiguous with known, important or key source populations of the species, OR is non-critical stopover habitat for migratory species.	2				
Site likely to support only a small or relictual species population or community, not near the geographical limit of the species/community range OR there are very few records for migratory species.	1				
Total Score					**7.49**

Table G-2 Squatter pigeon species stocking rate – offset area

Criteria	Score	Offset area score	Justification for score	Weighting	Weighted Score
Species presence					
Confirmed – species or community observed or recorded from the site	4	4	Squatter pigeons have previously been recorded within the south-west region of the Tralee property near the offset areas.	33.33%	3.33
Likely - site contains known or potential habitat for the species or community and species or community recorded in similar habitat in locality of the site	3				
Possible - site contains known or potential habitat for the species or community, however the species or community has not been recorded from locality of the site, or vice versa	2				
Unlikely - site contains habitat of limited value for the species or community and/or species or community not recorded from locality of the site	1				
Density of the species utilising the site					
Density of species on the site known, and consistent or greater than density known for the speices from the literature/anecdotal evidence	4	3	As there has been limited surveys undertaken, the density of squatter pigeons is inferred from the presence of suitable habitat within the offset areas. The habitat in the offset areas are likely to support density consistent with literature/anecdotal evidence.	33.33%	2.50
Density of species inferred from confirmed presence of appropriate habitat, with evidence to suggest it is likely to support density consistent with literature/anecdotal evidence	3				
Density of the species very sparse, with likelihood that site is suboptimal, potentially indicative of relictual population	2				
Species not confirmed on site, with no evidence of appropriate habitat	1				

Criteria	Score	Score	Justification for score	Weighting	Weighted Score
Role of site population in regards to the overall species population					
Site supports a key source species population for breeding and/or dispersal or community at the state to national scale, necessary for maintaining genetic diversity AND/OR the population is outside or near the geographical limit of the species/community range OR is critical stopover habitat for migratory species at the national or state scale.	4	2	The species is regularly recorded in the Middlemount area and the species is noted as remaining common north of the Carnarvon Ranges (DoE 2016). The offset area has not been identified as containing an important species population for breeding or dispersal, or a community that is a contiguous or functional link between known, important or key source species populations or communities at the landscape to regional scale.	33.33%	1.67
Site supports an important species population for breeding or dispersal, or a community that is a contiguous or functional link between known, important or key source species populations or communities at the landscape to regional scale, OR is an important stopover habitat for migratory species.	3				
Site supports a species population/community that is not contiguous with known, important or key source populations of the species, OR is non-critical stopover habitat for migratory species.	2				
Site likely to support only a small or relictual species population or community, not near the geographical limit of the species/community range OR there are very few records for migratory species.	1				
Total Score					**7.49**

APPENDIX H DRY SEASON FEED BUDGET

DRY SEASON FEED BUDGET

AMOUNT OF FEED CURRENTLY PRESENT ________Kg/Ha

LESS: AMOUNT OF FEED DESIRED AT THE END OF THE DRY SEASON
(Refer to attached table A) -________Kg/Ha

= TOTAL USEABLE FEED =________Kg/Ha ❶

UTILIZATION (proportion of useable feed that livestock can use)❷
- 0.40 (40%) NATIVE PASTURE (in good condition)
- 0.35 (35%) NATIVE PASTURE (if less than 25% desirable (decreaser) species)
- 0.50 (50%) IMPROVED PASTURE (usually better adapted to higher grazing pressure)

TOTAL USEABLE FEED X UTILIZATION % = FEED AVAILIABLE FOR THE GRAZING ANIMAL

__________❶ X __________❷ % = __________❸ Kg/Ha

TO CALCULATE SAFE STOCKING RATE:

FEED CONSUMPTION / DAY (Refer to attached table B) ________Kg/day❹

DETERMINE THE NUMBER OF DAYS OF FEED REQUIRED ________days ❺
eg. April 1 → November 1 = 214 days

FEED CONSUMPTION / DAY X NO. OF DAYS = FEED REQUIREMENT / HEAD

__________❹ X __________❺ = __________ Kg/Hd❻

FEED REQUIREMENT(Kg/Hd) ÷ FEED AVAILIABLE (Kg/Ha) = STOCKING RATE

__________❻ ÷ __________❸ = ________Ha/Hd

AREA OF PADDOCK (Ha) ÷ STOCKING RATE (Ha/Hd) = NUMBER OF STOCK

__________ ÷ __________ = ________ HEAD

TABLE (A)

SUGGESTED MINIMUM AMOUNT OF FEED TO GIVE ADEQUATE COVER AND TO PROVIDE A BASE FOR NEW SEASON PASTURE GROWTH

RAINFALL ZONE (mm)	BRIGALOW / GIDGEE	FOREST	DOWNS*	BLACK SPEAR	SPINIFEX
500	800	550	800		450
600	1000	650	1000	800	
700	1200	750	1200	1000	
800	1400	750		1200	

*Higher if parthenium a potential problem

800 - 1500 Kg/Ha needed for a successful burn

TABLE (B)

DRY MATTER INTAKE OF BEEF CATTLE

	ANIMAL	BODY WEIGHT (Kg)	AVERAGE DAILY GAIN (Kg/DAY)	DRY MATTER INTAKE (Kg/DAY) *
1				
2	GROWING CATTLE	150	0.00	3.0
			0.25	3.3
			0.50	3.6
			0.75	3.7
3		200	0.00	3.7
			0.25	4.4
			0.50	4.8
			0.75	5.0
4		300	0.00	5.0
			0.25	6.0
			0.50	6.9
			0.75	7.3
5		400	0.00	6.2
			0.25	7.4
			0.50	8.6
			0.75	9
6		500 (estimated)	0.00	7.8
			0.25	9.3
			0.50	10.6
			0.75	11.1
7	DRY PREGNANT MATURE COWS	350	0.00	8.7
		450	0.00	11.2
8	LACTATING COWS	350	0.00	9.8
		450	0.00	12.6

*Values from: Nutrient Requirements of Beef Cattle #4 NAS (1970)

Minson & McDonald (1987) Tropical Grasslands 21:3

APPENDIX I BIOCONDITION

Department of Science, Information Technology, Innovation and the Arts

BioCondition

A Condition Assessment Framework for Terrestrial Biodiversity in Queensland

Assessment Manual

Queensland Herbarium, Science Delivery

Version 2.2

February, 2015

Great state. Great opportunity.

Queensland Government

Prepared by

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Introduction

The management of native vegetation to produce services such as food and fibre has meant that an estimated 62 per cent of Australia's native vegetation has been modified by agricultural and grazing enterprises (Thackway and Lesslie 2006). Knowledge of the extent of native vegetation by broad structural and floristic type is therefore considered integral for natural resource planning, management and environmental reporting. Consequently, vegetation mapping programs to describe structural and floristic type have been conducted across the majority of the states and territories of Australia.

Compared with vegetation *extent*, the assessment of vegetation *condition* is considerably less well documented in Queensland, and indeed most of Australia. It has only been relatively recently that policy demands and expectations have conceptualized vegetation condition as a major component of native vegetation management, primarily to assist decision making for developmental approvals, incentive payments and market-based investments (Keith and Gorrod 2006). Regional natural resource management groups are also interested in vegetation condition, given its listing as a national environmental indicator for reporting targets (MEWG 2004). At the property scale, land managers are increasingly becoming aware of the challenge to demonstrate duty of care (Bates 2001; Neldner 2006). A procedure to effectively assess vegetation condition is necessary to support these decision-making and reporting schemes, including the implementation of offsets and biobanking and comprehensive environmental accounts (Hawke 2009). The ability to assess and monitor vegetation condition is also essential for governments to administer legislation relating to the landscapes and biodiversity covered by their jurisdiction.

A simple, rapid assessment approach is highly desirable as compared with a time-consuming and complicated, if thorough, approach as it facilitates uptake of use by resource managers (Andreasen *et al.* 2001). Accordingly, a number of condition assessment tools have utilised key attributes or surrogates of biodiversity values that can be rapidly measured in the field (Gibbons and Freudenberger 2006). These include the 'Habitat Hectares' assessment framework in Victoria (Parkes *et al.* 2003) and 'BioMetric' in New South Wales (Gibbons *et al.* 2008).

Box 1: Definition of Biodiversity

Biodiversity is defined as:

'….the variety of life, its composition, structure and function, at a range of scales'
(Freudenberger and Harvey, 2003)

Composition:	the variation in species, populations and gene pools
Structure:	the physical variation of habitat and ecosystem components, such as tree, shrub and ground layers
Function:	"the way it all works together"; hard to see, but includes important processes such as carbon, nutrient and water cycling

BioCondition is a condition assessment framework for Queensland that provides a measure of how well a terrestrial ecosystem is functioning for biodiversity (Box 1) values. It is a site-based, quantitative and therefore repeatable assessment procedure that can be used in any vegetative state, and provides a numeric score that can be summarised as a condition rating of 1, 2, 3 or 4, or functional through to dysfunctional condition for biodiversity. In BioCondition, 'condition' refers to the degree to which the attributes of a patch of vegetation differ from the attributes of the same vegetation in its reference state (Box 2).

Box 2: Definition of condition for biodiversity

Condition for biodiversity is defined as:

The similarity in key features of the regional ecosystem being assessed with those of the same regional ecosystem in its reference state.

The reference state refers to the natural variability in attributes of an ecosystem relatively unmodified since the time of European settlement, or the 'best on offer'. Benchmarks for attributes are derived from this state.

In BioCondition, the reference state refers to the natural variability or range in attributes of an ecosystem that is relatively unmodified since European settlement, or 'best on offer' (BOO). The reference approach has been criticized as being the construct of another Clementsian-based successional model (McCarthy *et al.* 2004), but this will depend on what state is used as the 'desired' state of condition for comparison (Gibbons and Freudenberger 2006). The BioMetric approach (Gibbons *et al.* 2008) aims to avoid this criticism by providing a range of values as the benchmark for vegetation communities, representing the natural alternative states that the community may display as a consequence of environmental variation or natural disturbance. In general, the 'historical' pristine natural state, with absence of post-European human disturbance is usually used as the reference state (e.g. Parkes *et al.* 2003). However, the use of sites in a 'pristine' state is unrealistic, given that impacts from post-European settlement management are widespread. Furthermore, it is extremely unlikely that a given patch of vegetation could be restored to historical states (Hobbs and Norton 1996; Oliver *et al.* 2002). Sites that have been least impacted by local threats should be of increased value for aspects of biodiversity, and thus constitute the best available benchmark representing the desired state (Landsberg and Crowley 2004).

The BioCondition method is designed for use by assessors who have a reasonable working knowledge of regional ecosystem (RE) mapping and vegetation assessment at the site scale. It provides a protocol for vegetation condition assessment at the patch, paddock or property scale. The BioCondition score does not provide an index of habitat *suitability* for fauna, as this will depend on many other factors that are not directly surrogates of condition, such as predator risk, and sheltering component of habitat such as rock cover and density of dead, hollow-bearing trees. Furthermore, we need to be cognisant that vegetation states other than the reference state may also be important for biodiversity in some situations.

Describing vegetation as 'poor' or 'dysfunctional' suggests that it is of little service to biodiversity, which is not always the case. For example, regrowth, thickened vegetation, and even swards of exotic grass all represent transitional vegetative states that provide some service to native fauna in the landscape, particularly within heavily modified landscapes (Bowen *et al*. 2007; Eyre *et al.* 2009a,b). Also, for some attributes, we still do not understand the complexities of their response to disturbance events (Eyre 2010). What constitutes a 'natural state' for benchmarking purposes for some attributes remains questionable? For example, a dense or 'thickened' midstorey is often described as symptomatic of inappropriate land management, but it may be simply reflecting natural ecological dynamism (Fensham 2008). Whichever the case, patches of vegetation in the landscape with a dense midstorey are important refuge areas for diurnal birds (Maron and Kennedy 2007; Eyre *et al.* 2009a). Finally, BioCondition is not intended for use in regional planning or assessment of conservation significance, although outputs can contribute to this. The Biodiversity Planning Assessments (BPAs) have been prepared for these purposes and can be sourced from the Queensland Government website.

Box 3: Components of BioCondition

The primary components of BioCondition include:

1. the assessment unit
2. a suite of vegetation condition attributes that act as surrogates or indicators of biodiversity values
3. benchmarks for each of the attributes for each regional ecosystem
4. an assessment method
5. a scoring system that will provide a final 'condition' score.

1.1 Drivers and Constraints

In Australia, existing frameworks and procedures to assess vegetation condition for biodiversity differ in their approaches, and this is reflective of the various legislative, management and policy objectives, as well as the resources (such as time, expertise and budget) available to conduct the assessments. State-based condition assessment methodologies in Victoria (Habitat Hectares; Parkes *et al.* 2003) and New South Wales (BioMetric; Gibbons *et al.* 2005) have a legislative basis and are therefore more rigidly implemented and resourced relative to other available assessments. However, methods to assess resources for demonstration of sustainable use are usually less rigid in their implementation, and operator expertise is often less specialized (e.g. ABCD land condition assessment by landholders; Chilcott *et al.* 2003). Examples of existing condition assessment methodologies can be aligned relevant to the gradation between available resources and the rigor of the objectives required to conduct the assessments in a broad matrix (Table 1). The most challenging assessment frameworks to develop sit within the compartment of the matrix corresponding with high operational constraints and low regulatory rigor. In this compartment, the conduct of any assessment must provide as reliable an estimate of condition for as little effort as possible, given it is reliant on the self-motivation of a landholder without any financial or technical assistance.

Table 1: Examples of vegetation condition assessments within a matrix of increasing operational constraints and regulatory requirements

		Management or policy objectives		
		Sustainable use	**Protection**	**Regulation**
Operational constraints	**High**	**Self-motivated landholder assessment** e.g. Stocktake (Aisthorpe and Paton 2004) for assessing ABCD land condition (Chilcott *et al*. 2003)	**Incentive programs** e.g. Queensland Government Nature Assist for the establishment of Nature Refuges	**Regulatory-motivated landholder assessment**
	Medium	**Site-based monitoring** e.g. Landscape Function Analysis (Tongway and Hindley 2005)	**Incentive programs employing market-based instruments** e.g Habitat Hectares (Parkes *et al*. 2003) for BushTender auctions (Vic)	**Development applications** e.g. BioMetric (Gibbons *et al*. 2008) for clearing native vegetation (NSW); offsetting
	Low	**Regional long-term monitoring programs** e.g. TRAPS grazed woodland dynamics monitoring (Back *et al.* 1997); NFPP productive forest monitoring (QDPI 1995)	**Formal reservation** e.g. Biodiversity and habitat assessments (Eyre *et al.* 1998) for the South East Queensland Regional Forest Agreement	**Environmental impact assessment** e.g. for assessing impact of mining or petroleum activities under the *Environmental Protection Act 1994*

1.2 Version control

This version (Version 2.2) differs only slightly from the previous version (Version 2.1), including;

- Reformatting into the current Queensland Government template
- Removal and amendment of superfluous webpage links.
- References to retracted or changed Queensland Government policies and strategies have been removed or updated.

NOTE: There is no methodological change between V 2.1 and V 2.2.

2 The assessment: getting started

2.1 Define the objective of the assessment

For any assessment or monitoring program, the development and clear articulation of the objective for the assessment is a critical first step. The objective will clarify if a rapid condition assessment such as BioCondition is the appropriate method to use. The objective will also determine the spatial and temporal scale of the assessment required (i.e. how many assessment sites through space and time are required). It will determine how the assessment unit should best be delineated or if extra attributes may be needed. For example, if the objective is to assess the condition of a grazing paddock for biodiversity, then assessment units would be delineated for remnant and non-remnant vegetation in that paddock, but if the objective was to assess the condition of the remnant vegetation for biodiversity across a property, then the assessment units would be delineated based on remnant vegetation only. Having clear objectives will provide a foundation for assessing the value of the assessment program (Field *et al*. 2007).

2.2 Resources required

Prior to visiting an area to assess vegetation condition using BioCondition, it will be important to collate existing biodiversity and spatial (mapping) information relating to the area. Queensland Government spatial datasets can be downloaded from the Queensland Government's QSpatial website. Digital regional ecosystem mapping (showing remnant vegetation) will be desirable, as will any orthorectified digital imagery or aerial photographs.

Regrowth vegetation, as well as remnant vegetation, is assessable for BioCondition, and therefore mapping showing areas of regrowth will also be required. Regrowth mapping can be downloaded from the QSpatial website as *Vegetation Management Act former high value regrowth vegetation version 2.1*. This dataset maps areas of non-remnant woody vegetation that were used for vegetation management purposes before December 2013. The mapping was derived from the Queensland Government's Remote Sensing Centre 2006 Foliage Projective Cover (FPC) mapping and 1989 to 2007 'Woody Change' product mapping. Mapping and imagery should encompass the entire area to be assessed, including a buffer of at least 2 km.

The following equipment is desirable for completing a BioCondition assessment:

- 100 m transect tape
- 50 m transect tape (optional)
- 1 x 1 m quadrat for measuring ground cover (or some 1 m long sticks)
- compass (to lay out the site)
- star pickets for the 0 m and 50 m point along the transect for relocating the site
- diameter tape or a smaller measuring tape
- this manual (or a copy of Appendix 1) and copies of the BioCondition assessment datasheet (Appendix 2)

- access to the Internet in order to obtain information about the REs that occurs on the property or management area; RE maps (remnant, regrowth and pre-clear) and RE descriptions can also be obtained from the QSpatial website. With descriptions of REs available on the Queensland Government Website (http://www.qld.gov.au/).
- benchmark documents for each of the REs that will be assessed. (Available on the Queensland Government Website (http://www.qld.gov.au/).
- clinometer, hypsometer or ruler for measuring tree heights
- digital or print film camera
- clipboard, pencils and erasers
- flagging tape (not essential)
- plant identification books (not essential)
- Global Positioning System (GPS).

See Appendix 3 for further information on resources.

2.3 Benchmarks

Benchmarks are quantitative values derived from reference sites for each site condition attribute assessed in BioCondition, and are used as a reference value for comparison purposes. They are specific to each RE, and are based on the average or median value from reference or BOO sites. The aim of the benchmarks is to discriminate condition states between assessable sites. Benchmarks have now been developed for a number of REs in Southeast Queensland, New England Tablelands, Brigalow Belt, Mulga Lands, Northwest Highlands, Mitchell Grass Downs, Channel Country and Desert Uplands bioregions, and are currently available on the Queensland Government Website (http://www.qld.gov.au/).

The benchmark documents can be subject to periodic review and will be updated with addition of further reference site data. While every effort has been made to ensure that the information presented in the benchmarks is as reliable as possible, the State of Queensland accepts no liability and gives no assurance in respect of their accuracy and shall not be liable for any loss or damage arising from their use. Benchmarks are based on a combination of quantitative and qualitative information. The benchmarks have been generated from existing standardised floristic and habitat data collected from reference sites, and/or elicited from experts with knowledge on REs. Since there are data gaps for many REs and/or attributes within REs, expert elicitation is essential for the setting of appropriate benchmarks. A method to elicit expert knowledge specifically for the validation and/or development of benchmarks has been designed and tested specifically for BioCondition (Low Choy *et al.* 2009).

The natural variability in structure and floristic composition under a range of climatic and natural disturbance regimes throughout the geographic extent of the RE has tried to be considered during benchmark development. The establishment and assessment of local reference sites may be required to account for this spatial and temporal (seasonal and annual) variability. Assessment of local reference sites will also be required in cases where benchmarks are not yet available for REs, or an assessment needs to be conducted during less than optimal conditions. Quantitative benchmark data can then be generated by locating and setting up a local BOO reference site. Reference site assessment does require reasonable botanical and habitat assessment experience and skills, and entails detailed measurement and recording of vegetation floristics and structure. A reference site assessment protocol (Eyre *et al.* 2011) is available from the Queensland Government website.

3 The assessment unit and site selection

3.1 Delineation of the assessment unit

As for any assessment relying on a limited number of field sites, the location of these sites is very important for the overall adequacy of the assessment. The delineation of assessment units and the number of sites to assess will depend upon the overall objective of the assessment. Units of assessment are used to determine where and how many sites are needed to adequately assess the condition of the property or area of interest. Assessment units are relatively homogenous units defined by a unique RE and broad condition state (i.e. 'remnant' versus 'regrowth' versus 'non-remnant'). Non-remnant vegetation includes any vegetation that has not been otherwise mapped as remnant or regrowth vegetation by the Queensland Government. The non-remnant vegetation can be further delineated into two separate assessment units if required (e.g. for offsets), i.e. 'young woody regrowth' and 'non-remnant vegetation'. Although not currently mapped, this delineation can be obtained by using the woody cover mapping of SLATS and the pre-clearing RE mapping in areas that are not already mapped as remnant vegetation or high-value regrowth. Definitions of the broad condition states that can be used to delineate assessment units are given in Box 4.

Depending upon the objective of the assessment, there may be a requirement to assess all vegetation, or just components. Assessment units do not need to be continuous tracts, and can occupy two or more discrete areas, but should be larger than 1 ha in area (100 x 100 m) (see Figure 1). Assessments being conducted within discrete management areas, e.g. a cattle grazing property, can also use management units such as paddocks to delineate the assessment units. Ideally, to assess the condition of an area the aim would be to locate sites within each assessment unit, based on each broad condition state and RE. However, the purpose of the assessment and resources available to conduct an assessment of an area will ultimately influence the size and number of units to assess. For example, the purpose of an assessment may be to assist with prioritising ameliorative management practices within remnant and regrowth Endangered REs. Delineation of assessment units would then be restricted to remnant and regrowth Endangered REs, and exclude non-remnant vegetation.

It is best to generate a map of the area to be assessed showing the extent and types of remnant vegetation, the distribution of any mapped regrowth vegetation, the distribution of pre-cleared vegetation (if required), the position of roads, watering points and the location of fence lines so that assessment units can be mapped and area statements derived. This map can then be used in advance of conducting field assessments, to plan the locations of the assessment sites. Free RE maps and regrowth maps are available as downloadable hard copy maps for properties and as digital data from the Regional Ecosystems area of EHP's website www.ehp.qld.gov.au and Queensland government data website (https://data.qld.gov.au/). RE mapping is also available using the Biota Globe in the Queensland Globe using Google Earth (www.dnrm .qld.gov.au/). The hard copy maps and digital data can be used to produce a map specific for the area. The applicability of the RE mapping should be assessed in the field to check if it is relevant at the scale at which the assessment is being conducted. REs are defined at scales which range from 1:50 000 (e.g. South East Queensland) to 1:100 000 (e.g. rangeland bioregions) and a single polygon may contain several mapped REs (heterogeneous polygons).

Box 4: Definition of remnant vegetation and regrowth vegetation for delineating assessment units

Remnant vegetation is defined under the *Vegetation Management Act 1999* as vegetation shown on a regional ecosystem or remnant map.

Where there are no maps available, remnant vegetation is defined as vegetation where the dominant canopy has greater than 70% of the height and greater than 50% of the cover relative to the undisturbed height and cover of that stratum and dominated by species characteristic of the vegetation's undisturbed canopy.

In grassland ecosystems, remnant status is assigned to grasslands that;

a) Have not been ploughed in the last 15 years (generally detectable on Landsat imagery) and;
b) Contain >20% of the native species normally found in the ecosystem under the same ecological and seasonal conditions (as defined in benchmark documents or REDD) and;
c) Have a high ratio of native species to exotic species (>5:1).

***High-value regrowth vegetation* is defined under the *Vegetation Management Act 1999* as vegetation;**

a) Located in areas that has not been cleared since 31 December 1989 and that is an endangered, of concern or a least concern regional ecosystem.
b) Under the Act, the definition applies to vegetation located on a lease issued under the Land Act 1994 for agriculture or grazing purposes (i.e., not freehold land). However, for the purposes of delineating assessment units for BioCondition, then the above definition can be used.

***Non-remnant vegetation* is defined as all vegetation that is not mapped as remnant vegetation or regrowth vegetation, as defined above.**

Non-remnant vegetation can be further delineated to include;

a) young woody regrowth, defined as woody vegetation of any endangered, of concern or least concern regional ecosystem that has been cleared since 31 December 1989. This can be mapped using SLATS woody cover and assigned to the most likely regional ecosystem by referring to the pre-clearing regional ecosystem mapping.
b) significantly modified vegetation that fails to meet the structural and/or floristic characteristics of remnant vegetation, and is not mapped as regrowth or cannot be mapped as young woody regrowth. It also includes urban and cropping land, and modified grasslands that do not match the criteria for remnant status.

3.2 Number and location of sites

As a guide it is best to aim for two to five sites per assessment unit, dependant on the area of each unit (i.e. assessment unit <60 ha, aim for at least two sites, assessment unit >500 ha, aim for five sites). Select a site location that is representative of the unit you are assessing, and at least 50 m from any major disturbance, such as a road or a dam. Also aim to locate sites at least 1 km apart. This is particularly important if it is intended to survey fauna at the sites, to ensure independence of the data between sites assessed (Eyre *et al.* 1998).

3.3 When to assess

It is not favourable to sample during the peak of summer or following a period of drought due to a reduction in plant diversity. The best time for assessment is at the end of the summer rainfall growing season, when plant diversity is greatest. For the majority of Queensland, this is often from late March to late May, but is dependent on local seasonal conditions. As a general rule of thumb, site assessment north of the Tropic of Capricorn should generally be conducted after the wet season, ideally between March and May, to ensure adequate sampling of ground cover species (Neldner *et al*. 2004). South of the Tropic of Capricorn, site assessment should be generally conducted in May or June following the wetter summer months. An exception would be sampling in spring following an unseasonably wet winter, when many plant species are flowering.

It is not always possible to assess condition during optimal times, particularly in areas experiencing long-term drought. In these cases, it is recommended that a “local” reference site/s within the RE of interest and representing the desirable condition state (i.e. mature and relatively undisturbed or a BOO site) is located and used to generate interim benchmarks with which the BioCondition assessment site can be compared. The reference site/s should be measured at the same time as the BioCondition sites to account for variation due to seasonal or drought effects, particularly in the attributes i) species richness; ii) tree canopy cover; and iii) perennial grass cover.

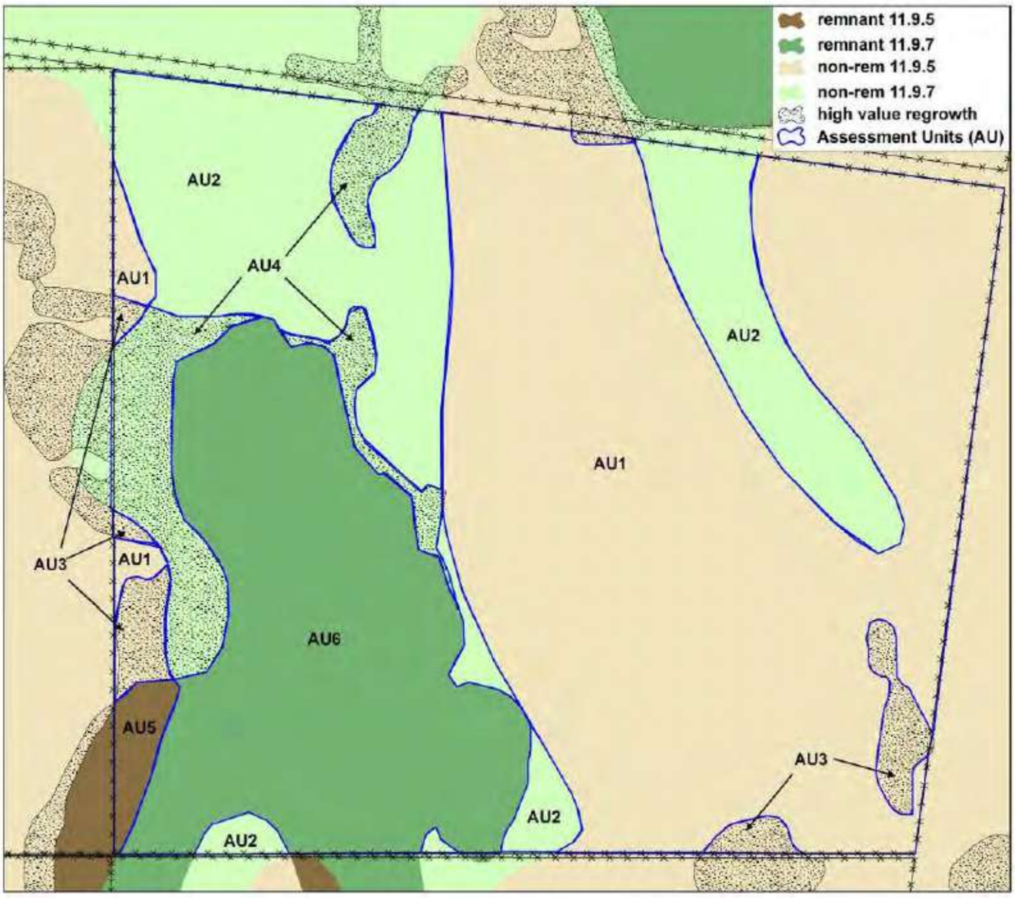


Figure 1: Assignation of the assessment unit

In this example (Figure 1), six assessment units (AU) have been identified for a paddock. AU1 represents an assessment unit delineated by a non-remnant area of brigalow and belah scrub 11.9.5 (mapped using the pre-cleared RE mapping); AU2 is non-remnant poplar box woodland 11.9.7; AU3 is regrowth RE 11.9.5 or; AU4 is regrowth RE 11.9.7; AU5 is remnant RE 11.9.5; and AU6 is remnant RE 11.9.7.

3.4 Setting up the assessment site

Details of the site assessment are presented here. A quick field guide is provided in Appendix 1. The assessment site constitutes a 100 m x 50 m (0.5 ha) area, within which 10 site-based attributes are measured. This correlates to the habitat and BioCondition reference site assessment area used to identify benchmarks for attributes (Eyre *et al.* 2011).

The site should be marked out by laying out a 100 m centre-line transect that follows the contour, i.e. along a slope as opposed to up or down a slope. Mark the 50 m point on the transect with a star picket or tyre on the ground[1]— this point acts as the centre of the assessment site. For REs characterised by a tree layer, marking out 25 m either side of the transect line forms the larger assessment area of 100 x 50 m. A greater need arises for precision when assessing the numbers of large trees within the site (it may require measuring out the distance when trees appear to be ‘borderline’ within the site). The assessment of the ten site-based attributes is conducted within five assessment areas within the 100 x 50 m site, as shown in Figure 2, and summarised as follows:

1. 100 x 50 m area: assessed for number of large trees, recruitment of canopy species, tree canopy height and native tree species richness. In long, linear assessment units (e.g. riparian areas), it may be necessary to adjust the configuration of the 100 x 50 m plot area so that these attributes are adequately sampled. In these cases, it is recommended that the plot area remains the same, if possible e.g. extend the length of the plot to 200 m, but reduce the width of the plot to 25 m.

2. 100 m transect: assessment of tree canopy cover and native shrub canopy cover.

3. 50 x 10 m sub-plot, centred from the 25 m point to the 75 m point along the centre transect, and encompassing 5 m either side of the transect: assessed for non-native plant cover and native plant species richness of shrubs, grass and non-grass species. This equates to the CORVEG standard plot area used by the Queensland Herbarium (Neldner et al. 2012).

4. 50 x 20 m sub-plot, centred from the 25 m point to the 75 m point along the transect, and encompassing 10 m either side of the transect: assessed for coarse woody debris.

5. Five 1 x 1m quadrats, starting at the 35 m point and located on alternate sides of the centre-line, 10 m apart along the 100 m transect: assessed for native grass cover and organic litter (an average value is derived over the five quadrats).

Photographs are recommended to be taken each time a BioCondition assessment is undertaken (Appendix 4). Spot photos of the 1 x 1 m quadrats can be taken to document change in ground cover over time, while a landscape or series of landscape photos provides a record of the tree and shrub layers and the general condition of the site. At the centre point of the transect it is useful to take four photos north, south, east and west of the 50 m plot centre.

[1] In more open areas, where there are cattle present, tyres can be preferential due to the tendency of cattle to use star pickets as scratching posts leading to concentrated disturbance around the posts.

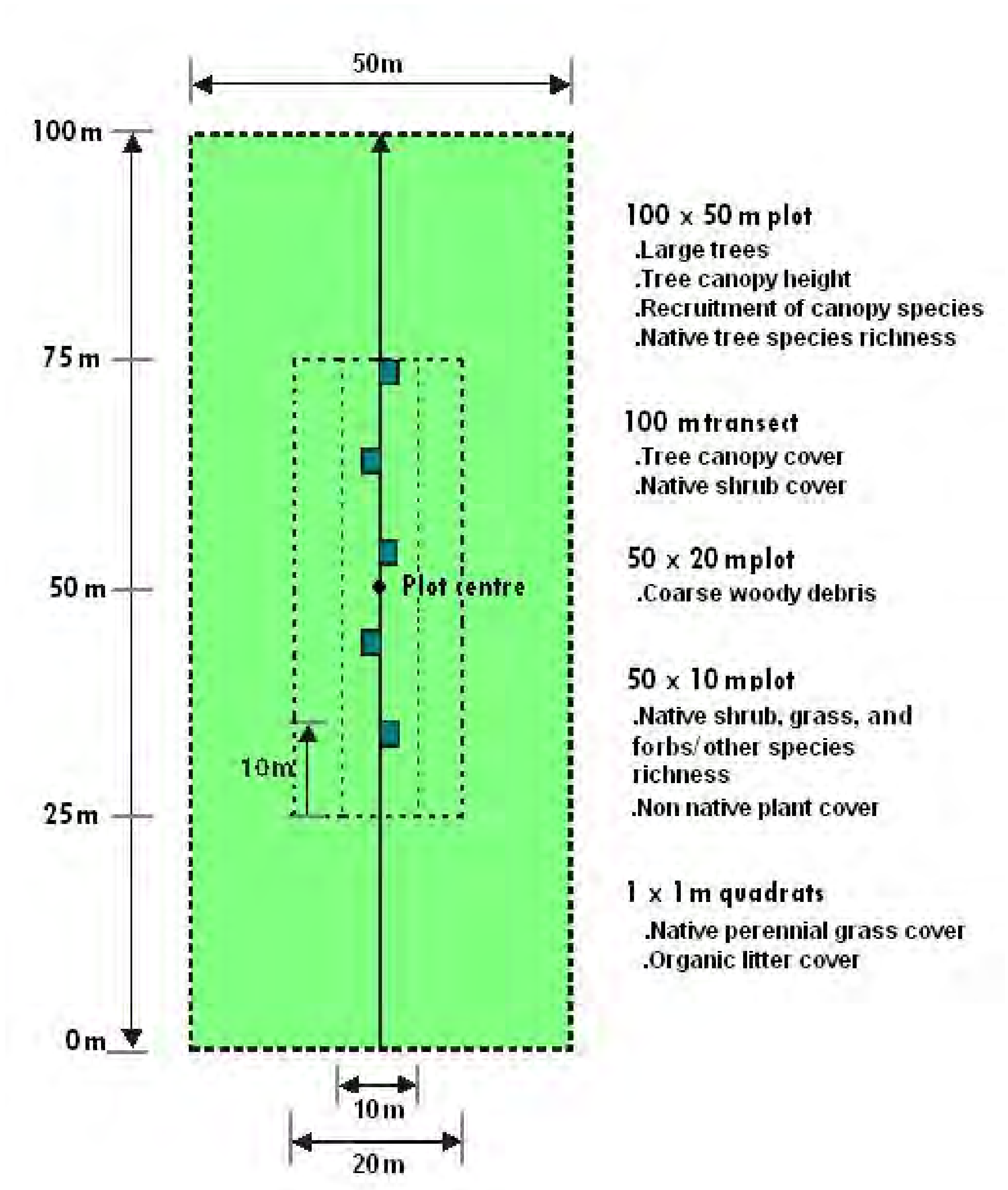


Figure 2: BioCondition field site area and layout

4 The assessable attributes and scores

A full species survey or census to quantify the biodiversity values of a patch of vegetation is expensive to conduct and requires high levels of technical expertise. As such, use of indicators of biodiversity, or measurable surrogates of biodiversity, is a relatively reliable and cost effective approach to assess or monitor biodiversity (Noss 1990, Sarkar and Margules 2002, McElhinny *et al.* 2005). At the site scale, biodiversity indicators are either based on key or 'indicator' species or structural aspects of the vegetation that are known to be important for biodiversity values (Lindenmayer *et al.* 2000; Parkes *et al.* 2003; McElhinny *et al.* 2005).

The approach using key indicator species is limited because relationships between species and biodiversity are yet to be established (Lindenmayer and Cunningham 1997; Margules *et al.* 2002), as well as other inherent issues with survey conditions and how these can influence detectability of species (e.g. Wayne *et al.* 2005). Experience and skills in species detection and identification can also limit efficacy of direct assessment of species. However, indicators based on key vegetative structural elements are proving to be a more reliable and cost effective approach for the assessment of biodiversity, and form the basis of assessment of vegetation condition elsewhere in Australia (Parkes *et al.* 2003; Oliver and Parkes 2003; Gibbons *et al.* 2008).

The suite of assessable attributes in BioCondition was selected based on:

- known or perceived surrogacy for biodiversity values and representation of ecological processes relative to composition, structure and function (Table 2)
- ease of measurability in field situations
- known or perceived sensitivity to change
- lack of correlation between each other
- ability to allow discrimination between sites
- value in educating or instructing on biodiversity values.

The dwarf grey skink (*Menetia greyii*) (left) and Burnett's skink (*Carlia foliorum*) both need woody debris and organic litter as habitat.

Table 2: Summary of the functional role of vegetation for biodiversity and indicators of those functions

Vegetation functions	Attributes that act as indicators of the functions
Structural aspects	
Provision of reliable foraging resources for wildlife (e.g. nectar, leaves, seeds)	Large trees Shrub cover Tree canopy cover Native perennial grass Coarse woody debris Organic leaf litter Ground cover
Provision of reliable sheltering resources and or breeding sites for wildlife	Large trees and/or hollow-bearing trees Coarse woody debris Tree canopy cover Shrub cover Organic litter Perennial grass cover
Functional aspects	
Nutrient and water cycling	Tree canopy cover Organic litter cover Coarse woody debris
Maintenance of soil condition	Organic litter cover Native perennial ‘decreaser’ grass species basal area Native perennial non-grass cover Coarse woody debris
Retention of plant propagules	Organic litter Coarse woody debris
Compositional aspects	
Maintenance of plant species diversity	Native plant species richness Recruitment of canopy species Native perennial ‘decreaser’ grass species basal area Non-native plant species cover (lack of)

4.1 The assessable attributes

In BioCondition, attributes are weighted to standardise relative ‘importance’, meaning the degree to which the attribute:

- has a potential impact upon long-term condition (e.g. non-native plants)
- is difficult or takes a long time to replace in a system if lost (e.g. large trees)
- has habitat value based on empirical research.

The attributes of biodiversity that are assessable in BioCondition, and their relative weightings that contribute to the overall condition score, are shown in Table 3.

Attributes collected for the BioCondition assessment represents the minimum that should be collected to make a robust condition assessment. In BioCondition, the assessor will need to distinguish between dominant plant species, although it is not required that they identify what those species are, although they will need to be able to distinguish between native and non-native species[2]. If sufficient expertise exists, assessors are encouraged to collect more comprehensive data, e.g. identify and list species present in each layer as a way of value adding to the information collected at each site.

Table 3: The assessable attributes and weightings for deriving the final BioCondition score

	Attribute	Weighting (%)
Site-based condition attributes	Large trees Tree canopy height Recruitment of canopy species Tree canopy cover (%) Shrub layer cover (%) Coarse woody debris Native plant species richness for four lifeforms Non-native plant cover Native perennial grass cover (%) Litter cover	15 5 5 5 5 5 20 10 5 5
Landscape attributes (fragmented subregions[3])	Size of patch Context Connectivity	10 5 5
OR Landscape attributes (intact subregions)	Distance to permanent water	20
TOTAL		100

4.2 Assessing regional ecosystems with naturally missing attributes

For treeless or non-woody species dominant REs, e.g. grassland REs (as defined in the glossary), the woody-type site attributes such as tree canopy cover, tree canopy height, large trees etc are not assessable and the final condition score is standardised accordingly. A similar standardisation is made for shrubland REs, which naturally lack large trees and coarse woody debris, and mangrove ecosystems, which naturally occur without native perennial grass cover. In such cases,

[2] Trials performed by a range of assessors with varying levels of botanical knowledge found that the native species richness counts were within 10% of each other.

[3] See Section 6 for definition and locality map of bioregions and subregions that contain fragmented landscapes, and bioregions and subregions that contain intact landscapes.

the benchmark value will be zero for these attributes, thus the maximum score for the attributes is adjusted to zero. **In general, if the benchmark document gives a zero for an attribute, then the attribute is discounted from the final score.** This has the effect of standardising the scoring for these REs to between 0 and 1 when calculating the total BioCondition score.

A grassland ecosystem, which naturally does not contain trees or shrubs, gets a maximum score of 50, incorporating a total possible score of 30 for the site-based attributes, plus a further possible score of 20 for the landscape scale attributes (Table 4). Similarly, a mangrove ecosystem which does not support grasses or litter means the attributes grass species richness, perennial grass cover and litter cover are not included in the BioCondition assessment or scoring procedure (Table 4). If the total score for an assessment site in grassland is 50, then it's standardised BioCondition score is 1.0, while a total score of 50 in a mangrove ecosystem would give a BioCondition score of 0.59, and in a wooded non-mangrove ecosystem the BioCondition score is 0.5.

Table 4: The assessable attributes and weightings in ecosystems where attributes are naturally absent

Attribute	Wooded ecosystems Weighting (%)	Grassland ecosystems Weighting (%)	Shrubland ecosystems Weighting (%)	Mangrove* ecosystems Weighting (%)
Site-based Large trees	15	0	0	15
Tree canopy height	5	0	0	5
Recruitment of dominant canopy species	5	0	5	5
Tree canopy cover (%)	5	0	0	5
Shrub layer cover (%)	5	0	5	5
Coarse woody debris	5	0	0	5
Native plant species richness - Trees - Shrubs - Grasses - Other	5 5 5 5	0 0 5 5	0 5 5 5	5 5 0 5
Non-native plant cover	10	10	10	10
Native perennial grass cover (%)	5	5	5	0
Litter cover	5	5	5	0
Total site score	**80**	**30**	**45**	**65**
Landscape Size of patch	10	10	10	10
Context	5	5	5	5*
Connectivity	5	5	5	5
OR Distance to artificial water	20	20	20	N/A
Total landscape score	20	20	20	20
TOTAL BioCondition SCORE	100	50	65	85

* ocean may be included as 'remnant'

5 Assessment of site-based attributes

5.1 100 x 50 m plot

5.1.1 Large trees

Large trees are an important resource within forest and woodland ecosystems. They provide greater leaf material, nectar and bark-surface area for foraging purposes, and are more likely to contain hollows and crevices for nesting and sheltering purposes. Large trees are defined as the number of living trees per hectare with a diameter at breast height (DBH) greater than the DBH threshold provided in the benchmark document. Native trees larger than the DBH threshold are counted within the 100 x 50 m assessment area (i.e. 0.5 hectare, this value will need to be doubled to compare with the benchmark value).

In some REs a large tree DBH threshold will be identified for both eucalypt[4] and non-eucalypt tree species due to the natural variation in potential size. For example, a mature mulga tree (*Acacia aneura*) can never reach the size of a mature poplar box (*Eucalyptus populnea*), therefore the large tree DBH threshold is smaller for mulga than for poplar box. Where the benchmark document specifies different diameter thresholds for large eucalypt and non-eucalypt trees, the benchmark number of large trees will be the number of large eucalypts and the number of large non-eucalypts added together to give one per hectare value which is then scored using Table 5. An example of scoring large trees is given in Box 5.

Table 5: Description and scores for the number and habitat value of large trees

Description	Score
No large trees present	0
0 to 50% of benchmark number of large trees	5
≥50% to 100% of benchmark number of large trees	10
≥ benchmark number of large trees	15

Box 5: Example of scoring large trees

Scoring large trees

RE 11.4.12: Benchmark document has a DBH threshold for eucalypts as 58 cm with the 12 large trees per ha. For non-eucalypts the DBH threshold is 26 cm with 16 large trees per ha. The benchmark is 12 + 16 = **28 large trees per ha**.

During the BioCondition assessment 6 large eucalypt trees (>58 cm DBH) were counted (i.e. 12 large eucalypt trees per ha) and 3 large non-eucalypt trees (>26 cm DBH) were counted (i.e. 6 large non-eucalypt trees per ha).

The assessment gives **18 large trees per ha**. This is within 64% of the benchmark value (i.e. 18/28 = 64%), which means the score will be on the third row of Table 10, receiving a score of **10.**

[4] Eucalypt includes species of genera *Eucalyptus, Corymbia, Angophora, Lophostemon* and *Syncarpia*.

5.1.2 Tree canopy height

Tree height is indicative of stand development and site productivity and is relatively simple to measure. Tree height and cover are used by the Queensland Herbarium in the definition of remnant vegetation in the production of the RE mapping (Neldner *et al*. 2012).

Tree canopy height (measured to the top of the highest leaves) refers to the median canopy height in metres, estimated for the trees in the ecologically dominant layer (EDL) or canopy layer (see Box 6) within the 100 x 50 m assessment area. The median canopy height is the height that has 50% of canopy trees higher and lower than it (Figure 3). This is generally synonymous with average height except when there are some trees that are substantially higher or lower than the median (Neldner *et al.* 2012). Description and scoring categories for assessing tree height are given in Table 6. A reliable method for assessing tree height is provided in Appendix 5. It is recommended that a clinometer or hypsometer be used if available.

For this attribute, if there is a distinct emergent or subcanopy layer in the appropriate RE benchmark, the height of each these layers (EDL, emergent and subcanopy) is measured and scored separately. In these cases, the score for each is then averaged to give one score for tree height. For disturbed/regrowth sites, which frequently only have one diffuse layer, the canopy height of the species present is compared to the values in the appropriate layer in the benchmark.

Box 6: Identifying vegetation layers for BioCondition assessment

In BioCondition, assessment of the **tree height**, **recruitment** and **tree canopy cover** attributes require consideration of the vegetation layers or strata that typify the RE of interest.

Where there is an emergent tree layer identified in the appropriate RE benchmark document, e.g. widely scattered popular box (*Eucalyptus populnea*) trees emerging above a dominant canopy of mulga (*Acacia aneura*), then the emergent layer species are assessed separately from the EDL species for the purposes of these three attributes. Similarly if a subcanopy layer is identified in the appropriate RE benchmark because it contributes a significant amount of biomass to the vegetation, e.g. a conspicuous subcanopy layer of *Allocasuarina littoralis* under a canopy of *Eucalyptus crebra*, then the subcanopy layer is assessed as well as the EDL species for the three attributes. The process for stratifying the vegetation into layers and examples are given in **Appendix 6**.

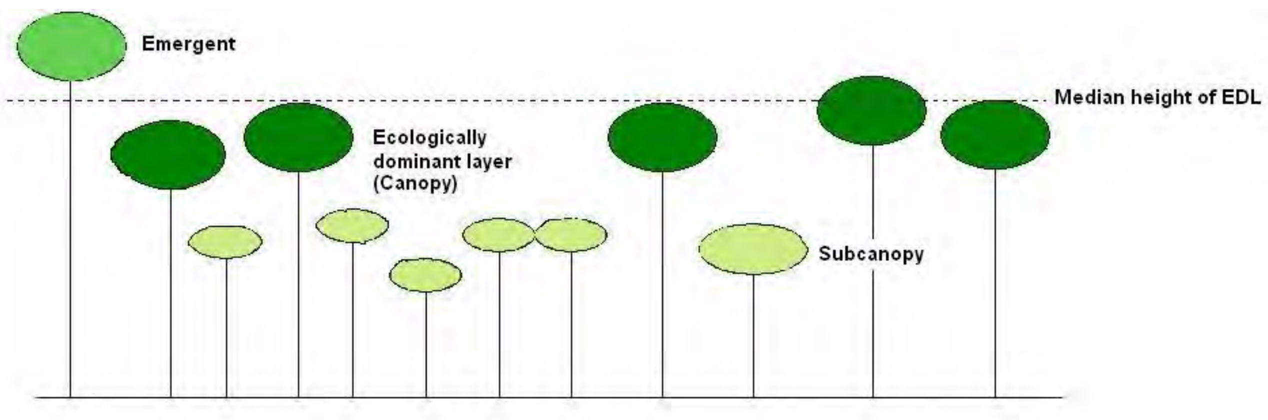


Figure 3: Median height of the ecologically dominant Layer (EDL)

Table 6: Description and scores for tree canopy height

Description	Score
<25% of benchmark height	0
≥25% to 70% of benchmark height	3
≥70% of benchmark height	5

5.1.3 Recruitment of dominant canopy species

Recruitment or regeneration is essential to the sustainability of any ecosystem. Some land management practices, such as burning or grazing, and natural processes such as drought, can affect the processes required for natural regeneration.

The recruitment attribute assesses the presence of regeneration of the dominant canopy species in the 100 x 50 m assessment area. The canopy equates to the EDL for forests and woodlands, plus the emergent and subcanopy layers if they contribute a significant amount of biomass (Box 6 and Appendix 6). Where the EDL is the shrub layer, then the recruitment of the dominant species from this layer and any emergent tree layer are included for this attribute. Due to the seasonal and therefore ephemeral nature of non-woody vegetation, the assessment of recruitment is restricted to woody perennial species only.

Recruitment is assessed as the proportion of dominant species present at a site that are regenerating, i.e. having individuals with a DBH <5 cm. For example, if four dominant canopy species occur at the site, but only two of these species are present as regeneration, then the proportion is 50%. This would be allocated a BioCondition score of 3 (Table 7).

Table 7: Description and scores for the recruitment of canopy species

Description	Score
<20% of dominant canopy* species present as regeneration	0
≥20 – 75% of dominant canopy* species present as regeneration	3
≥75% of dominant canopy* species present as regeneration	5

*canopy species are those species listed in the RE benchmark in the EDL, emergent and subcanopy layers or as identified in the RE description (REDD database) that make up the dominant proportion of the EDL, emergent and subcanopy layers (but does not include those listed as occurring as scattered individuals).

Note: As only the dominant species are assessed for Recruitment, not all of the species counted during the assessment of Native Tree[5] Species Richness (Section 5.1.4) will necessarily be included in the assessment of this attribute.

5.1.4 Native tree species richness

The richness of plants or flora species is recognised as an important attribute to assess in studies related to the assessment of condition for biodiversity. Not only does it reflect a portion of the

[5] Or shrubs in the case of shrub lands

biodiversity present on site, the number, and abundance of plant species can have a direct relationship on the fauna present and influence a whole range of functional processes reflective of the condition of a stand.

To simplify measurement, native plant species richness, rather than diversity (diversity measures incorporate abundance), is estimated for four life-forms: trees, shrubs, grasses and forbs/other (see Appendix 7 for a list of life-form groups categorised for BioCondition and Appendix 8 for a description of those life-forms). For native tree species richness assessment is based on the number of native tree species observed in the 100 x 50 m plot. For all other life forms (shrubs, grasses, forbs/others) species richness is assessed in the 50 x 10 m plot (see Section 5.4.1). Native tree species richness is scored with the other life-forms as described in Table 11.

5.2 100 m transect

5.2.1 Tree canopy cover

Tree canopy cover can be used to characterise stand productivity and the distribution and abundance of biomass (McElhinny 2002). It refers to the estimation of the percentage canopy cover of the living, native tree layer along the 100 m transect, using the line intercept method (Greig-Smith 1964). For this attribute, only the cover of the species making up the EDL or tree canopy cover is assessed for the majority of REs. Canopy cover equates to crown cover as defined by Walker and Hopkins (1990). The vertical projection of the tree canopy over the 100 m transect is recorded. The total length of the projected canopy of each layer is then divided by the total length of the tape to give an estimate of percentage canopy cover on the site, which then can be compared with the benchmark value. Over-abundance or under-abundance (e.g. thinning) in the tree canopy will result in lower scores (Table 8).

If there is, or should be, a distinct emergent or subcanopy layer (this will be defined by the benchmark document for the assessable RE), then the canopy cover of each of these layers (EDL, emergent and subcanopy) is assessed separately, then averaged to give one score for tree canopy cover. If exotic species are present in the canopy (e.g. camphor laurel *Cinnamomum camphora*, exotic pines *Pinus* spp.) then cover of these can be measured separately and indicated with an asterisk (*) but will not form part of the final scoring for the site. Figure 4 and Box 7 provide an example of tree canopy cover assessment and scoring.

Table 8: Description and scores for tree canopy cover

Percentage of Tree Canopy (EDL) Cover [6] relative to Benchmark	Score
<10% of benchmark	0
≥10% and <50%	2
≥50% or ≤200%	5
>200%	3

[6] (and Emergent and Subcanopy if these layers are identified in the benchmark document)

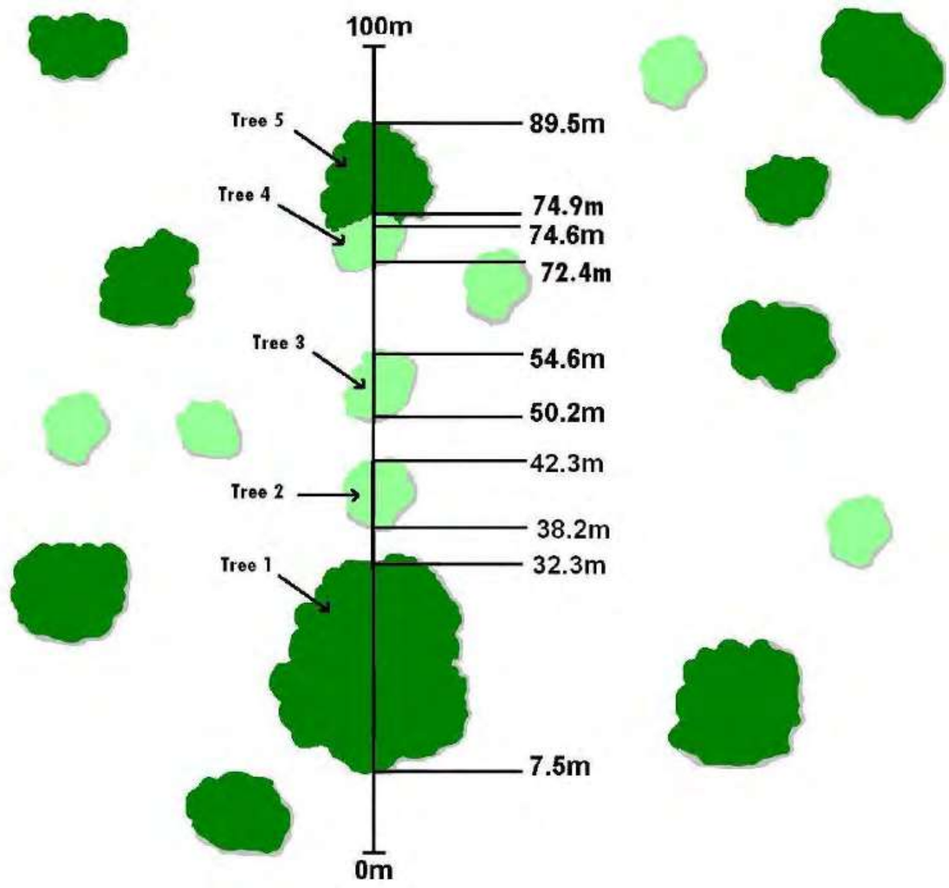


Figure 4: Example of assessing canopy cover percentage

Box 7: Example of scoring tree canopy cover

In Figure 4, this regional ecosystem has a canopy (EDL) and a subcanopy.

The canopy cover (EDL) is **39.7%**, calculated as:

= (canopy cover Tree 1) + (canopy cover Tree 5)

= (32.3–7.5) + (89.5–74.6) = 24.8 + 14.9 **= 39.7%**.

If the canopy benchmark for this regional ecosystem is **42%**, then the assessment is within **95%** of the benchmark (i.e. **39.7/42 = 94.5%**). This corresponds with the third row of Table 8, with a score of **5**.

The subcanopy cover is 11%, calculated as:

= (cover Tree 2) + (cover Tree 3) + (cover Tree 4)

= (42.3 – 38.2) + (54.6 - 50.2) + (74.9 –72.4) = 4.1 + 4.4 + 2.5 = **11%**

This is compared to the subcanopy benchmark of 30%, so the assessment is within 37% of the benchmark (i.e. **11/30 = 36.6%**), which corresponds with the second row of Table 8. Therefore, the assessment would receive a score of **2** for the subcanopy cover layer.

The averaged, final score for tree canopy cover is 3.5 (i.e. $\frac{5\text{ [canopy]} + 2\text{ [subcanopy]}}{2}$ = 7/2)

5.2.2 Shrub cover

Shrub canopy cover refers to the estimate of the percentage cover of native shrubs recorded along the 100 m transect (similar to the estimation of tree canopy cover using a vertical projection of shrub crowns downwards over the centre line transect). Management and disturbance can result in shrub cover that is either insufficient, which has been shown to reduce habitat quality for birds in Queensland (Eyre *et al.* 2009a), or excessive, which may not represent a stable state, particularly in the rangelands (Witt *et al.* 2009). Consequently, the score is reduced if shrub cover is either under-abundant or overabundant (>200%) relative to the benchmark (Table 9). This is to account for the issue of woody vegetation thickening, which can arise under particular climatic conditions from the interactions of varying fire and grazing regimes. If non-native shrubs (e.g. *Lantana* spp.) are present along the transect line, these can be measured separately and indicated with an asterisk (*) but will not form part of the scoring of the site.

Table 9: Description and scores for shrub cover

Description	Score
<10% of benchmark shrub cover	0
>/= 10 to <50% or >200% of benchmark shrub cover	3
≥50% or ≤200% of benchmark shrub cover	5

5.3 50 x 20 m plot

5.3.1 Coarse woody debris

Coarse woody debris (CWD) is an important component in many aspects of ecosystem functioning (Woldendorp *et al.* 2002; Mackensen *et al.* 2003). It is primarily measured as a habitat surrogate for ground-dwelling fauna (MacNally and Horrocks 2002), but can also be used as a variable in the estimate of carbon biomass, and as an indicator of management disturbance (Eyre *et al.* 2010).

In BioCondition, coarse woody debris refers to logs or dead timber on the ground that is >10 cm diameter and >0.5 m in length (and more than 80% in contact with the ground). Assessment is conducted by measuring the length of all fallen woody logs and other coarse woody debris (>10 cm diameter and >0.5 m in length) to the boundary of the 50 x 20 m plot (i.e. 0.1 ha). The total measured value is multiplied by 10 for comparison with the benchmark which is a metre per hectare value). Scores are lower for sites where there is an over-abundance of CWD (Table 10), because in some ecosystems, such as silviculturally managed cypress pine, an overabundance of CWD is indicative of disturbance from selective clearing or silvicultural treatment.

Table 10: Description and scores for number of CWD

Description	Score
<10% of benchmark number or total length of CWD	0
>/= 10 to <50% or >200% of benchmark number or total length of CWD	2
≥50% or ≤200% of benchmark number or total length of CWD	5

5.4 50 x 10 m plot

5.4.1 Native plant species richness

To simplify measurement, native plant species richness, rather than diversity (diversity measures incorporate abundance), is estimated for four life-forms: trees, shrubs, grasses and forbs/other (see Appendix 7 for a list of life-form groups categorised for BioCondition and Appendix 8 for a description of those life-forms). For a species that may occur in a number of layers with different lifeforms, for example, *Acacia harpophylla,* which may occur as a tree in the canopy and also as a shrub in the shrub layer, then the species is counted for each layer it occurs in. Where a species has two lifeforms in the same layer, such as *Acacia aneura,* which may have a single stemmed 'tree' lifeform as well as multi-stemmed 'shrub' lifeform in the same layer, then it is classed as the most frequent lifeform in that layer. Assessment is based on the number of native shrub, grass and forb/other species observed in the 50 x 10 m plot for each benchmarked life-form group (Table 11). Native tree species richness is assessed over the 100 x 50 m plot (see Section 5.1.4).

Table 11: Description and scores for native plant species richness for each life form

Description	Score
<25% of benchmark number of species within each life-form	0
≥25% to 90% of benchmark number of species within each life-form	2.5
≥90% of benchmark number of species within each life-form	5

5.4.2 Non-native plant cover

Non-native plants are introduced or exotic plant species that cause major modification to native species richness, abundance and ecosystem function (Humphries *et al.* 1991: Grice 2004). Generally, two types of non-native plant invasion are recognised: introduction of exotic plants and movement of native species into new areas well outside their natural range. In the Australian rangelands, there are limited studies that quantify the effects of non-native plants on fauna, although the few studies available suggest a negative net effect (Grice 2004). The establishment of exotic pastures e.g. buffel grass *Cenchrus ciliaris* has been associated with a loss in native species and alterations in fire regimes (Fensham and Fairfax 2000; Franks 2002; Jackson 2005; Eyre *et al.* 2009b).

Non-native plant cover is the percentage cover of the total vegetation cover that is comprised of exotic and non-indigenous species, assessed within the 50 x 10 m sub-plot. Where there are non-native plants present in more than one layer, such as a grass in the ground layer and shrub in the shrub layer, then the cover in each layer are added together. The benchmark for non-native plant cover for any ecosystem type is zero (Table 12).

Table 12: Description and scores for non-native plant cover

Description	Score
>50% of vegetation cover are non-native plants	0
≥25 – 50% of vegetation cover are non-native plants	3
≥5 – 25% of vegetation cover are non-native plants	5
<5% of vegetation cover are non-native plants	10

5.5 1 x 1 m quadrats

5.5.1 Native perennial grass cover

In earlier versions of BioCondition, three components of the ground layer were scored based on cover: perennial grass species; perennial forb (non-grass) species; and annual grass and forb species. Perennial forb cover and annual species cover are no longer assessable in BioCondition as many assessors are not confident about the identification of annual species (Kelly et al. 2011), and there is high correlation between forb and perennial grass cover and that there is wide inter- and intra-seasonal variation that can occur particularly in the drier parts of Queensland.

Perennial grass cover refers to the average percentage cover of native perennial grasses, assessed within each of the five 1 x 1 m quadrats and averaged to give a value for the site which is then scored against the benchmark value (Table 13). The ground cover is measured by a vertical projection downwards of the living and attached plant material. A stylised guide is provided in Figure 5 to help estimate cover percent. This cover equates to the projected foliage cover in Walker and Hopkins (1990).

Table 13: Description and scores for native perennial grass species cover

Description	Score
<10% of benchmark native perennial (or preferred and intermediate) grass cover	0
≥10 to 50% of benchmark native perennial (or preferred and intermediate) grass cover	1
≥50 – 90% of benchmark native perennial (or preferred and intermediate) grass cover	3
≥90% of benchmark native perennial (or preferred and intermediate) grass cover	5

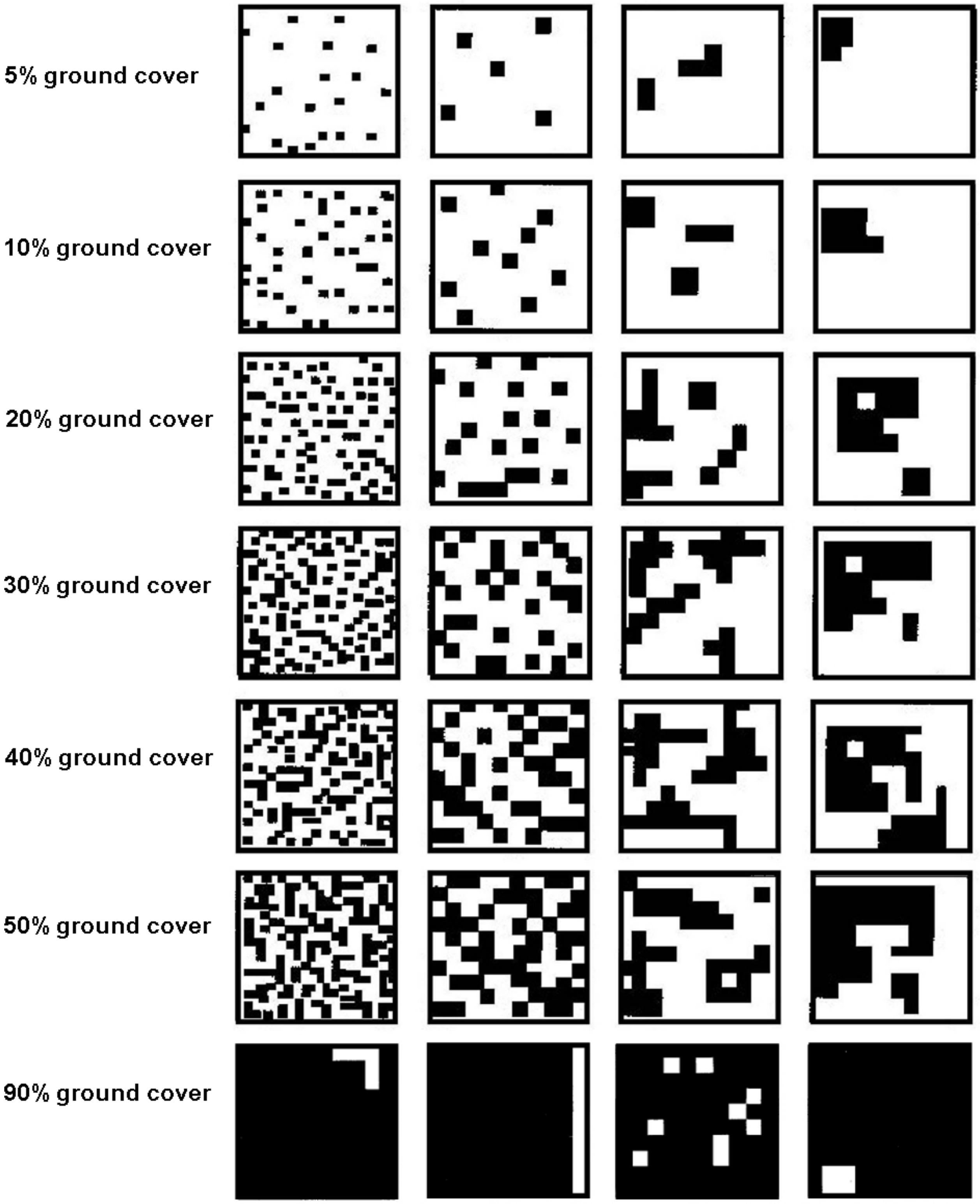


Figure 5: Stylised examples of ground cover proportions.

Various ground cover amounts (%) can be evenly spread across the quadrat or distributed in patches.

5.5.2 Organic litter

Litter is described as a key habitat component for wildlife and woodland functioning (McIntyre *et al.* 2002). Leaf and woody litter protects the soil from erosion and its decomposition provides continual nutrient supply into the ecosystem. It supports a diverse range of invertebrates, which in turn provide a food source for vertebrate species.

Litter is defined as including both fine and coarse organic material such as fallen leaves, twigs and branches <10 cm diameter. Organic litter cover refers to the average percentage cover assessed within each of the five 1 x 1 m quadrats. Note that within a quadrat, the sum of the native ground cover (shrubs, grasses and forbs etc), non-native plant ground cover, organic litter (including any CWD) and bare ground/rock cover should equal 100%.

Sites with over-abundance as well as under-abundance of organic litter cover receive lower scores (Table 14).

Table 14: Description and scores for percentage of organic litter

Description	Score
<10% of benchmark organic litter	0
≥ 10 to <50% or >200% of benchmark organic litter	3
≥50% or ≤200% of benchmark organic litter	5

Litter provides shelter during the day for ground geckos like this foraging thick-tailed gecko *Underwoodisaurus milii.*

6 Assessment of landscape-scale attributes

The context of the landscape surrounding the site is also assessed in BioCondition. This is because landscape context is known to have a significant influence on the long-term viability of the habitat patch for biodiversity values (Andren 1994; Fahrig 1997, 2001).

Landscape context does not only refer to fragmented landscapes with sharp or high contrast edged boundaries (e.g. vegetated versus cleared boundaries), but also intact landscapes where there are gradients of habitat quality or low contrast edges (e.g. increased grazing disturbance with distance from water points). These concepts correlate with ‘abrupt’ or ‘gradual’ boundaries used in landscape ecology (McIntyre and Barrett 1992; McAlpine and Eyre 2002).

In BioCondition, landscape context attributes are scored using different attributes depending upon whether the assessment is within a *fragmented landscape* (patch size, connectivity and context), or an *intact landscape* (distance to water). Fragmented landscapes can be defined as areas where the amount of remnant vegetation is less than 65% (McIntyre and Hobbs 2000). This includes subregions in South East Queensland, Brigalow Belt, New England Tableland, Central Queensland Coast and Wet Tropics bioregions. It also includes the West Balonne Plains, Eastern Mulga Plains, Nebine Plains, North Eastern Plains and Langlo Plains subregions in the Mulga Lands bioregion and the Jericho subregion in the Desert Uplands bioregion (Accad *et al*. 2010). Other subregions in the Mulga Lands, and Cape York Peninsula, Einasleigh Uplands, Gulf Plains, Northwest Highlands, Mitchell Grass Downs, Desert Uplands and Channel Country can be defined as intact landscapes (Figure 6).

The landscape context attributes are best calculated using data stored in Geographical Information Systems (GIS). RE mapping (remnant) and regrowth (non-remnant) vegetation mapping can be used to assess landscape context and is available from the Regional Ecosystem Maps section of the Queensland Government QSpatial website (http://qspatial.information.qld.gov.au/IQAtlas/) and the Queensland government data website (https://data.qld.gov.au/). Alternatively, Appendix 9 provides a method for the calculation of area using aerial photographs.

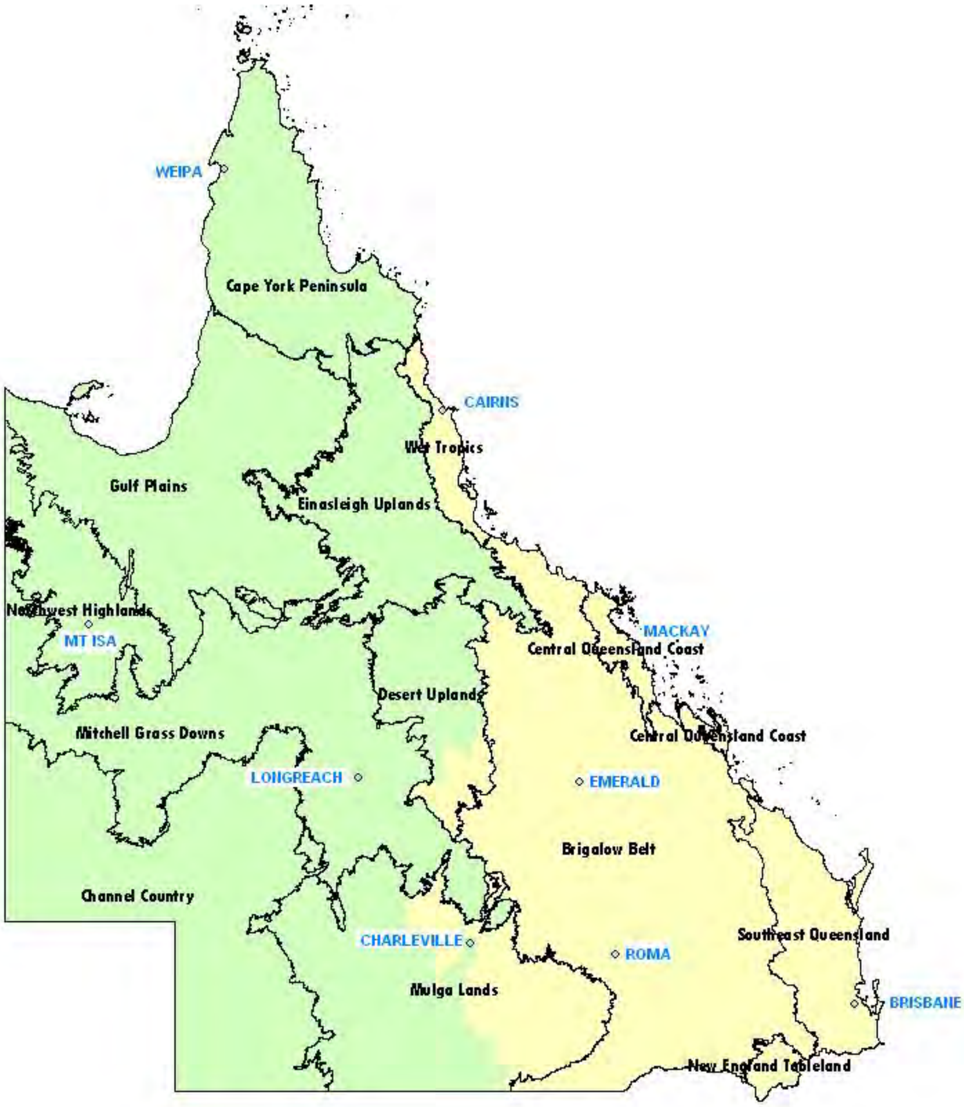


Figure 6: Fragmented (yellow) and intact (green) regions of Queensland

6.1 Fragmented landscapes

6.1.1 Size of patch

This attribute is a measure of the size of the patch of vegetation in which the assessment unit is located. The scoring reflects the importance of large patches in the landscape, and is based on the size of a patch of either remnant vegetation, or regrowth vegetation, or a combination of remnant and regrowth vegetation (Table 15). Larger patches are less susceptible to ecological edge effects and are more likely to sustain viable populations of native flora and fauna than smaller patches (McIntyre *et al.* 2000; Lindenmayer *et al.* 1999). Larger patches are also less susceptible to propagule pressure from exotic pasture species such as buffel grass (Eyre *et al.* 2009b).

The assessment unit may form a component of a patch that includes a range of other units of REs of varied condition states. For BioCondition assessments, an estimate of patch area will include any remnant or regrowth vegetation (i.e. irrespective of RE or tenure) that is contiguous with the assessment unit (Figure 7). In cases where the assessable patch is connected to larger areas of remnant vegetation, but through narrow corridors (<200 m in width) within 1 km radius of the site, then these areas should be treated as a different patch and not included in the calculation of patch size (e.g. Figure 8).

Patch size is assessed for vegetation mapped as either remnant and/or regrowth. Regrowth is included in the assessment of patch size in recognition of its contribution to increasing or maintaining biodiversity values, particularly in highly modified landscapes (Bowen *et al.* 2007).

Table 15: Description and scores for size of patch

Description	Score
<5 ha remnant **AND/OR** regrowth	0
≥5 – 25 ha remnant **AND/OR** regrowth	2
≥25 – 100 ha remnant **OR** ≥25 – 200 ha remnant and regrowth **OR** ≥25 – 200 ha regrowth	5
≥100 – 200 ha remnant **OR** >200 ha remnant and regrowth **OR** >200 ha regrowth	7
≥200 ha remnant	10

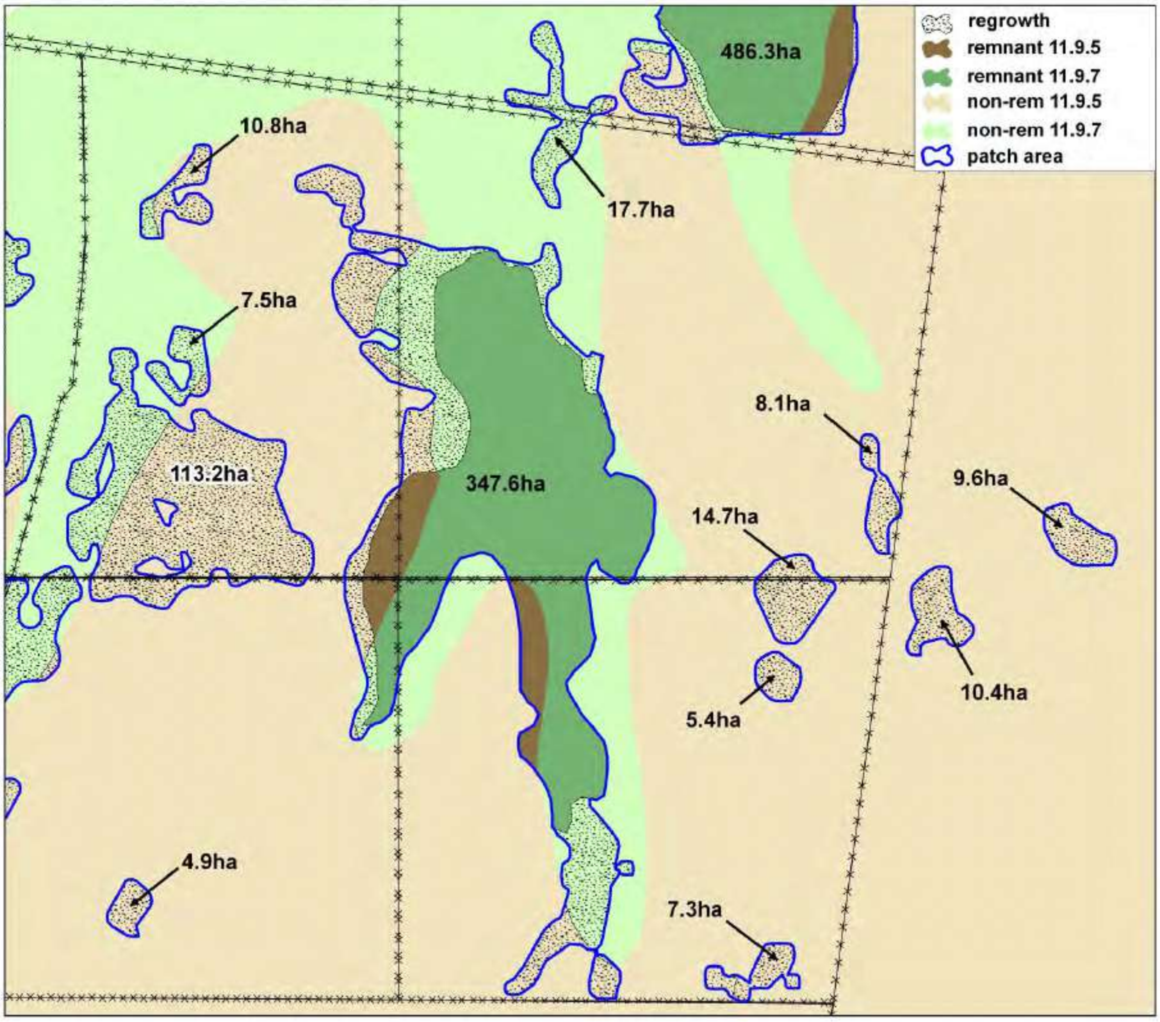


Figure 7: Example of the delineation of the patch area

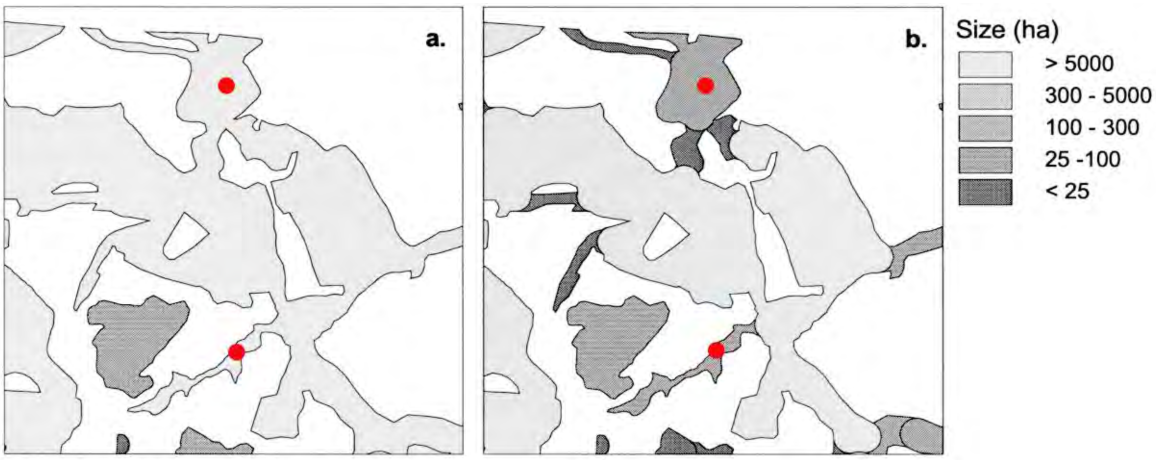


Figure 8: Patch size of remnant vegetation (a) before, and (b) after segmentation of narrow (<200 m) linear landscape elements

For example, before segmentation patch area of Site A >5000 ha, and after segmentation 25 to 100 ha. This site would therefore score 5 in BioCondition.

6.1.2 Connectivity

As a landscape level attribute, connectivity aims to assess the degree to which the assessment unit is connected with adjacent native vegetation. Connectivity relates to the capacity species have to disperse through the landscape between suitable patches of habitat, and therefore has important implications for species persistence (With 2004). A landscape with high connectivity is one in which a particular fauna species can readily move between suitable areas of habitat. A landscape with low connectivity means populations become largely isolated (Bennett *et al.* 2000). Immigration by a species into a single patch of habitat is related to connectivity at the landscape scale. However, other aspects such as the size of the patch (landscape attribute 1) and the amount of habitat in the landscape (landscape attribute 3), as well as the dispersal behaviour of species all contribute to the strength of the relationship (Tischendorf and Fahrig 2000).

In BioCondition there are four broad categories that describe the connectivity of the assessment unit within the landscape (Table 16 and Figure 9). Both remnant and regrowth vegetation are assessed within the connectivity attribute.

Table 16: Description and scores for connectivity in the landscape.

Category	Description	Score
Low	The assessment unit is not connected using any of the below descriptions.	0
Medium	The assessment unit: is connected with adjacent remnant vegetation along >10% to <50% of its perimeter **OR** is connected with adjacent remnant vegetation along <10% of its perimeter **AND** is connected with adjacent regrowth native vegetation > 25% of its perimeter.	2
High	The assessment unit: is connected with adjacent remnant vegetation along 50% to 75% of its perimeter.	4
Very high	The assessment unit: is connected with adjacent remnant vegetation along >75% of its perimeter **OR** includes > 500 ha remnant vegetation	5

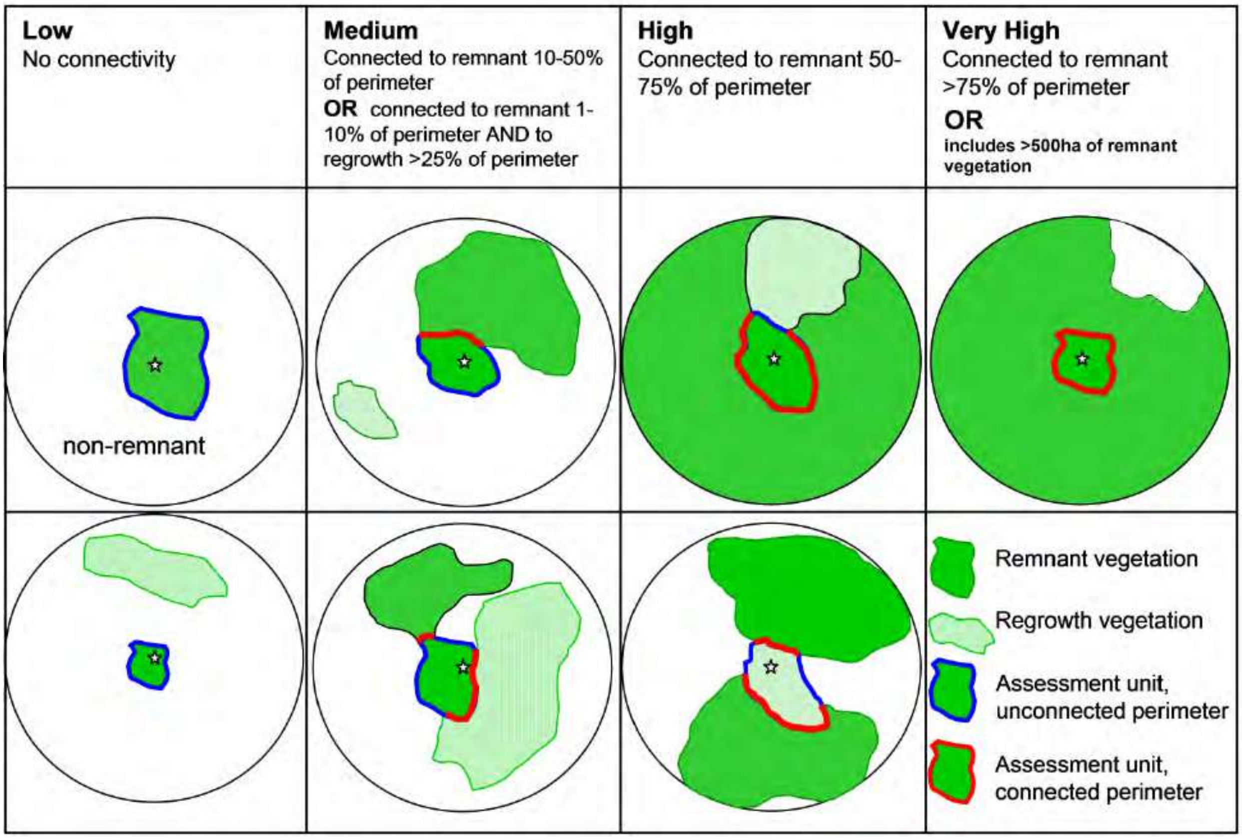


Figure 9: Examples of landscape connectivity scores

6.1.3 Context

The context attribute refers to the amount of native vegetation that is retained in the landscape proximal to the site being assessed. A 1 km radius buffer from the 50 m mark of the BioCondition transect is used to delineate a circular spatial extent. The scoring relates to the proportion of native remnant vegetation and/or regrowth vegetation) is retained within the 1 km radius landscape, and categorised as Low, Medium, High or Very High vegetation cover (Table 17, Figure 10).

The percent thresholds used to categorise the scores have been derived from the literature, which generally demonstrate that there is a 10 to 30% threshold of habitat loss within a landscape below which species will be lost from the ecosystem (Andren 1994; McIntyre *et al.* 2000; Radford *et al.* 2005).

Table 17: Description and scores for landscape context

Category	Description	Score
Low	<10% remnant vegetation AND <30% native non-remnant vegetation (regrowth)	0
Medium	≥10% to 30% remnant vegetation AND <30% regrowth **OR** <10% remnant vegetation AND ≥30% regrowth	2
High	≥30% to 75% remnant vegetation **OR** ≥10% to 30% remnant vegetation AND ≥30% regrowth	4
Very High	>75% remnant vegetation	5

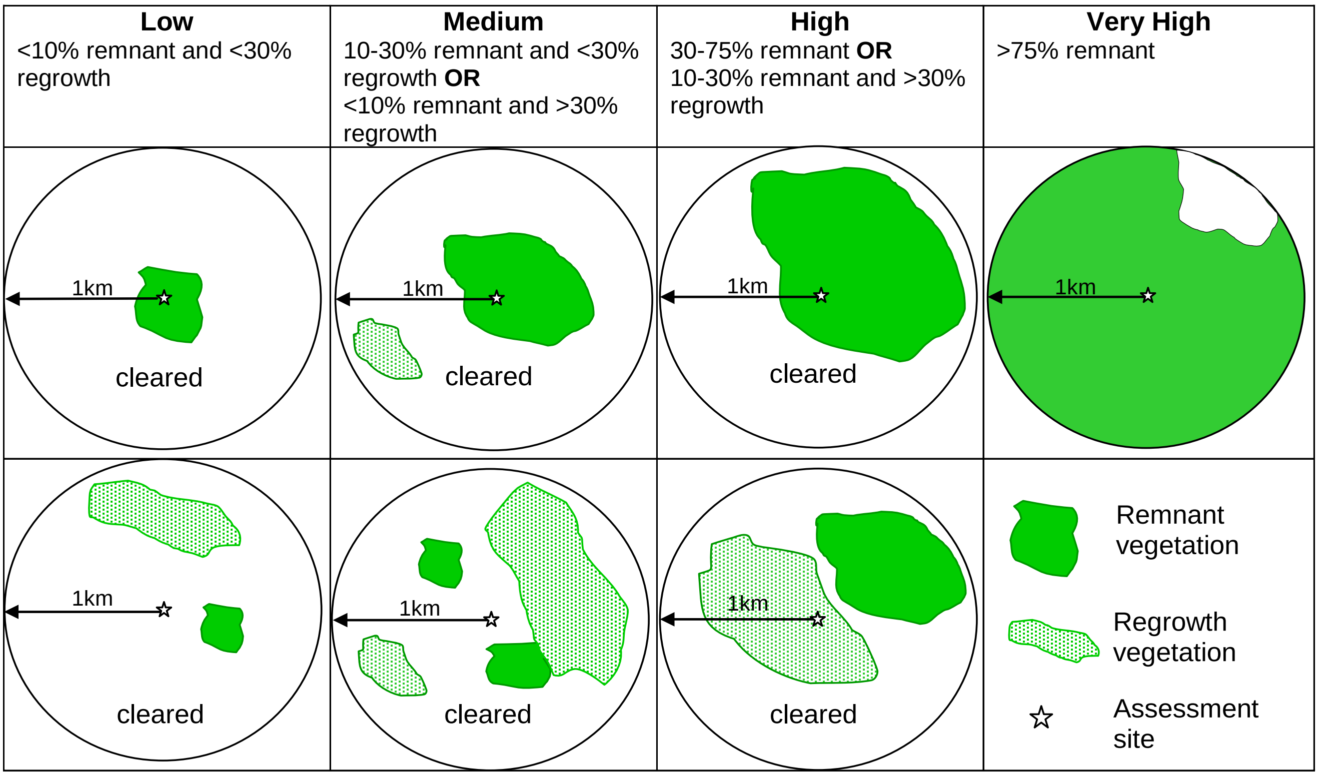


Figure 10: Examples of landscape context scores

6.2 Intact landscapes

6.2.1 Distance from permanent water

The intact landscapes of Queensland’s arid and semi-arid rangelands include a diversity of relatively unfragmented ecosystems of tropical savannas, woodlands, shrublands and grasslands (James *et al.* 1999; Woinarski and Fisher 2003). The dominant landuse is grazing by domestic livestock with minimal deliberate landscape modification in terms of vegetation clearing (Freudenberger and Landsberg, 2000). However, natural permanent water is rare in the landscape and to support the pastoral industry there has been an ongoing program of artificial waterpoint development since the late 1800s (Fensham and Fairfax 2008). This creates a pattern of grazing pressure, from stock as well as feral and native herbivores, that tends to radiate in intensity with distance from permanent water, known as a piosphere (James *et al.* 1999). Consequently, with increased densities of artificial water points in the rangelands, areas of water remoteness for grazing relief are becoming increasingly rare. The issue with piospheres is that species assemblages can change in response to variation in grazing intensities, with the loss of 'decreaser' species, or species sensitive to grazing pressure, closer to water points (Landsberg *et al.* 1999; Pringle and Landsberg 2004).

Distance from permanent water points is therefore a landscape level attribute that is measured and scored in BioCondition for the intact landscapes of the Queensland rangelands. Scoring is based on the shortest distance from the centre of the site to the nearest accessible permanent water point within the one fenced area (Table 18).

Three sources of water are used to provide permanent water for stock in the rangelands (James *et al.* 1999), including:

- unconfined aquifers, where water is pumped to the surface by windmill, solar or diesel pumps
- artesian and sub-artesian aquifers e.g. the Great Artesian Basin, where water is either naturally forced to the surface or pumped
- stored surface runoff, where surface runoff from rain is trapped in dams.

For the BioCondition assessment, permanent water points are typically dams (earth tanks), raised ring tanks and troughs on pipelines, but can include natural permanent water supplies such as rivers and waterholes.

Table 18: Description and scores for distance from permanent water. The description is relevant to the assessment site.

Description	Score
0 to 500 m from water point	0
500 m to 1 km from water point	2
1 km to 3 km from water point	5
3 km to 5 km from water point	10
>5 km from water point	20

Cattle drink from a ring tank in poplar box country, Brigalow Bioregion

7 Calculating and classifying the BioCondition score

The BioCondition (BC) score for the assessment site is determined by adding the scores obtained for each site-based and landscape level attribute (Table 19) and dividing by the maximum possible score for the RE (e.g. 100 for wooded REs, 50 for grassland REs, 65 for shrub land REs, or 85 for mangrove REs). Dividing the summed total by the maximum possible score standardises the total between 0 and 1, which allows equivalence between different ecosystems such as grasslands, for which the benchmark value of some attributes
is zero.

Table 19: Scoring and weighting of the site-based and landscape scale attributes

	Attribute	Weighting (%)
Site-based attributes		
a	Large trees	15
b	Tree canopy height	5
c	Recruitment of canopy species	5
d	Tree canopy cover (%)	5
e	Shrub layer cover (%)	5
f	Coarse woody debris	5
g	Native plant species richness for four life-forms	20
h	Non-native plant cover	10
i	Native perennial grass cover (%)	5
j	Litter cover	5
Landscape attributes		
k	Patch size	10
l	Connectivity	5
m	Context	5
n	Distance to water	20

The BioCondition score (BC) for a site can be calculated as:

Equation 1:

$$BC = \frac{a + b + c + d + e + f + g + h + i + j + \text{either } (k + l + m) \text{ or } (n)}{Y + Z}$$

Where:

a–n are the attributes a to n (from Table 18 above)

Y is the maximum site-based score that can be obtained site-based attributes (a–j) that are relevant to the RE being assessed e.g. in a wooded ecosystem *Y* = 80, and in a grassland *Y* = 30.

Z is the maximum site score that can be obtained for landscape attributes (k–m in fragmented landscapes or n in intact landscapes) (*Z* = 20).

If the site-based scores and landscape-scale scores are required to remain separate and yet still comparable across ecosystems, this can be achieved using the following calculations;

Site-based score (S_c)

$$S_c = \frac{a + b + c + d + e + f + g + h + i + j}{Y}$$

Landscape score (Lc)

In fragmented landscapes $Lc = \frac{k + l + m}{Z}$ OR in intact landscapes $Lc = \frac{n}{Z}$

A BioCondition score (BC) for an assessment site is:

$$BC = (S_c \times Y/(Y+Z)) + (L_c \times Z/(Y+Z))$$

Note that the above calculation is a re-expression of equation 1, in that it will give the same score if all attributes (site-based and landscape-scale) were simply added together and divided by 100 (or 50 for grassland REs, 65 for shrubland REs, or 85 for mangrove REs).

7.1 To obtain an overall BC score for an area

If an estimation of condition by area is required (as determined by the objective), an area-weighted score can be derived by relating the BC scores to the overall assessment unit. This type of calculation may be required for use in offsets. This is achieved by averaging the BC score for each assessment site within the assessment unit, and then multiplying the average by the area of the assessment unit. This will give a notional score on a per hectare basis.

1. Obtain the average BC for an assessment unit;

$$BC_{(average)} = \frac{BC_1 + BC_2 + \ldots BC_x}{N}$$

$BC_{(average)}$ Average BC score for an assessment unit

BC_x BC score for assessment site x within the assessment unit

N Number of assessment sites sampled within the assessment unit

2. Obtain an area-weighted BC score for the assessment unit.

$$Z_y = (BC_{(average)} \times A)$$

Z_y Area-weighted site score for assessment unit y

A Area in hectares of the assessment unit y

If the assessment unit Z_y is disjunct, or made up of discrete, separated units (Z_{ya}..Z_{yx}), then an area-weighted BC score is obtained by:

$Z_y = Z_{ya} + Z_{yb} + ..Z_{yx}$

Where:

Z_{yx} is the area-weighted score for disjunct unit *x* of assessment unit *y*

3. Obtain the overall area-weighted BC score for the area of interest.

Overall area-weighted score for the area of interest $= Z_A + Z_B + \ldots Z_X$

Z_A Area-weighted site score for assessment unit A

Z_B Area-weighted site score for assessment unit B

Z_X Area-weighted site score for assessment unit X

An example of the calculation procedure is given in Box 8.

7.2 Categorising the BioCondition score to align with the ABCD framework

To align with grazing land condition the 'ABCD' assessment framework (Chilcott *et al.* 2003; Karfs *et al.* 2009), BioCondition scores can also be categorised as a rating of 1 (for 'functional' biodiversity condition) to 4 (for 'dysfunctional' biodiversity condition). Figure 11 provides an example of various condition states of a Brigalow Belah RE (11.9.5), where BioCondition scores have been categorised into the '1234' classes.

An effective way to categorise the BioCondition score as '1234' is to use summary statistics (mean ± standard deviation) of all the BioCondition scores generated for the overall assessment (Table 20). However, this does require a range of BioCondition scores, from dysfunctional through to functional condition, and from a reasonably large sample of sites. Therefore, based on BioCondition scores for >190 sites evenly distributed across condition states (Eyre *et al.* unpublished data) the classification provided in Table 21 can be used.

Table 20: Rules used to delineate the BioCondition '1234' classes

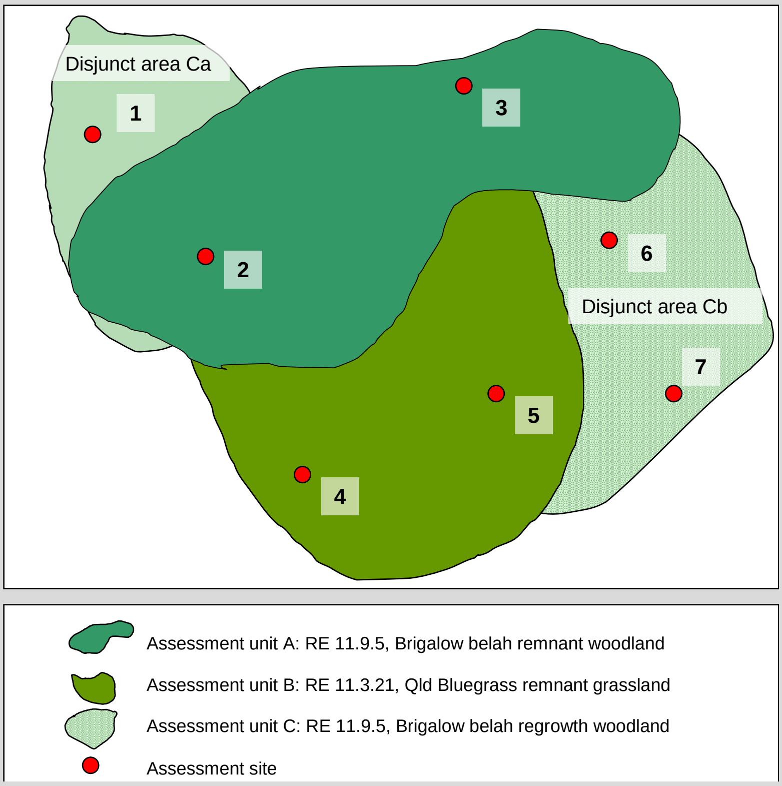
BioCondition class	Lower cut-off of site score for classification
1	Mean +1 standard deviation
2	Mean
3	Mean –1 standard deviation
4	All scores > Mean –1 standard deviation

Table 21: Final classification of BioCondition scores into '1234'

BioCondition class	% Value
1	>0.80
2	>0.60 – 0.80
3	0.40 – 0.59
4	<0.40

Box 8: Example of deriving an area-weighted BioCondition score

The objective of the assessment is to obtain an area-weighted score for the total area of remnant and regrowth vegetation



Seven BioCondition assessment sites were located between three assessment units, and each obtained the following scores:

Assessment site	**Assessment unit**	**Ecosystem type**	**Site score (S_c)**	**Landscape score (L_c)**	**Total BC score**
1	Ca	Wooded	35/80 = 0.44	13/20 = 0.65	0.48
2	A	Wooded	77/80 = 0.96	14/20 = 0.70	0.91
3	A	Wooded	71/80 = 0.89	12/20 = 0.60	0.83
4	B	Grassland	22/30 = 0.73	13/20 = 0.65	0.70
5	B	Grassland	24/30 = 0.80	14/20 = 0.70	0.76
6	Cb	Wooded	18/80 = 0.23	14/20 = 0.70	0.32
7	Cb	Wooded	20/80 = 0.25	12/20 = 0.60	0.32

AT A GLANCE: *BRIGALOW BELAH SCRUB*

Land type: BRIGALOW AND BELAH SCRUB ***Regional Ecosystem: 11.9.5***

RATING 1:

- 3 or more tree species and high canopy cover (more than 35 %)
- More than 4 shrub species and cover (more than 10 % but not more than 45%)
- More than 11 trees larger than 30 cm DBH* (or 90 cm circumference)#
- More than 6 fallen logs in a 10m radius from a given point
- More than 30 % of the ground covered by native intermediate and preferred grass species
- More than 25 % of the ground covered by litter
- Is well connected with other remnant vegetation
- More than 75 % of the surrounding landscape contains remnant and/or high value regrowth vegetation

RATING 2:

- 2 tree species with medium canopy cover (20-35 %)
- 2-4 shrub species with medium cover (5-10 %)
- 6 to 10 trees larger than 30 cm DBH (or 90 cm circumference)
- 3-5 fallen logs in a 10m radius from a given point
- 16-29 % of the ground covered by native intermediate and preferred grass species
- 10 –25 % of the ground covered by litter
- Well connected with other remnant and/or high value regrowth vegetation
- More than 30 % of the surrounding landscape contains remnant and/or regrowth vegetation

RATING 3:

- 1 tree species and low tree canopy cover (5 –20 %)
- 1 shrub species and low shrub cover (3-5 %)
- 1-5 trees larger than 30 cm DBH (or 90 cm circumference)
- 2 fallen logs in a 10m radius from a given point
- 5 -15% of the ground covered by native or more than 10% non native intermediate and preferred grass species
- 5 -10% of the ground covered by litter
- Not well connected with other remnant vegetation
- 10-30% of the surrounding landscape contains remnant and/or high value regrowth vegetation

RATING 4:

- Very few trees (< 5 % cover), if any, none large.
- Few shrubs of same species (less than 2 % cover) OR an over-abundance of shrubs (more than 45 %)
- None or 1 fallen log in a 10m radius from a given point
- Less than 5 % of the ground covered by native intermediate and preferred grass species
- Less than 5 % of the ground covered by litter
- Less than 10 % of the surrounding landscape contains remnant Or less than 30 % of the surrounding landscape contains remnant and high value regrowth vegetation

*dbh—Diameter at breast height (measured at 1.3m above the ground) #Count within a 50 x 50m area

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'1234' Biodiversity Condition Framework

Figure 11: Example of '1234' condition states for Brigalow Belah RE 11.9.5

8 Glossary

Annual species	Annual species are short-lived plants, completing their life-cycle within a single vegetative period, which can vary from a few weeks to several months. Annuals usually die within one year. Annual grasses are generally characterized by short growth, not forming large tussocks or root mass, no evidence of previous seasons growth (i.e. remains of last year's tiller bases, and absence of stolons or rhizomes), with reproduction generally from seed.
Assessment unit	Relatively homogenous unit that is one RE type in one broad condition state (remnant or non-remnant).
Benchmark	A description of a RE that represents the median or average characteristics of a mature and relatively undisturbed ecosystem of the same type.
BioCondition Score	The score assigned to the assessed site that indicates its condition relative to the benchmarks set for the RE being assessed. The score can be expressed as a percentage, on a scale of zero to one, or as a category of 1, 2, 3 or 4.
Biodiversity	The diversity of life forms from genes to kingdoms and the interactions and processes between.
Canopy	The layer formed collectively by the crowns of adjacent trees or shrubs in the case of shrub lands. It may be continuous or discontinuous. The canopy usually refers to the ecological dominant layer.
Cryptogam	Collective term which includes lichens, liverworts, mosses and hornworts.
Diameter at breast height (DBH)	DBH is a measure of the size of the tree and is consistently measured at 1.3 m from the ground. On sloping ground, DBH is measured on the high side of the tree from bare earth ground level. Ensure that the tape is horizontal or at a tangent to the trunk when reading the diameter. On leaning trees, on level ground, 1.3 m is measured from the underside of the lean. If a whorl, bump scar or other abnormality occurs at the 1.3 m mark, measure the diameter at a nominated height (measured in whole 0.1 m increments) above the defect. If a representative measure as described above cannot be taken (e.g. presence of strangler figs), a reasonable estimate of the diameter should be made viewing the tree from two different directions. For multiple stems, a diameter is recorded for each stem, when it divides below 1.3 m.
Dominant species	A species that contributes most to the overall above-ground biomass of a particular stratum (= predominant species).
Ecologically dominant (predominant) layer or species (EDL)	The layer or species making the greatest contribution to the overall biomass of the site and the vegetation community.
Emergent layer	The tallest layer/stratum is regarded as the emergent layer if it does not form the most above-ground biomass, regardless of its canopy cover e.g. poplar box (*Eucalyptus populnea*) trees above a low woodland of mulga (*Acacia aneura*).
Eucalypt species	Under BioCondition, a eucalypt species is any species from the following genera: *Eucalyptus*, *Corymbia*, *Angophora*, *Lophostemon*, and *Syncarpia*.
Forb	Herbaceous or slightly woody, annual or sometimes perennial plant that is not a grass or life form defined under 'Other species'.

Grass	A collective term for the following plant life forms: tussock grass which forms discrete but open tussocks usually with distinct individual shoots; hummock grass which are coarse xeromorphic grasses with a mound-like form often dead in the middle e.g. genus *Triodia*; other grasses of the family Poaceae, but having neither a distinctive tussock nor hummock appearance.
Grassland RE	A remnant RE described as having a structure code that does not include the terms 'forest', 'scrub', 'vine land', 'shrub land', 'heath' or 'woodland' in the Regional Ecosystem Database.
High-value regrowth	Vegetation that is endangered, of concern and least concern REs that have not been cleared since 31 December 1989
Large tree	A living tree identified as 'large' by a DBH threshold as defined in the benchmark document relevant to a RE. In some REs a different large tree threshold will be identified for eucalypt and non-eucalypt species due to the variation in potential size of these two tree types. For the purpose of defining large trees eucalypts include trees of genera *Angophora, Eucalyptus, Corymbia* and *Lophostemon.* If a large DBH threshold is not provided in the benchmark document, then generic thresholds of >20 cm DBH for non-eucalypts and >30 cm DBH for eucalypts can be used.
Landscape Context	Relates to the size, connectivity and the context or neighbourhood landscape that the site sits within.
Layer	See stratum
Non-eucalypt species	Under BioCondition, a non-eucalypt species is defined as any species that is not listed as a eucalypt.
Non-native plant	Any plant that requires some form of action to reduce its harmful effects on the economy, the environment, human health and amenity. This definition includes both exotic and non-indigenous native species.
Non-remnant vegetation	Non-remnant vegetation is vegetation that fails to meet the structural and/ or floristic characteristics of remnant vegetation. It may include regrowth, heavily thinned or logged and significantly disturbed vegetation, and cleared areas. Non-remnant vegetation may retain significant biodiversity values and includes areas mapped as 'high-value' regrowth.
Organic litter	Includes both fine and coarse organic material such as fallen leaves, twigs and branches <10 cm diameter.
Other species	All plant life-forms that are not trees, shrubs, grasses or forbs.
Perennial species	Perennial species are long-lived plants, tending to persist for three or more years. Generally perennial grasses are characterized by larger bulk than annual grasses i.e. forming tussocks and large root mass with evidence of previous seasons growth i.e. remains of last years tiller bases, and presence of stolons or rhizomes.
Reference site	A site that represents an example of a RE in its reference state, i.e. the natural variability in attributes of an ecosystem relatively unmodified since the time of European settlement. As not all RE's will have examples of totally unmodified states, reference sites represent the "Best On Offer" reference state for that RE in a local area. Data obtained from reference sites are used to establish benchmarks for each of the attributes used within BioCondition (a separate method for collecting data at reference sites is available as a companion document to the BioCondition manual—see Eyre *et al.* (2011).

Regional Ecosystem (RE)	REs were defined by Sattler and Williams (1999) as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil.
Remnant vegetation	Remnant vegetation is defined in the *Vegetation Management Act 1999* as vegetation shown on a RE or remnant map. A map showing remnant RE is the same as a 'remnant endangered (or of concern or not of concern) RE map' defined under the *Vegetation Management Act 1999.* Where there are no maps available, remnant vegetation is defined as vegetation where the dominant canopy has greater than 70% of the height and greater than 50% of the cover relative to the undisturbed height and cover of that stratum and dominated by species characteristic of the vegetation's undisturbed canopy.
Shrub	Woody plant that is multi-stemmed from the base (or within 200 mm from ground level) or if single stemmed, less than 2 m tall.
Shrub canopy cover	The estimation of the percentage canopy cover of the living shrub layer (see Shrub).
Shrub canopy height	The median canopy height in metres, as estimated for the shrub layer (see Shrub canopy cover).
Stratum	A layer in a community produced by the occurrence at approximately the same level (height) of an aggregation of plants of the same habit (Beadle and Costin 1952).
Tree	Woody plants, more than 2 m tall with a single stem or branches well above the base.
Tree canopy cover	Refers to the estimation of the percentage canopy cover of the canopy tree layer
Tree canopy height	The median canopy height in metres, as estimated for the canopy tree layer (see Tree canopy cover).

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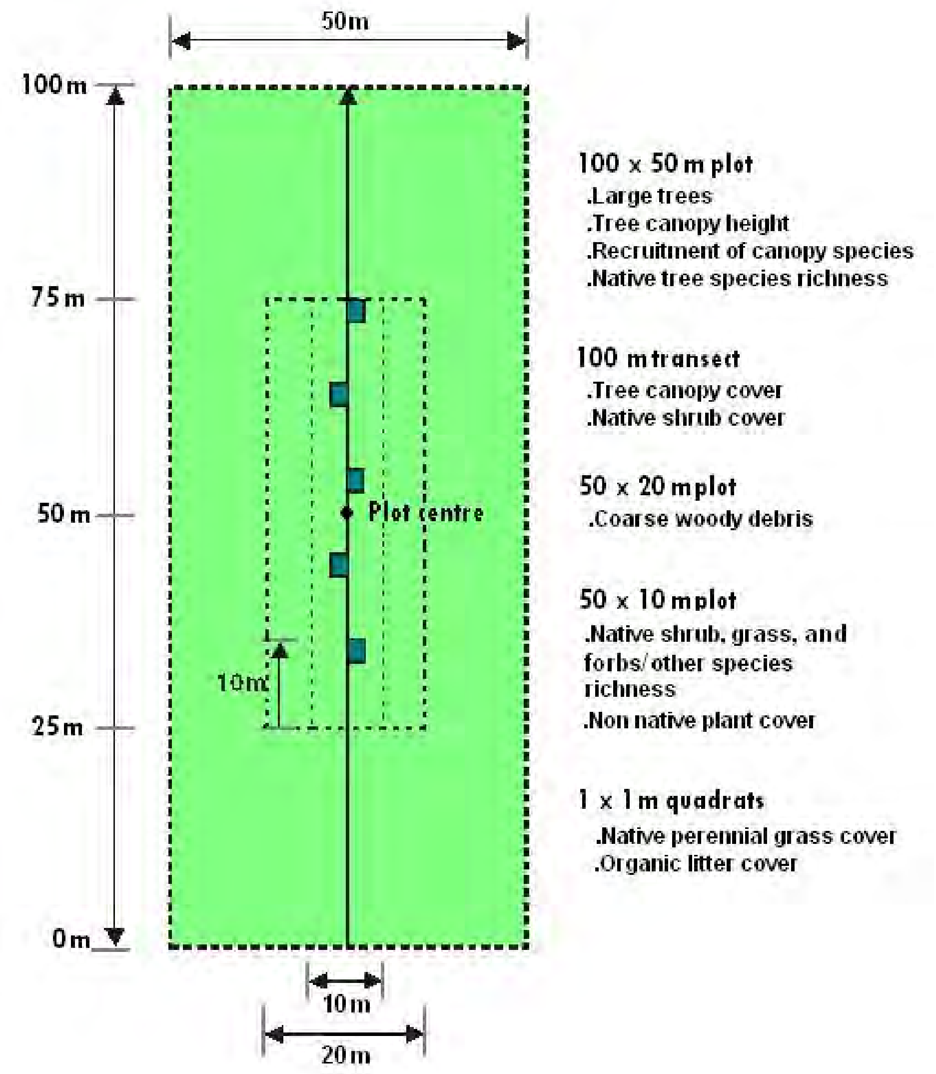
10 Appendices

Appendix 1: Field assessment summary guide

<u>Step 1</u>: **Lay out the plot -** The site can be marked with a 100 m transect that follows the contour i.e. along a slope as opposed to up or down a slope. Mark the 50 m point on the transect with a star picket or temporary marker—this point acts as the centre of the assessment site. Record the compass bearing that the transect follows from the zero point, and also record the location of the zero metre point by GPS.

<u>Step 2</u>: **The field assessment -** Start at the centre of the plot (50 m mark on the transect), and record the site number, Regional Ecosystem (RE), the date of assessment and the property or location name. Using a GPS, mark the position of the 50 m point on the transect. Take landscape photos north, south, east and west (Appendix 4), to provide a record of the tree and shrub layers and the general condition of the site. The assessment of the 10 site-based attributes is conducted within five assessment areas on the 100 x 50 m site, as shown in figure below.



<u>Step 3</u>: Area 1; 50 x 10 m sub-plot, incorporates 25 m to 75 m along the transect, and encompasses 5 m either side of the transect.

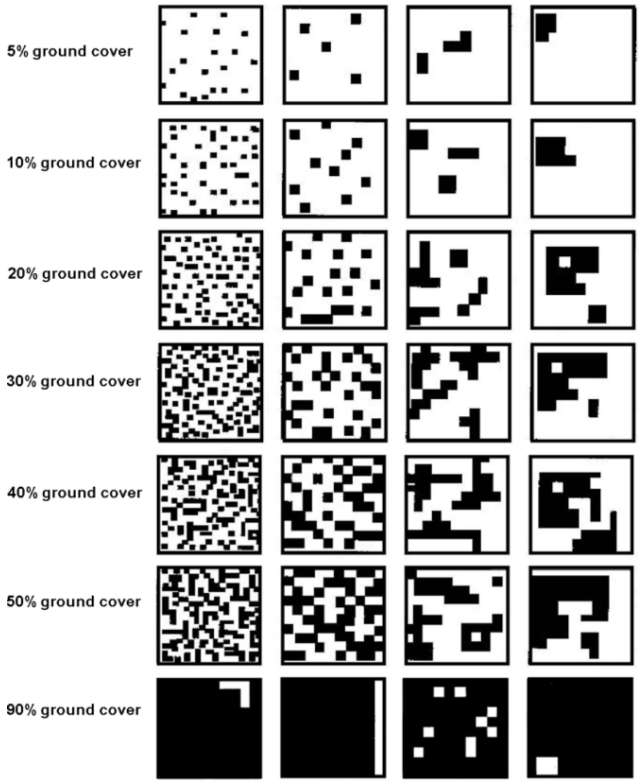
- **Native plant species richness** is assessed by slowly walking along each side of the centre-line and tallying the number of species in each of three life-forms: shrubs, grasses and forbs/other. *NB: Tree species richness is assessed in the 50 x 100 m plot.*

- **Non-native plant cover** is assessed by estimating the cover of exotic species as a component of the overall vegetation cover. The estimate can be improved by dividing the 50 x 10 m plot into smaller areas and then averaging the cover estimate over the entire area. For example, 20 x 5 x 5 m (i.e. 10 plots each side of the tape).

Step 4: Area 2; 50 x 20 m sub-plot, incorporates 25 m to 75 m along the transect, and encompasses 10 m either side of the transect.

- **Coarse woody debris** is assessed by measuring the length of all logs >10 cm diameter, 0.5 m in length and within the 50 x 20 m sub-plot. Logs are assessed if 80% of the log is in contact with the ground. Measure only the portion of the log that is greater than 10 cm diameter or lies within the sub-plot, i.e. only measure the length of the log to the boundary of the sub-plot.

Step 5: Area 3; Five 1 x 1 m sub-plots, starting at the 35 m point, assess ground cover in 1 x 1 m quadrats located 10 m apart, on alternate sides along the transect. If the quadrat location coincides with a feature such as a tree or large log it is acceptable to move the quadrat 1 m up or down the transect. Assess each of the ground cover components so that the cover totals 100% (use figure below as a guide on cover estimates). Although not all components are used in the scoring for BioCondition, assessment of all attributes improves ability to estimate cover of the assessable attributes. Spot photos can be taken of each quadrat to document change in ground cover over time.



- **Native perennial grass cover** refers to the percentage cover of native perennial grasses, assessed within each of the five 1 x 1 m quadrats and averaged to give a value for the site. Depending on the nature of your assessment all perennial grasses can be assessed, or the native perennial grass cover can be split into those species listed in the land type documents as preferred and intermediate or as non-preferred.

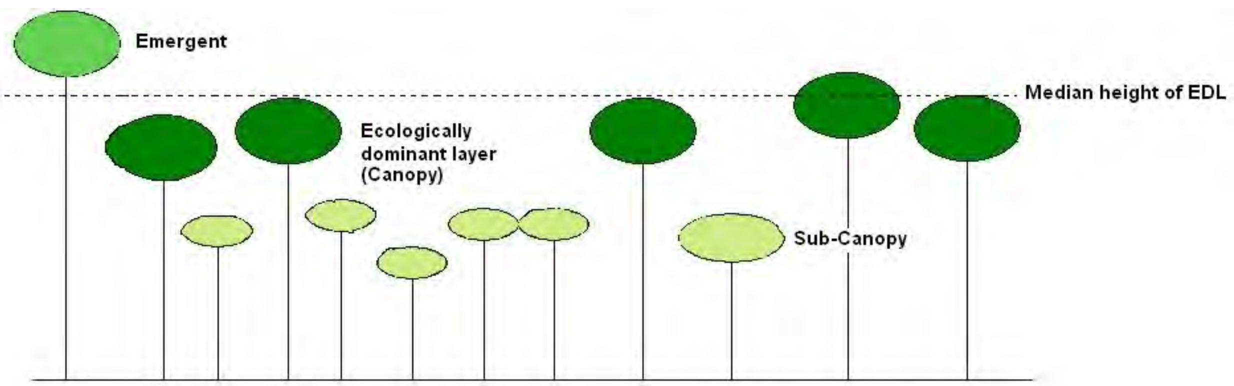
- **Organic litter** is assessed by estimating the cover of fine and coarse organic material such as fallen leaves, twigs and branches <10 cm diameter from the five quadrats and then averaged.

<u>Step 6</u>: Area 4: 100 x 50 m area: Visualising or marking out 25 m either side of the transect line forms the larger assessment area of 100 x 50 m. A greater need arises for precision when assessing the numbers of large trees (i.e. measuring the distance to trees that appear to be 'borderline' within the site). Refer to the benchmark document to determine if there are separate benchmarks for the canopy, emergent and/or subcanopy layers. If more than one layer is identified in the benchmark document, then assessment of each layer is required for the recruitment, canopy height and cover attributes.

- **Number of large trees** is assessed by counting the number of trees within the 100 x 50 m plot area over a certain size threshold, as recorded on the benchmark document for the RE that you are assessing. If no benchmark exists for the RE of interest, use the threshold of 30 cm DBH for 'eucalypt' trees (genera *Eucalyptus, Corymbia, Angophora, Lophostemon* and *Syncarpia*) and 20 cm DBH for 'non-eucalypts'.

- **Recruitment of canopy species** is assessed by observing the proportion of the dominant canopy (EDL) species regenerating (<5 cm DBH) within the 100 x 50 m plot area. Only one regenerating individual is required of each species (e.g. if there are four dominant species of trees then four species need to occur as regeneration to get 100%).

- **Tree canopy height** (measured to the top of the highest leaves) refers to the median canopy height in metres (see figure below), estimated for trees in the EDL (canopy layer). If there are emergent and/or subcanopy layers identified in the benchmark document, median height of these layers needs to be assessed also. The median canopy height is the height that has 50% of canopy trees larger and smaller than it. It is recommended that a clinometer or hypsometer be used if available.



- **Tree species richness** is the count of different tree (single stemmed over 2m) species over the whole 100 x 50m area.

<u>Step 7</u>: Area 5: 100 m transect: tree canopy and shrub canopy cover are assessed along the 100m transect using the line intercept method.

- **Tree canopy cover** refers to the estimation of the percentage canopy cover of the living, native tree canopy overlapping the 100 m transect. For this attribute, in the majority of cases, only the cover of the trees making up the canopy layer are included. The canopy equates to the ecologically dominant layer (EDL) for forests and woodlands. However, if the benchmark document lists values for more than one layer, then the heights and covers of these layers are assessed separately. Assessors work along the transect line and record the start and finish distance of tree canopies that overlap the transect line[7]. If overlapping trees are in the same layer then they can be recorded as the one tree group.

- **Native shrub canopy cover** uses the same method as for tree canopy cover using a vertical projection of shrub crowns downwards and above the line.

[7] and assign them to canopy and/or subcanopy and/or emergent layers if these layers are distinguished within the benchmark document

Appendix 2: BioCondition field assessment sheet

BIOCONDITION SITE ASSESSMENT DATASHEET

Queensland Government

OFFICE USE ONLY
Entered:..................
Checked:..................
Corrected:..................

Site ID: ....

DATE: ..... / ..... / .....

BioCon survey number:..................

OBSERVERS: ....

SITE INFORMATION

General habitat survey number:..................

LOCATION: (GPS reference) Bioregion: _ _ _ _ _ _ _ _ _ _ _ _

Datum: ☐ AGD84 ☐ GDA94 (WGS84) OTHER: _ _ _ _ _ Location derivation: _ _ _ _ _ _

Road: zone: _ _ easting: _ _ _ _ _ _ northing: _ _ _ _ _ _ _ Plot Centre Direction: _ _ _ m at _ _ _ degrees

Plot Origin: zone: _ _ easting: _ _ _ _ _ _ northing: _ _ _ _ _ _ _ Accuracy: _ _ _

Plot Centre zone: _ _ easting: _ _ _ _ _ _ northing: _ _ _ _ _ _ _ Accuracy: _ _ _

Plot bearing: _ _ _ Plot alignment description: _

Locality description (include tenure and reserve number): _

_ _

_ _

REGIONAL ECOSYSTEM AND TREE HEIGHTS:

Habitat Description _

_ _

_ _

Regional Ecosystem: _ _ _ _ _ Tree Canopy (EDL*) height:........ Tree subcanopy and/or emergent ht: S:........ E:........

SITE PHOTOS: (Photo Numbers)

Plot centre: North ☐ South ☐ East ☐ West ☐

Landscape photo(s): ☐ Spot photo(s): ☐

50 x 20m area: Coarse woody debris: (NB: All logs >10cm, >0.5m within 50 x 20m area measured to the plot boundary)

Length: ....

....

....

....

....

....

....

.... Site Total:
Per ha Total:

100 x 50m area: Total native tree spp richness: (NB: *Ecologically Dominant Layer. Tree defined as single stemmed over 2m. All tree species in the 100 x 50m (not just EDL species)

....

....

....

....

....

.... Total:

Proportion of dominant canopy (EDL) species with evidence of recruitment: .... %

50 x 10m area: Native Plant Spp Richness: (NB: List species if known or count if unknown. Shrub is defined as single stemmed below 2m or multi-stemmed from base or below 20cm) Total

Shrub spp. richness: ....

....

....

Grass spp. richness: ....

....

....

Forbs and others spp. richness: ....

....

....

Non-native plant cover (%): .... %

....

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BIOCONDITION SITE ASSESSMENT DATASHEET cont....

Five 1 x 1m plots: *attributes are essential to assess as used in scoring, however assessment of all attributes improves your ability to more accurately visualise proportions of each of the attributes.

Ground Cover:	1	2	3	4	5	Mean
Native perennial ('decreaser') grass cover*						
Native other grass (if relevant)*						
Native forbs and other species (non-grass)						
Native shrubs (<1m in height)						
Non-native grass						
Non-native forbs and shrubs						
Litter*						
Rock						
Bare ground						
Cryptograms						
Total	100%	100%	100%	100%	100%	

100 x 50m area: *from benchmark doc.

Eucalypt large tree DBH*: ....

Non-eucalypt large tree DBH*: ....

No. of large eucalypt trees: ....

No. of large non-eucalypt trees: ....

Total large trees: ....

100m transect:

Tree Canopy Cover: (Only assess Emergent (E) or Subcanopy (S) layers if the benchmark document stipulates that layers are present *If trees are in the same layer and continuous along the transect you can group them)

Tree or tree group* (C or S or E)	Distance (m)	Total	Tree or tree group* (C or S or E)	Distance (m)	Total	Tree or tree group* (C or S or E)	Distance (m)	Total	Tree or tree group* (C or S or E)	Distance (m)	Total
									Total C: Total S: Total E:		

Shrub Canopy Cover: * denote as native or exotic. Only native shrub cover is used in the scoring.

Shrubs*	Distance (m)	Total	Shrubs*	Distance (m)	Total	Shrubs*	Distance (m)	Total	Shrubs*	Distance (m)	Total	Shrubs*	Distance (m)	Total
												Total native:		
												Total exotic:		

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Appendix 3: Resources/Contacts for further information

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Appendix 4: Taking photos

(Adapted from Land Manager's Monitoring Guide Photopoint Monitoring, and Land Management Agreement - Rural Leasehold Land Self-Assessment Guideline and BioCondition v1.6).

Taking photographs of site features from a fixed point is a great way to keep a permanent visual record of how attributes have changed over time. Photographs can be the most reliable and useful record collected in any monitoring program, as they best represent how things were over time, in comparison to our memories which aren't as reliable as we think.

Each time you do an assessment, two photo types are recommended to be taken at each site.

1. Spot photo

This is a photo taken from head height looking nearly vertically down on a spot marked with a one square metre frame or quadrat, as shown in Figure 12. You can use the base of your plot centre marker to relocate the same spot each time you visit. Spot photos provide a detailed picture of the ground cover, organic litter and plant species for a standard-sized area. It is common to find a great variety in ground cover at any given site so taking more spot photos will help record this variation. It is important to have a system that allows you to take the spot photos in the same place each time you do an assessment. For example, spot photos could be taken along the transect line where you are doing your ground and litter cover assessments (i.e. 35, 45, 55, 65 and 75 m).

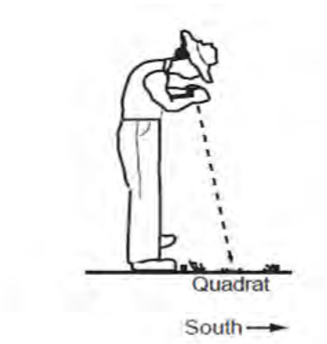


Figure 12: Taking a spot photo—try and keep the top of your feet out of the frame and angle the camera down as straight as possible

2. Landscape photo

Landscape photos are taken of features in the intermediate distance or further to provide an overview of the entire site and its surrounds. They illustrate the general condition of the site, showing changes in tree, shrub and ground layers over time. These site specific landscape photos can also be used to record particular disturbance events such as flood levels and damage or the impacts of a bushfire.

The landscape photo is taken from near the plot centre, holding your camera so that the image is taken with a 'landscape' perspective—that is where the picture is wider than it is high. Stand next to the plot centre marker (Figure 13), facing south (recommended direction – see 'photo tips'), and position the horizon so it cuts the photo frame in half (half above the horizon and half below). Then take the photo focusing on infinity. Recording how the photo was lined up or simply taking a copy of the picture with you on future visits will make lining up the shot easier. Alternatively, taking a series of plot centre landscape photos in a north, south, east and west direction (with the aid of a compass), allows you to pick up more of the variation across the site and is easy to replicate next time an assessment is done.

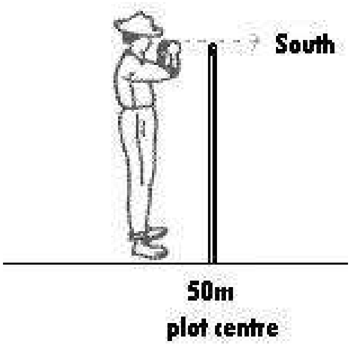


Figure 13: Taking landscape photos—record the bearing or direction of the photo in order to assist with replicate photos on subsequent visits.

Photo tips

- *Any type of camera from colour print film to a digital camera can be used to take these photos. Digital cameras are ideal, allowing instant review of an image for clarity and colour—this ensures you always have a good photo for your records.*

- *The best photos are generally taken on a clear day between 9 am and 3 pm. Before 9 am and after 3 pm will generally result in more shadowing and different colour cast which may conceal some important features. Overcast days are great for photography in closed communities such as rainforests, scrubs and thickets, as the even light removes much of the shadowing.*

- *A common problem is too much light blanking out the colour and detail of the image. If you have control over your camera settings, this can be reduced by setting the exposure compensation to a negative setting. This is done by using the auto-exposure lock (AE lock) or by using spot metering. Your camera's user guide will explain how to use these functions on your particular camera. The troubleshooting section is often a good place to find these and other useful solutions.*

- *You will always get a better photo by having the sun behind you with the sunlight shining on the landscape facing you. If you are only taking one photo it is best to be facing south to avoid having the sun shining into your lens.*

- *For each photograph, record the relevant area, land type and site, the date the photo was taken, and the direction the photo was taken (N/S/E/W). The date stamp feature on your camera may be useful if it does not obscure important components of a photograph. Photos can be stored in a database (scanned if not digital) and/or printed and kept on file with the monitoring records.*

Appendix 5: Measuring tree height

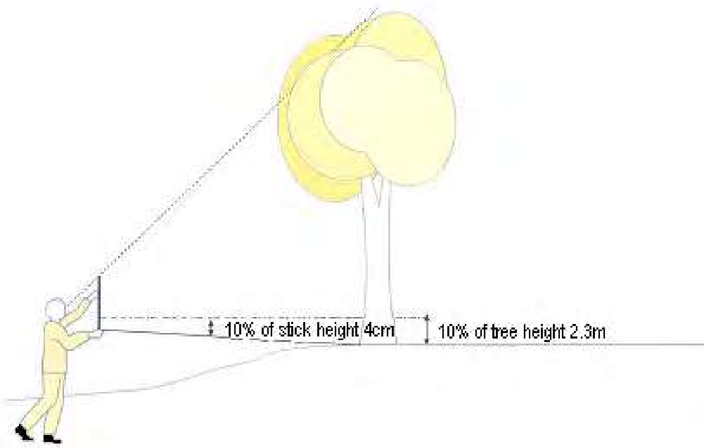
a) Stick or pencil method

(Extracted from Abed, T., and Stephens, N.C. (2002). *Tree measurement manual for farm foresters - Practical guidelines for farm foresters undertaking basic inventory in farm forest plantation stands*. National Forest Inventory, BRS, Canberra.)

1. Take a straight stick of known length (preferably 30 – 40 cm long)
2. Place a mark on the stick at the point 1/10th of its length from the bottom. For example, if the stick is 30 cm long, place the mark at 3 cm from the bottom.
3. Holding the stick vertically at full arm's length, walk backwards from the tree you wish to measure, until the top and bottom of the stick match with the top and bottom of the tree.
4. Note where your mark lines up with the tree trunk and have your co-worker, standing at the tree, put their hand up to this point on the tree trunk. Then measure the distance from the ground to this point on the tree. Call this the 'tree mark height'.
5. As the mark on the stick was 1/10th of it total length, the mark on the tree is also 1/10th of the total tree height. Therefore multiply the tree mark height by 10 to get the total tree height.

Hint 1: Depending on the height of the trees you may need a longer or shorter stick. Alternatively a tape measure or ruler can be used instead of a stick.

Hint 2: The stick or pencil method has the disadvantage of having a high level of error and is time consuming. It is recommended that, if possible, a vertex hypsometer or clinometer (see next section) should be used to determine tree height. Optical hypsometers use lasers to calculate the horizontal distance to the tree, and then automatically calculate the height of the tree once the angle to the highest part of the tree and to its base is recorded.



b) Clinometer method

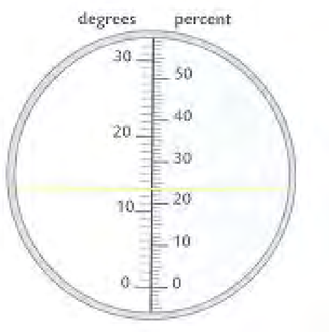
(Extracted from Abed and Stephens 2002)

The Suunto clinometer (clino) is a tool commonly used by foresters to measure tree heights and slope angles. At the rear of the clino is a peephole, which shows a percentage scale and a horizontal line (see figure below).

1. First measure the horizontal distance between the base of the tree and the operator.
2. Looking through the peephole, line up the horizontal line with the top of the tree (the highest part of the tree—usually foliage) and read off the corresponding number from the percentage scale, which is on the right hand side. The scale on the left is in degrees and should not be used.
3. Line up the horizontal line with the base of the tree and again read off the corresponding number from the percentage scale.
4. If the base of the tree is above you (i.e. you're on the downward slope) then subtract the number from step 3 from the number in step 2 and multiply by the horizontal distance to get a total tree height.
5. If the base of the tree is level with you or below you (i.e. you're on the upward slope) then add the numbers together and multiply by the horizontal distance to get a total tree height.
6. If the tree is leaning, stand at right angles to the lean so the tree isn't leaning towards or away from you. If the highest part of the tree is not directly above the trunk, then adjust the horizontal distance so that it relates directly to the highest part of the tree.

Hint: If you can't see the bottom of the tree because of branches or understorey, sight to a point up the stem that can be seen and treat this as the base of the tree and continue with the procedure as described above. Then add the height from the base to the point you could see to get your estimate of total height.

Looking through a clinometer



Using a clinometer

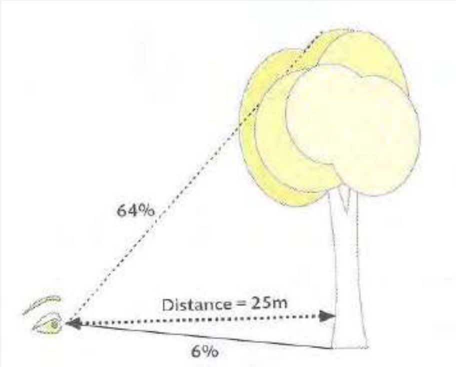
The heights of the crown can also be measured using a laser instrument called a hypsometer. Where the top of the tree is not directly above the base of the trunk, it is important to also measure the point directly below the highest point of the tree canopy to get an accurate crown height.

EXAMPLE:

Jenny wants to determine the height of two trees, with the first tree slightly below her and the second tree slightly above her. Using a tape measure, she measures the distance between her and the first tree, which is 25 m away. Using the clinometer, she sights to the top of the tree and sees the horizontal line align with the percentage number 64, she then sights to the base of the tree and finds the percentage number to be 6. She adds both percentage numbers and multiplies the distance to get a tree height of 17.5 m.

Tree height = 25 x (0.64 + 0.06)

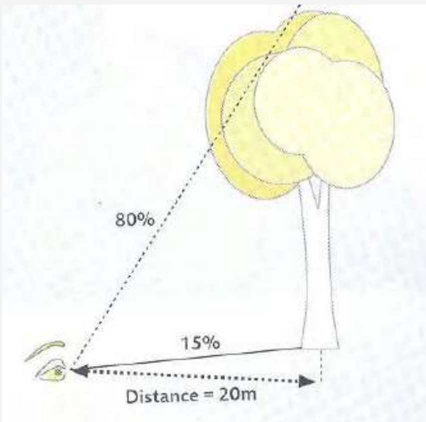
= 17.5 m



Jenny then repeats the procedure with the second tree and measures a distance of 20 m from the tree. The percentage to the top of the tree is 80. The percentage to the bottom of the tree is 15. Therefore tree height of the second tree is 13 m.

Tree height = 20 x (0.8 –0.15)

= 13 m



Appendix 6: Stratifying vegetation

In BioCondition, assessment of the tree height, recruitment and tree canopy cover attributes require consideration of the distinct vegetation layers or strata that make up the community. In general, site-based assessment of vegetation uses structure (vertical and horizontal distribution of vegetation: its growth form, height, cover and strata) and floristics (dominant genera or species in various strata and characteristic species) (Hnatiuk *et al*. 2009). In Queensland, the structural and floristic characteristics of the vegetation are used in defining and describing REs. Details of the methods used to classify vegetation and regional ecosystems in Queensland are described in Neldner *et al.* (2012).

Determining the ecologically dominant layer

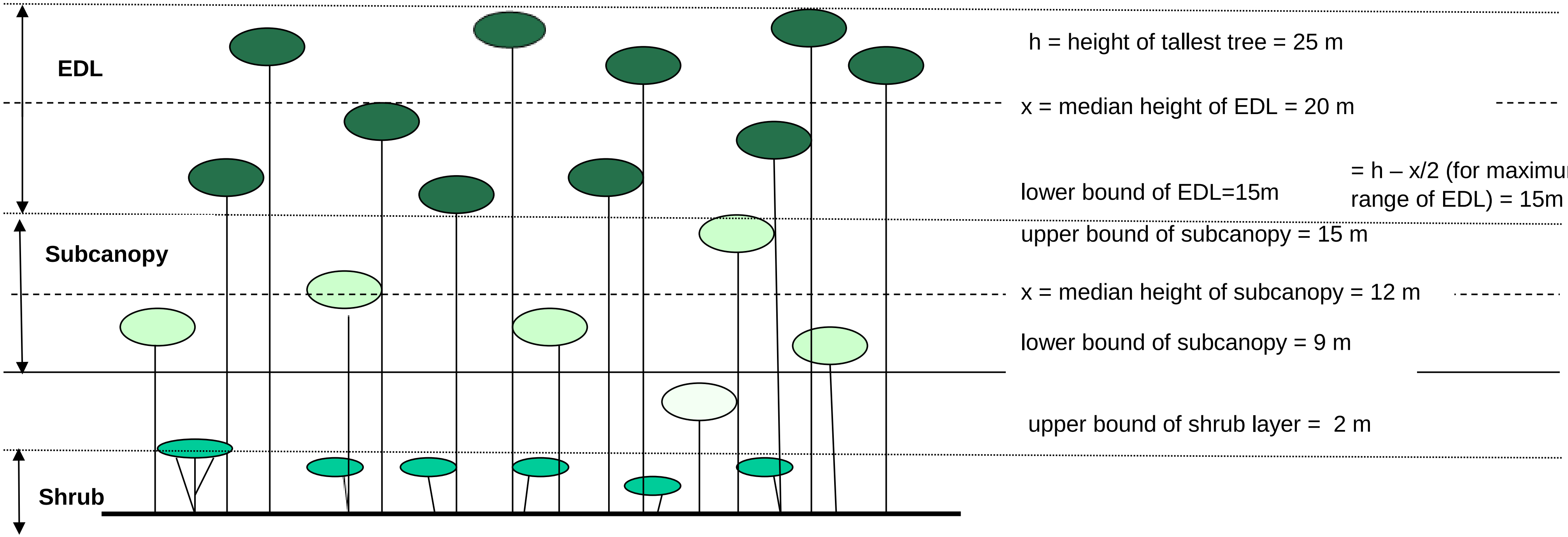
Once the vegetation community has been classified into strata (see Box 9), the determination of the ecologically dominant layer (EDL) is made. The EDL contains the greatest amount of above-ground vegetation biomass (Neldner 1984).

Example 1: EDL; RE 3.5.24, *Eucalyptus chlorophylla* open-woodland (EDL), Cape York Peninsula

Here the above-ground biomass of the trees is estimated to be larger than the grass layer, and is the EDL. Generally if the tree layer in these situations has a canopy cover of 8% or more, then the trees will form the EDL.

In the majority of cases in wooded communities, it is the tallest layer that forms the most above-ground biomass, except in the case of widely scattered emergent trees. Therefore, in most cases only the EDL layer is assessed for the attributes tree canopy cover, height and recruitment in BioCondition. Exceptions include rainforest canopies with emergent species and mixed genus woodlands (e.g. poplar box and mulga woodlands).

Box 9: Method to determine vegetation strata, when not obvious



1. The median EDL tree height (x) is 80% of the height of the tallest tree (excluding emergents).
2. The height range for the EDL = x/2
3. The lower height bound of the EDL = h – x/2.
4. Repeat the process to obtain the height range for the subcanopy.
5. The shrub layer contains all woody plants that are either multi-stemmed from the base (or within 200 mm from ground level) or if single stemmed, less than 2 m tall.

Example (above diagram): height of tallest tree h = 25 m. Therefore the height range for the EDL is 15 to 25 m with a median = 20 m (80% of h); the subcanopy is 9 to 15 m, the shrub layer is <2 m.

Example 2: Emergent layer and EDL; RE 5.7.2, *Acacia catenulata* low woodland (EDL) with emergent *Eucalyptus thozetiana*.

Example 3: EDL and shrub layer; RE 2.5.15, *Melaleuca viridiflora* low woodland (EDL) with a distinct shrub layer of *Petalostigma banksii* on western Cape York Peninsula.

Example 4: EDL and shrub layer; RE 2.5.12, *Eucalyptus pruinosa* low woodland (EDL) with low shrub layer of *Acacia* spp.

Example 5: Multi-layers: RE 8.5.1, coastal *Corymbia* spp. woodland (EDL) with a subcanopy layer of *Melaleuca viridiflora* and immature canopy trees. The layers in some forest communities can be relatively indistinct.

The impact of disturbance on vegetation structure

While in an undisturbed state, a vegetation community will develop a distinct structure (height and cover) based on the growth forms of the species present and their abundance. Frequently different species define and dominate different layers. However, within an ecosystem the structural attributes (height and cover) will frequently vary depending on the environmental conditions at the site (e.g. rainfall and soil depth). Where there has been significant natural (e.g. cyclones, fires or floods) or human disturbance (e.g. clearing or logging), the structure and floristics of the vegetation can be significantly altered. At these sites, the development of distinct layers may not occur or be indefinite, and the resultant communities may develop a number of structural outcomes (see below). In these situations, it is important to compare the heights and canopy covers of the vegetation at the site to the defined layers in the benchmark documents. For example, in the RE 6.5.3 *Eucalyptus populnea* predominates forming a distinct but discontinuous canopy (10 - 20 m tall). A lower tree layer (subcanopy) of *Acacia aneura* is sometimes present. After disturbance, at least three structures may develop (1) *E. populnea* woodland with little or no subcanopy, (2) *A. aneura* woodland with none or only scattered *E. populnea* emergents, or (3) regenerating woodland of both species. In each structural type it is important to compare the heights and covers of both *E. populnea* and *A. aneura* with the layers they dominate in the benchmark site.

RE 6.5.3: *Eucalyptus populnea* predominates forming a distinct but discontinuous canopy (10 – 20 m tall) (EDL). A subcanopy of *Acacia aneura* is sometimes present.

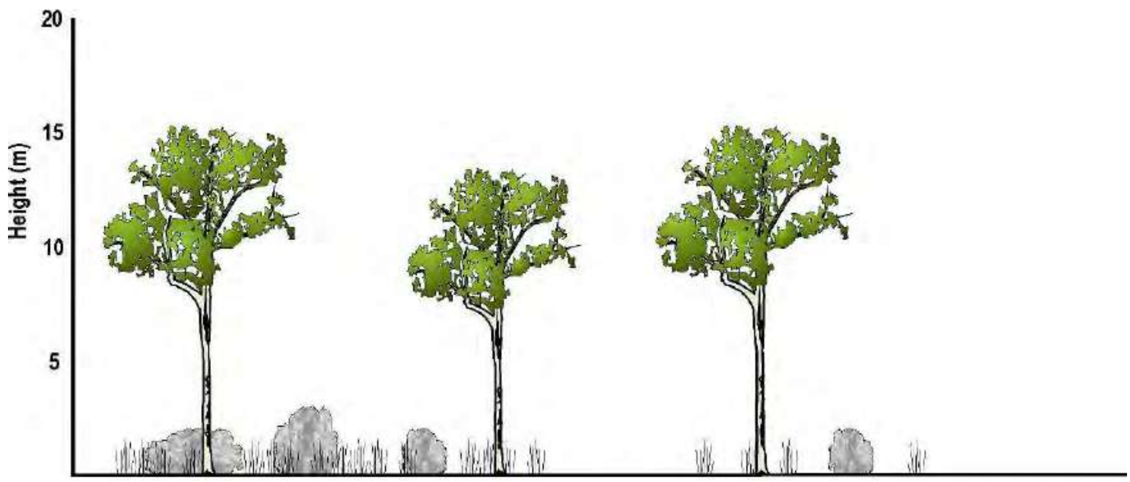
Examples of benchmarks for REs with more than one layer

RE 6.5.3 *Eucalyptus populnea* woodland with *A. aneura* subcanopy.

Canopy (EDL) of *Eucalyptus populnea*
Benchmark height = 15 m. Benchmark canopy cover = 18%

Subcanopy of *Acacia aneura*
Benchmark height = 8 m. Benchmark canopy cover = 30%

SCENARIO 1. Assessment of 6.5.3, where the site has all or most of *A. aneura* cleared, and remaining vegetation is *E. populnea* woodland.



All *Acacia aneura* cleared.

Height of canopy (EDL) = 15 m, height of subcanopy = 0 m. Measured canopy (EDL) cover = 18%, subcanopy cover = 0%. Using BioCondition scores, this site will score 5 for canopy (EDL) height (15/15 = 100% of benchmark) and a score of 5 for canopy (EDL) cover (18/18 = 100% of benchmark), but 0 for subcanopy height (0/8 = 0% of benchmark) and subcanopy cover (0/30 = 0% of benchmark). Therefore, when the scores for canopy and subcanopy are averaged for the attributes height and cover, the overall scores are 2.5 for height and 2.5 for canopy cover.

SCENARIO 2. All or most of *E. populnea* has been cleared, and remaining vegetation is *A. aneura* low woodland.

Most *Eucalyptus populnea* cleared

Even though *A. aneura* is the EDL at this site, values are compared to subcanopy benchmarks as this is where it dominates in the undisturbed state. Height of subcanopy (*A. aneura*) = 8 m, height of canopy (EDL, *E. populnea*) is 15 m. Measured subcanopy cover = 30%, canopy (EDL) cover = 8%. This site scores 5 for height (15/15 =100% of canopy benchmark gets score of 5 and 8/8 = 100% of subcanopy benchmark gets score of 5) and 4 for cover (8/18 = 44% of canopy benchmark gets score of 3 and 30/30 = 100% of subcanopy benchmark gets score of 5).

SCENARIO 3. All vegetation has been cleared, and regrowth vegetation is an *E. populnea, A. aneura* low woodland

All vegetation cleared. Single layer of regrowth.

Height of canopy = 5 m (both species). Measured canopy cover = 15% *E. populnea* and 30% *A. aneura.* This site scores 3 for canopy height (5/15 = 33% of benchmark) and 5 for subcanopy height (5/8 = 63% of benchmark), giving an average score of 4 for height. This site scores 5 for both canopy and subcanopy cover (15/18 = 83% of canopy benchmark and 100% of subcanopy benchmark), giving an average score of 5 for cover.

Appendix 7: Life/growth forms used in BioCondition

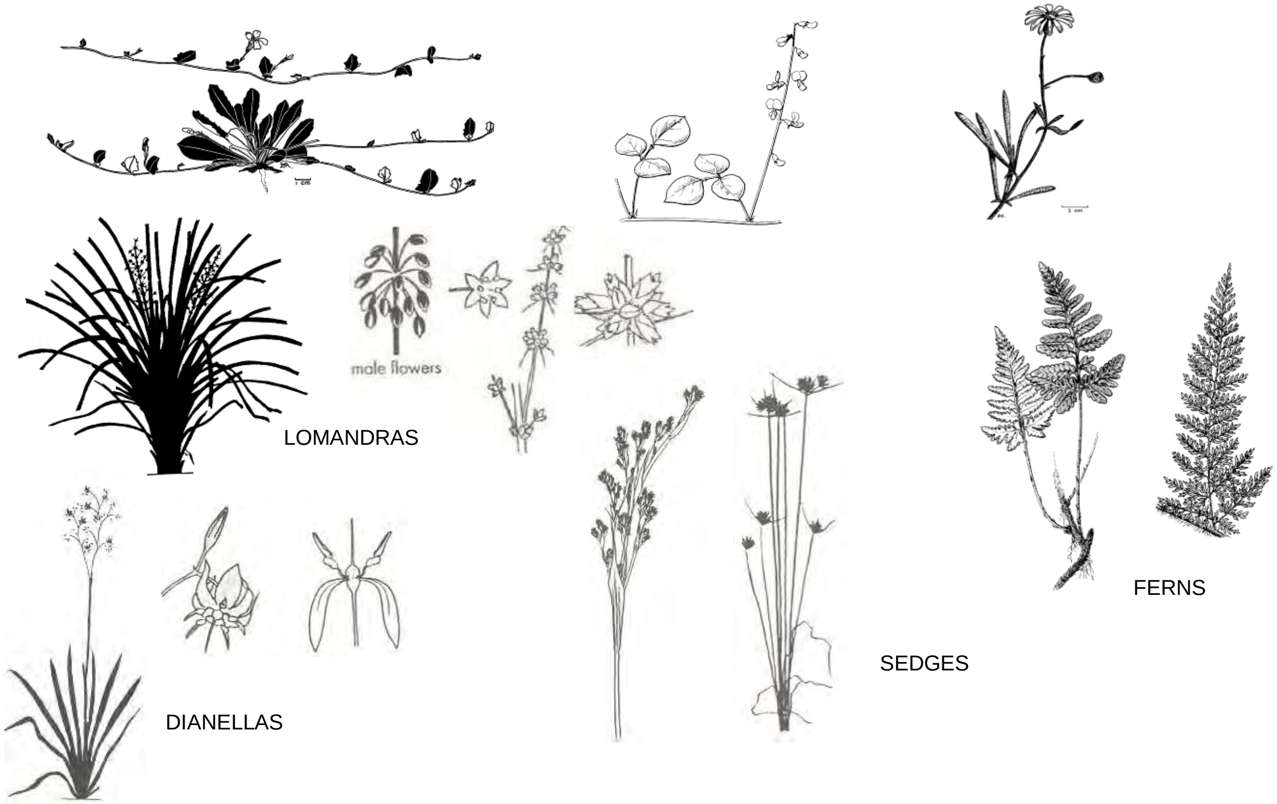
Code	Name	Description	BioCondition Category
T	TREE	Woody plants, more than 2 m tall with a single stem or branches well above the base	Tree
M	TREE MALLEE	Woody perennial plant usually of the genus *Eucalyptus*. Multi-stemmed with fewer than 5 trunks of which at least 3 exceed 10 cm diameter at breast height (DBH). Usually 8 m or more.	Tree
S	SHRUB	Woody plant multi-stemmed from the base (or within 200 mm from ground level) or if single stemmed, less than 2 m.	Shrub
Y	MALLEE SHRUB	Commonly less than 8 m tall, usually with 5 or more trunks, of which at least three of the largest do not exceed 10 cm DBH.	Shrub
Z	HEATH SHRUB	Shrub usually less than 2 m, commonly with ericoid leaves (nanophyll or smaller). Often a member of one of the following families: Ericaceae, Myrtaceae, Fabaceae and Proteaceae. Commonly occur on nutrient-poor substrates.	Shrub
C	CHENOPOD SHRUB	Single or multi-stemmed, semi-succulent shrub of the family Chenopodiaceae exhibiting drought and salt tolerance.	Shrub
U	SAMPHIRE SHRUB	Genera (of Tribe Salicornioideae, viz: *Sarcocornia*, and *Tecticornia*) with articulate branches, fleshy stems and reduced flowers within the Chenopodiaceae family, succulent chenopods. Also the genus *Suaeda*.	Shrub
G	TUSSOCK GRASS	Forms discrete but open tussocks usually with distinct individual shoots, or if not, then forming a hummock. These are the common agricultural grasses.	Grass
H	HUMMOCK GRASS	Coarse xeromorphic grass with a mound-like form often dead in the middle; genus *Triodia*	Grass
W	OTHER GRASS	Member of the family Poaceae, but having neither a distinctive tussock nor hummock appearance.	Grass
V	SEDGE	Herbaceous, usually perennial erect plant generally with a tufted habit and of the families Cyperaceae and Restionaceae.	Other
R	RUSH	Herbaceous, usually perennial erect plant. Rushes are grouped into families Juncaceae, Typhaceae, Restionaceae and the genera *Lomandra* and *Dianella*.	Other
F	FORB	Herbaceous or slightly woody, annual or sometimes perennial plant; not a grass, and including ground orchids.	Forbs
D	TREE FERN	Spirally arranged crowns on erect trunks several metres high (U.N.E 1989), characterised by large and usually branched leaves (fronds), arborescent and terrestrial; spores in sporangia on the leaves.	Shrubs
E	FERNS AND FERN ALLIES	Characterised by large and usually branched leaves (fronds), herbaceous to arborescent and terrestrial to aquatic; spores in sporangia on the leaves.	Other

Code	Name	Description	BioCondition Category
B	BRYOPHYTE	Mosses and Liverworts. Mosses are small plants usually with a slender leaf-bearing stem with no true vascular tissue. Liverworts are often moss-like in appearance or consisting of a flat, ribbon-like green thallus.	Other
N	LICHEN	Composite plant consisting of a fungus living symbiotically with algae; without true roots, stems or leaves.	Other
K	EPIPHYTE	Epiphytes (including orchids), mistletoes and parasites. Plant with roots attached to the aerial portions of other plants. Often could also be another growth form, such as fern or forb.	Other
L	VINE	Climbing, twining, winding or sprawling plants usually with a woody stem.	Other
P	PALM	Palms and other arborescent monocotyledons. Members of the Arecaceae family or the genus *Pandanus*. (*Pandanus* is often multi-stemmed).	Trees
X	XANTHORR HOEA	Australian grass trees. Members of the family Xanthorrhoeaceae.	Shrubs
A	CYCAD	Members of the families Cycadaceae and Zamiaceae	Shrubs
J	SEAGRASS	Flowering angiosperms forming sparse to dense mats of material at the subtidal and down to 30m below MSL. Occasionally exposed.	Grass
Q	AQUATIC	Plant growing in a waterway or wetland with the majority of its biomass under water for most of the year. Fresh, saline or brackish water.	Other
O	LOWER PLANT	Alga, fungus.	Other
UNK	UNKNOWN		Other

Appendix 8: Life-form identification

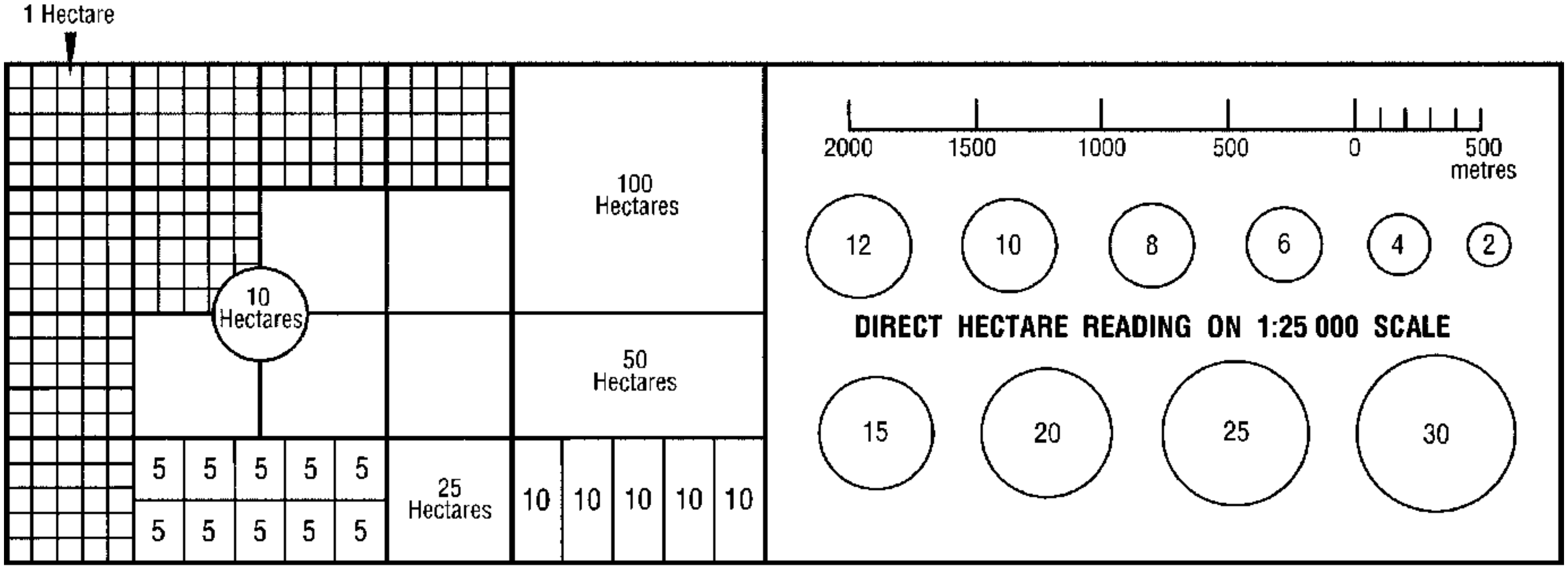
Diagrams reproduced from the Queensland Herbarium and with permission from Robinson, L. (1991). *Field guide to the Native Plants of Sydney*. Kangaroo Press, Sydney.

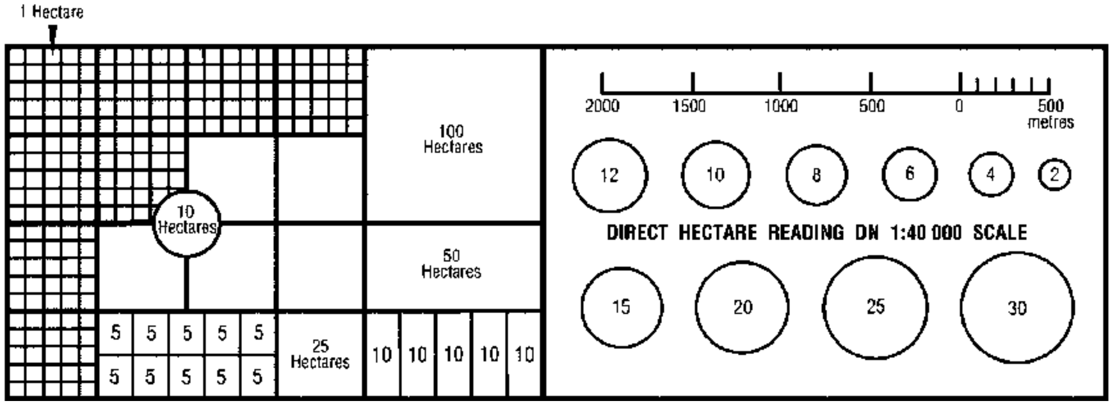
Diagrams (not to scale)	Description
	**Trees:** Trees include all single stemmed woody plants (with the exception of mallee species, which are multi-stemmed) greater than 2 m tall.
	**Shrubs:** Includes woody plants with multiple stems (excluding mallees.). Includes Cycads and Xanthorrhoeas.

Diagrams (not to scale)	Description
	**<u>Grasses:</u>** Includes all perennial and annual grasses (annual grasses are characterised by short growth, and don't form large tussocks or root mass like perennial grasses, no evidence of previous seasons growth (i.e. remains of last year's tiller bases, and absence of stolons or rhizomes, tussock, hummock and other grass species belonging to the family Poaceae).
	**<u>Forbs:</u>** Herbaceous or slightly woody, annual or sometimes perennial plants other than grasses. **<u>Other species</u>**: Slightly woody plants (subshrubs) or ferns, vines, sedges or rushes. Less than 1 m. Sedges and rushes such as Lomandra and Dianella can often be mistaken for grass. Distinction is based on the flowers. In the case of Lomandra the leaves are often flat with some parallel venation and are often quite tough. Although some species have cylindrical leaves and can be difficult to distinguish unless there are flowers, which are typically yellow. Dianella are similar often with broad flat leaves, usually arising from a flat base, flowers tend to be rich blue.

Appendix 9: Aerial photograph area calculation guide

From: Jones, K.L. (2000) *Aerial Photography Interpretation standards and guidelines for mapping forest resource and condition in Queensland.* Department of Natural Resources, Brisbane. ISBN 0734516584.





Appendix 10: A method to display BioCondition scores for attributes at a site

There are a number of methods that have been used to display the results of vegetation condition site assessments (Neldner and Ngugi 2014; Oliver et al. 2014). One of these is the radar or "spider web" graphs which can be constructed in Microsoft Excel. The spider web diagrams of the BioCondition attribute scores provide a comparison between site scores and the benchmark for each attribute. This can assist in the clear detection of attributes requiring management attention during monitoring programs in vegetation rehabilitation and/or areas undergoing changes in management.

Table 22. BioCondition scores relative to the maximum score for each attribute.

Attribute	Large trees	Tree canopy height	Recruit-ment	Tree canopy cover	Shrub layer cover	Coarse woody debris	Native plant species richness	Non-native plant cover	Native perennial grass cover	Litter cover
maximum score for attribute	15	5	5	5	5	5	20	10	5	5
score _2010	5	2	3	3	3	2	10	10	3	3
site score relative to maximum score_2010	33.33	40	60	60	60	40	50	100	60	60
score _2013	10	3	3	3	5	5	14	5	3	5
site score relative to maximum score_2013	66.67	60	60	60	100	100	70	50	60	100
score _2015	10	5	5	5	5	5	17.5	5	5	5
site score relative to maximum score_2015	66.67	100	100	100	100	100	87.5	50	100	100

The example in Figure 14 shows the change in site scores relative to the maximum score for each attribute from measurements made at a site in 2010, 2013 and 2015, using a radar graph. The sub-scores for each of the life-forms contributing to the native plant species richness attribute score (i.e. trees, shrubs, grasses and forbs/other) could be also be graphed if required. Similarly, the landscape attributes could also be displayed on the graph.

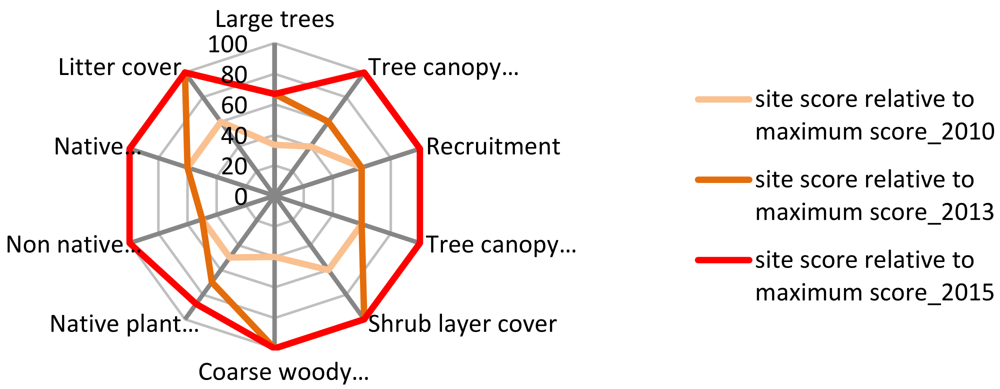


Figure 14 BioCondition scores relative to the maximum score for each attribute

APPENDIX J LAND MANAGER'S MONITORING GUIDE – GROUND COVER INDICATOR

Department of Environment
and Resource Management

Land Manager's Monitoring Guide

Ground cover indicator

Prepared by:

Environment and Resource Sciences

Department of Environment and Resource Management

August 2010

Contents

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.

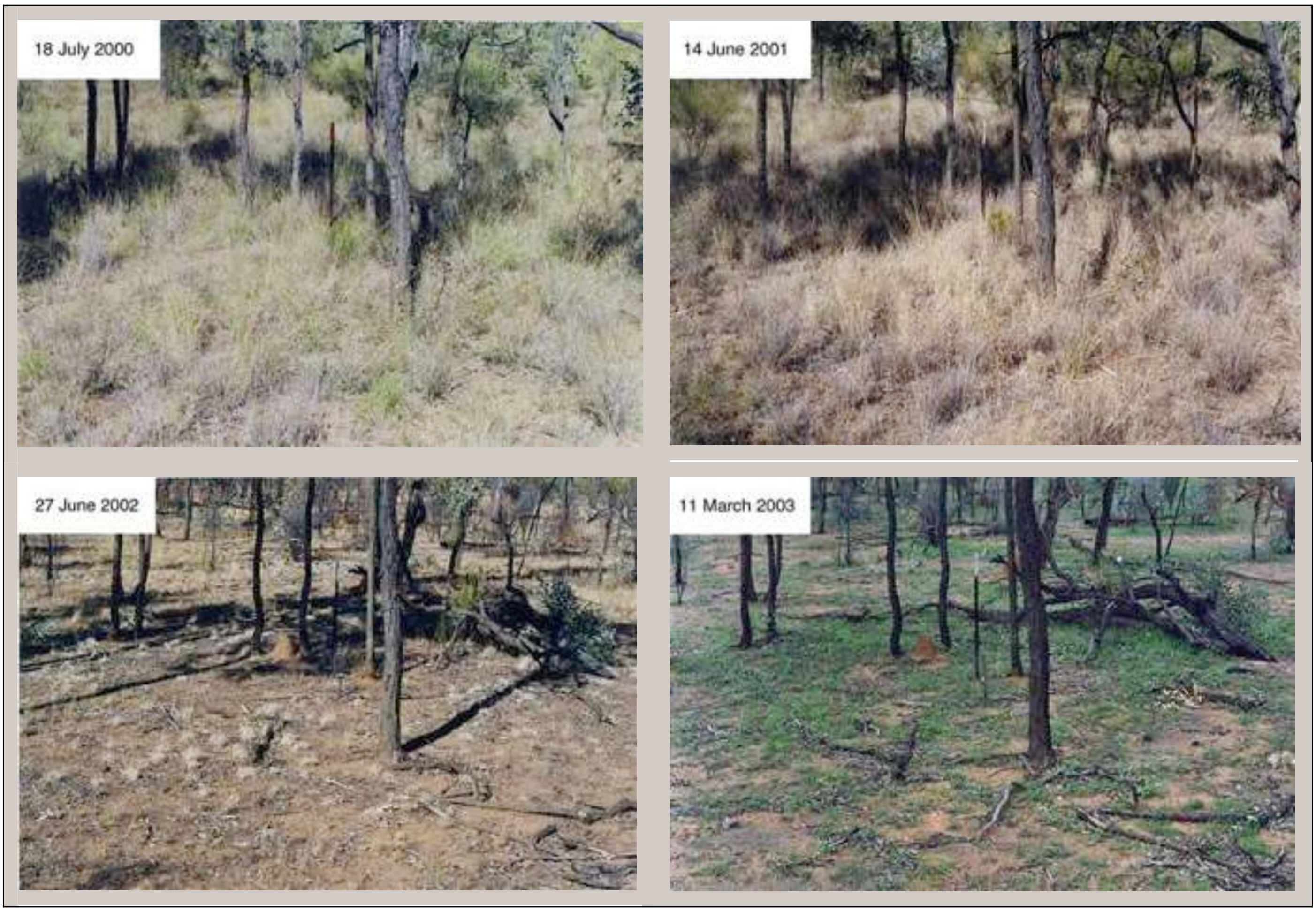


Figure 1: Photographs comparing ground cover at the same point over a three year span

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)

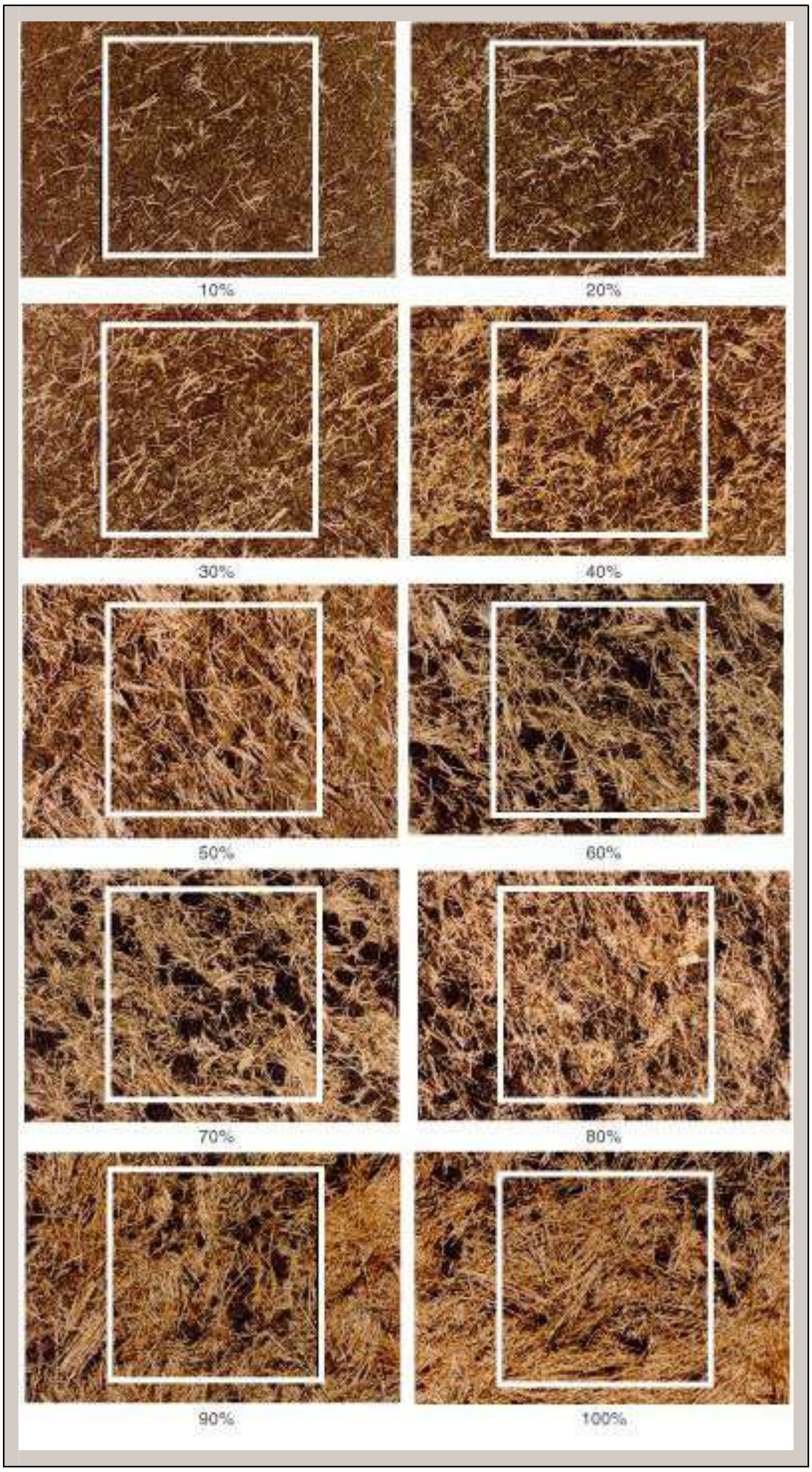


Figure 3: Photographs of wheat stubble cover levels in 10% increments (Molloy 1988)

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.

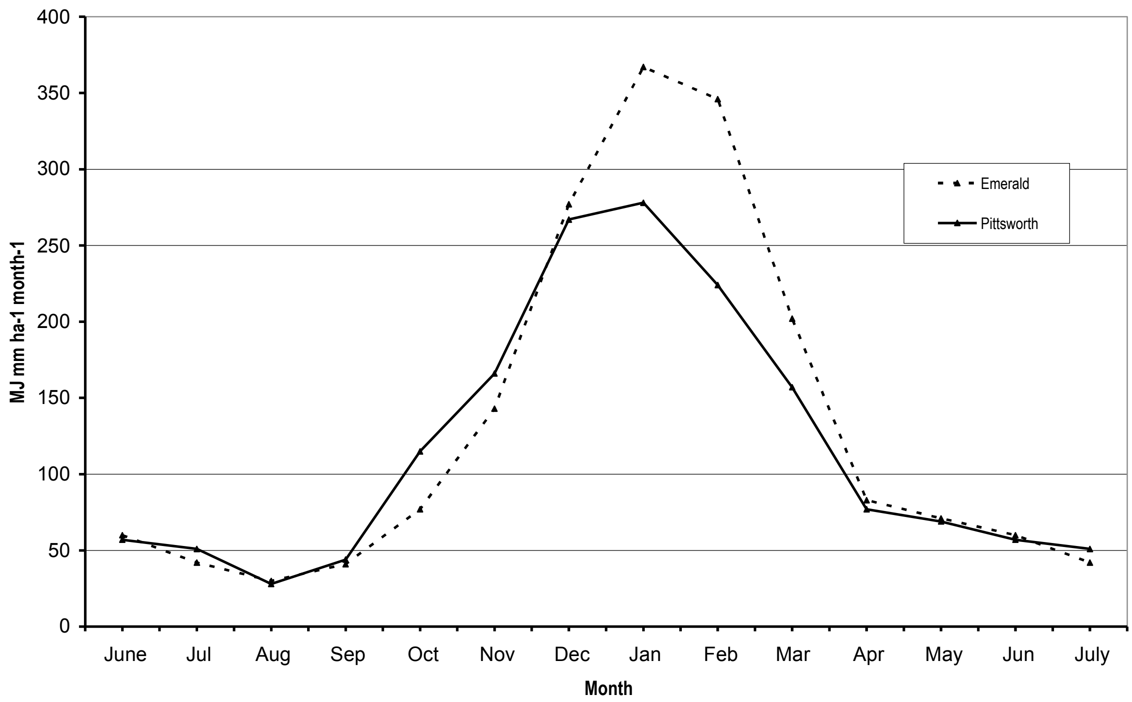


Figure 4: Average monthly rainfall erosivity values for Emerald and Pittsworth

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.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>.

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.

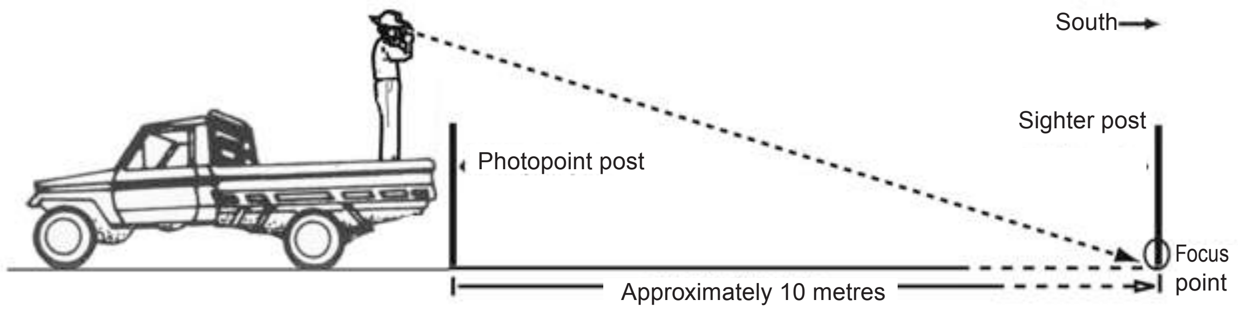


Figure 5: Taking the 'trayback' photo (Department of Natural Resources 1997)

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.

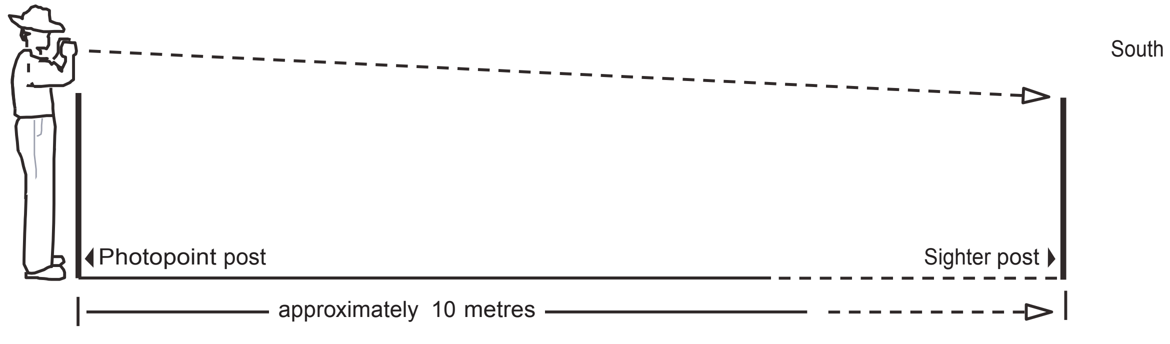


Figure 6: Taking the landscape photo (Department of Natural Resources 1997)

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 my 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.

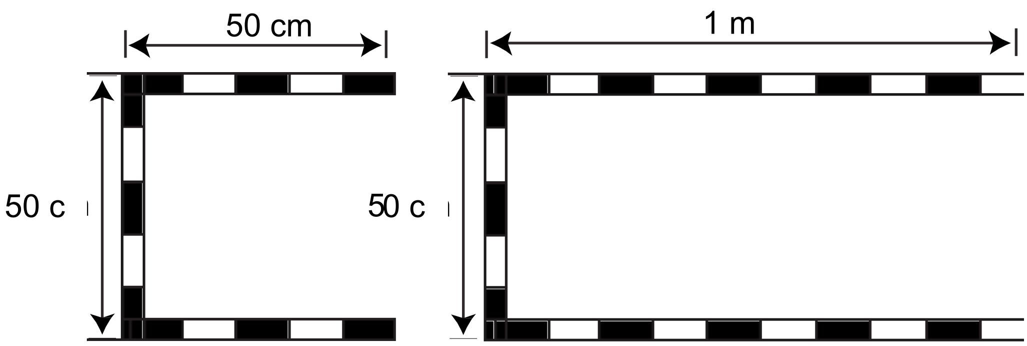


Figure 7: Two types of quadrats used for measuring ground cover

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 point 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.

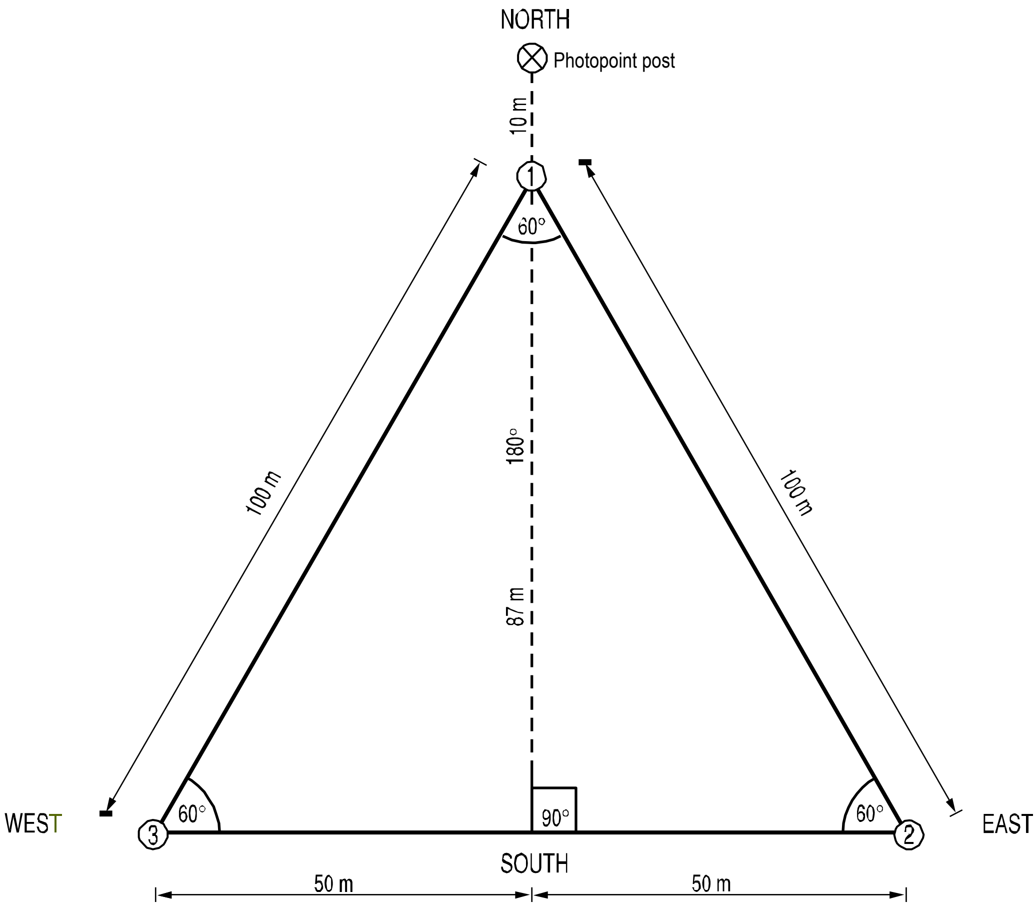


Figure 8: Approximate dimensions for a monitoring triangle

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.

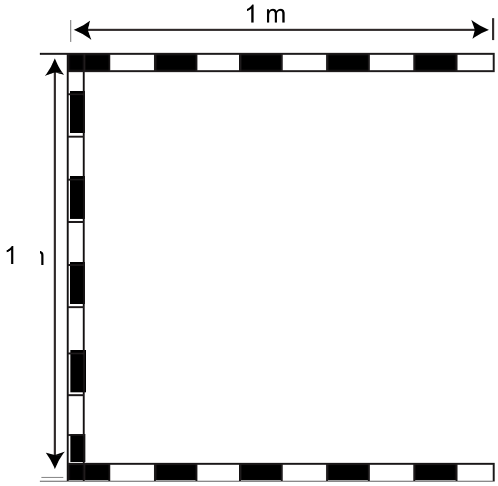


Figure 9: Quadrat recommended for use in measuring ground cover for BioCondition assessment

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.

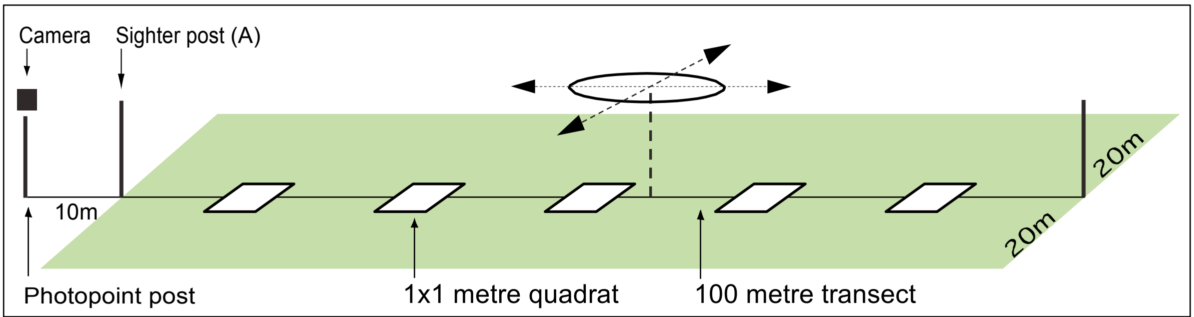


Figure 10: Standard monitoring site for BioCondition Assessment

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).

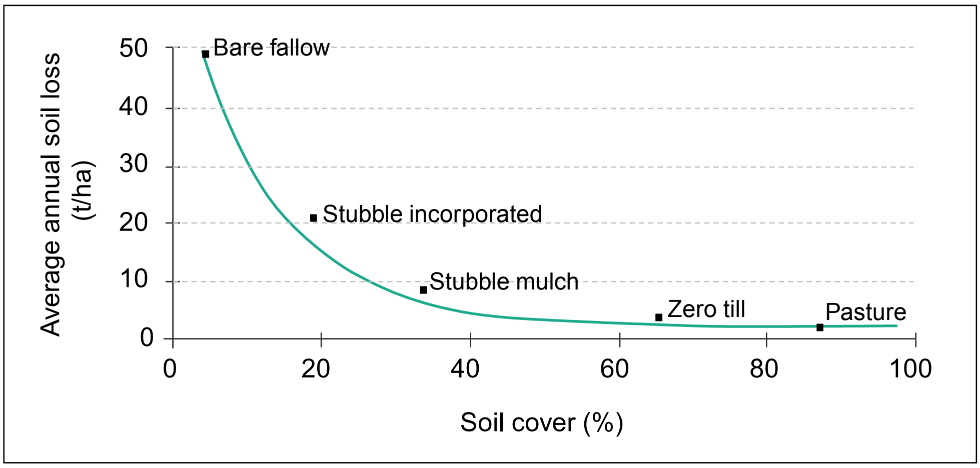


Figure 11: Annual average soil loss (1978–92) vs. cover for contour bay catchments on the eastern Darling Downs (Freebairn 2004)

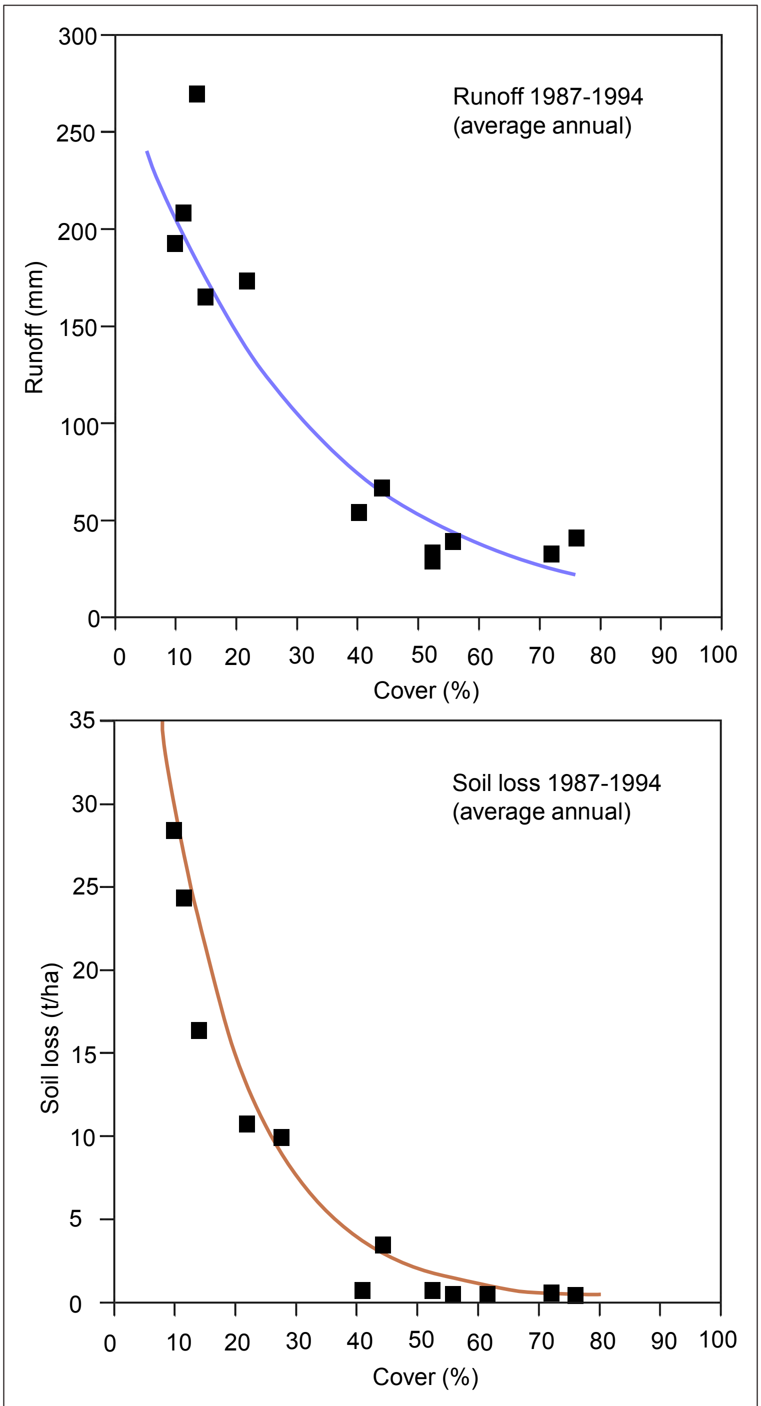


Figure 12: Average annual runoff and soil loss (1987–94) vs. ground cover for native pasture in Central Queensland (Mark Silburn, Queensland Department of Natural Resources and Water, pers. comm. 2005)

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.

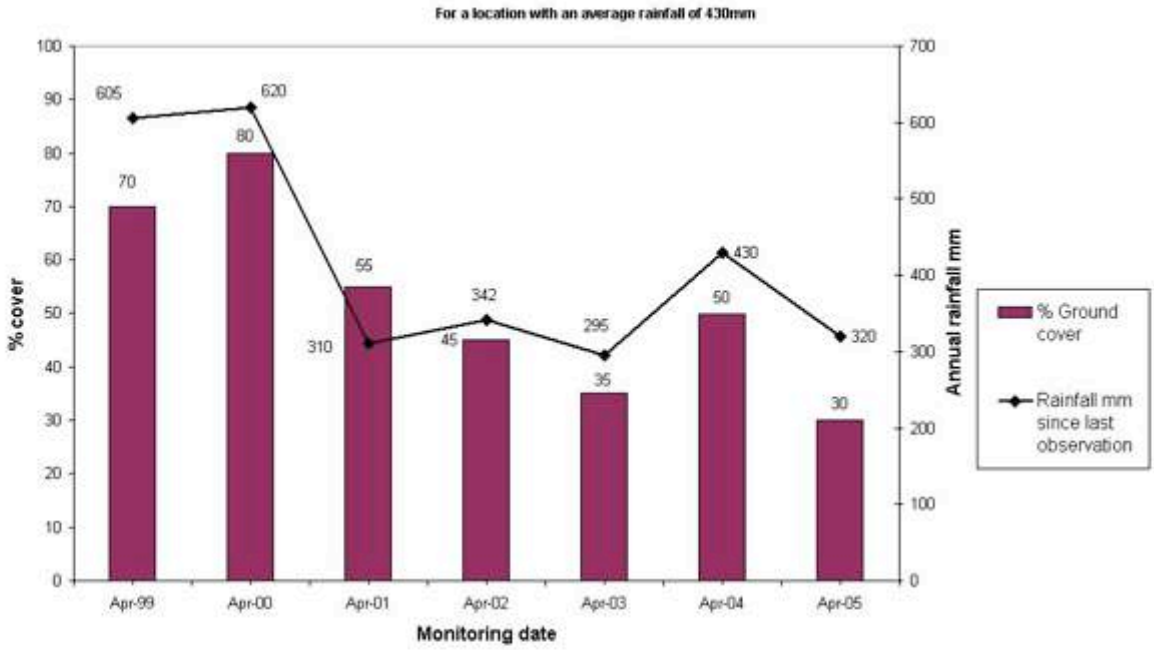


Figure 13: Rainfall and changes in pasture ground cover from 1999 to 2005

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/objtwr/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.

References

Department of Natural Resources 1997, *Grass check*, Publication DNRQ97002, Queensland Department of Natural Resources.

Department of Primary Industries 2003, *Pasture photo standards CD*, Queensland Department of Primary Industries.

Finlayson, B and Silburn, M 1996, 'Soil, nutrient and pesticide movements from different land use practices and subsequent transport by rivers and streams', in HM Hunter, AG Eyles and GE Rayment (eds), *Downstream effects of land use*, pp. 129–40, Department of Natural Resources, Queensland.

Francis, A and Payne, R 2003, *Field method for measuring soil surface cover*, Primary Industries and Resources SA fact sheet No. 8/01.

Freebairn, D 2004, Some observations on the role of soil conservation structures and conservation, *Journal of the Australian Association of Natural Resource Management* 7(1), 8–13.

Molloy, J 1988, *Field manual for measuring stubble cover*, Queensland Department of Primary Industries.

Partridge, I 1992, *Managing native pastures – a grazier's guide*, Information Series QI92009, Queensland Department of Primary Industries.

Tongway, D 1994, *Rangeland soil condition assessment manual*, CSIRO Division of Wildlife and Ecology, Canberra.

Authors

Bruce Carey and Andy Grodecki, Queensland Department of Environment and Resource Management.

APPENDIX K RISK ASSESSMENT

A risk assessment has been undertaken to identify and analyse any real or potential risks associated with achieving the management objectives and outcomes; the actions to be taken to minimise those risks and; any remedial action that will be undertaken if any of the risks occur.

Table K-1: Risk framework

		Consequence				
Likelihood		Minor	Moderate	High	Major	Critical
	Highly Likely	Medium	High	High	Severe	Severe
	Likely	Low	Medium	High	High	Severe
	Possible	Low	Medium	Medium	High	Severe
	Unlikely	Low	Low	Medium	High	High
	Rare	Low	Low	Low	Medium	High

Table K-2: Likelihood and consequence

Qualitative measure of likelihood (how likely is it that this event/circumstances will occur after management actions have been put in place/are being implemented)	
Highly likely	Is expected to occur in most circumstances
Likely	Will probably occur during the life of the project
Possible	Might occur during the life of the project
Unlikely	Could occur but considered unlikely or doubtful
Rare	May occur in exceptional circumstances
Qualitative measure of consequences (what will be the consequence/result if the issue does occur)	
Minor	Minor incident of environmental damage that can be reversed
Moderate	Isolated but substantial instances of environmental damage that could be reversed with intensive efforts
High	Substantial instances of environmental damage that could be reversed with intensive efforts
Major	Major loss of environmental amenity and real danger of continuing
Critical	Severe widespread loss of environmental amenity and irrecoverable environmental damage

Table K-3: Risk Assessment

Objective	Event or circumstance[7]	Likelihood	Consequence	Risk level	Trigger	Contingency/s	Related monitoring activity
Minimise predation risk by pest animals and habitat degradation risk by pest animals in the offset site	Evidence of pest animal predation on the offset matters or evidence of habitat degradation identified as part of ongoing offset monitoring events.	Unlikely	Moderate	Low	▶ An increase in the number of pest animals (dogs, foxes, feral cat, pig or rabbit) within the offset site identified as part of pest animal monitoring event. ▶ A decrease in the habitat condition score for the offset matters in comparison to the baseline condition score or latest condition score assessed as part of habitat condition monitoring events	▶ Revise the type of pest animal control activities undertaken to ensure a more effective technique. ▶ Increase the frequency of invasive pest animal control efforts in accordance with Queensland DAF guidelines and in conjunction with neighbouring land owners.	▶ General offset site monitoring ▶ Habitat condition assessments ▶ Photo monitoring ▶ Pest animal monitoring
Control invasion of offset site by invasive and other weed species	Evidence of habitat degradation as a result of invasive weed species identified as part of ongoing offset monitoring events	Possible	Moderate	Medium	An increase in weed species richness or abundance within the offset site identified as part of weed monitoring and habitat condition assessments.	▶ Review adherence to weed hygiene procedures outlined in Section 4.2 (general restrictions) to ensure compliance and update restrictions where required. ▶ Increase the frequency of weed control measures and monitoring events. ▶ Investigate alternative and more effective weed	▶ General offset site monitoring ▶ Habitat condition assessments ▶ Photo monitoring ▶ Weed monitoring

[7] Assumes effective implementation of management measures, as described in the plan.

Objective	Event or circumstance[7]	Likelihood	Consequence	Risk level	Trigger	Contingency/s	Related monitoring activity
						management control actions and implement as required.	
Minimise impact of livestock grazing on the condition of habitat and vegetation communities for the offset values	Degradation of habitat condition as a result of unauthorised grazing identified as part of habitat condition assessments and general offset site monitoring	Likely	Moderate	Medium	▶ Decrease in the habitat condition of the offset matters identified as part of habitat condition assessments. ▶ Evidence of unauthorised grazing within the offset site identified during ongoing monitoring events.	▶ Reduce stocking rates, and/or duration and frequency of strategic grazing events. ▶ Construction of temporary or permanent additional fencing to protect affected vegetation and offset values	▶ General offset site monitoring ▶ Habitat condition assessments ▶ Photo monitoring ▶ Targeted fauna and flora surveys
Improve the condition of habitat and vegetation communities for the offset values across the whole offset site through fire management.	Degradation of offset values as a result of an uncontrolled bushfire within the offset area resulting in a decrease in the habitat condition of the offset values.	Unlikely	High	Medium	▶ Fuel loads exceed the 1,500 kg/ha ▶ Uncontrolled bushfire within the offset area resulting in a decrease in the habitat condition of the offset values. ▶ A decrease in the habitat condition of the offset values following a controlled within the offset site.	Changes to stocking rates, and/or duration and frequency of strategic grazing events to reduce fuel loads within the offset area, and/or Amending fire management measures including Widening existing fire breaks or construction of additional firebreaks	▶ General offset site monitoring ▶ Habitat condition assessments ▶ Photo monitoring
Brigalow TEC (RE 11.4.9 and RE 11.3.1) within the offset area achieves a BioCondition class score of 1 (Functional	Change in the mapped distribution of Brigalow TEC in offset areas or there is tree mortality attributable to groundwater drawdown, remediation and/or rehabilitation.	Unlikely	High	Medium	▶ There is <20% of the dominant canopy species present as regeneration by 2022.	Active regeneration will be assessed and implemented if considered viable. Active regeneration may include direct seeding and/or planting of tube stock of dominant canopy species.	▶ General offset site monitoring ▶ Habitat condition assessments ▶ Photo monitoring

Objective	Event or circumstance[7]	Likelihood	Consequence	Risk level	Trigger	Contingency/s	Related monitoring activity
condition) and can be mapped as remnant vegetation under the VM Act.							
A quality score of 8 is achieved for squatter pigeon habitat within the offset area based on an assessment of site condition, site context and species stocking rate under the EPBC Act offsets assessment guide principles.	Insufficient canopy cover to meeting future offset condition target.	Unlikely	High	Medium	▶ There is <20% of the dominant canopy species present as regeneration by 2022.	Investigate and implement options for active regeneration. Active regeneration may include direct seeding and/or planting of tube stock of dominant canopy species.	▶ General offset site monitoring ▶ Habitat condition assessments ▶ Photo monitoring ▶ Targeted fauna and flora surveys