- Site: Narrabri Gasfield -- Job: Narrabri Gas Project -- Annex: EIS - Website Submissions -
- Activity: Online Submission from company Upper Mooki Landcare Inc (org_object) -

Online Submission from company Upper Mooki Landcare Inc (org_object)

Nicola Chirlian <nicky@tallawang.com> May 22 (15 days ago)
To: Stephen O'Donoghue

Name: Upper Mooki Landcare Inc. Executive Committee
Address: "Eastview"
MacDonald's Rd
WILLOW TREE NSW 2339

Date: 22nd May 2017

Attn: Executive Director, Resource Assessments
Department of Planning and Environment
GPO Box 39
Sydney NSW 2001

RE: Submission to the Santos Narrabri Gas Project Environmental Impact Statement

Dear Madam / Sir,

We are writing as the Executive Committee of Upper Mooki Landcare Inc. to state that our group objects to this project and recommends that it be rejected on environmental grounds.

A review of Chapter 15 of the Narrabri Gas Project (NGP) Environmental Impact Statement (EIS) was commissioned, and was conducted by Mr David Paull, Principal Ecologist, Ethical Ecology. Mr Paull has extensive experience in conducting environmental reviews and has specialised in the biodiversity of the Pilliga Forest. (see D. Paull, Curriculum Vitae).

Mr Paull found evidence of a number of serious omissions within the Environmental Impact Statement. His report which follows, details his review and presents several concerns regarding the adequacy of the assessment which remain unresolved, in particular:

 The adequacy of the methodology used to describe direct impacts is questionable. The lack of a development footprint by which impact could be measured according to `whole of government' guidelines gives uncertainty to the outcomes.
 Levels of indirect impact on the environment have been significantly under-estimated. Using fox predation as a measure, pre-mitigation levels of indirect impact should be at least doubled in magnitude, based on available evidence.
 Survey effort for some key fauna species is deficient and would have adversely affected the ability of the Environmental Impact Statement to adequately account for some species such as the Regent Honeyeater.
 A NSW and Commonwealth-listed threatened ecological community White Box Blakely's Red Gum-Yellow Box Woodland (and derived native grassland) has been mis-identified and presumed to be not present in the study area. New data from an independent survey confirms its presence along Bohena Creek.
. . . / 2
 The description of important habitat for a number of threatened species, such as the Regent Honeyeater, Pilliga Mouse, Koala, Black-striped Wallaby and Five-clawed Worm-skink does not appear to be accurate.
 New information from three independent surveys on the presence of the Koala in the study area discounts the assertion made in the EIS that it is not currently present.
 Due to deficiencies in the in the survey and assessment for two `matters for further consideration' (Regent Honeyeater and Five-clawed Worm-skink) the statutory requirements under the NSW Biodiversity Offset Policy have not been met.
 Direct impacts upon Brigalow Park State Conservation Area remains uncertain as do the magnitude of indirect impacts upon the adjacent Nature Reserve and existing biodiversity corridors.
 A Biodiversity Offset Strategy does provide any surety for how well it will `retire' the impact of the Project because the strategy provided in the EIS does not provide any like-or-like land-based offsets apart from an unproven rehabilitation plan, and rests on the hypothetical efficacy of a feral animal control proposal. The suitability of the offset package with respect to the statutory requirements under the NSW and the Commonwealth's Biodiversity Offset Policies are poor.

Based on these findings, this part of the Project assessment should be rejected as being data-deficient in relation to the Secretary's Requirements, and inadequate under the terms of NSW and Commonwealth Biodiversity Offset Policy. The matters outlined above should be addressed by the proponent before any further assessment is undertaken.

The complete review follows.

Yours sincerely
per Upper Mooki Landcare Inc. Executive Committee

Nicola Chirlian Myles Sevil Heather Ranclaud
Chair Secretary/Treasurer Publicity Officer

5 attachments

Attachement 4. Bibblewindi_Water_Treatment_Facility_Soil_Investigation_21Feb2012_749_.pdf
6.642 MB
Attachment 1 Survey of Bohena Creek Riperian Plant Communities.pdf
3.434 MB
Attachment 2 Koala Survey within PEL 238 October November 2016.pdf
2.131 MB
Attachment 3 OWAD Pilliga East State Forest Koala Survey.pdf
960.2 KB
Expert Review Narrabri Gas Project Terrestrial Ecology.pdf
2.013 MB

Nicola Chirlian <nicky@tallawang.com> May 22

To: Stephen O'Donoghue

Confidentiality Requested: no Submitted by a Planner: no Disclosable Political Donation: no

5 attachments

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Email Details

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Priority	Medium
Class	Organisation Object
Tags	No Tags
Visibility	All

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- 2.013 MB

Attachment 1. Survey of Bohena Creek riparian plant communities

Report for *Upper Mooki Landcare Inc*

By David C. Paull (BSc, MResSc, Dip. Hum.)

15 April 2017

Summary

The riparan vegetation bordering Bohena Creek was surveyed to describe its plant community type, diversity, structure and condition. The following are the main findings of this survey:

- The plant community along the banks of Bohena Creek is typically a grassy woodland, dominated by Blakely's Red Gum, Rough-barked Apple and White Cypess Pine. Other species such as Yellow Box and Kurrajong also occur less frequently in the canopy.
- The Plant Community Type which best fits this community is PCT544 *Rough-barked Apple - White Cypress Pine - Blakely's Red Gum riparian open forest / woodland of the Nandewar Bioregion and New England Tableland Bioregion* due to the similarity in species composition and topographical position.
- PCT 399 *Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion* was encountered within the creekbed environment at two sites.
- PCT401 *Rough-barked Apple – Red Gum - Cypress Pine woodland on sandy flats, mainly in the Pilliga region* was detected once, showing very little difference with the more frequently encountered red gum community, apart from the presence of Baradine Red Gum.
- PCT408 *Dirty Gum (Baradine Gum) – Black Cypress Pine – White Bloodwood shrubby woodland* was found at one creekside site due to some outcropping sandstone.
- Based on the similarity with characteristic species listed in the scientific determination for *White Box Blakely's Red Gum Yellow Box Woodland* (37%) the community identified here as PCT544 shows a high level of correspondence with the EEC.
- Due to the variation on site condition, eight of the sites would meet the understorey criteria for the Commonwealth-listed CEEC *White Box Blakely's Red Gum Yellow Box Woodland and Derived Native Grassland*.
- One site and one transect in particular (4.2) was found to be in poor condition, with high levels of dead trees, weed cover and low plant diversity. The reasons for this dieback remain unclear.

Background

Bohena Creek is a 5th order stream and the most important stream in the eastern Pilliga, feeding into the Namoi River 9 km north-west of Narrabri at the junction with Namoi Creek. In the upper reaches, the Bohena splits into two creeks within the Pilliga East State Conservation Area, the Borah and Yaminbah Creeks whose source is south of the Pilliga. In all, the catchment of these streams covers some 100km in length, north to south.

While regarded as an intermittent creek, Bohena is capable of discharging huge surface flows following times of good rain into the Namoi. In addition, this is aided by a perched aquifer which supports both riparian communities and groundwater dependence but also assists in rapid discharge of surface flow.

Bohena Creek flows north through the middle of the proposed Narrabri Gas production field and so it is important to understand the significance of this major stream both at a local and regional scale.

In the light of the recent submission of the EIS for the Narrabri Gas Project, this study attempts to verify the types riparian plant communities along Bohena Creek, to describe their condition, structure and composition.

Methodology

Site selection

Site selection was predominately governed by two main factors:

1. Proximity to creek. All transects were to be conducted as close as possible to the creekside evironment.
2. Access ease. All sites were located within 200m of access roads, primarily Creaghs Road, Bohena Creek Road and McCanns Road and the Newell Highway.
3. Sites were located as far as possible at a distance of 5km from each other. Some sites ended up further apart, some were closer due to logistical constraints.

In all, eight ‘sites’ were selected, each with two vegetation survey transects and one creekbed assessment area. The sites are depicted in Figure 1.

Figure 1. Location of study sites

Site surveys

Figure 2 shows the site layout with survey transects and quadrats. Two plots were located at each site of the creek, along with a cental creekbed assessment area. Vegetation surveys were carried out using the methdology as outlined in the Framework for Biodiversity Assessment (FBA) of a nested quadrat to survey diversity and a central transect line to survey cover. The following modifications were made to the methdology:

Figure 2. Layout of site surveys.

1. Transects were conducted over 100m in order to get a more detailed assessment on the number of dead standing trees and dominants in the different canopy layers above ground-level. All trees (>10cm dbh) were counted within an area 40m wide by 100m long (0.4 ha) and all overstorey and midstorey species were noted.
2. Cover estimates of the cover of the different vegetation strata and weeds were made across 20 points along the transect, each point 5 m apart. Where no 'hits' were recorded but plants in that layer or category were observed, this is recorded as <5%.
3. Creekbed assessments were undertaken within the 100m length of creekbed in line with the vegetation transects. This involved a walk over of the area, noting common species and a visual estimate of cover for the different strata. 'Island' vegetation were excluded from this analysis as they we found to be inhabited by terrestrial vegetation, more resembling the creek terraces.

Results

Community type

The site data is presented in Appendix 1. Four communities within the VIS Plant Community Type database were identified in the transects surveyed. Two community types, PCT544 (n=13) and 401 (n=1) were found to have a woodland structure, matching the criteria of the Grassy Woodland Keith Formation. One site was found to support the shrubby woodland type PCT 408, matching the criteria of the Dry Sclerophyll Forest (shrubby) Formation. One transect (4.2) was found to be in such poor condition that assigning a community type was based on assumptions about its natural condition.

Figure 3. PCT 544 (Transect 1.2)

Figure 4. PCT401 (Transect 4.1)

Figure 5. PCT 408 (Transect 5.1)

Not counting 'islands' which were not sampled, only two creek-bed sites (S7 and S8) were found to support a vegetation community, most being too bare to qualify as plant communities. These sites match the criteria of the plant community type 399, another Dry Sclerophyll Forest (shrubby) formation, though also labelled as being a 'wetland' which matches the on-ground conditions at these sites.

Figure 6. Creekbed at Site 7 (PCT399)

Permanent or semi-permanent waterholes were also detected at sites S5, S7 and S8, which are surrounded by similar wetland vegetation described as being PCT 399, though were not surveyed.

Figure 6. Waterhole at Site 4.

Native Plant diversity

Not all species were identified so total diversity across the sites is somewhat higher than presented here. In total, 69 species were identified in the PCT complex 544/401, with the most diverse layer being groundstorey, forbs with 27 identified species, grasses contributing 13 species. Understorey was not particularly diverse with 14 species, midstorey and canopy with six and seven species respectively.

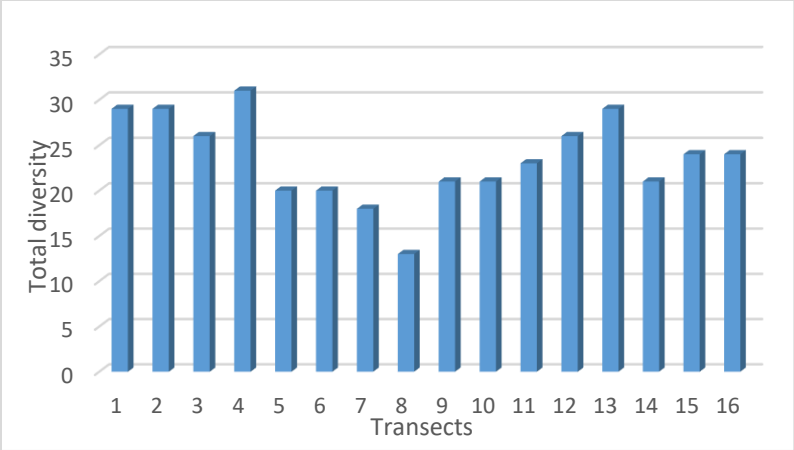

Figure 7. Native plant diversity across sites.

The lowest levels of diversity were found at transects 4.1 (#7) and 4.2 (#8) which also correlates with lower levels of 'condition' at these sites.

The most common overstorey species were Blakely's Red Gum, Rough-barked Apple and White Cypress Pine, occurring in different levels of dominance across the transects, though always present. Yellow Box was uncommonly encountered while Kurrajong and Bull Oak were encountered only once.

Mid-storey was usually dominated by one species, Dean's Wattle, though sometimes scattered tea tree and bottlebrush also occurred. These species were not present at most transects despite them being placed along the bank of the creek.

The understorey was generally dominated by two sedge species, Long-leaf Lomandra *Lomandra longifolia* and Rough Saw-sedge (*Gahnia aspera*) across most transects, along with the rushes *Juncus* sp and *Cyperus* sp. Xeric heaths and peas were generally scarce in the riparian zone examined, with the Darling Pea *Swainsona cadellii,* the most common of the Fabaceae in this layer.

Ground forbs were reasonably diverse, with ground-storeys commonly dominated by *Dichondra repens, Sida corrugata* and *Oxalis perrenans.* Grasses at the transects were most commonly the wire-grass *Aristida ramosa, Austrostipa setacea, Digitaria diffusa* and Weeping Grass *Microleana stipoides*. The exotic grass cover, couch *Cynodon dactylon,* was common.

One threatened species was detected, *Commersonia procumbens* at Transect 1.2.

Condition

Two measures of condition were analysed across the transects, numbers of dead standing trees and weed cover.

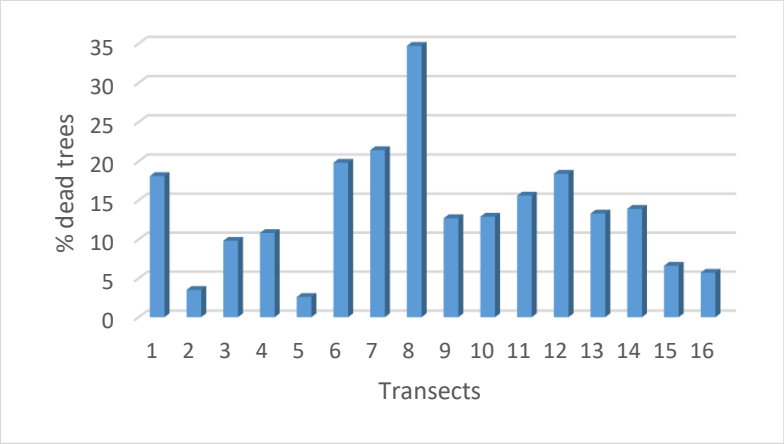

Figure 8. Proportion of dead standing trees as percentage of total standing stems across the transects.

Transect 4.2 has significantly more dead trees as a proportion of total standing stems than the other sites (with 34% of all standing stems being dead). Otherwise the normal level of standing dead trees lies between 2 and 20% of total standing stems in the rest of transects.

Where high numbers of dead trees were detected, resembling areas of dieback, it was found that the Blakely's Red Gum as the most affected. Transect 4.2 also contained a substantial number of trees suffering from dieback but for which regeneration has occurred along the stems. These were counted as 'live' trees in this study.

Drone footage of the creek vegetation along Bohena Creek south of X-Line Road up to the Plumb Road intersection shows distinct patches of red gum dieback in this part of the creek (Appendix 3).

Weed cover varied considerably at sites to between 5 and 50% cover within the groundstorey and understorey considered together. Consistent with the results concerning diversity and % dead trees, weed-cover was highest at the transects at site 4.

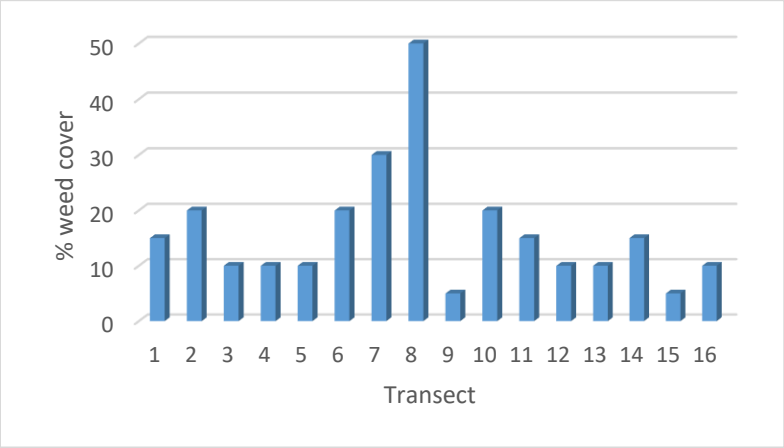

Figure 10. % weed cover across the transects

Nine weed species were commonly occurring at the survey sites, the species which account for most of the groundcover were Mayne's Curse *Glandularia aristigera*, Fleabane *Conzya bonariensis* and sometimes

Sticky Beak *Bidens pilosa*. Other commonly occurring species are *Cynodon dactylon, Sonchus oleaceus, Polycharpon tetraphyllum, Anagallis arvensis, Xanthium strumarium* and Prickly Pear *Opuntia stricta*.

Discussion

Community types

There was some variation in floristics and structure of the woodland communities within the study area, despite the targeting in the location of sites.

While most of the creek and riparian environment can be described as an alluvial environment, with creekbed and creek terraces on loam-sand soils, Pilliga Sandstone can abut the creekbed itself as was observed at one site. At transect 5.1, the geological boundary was noticeable on the eastern side of the creek, rising some three metres above the level of the creekbed. This area supported shrubby woodland.

One community was categorized as the PCT 401 due to the presence of Baradine Red Gum, *E. chloroclada,* though for the rest of the species within the community, it was not found to be measurably different from the more common type, identified here as PCT 544.

EcoLogical Australia (2016) have mapped several communities along Bohena creek, though categorise the dominant creekside community containing Blakely's Red Gum as being PCT399 *Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion*. From the Dry Sclerophyll (Shrubby) Forest and Western Slopes Dry Sclerophyll Forests Keith Class, the PCT description is as follows:

399	Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion	Eucalyptus blakelyi , Eucalyptus camaldulensis <--> chloroclada , Angophora floribunda , Callitris glaucophylla / Leptospermum polygalifolium subsp. transmontanum , Acacia deanei subsp. paucijuga , Acacia penninervis var. penninervis , Callistemon linearis / Arundinella nepalensis , Juncus continuus , Cyperus lucidus , Alternanthera denticulata

This assignment cannot be supported for the following reasons:

(a) The riparian woodland in question was found generally to contain a low overstorey height of 10-20 m, a relatively little mid-storey (0-30%) or understorey shrub cover (5-30% cover), a lack of sclerophyllous shrubs, and having a high litter cover with groundcover dominated by grasses and forb species. This would fall within the Keith formation as "Grassy Woodland', not "Dry sclerophyll (shrubby) forest".

(b) The species composition of this community was found to be more consistent with the grassy woodland type PCT 544 *Rough-barked Apple - White Cypress Pine - Blakely's Red Gum riparian open forest / woodland of the Nandewar Bioregion and New England Tableland Bioregion*, as it always contained White Cypress Pine *Callitris glaucophylla* and sometimes Yellow Box *Eucalyptus melliodora* in the overstorey; a mid-storey dominated by the soft-leaved wattle *Acacia deanii* with only scattered sclerophyllous species, such as *Persoonia*; a low shrub cover mostly dominated by

Lomandra longifolia and *Gahnia aspera*; sometimes aquatic plants are present, eg, *Juncus* and *Cyperus*; and a groundstorey containing species typically found in North-west Slopes and New England grassy woodlands, such as *Dichondra repens, Chrysocephalum, Glycine, Wahlenburgia, Chielianthes, Austrostipa, Micloeana* and *Aristida* grass spp. In the spring, this community typically contains high numbers of greenhood *Pterostylis* and *Diuris* orchids, while in autumn providing habitat for the lily *Crinium flaccidum.*

The VIS database description of this community states the following typical community composition. Except for the presence of Native Olive *Notolea microcarpa,* there is a high level of correspondence with the species common at the survey sites:

544	Rough-barked Apple - White Cypress Pine - Blakely's Red Gum riparian open forest / woodland of the Nandewar Bioregion and New England Tableland Bioregion	Angophora floribunda, Eucalyptus blakelyi , Callitris glaucophylla , Eucalyptus melliodora / Notelaea microcarpa var. microcarpa , Leptospermum polygalifolium subsp. transmontanum / Lomandra longifolia , Dichondra sp. a , Microlaena stipoides var. stipoides , Cyperus gracilis

Considerable ground-truthing in the project area by Ethical Ecology has shown that PCT 399 is present, though generally found to be associated with lower order streams where the banks are less developed or absent. This describes the majority of steams in the Pilliga forests. Tea-tree and bottlebrush seems to grow as dominant parts of the understorey where there are relatively high levels of surface or shallow groundwater flow (hence its description as a 'wetland' in the VIS database). Intermittent spring and rain flow from the minor streams all feed into the Bohena alluvium.

As found in this study, some areas of the creekbed, particularly containing waterholes, conform to this community, though most of Bohena Creek has relatively little aquatic vegetation.

PCT ID401 covers over 7,500 ha and is called '*Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region*' in the VIS database. On the ground, Black Cypress Pine *Callitris endlicheri* was found to be not present in these claypan areas where this community occurs, but instead is occupied by White Cypress Pine. This appears to be an error within the PCT database itself as the original description of this community (in Benson *et al.* 2010) gives the associated *Callitris* as White Pine *C. glaucophylla.*

Correspondence with Box Gum Woodland

Appendix 2 also shows the levels of correspondence of the dominant woodland in this study with characteristic species listed under the NSW listing of the endangered ecological community *White Box Blakely's Red Gum Yellow Box Woodland.*

Of the 68 species identified in this study as being part of the riparian woodland community, 25 (37%) of these are listed as characteristic species under the Box Gum Woodland NSW Scientific Committee determination. Of the 94 characteristic species listed in the determination, 28 (28.7%) were found within the targeted riparian community. In both regards this measure of correspondence with the scientific determination is high, supporting the notion that the community described at PCT544 matches the listing of Box Gum Woodland under the *Threatened Species Conservation Act 1997*.

For the Commonwealth-listed Box Gum Woodland CEEC, key is the diversity of the forb component of the groundstorey;

"*A patch in which the perennial vegetation of the ground layer is dominated by native species, and which contains at least 12 native, non-grass understorey species (such as forbs, shrubs, ferns, grasses and sedges) is considered to have a sufficiently high level of native diversity to be the listed ecological community".*

Only eight of the 16 surveyed transects would meet this criterion, due to the variation in condition encountered at the transects. Overall it could be easily acknowledged that this community does correspond with the Commonwealth listing.

Tree dieback

Within the central area of Bohena Creek, between where Oil Well Road and Brandon's Road intersect Bohena Creek Road, patches of dieback seem to be affecting the riparian red gums. Some regrowth on the branches of these red gums is occurring now, no doubt in response to above average rainfall in 2016, but dead tree rates of 30% of all standing stems are high as was noticed at one site. Drone imagery of Bohena Creek above and below X-Line Road show significant areas of red gum dieback on both sides of the creek.

What is causing this dieback? A likely candidate is reduced surface flow due to drought throughout the 2000s as well as hot years in 2014 and 2015. But if this were the case why is there no evidence of significant dieback outside the affected zone?

Another potential impact on tree health would be depressed water tables. Red Gums are known to have relatively shallow root systems, and are prone to drops in water tables. But again, why only within one zone?

An inescapable correlation is the fact that the dieback zone lies within an area with a high number of active and historic gas wells. Given the environmental risk assessment provide in the EIS, impacts from gas activities could result in aquifer depressurisation as well as contamination from coal seam water or other chemicals.

Further studies on water depth and quality in Bohena Creek warrants further investigation.

References

Benson JS, Richards PG, Waller S and Allen CB. 2010, 'New South Wales vegetation classification and assessment: Part 3 Plant communities of the NSW Brigalow Belt South, Nandewar and west New England Bioregions and update of NSW Western Plains and South-western Slopes plant communities, Version 3 of the NSWVCA database', *Cunninghamiana* 11(4), pp 457-579.

EcoLogical Australia, 2016. *Narrabri Gas Project: Ecological Impact Assessment.* Prepared for Santos NSW (Eastern) Pty Ltd.

Appendix 1: Data sheets for site surveys

Site No	**1**				
Description	Creaghs Crossing	Creaghs Road	Borah Creek		
t1		-30.77747	149.549219		
PCT	544				
Diversity	29				
Weed cover	15%				
Overstorey	Total	Angophora floribunda	Eucalyptus blakelyi	Callitris glaucophylla	
cover	30%				
height	15-20m				
Number >10cm	113 alive	64	9	40	
Dead trees	25 (18.1%)				
Midstorey	Total	Acacia polybotrya	Callitris glaucophylla	Acacia deanii	Acacia sertiformis
cover	10%				
Understorey	Total	Xanthorrhea acaulis	Hibbertia obtusifolia	Lomandra longifolia	Dianella revoluta
cover	20%				
Groundcover	Grasses 5	Forbs 12	litter	bare	
Cover	5%	5%	70-80%	5-10%	
Diversity	6	11			
t2		-30.77789	149.54866		
PCT	544				
Diversity	29				
Weed cover	30%				
Overstorey	Total	Angophora floribunda	Eucalyptus blakelyi	Callitris glaucophylla	Allocasuarina luehmannii
cover	20%				

height	15-20m				
Number >10cm	111	86	20	4	1
Dead trees	4 (3.5%)				
Midstorey	Total	Acacia deanii	Acacia polybotrya		
cover	10%				
Understorey	Total	Cyperus	Lomandra longifolia	Dianella revoluta	Lepidosperma laterale
cover	5%				
Groundcover	Grasses	Forbs	litter	bare	
Cover	<5%	<5%	90%	5%	
Diversity	6	10			
bed	-30.77755	149.54896			
Overstorey	Total				
cover	0				
Dead trees					
Midstorey	Total	Acacia deanii			
cover	<5%				
Understorey	Total				
cover	<5%				
Groundcover	Total				
Cover	<5%				

Site No	**2**		
Description	Garlands Crossing	Garlands Road	Bohena Creek
t1		-30.70468	149.56732
PCT	544		
Diversity	26		
Weed cover	10%		
Overstorey	Total	Angophora floribunda	Eucalyptus blakelyi

cover	20-25%					
height	15-20m					
Stems >10cm	111	58	53			
Dead trees	12 (9.8%)					
Midstorey	Total	Acacia deanii	Callistemon linearis			
cover	10%					
Understorey	Total	Lomandra longifolia	Olearia elliptica	Gahnia aspera		
cover	35%					
Groundcover	Grasses	Forbs	litter	bare		
Cover	20%	30%	40%	10%		
Diversity	5	15				

t2		-30.70471	149.56652			
PCT	544					
Diversity	31					
Weed cover	10%					
Overstorey	Total	Angophora floribunda	Eucalyptus blakelyi	Callitris glaucophylla	Eucalyptus melliodora	Brachychiton populneus
cover	30%					
height	15-20m					
Number >10cm	83	16	28	37	1	1
Dead trees	10 (10.8%)					
Midstorey	Total	Acacia deanii	Callistemon linearis			
cover	5%					
Understorey	Total	Lomandra longifolia	Dianella longifolia	Gahnia aspera		
cover	10%					
Groundcover	Grasses	Forbs	litter	bare		
Cover (%)	20	40	30	<5		
Diversity	6	16				

bed	-30.70449	149.567004		
Overstorey	Total			
cover	0			
Midstorey	Total	Acacia deanii		
cover	5%			
Understorey	Total	Juncus	Cyperus	Gahnia aspera
cover	5%			
Groundcover	Total			
Cover	<5%			

Site No	**3**			
Description	Oil Well Rd crossing	Bohena Creek		
t1	-30.65929	149.59342		
PCT	544			
Diversity	20			
Weed cover	10%			
Overstorey	Total	Angophora floribunda	Eucalyptus blakelyi	Callitris glaucophylla
cover	10%			
height	15m			
Number >10cm	76	39	6	31
Dead trees	2 (2.6%)			
Midstorey	Total	Acacia deanii	Olearia elliptica	
cover	<5%			
Understorey	Total	Hibbertia obtusifolia	Melichrus urceolatus	
cover	10%			
Groundcover	Grasses	Forbs	litter	bare
Cover	<5%	<5%	85%	10%
Diversity	5	8		

t2	-30.65931	149.59219		
PCT	544			
Diversity	20			
Weed cover	30%			
Overstorey	Total	Angophora floribunda	Eucalyptus blakelyi	
cover	15%			
height	15-20m			
Number >10cm	69	27	42	
Dead trees	17 (19.8%)			
Midstorey	Total	Acacia deanii	Callistemon linearis	
cover	10%			
Understorey	Total	Lomandra longifolia	Gahnia aspera	
cover	<5%			
Groundcover	Grasses	Forbs	litter	bare
Cover	<5%	<5%	70%	25%
Diversity	6	9		

bed	-30.65926	149.59287	
Overstorey	Total		
cover	0		
Dead trees			
Midstorey	Total	Acacia deanii	
cover	<5%		
Understorey	Total	Juncus	Gahnia aspera
cover	<5%		
Groundstorey	Total		
cover	<5%		

Site No	4				
Description	Bohena Creek Road	Sth of Brandons Rd junction			
t1	-30.60316	149.63229			
PCT	401?				
Diversity	18				
Weed cover	35%				

Overstorey	Total	A. floribunda	C. glaucophylla	E. chloroclada	E. blakelyi
cover	20%				
height (m)	15				
Number >10cm	92	27	54	9	2
Dead trees	25 (21.4%)				

Midstorey	Total	A. deanii	C. glaucophylla
cover	25%		

Understorey	Total	Lomandra longifolia	Gahnia aspera
cover	10%		

Groundcover	Grasses	Forbs	litter	bare
Cover	5%	5	75	15
Diversity	5	6		

t2	-30.60343	149.63084
PCT	544	
Diversity	13	
Weed cover	50%	

Overstorey	Total	E. blakelyi	A. floribunda	C. glaucophylla
cover	5%			
height	20m			
Number >10cm	47	12	10	25
Dead trees	25 (34.7%)			

Midstorey	Total	A. deanii		
cover	<5%			
Understorey	Total	L. longifolia	Cyperus	
cover	10%			
Groundcover	Grasses	Forbs	litter	bare
Cover	<5%	<5%	20%	70%
	4	3		

bed	-30.60327	149.63158
Overstorey	Total	
cover		
Dead trees	0	
Midstorey	Total	
cover	<5%	
Understorey	Total	
cover	<5%	
Groundcover	Total	
Cover	<5%	

Site No	**5**				
Description	Bohena Creek Road	Sth of Apple road junction			

t1	-30.56915	149.64954			
PCT	409				
Diversity	21				
Weed cover	5%				
Overstorey	Total	Angophora floribunda	Callitris glaucophylla	Eucalyptus chloroclada	Eucalyptus blakelyi
cover	15%				
height	15m				

Number >10cm	48	4	38	5		1
Dead trees	7 (12.7%)					
Midstorey	Total	Acacia deanii	Callitris glaucophylla			
cover	10%					
Understorey	Total	Melichrus urceolatus	Calytrix tetragona	Cryptandra amara	Leucopogon muricatus	
cover	30%					
Groundcover	Grasses	Forbs	litter	bare		
Cover	5%	5%	60%	30%		
Diversity	3	8				

t2	-30.56858	149.64850
PCT	544	

Diversity	21			
Weed cover	20%			
Overstorey	Total	Eucalyptus blakelyi	Callitris glaucophylla	
cover	10%			
height	15-20m			
Number >10cm	46	21	25	
Dead trees	8 (12.9%)			
Midstorey	Total	Acacia deanii		
cover	30%			
Understorey	Total	Lomandra longifolia	Gahnia aspera	
cover	30%			
Groundcover	Grasses	Forbs	litter	bare
Cover	5%	5%	80%	10%
Diversity	4	13		

bed	-30.55889	149.64905
Overstorey	Total	E. blakelyi
cover	<5%	
Dead trees		
Midstorey	Total	Acacia deanii
cover	5%	
Understorey	Total	Phragmites
cover	<5%	

Site No	6			
Description	Maudes Crossing	Maudes Road	Bohena Creek	
t1	-30.53889	149.65956		
PCT	544			
Diversity	23			
Weed cover	15%			
Overstorey	Total	E. blakelyi	A. floribunda	C. glaucophylla
cover	10%			
height	15m			
Number >10cm	108	8	1	96
Dead trees	20 (15.6%)			
Midstorey	Total	Acacia deanii		
cover	10%			
Understorey	Total	Lomandra longifolia	Gahnia aspera	
cover	5%			
Groundcover	Grasses	Forbs	litter	bare
Cover	10%	20%	40%	30%
Diversity	5	13		

t2	-30.53917	149.65875		
PCT	544			
Diversity	26			
Weed cover	10%			
Overstorey	Total	Angophora floribunda	E. blakelyi	C. glaucophylla
cover	20%			
height	15m			
Number >10cm	80	16	16	48
Dead trees	18 (18.4%)			
Midstorey	Total	A. deanii	C. glaucophylla	
cover	60%			
Understorey	Total	Lomandra longifolia	Crinium flaccidum	Gahnia aspera
cover	30%			
Groundcover	Grasses	Forbs	litter	bare
Cover	20%	20%	60%	0%
Diversity	5	14		
bed	-30.53900	149.65916		
Overstorey	Total			
cover	0			
Midstorey	Total			
cover	0			
Understorey	Total			
cover	<5%			
Groundcover	Total			
Cover	<5%			

Site No	**7**				
Description	Teds Hole	McCanns Road	Bohena Creek		

t1		-30.48398	149.65308		
PCT	544				
Diversity	29				
Weed cover	10%				
Overstorey	Total	Angophora floribunda	Eucalyptus blakelyi	Eucalyptus melliodora	Callitris glaucophylla
cover	15%				
height	15				
Number >10cm	78	19	12	2	45
Dead trees	12 (13.3%)				
Midstorey	Total	Acacia deanii	Callitris glaucophylla		
cover	5%				
Understorey	Total	Lomandra longifolia	Gahnia aspera		
cover	20%				
Groundcover	Grasses	Forbs	litter	bare	
Cover	20%	40%	35%	5%	
Diversity	6	16			

t2		-30.48431	149.65398	
PCT	544			
Diversity	21			
Weed cover	15%			
Overstorey	Total	Eucalyptus blakelyi	Angophora floribunda	Callitris glaucophylla
cover	5%			

height	15			
Number >10cm	93	21	4	68
Dead trees	15 (13.9%)			
Midstorey	Total	Acacia deanii		
cover	5%			
Understorey	Total	Lomandra longifolia	Gahnia aspera	
cover	10%			
Groundcover	Grasses	Forbs	litter	bare
Cover	10%	10%	75%	5%
	4	11		
bed		-30.48418	149.65361	
Overstorey	Total	Eucalyptus blakelyi		
cover	5%			
Dead trees	0			
Midstorey	Total	Callistemon linearis	Leptospermum polygalifolium	Acacia deanii
cover	50%			
Understorey	Total	Juncus	Cyperus	Gahnia aspera
cover	10%			
Groundcover	Total			
Cover	<5%			

Site No	**8**			
Description	Newell Hwy Bridge	Bohena Creek		
t1		-30.44481	149.67121	
PCT	544			
Diversity	24			
Weed cover	5%			
Overstorey	Total	Angophora floribunda	Eucalyptus blakelyi	Callitris glaucophylla
cover	50%			
height	15m			
number <10cm	142	35	11	116
Dead trees	10 (6.6%)			
Midstorey	Total	Callistemon linearis	Acacia deanii	
cover	5%			
Understorey	Total	Lomandra longifolia	Brachyloma daphnoides	
cover	10%			
Groundcover	Grasses	Forbs	litter	bare
Cover	70%	20%	10%	0%
Diversity	5	12		
t2		-30.44577	149.67001	
PCT	544			
Diversity	24			
Weed cover	10%			
Overstorey	Total	Angophora floribunda	Eucalyptus blakelyi	Callitris glaucophylla
cover	25%			

Number <10cm	83	1	67	15	
Dead trees	5 (5.7%)				
Midstorey	Total	Leptospermum polygalifolium	Callitris glaucophylla		
cover	5%				
Understorey	Total	Lomandra longifolia	Gahnia aspera		
cover	5%				
Groundcover	Grasses	Forbs	litter	bare	
Cover	50%	20%	25%	5%	
Diversity	6	12			
bed		-30.44542	149.67049		
Overstorey	Total	Eucalyptus blakelyi			
cover	10%				
Dead trees	0				
Midstorey	Total	Callistemon linearis	Leptospermum polygalifolium	Acacia deanii	
cover	10%				
Understorey	Total	Juncus	Cyperus	Carex	Alternathera
cover	90%				
Groundcover	Total	Ariundella			
Cover	5%				

Appendix 2: Species list

Table 1. Species list of community PCT 544/401 showing diversity and correspondence with characteristic species listed under the NSW listing of the endangered ecological community *White Box Blakely's Red Gum Yellow Box Woodland.*

	Overstorey	7
x	Eucalyptus blakelyi	
	Eucalyptus chloroclada	
	Angophora floribunda	
x	Callitris glaucophylla	
x	Eucalyptus melliodora	
x	Brachychiton populneus	
	Allocasuarina leuhmannii	
	Midstorey	6
	Acacia deanii	
	Acacia polybotrya	
	Acacia sertiformis	
	Callistemon linearis	
	Leptospermum polygalifolium	
	Senna artemisoides	
	Understorey	15
	Lomandra longifolia	
	Gahnia aspera	
x	Brachyloma daphnoides	
x	Dianella revoluta	
x	Dianella longifolia	
	Lepidosperma laterale	
	Crinium flaccidum	
	Persoonia sericea	
	Juncus sp	
	Cyperus sp	
x	Hibbertia obtusifolia	
	Xanthorrhea acaulis	
x	Melichrus urceolatus	
	Swainsona cadellii	
x	Olearia elliptica	
	Grasses	14
x	Aristida ramosa	
	Aristida caput-medusa	
	Aristida jerichoensis	

	Microleana stipiodes	
	Digitaria diffusum	
	Eragrostris brownii	
x	Cymbopogon refractus	
x	Austrostipa scabra	
	Austrostipa verticullata	
	Austrostipa setacea	
x	Themeda australis	
	Ariundella nepalensis	
x	Dichelachne micrantha	
	Imperata major	
	Forbs	27
	Dichondra repens	
	Helichrysum apiculatum	
x	Glycine clandestina	
x	Glycine tabacina	
x	Oxalis perennans	
	Pomax umbellata	
	Fimbristylus dichotoma	
	Urtica incisa	
x	Rumex brownii	
x	Sida corrugata	
	Lomandra multiflora	
x	Brunoniella australis	
	Goodenia glabra	
	Goodenia hederacea	
x	Geranium solanderi	
x	Plantago debilis	
	Desmodium brachypodium	
x	Templetonia stenophylla	
	Poranthera microphylla	
x	Cheilanthes sieberi	
	Ajuga australis	
	Einadia trigonos	
	Podolepus jaceoides	
	Alternanthera denticulata	
	Commersonia procumbens	
	Vernonia cinerea	
	Vittadinia dissecta	
25		69
36.8%		

Table 2. Characteristic species of the NSW listing of the endangered ecological community *White Box Blakely's Red Gum Yellow Box Woodland* and level of correspondence with species detected in this study.

Acacia buxifolia	
Acacia implexa	
Acacia paradoxa	
Allocasuarina verticillata	
Alectryon oleifolius	
Aristida behriana	
Aristida ramosa	x
Asperula conferta	
Atalaya hemiglauca	
Austrodanthonia auriculata	
Austrodanthonia bipartita	
Austrodanthonia racemosa	
Austrodanthonia richardsonii	
Austrostipa aristiglumis	
Austrostipa blackii	
Austrostipa nodosa	
Austrostipa scabra	x
Bothriochla macra	
Brachychiton populneus	x
Brachyloma daphnoides	x
Bracteantha viscosa	
Brunoniella australis	x
Bulbine bulbosa	
Bursaria spinosa	
Callitris endlicheri	
Callitris glaucophylla	x
Capparis mitchellii	
Cassinia longifolia	
Cassinia quinquefaria	
Cheilanthes sieberi	x
Chloris trucata	
Chloris ventricosa	
Chrysocephalum apiculatum	x
Cymbopogon refractus	x
Dianella longifolia	x
Dianella revoluta	x
Dichanthium sericeum	
Dichelachne micrantha	x
Dichelacne sciurea	

▯	Diuris dendrobioides	
▯	Dodonaea viscosa	
▯	Echinopogon caespitosus	
▯	Ehretia membranifolia	
▯	Elymus scaber	
▯	Eremophila mitchellii	
▯	Eucalyptus blakelyi	x
▯	Eucalyptus albens	
▯	Eucalyptus bridgesiana	
▯	Eucalyptus conica	
▯	Eucalyptus goniocalyx	
▯	Eucalyptus melliodora	x
▯	Eucalyptus microcarpa	
▯	Eucalyptus nortonii	
▯	Eulalia aurea	
▯	Exocarpos cupressiformis	
▯	Geijera parviflora	
▯	Geranium solanderi	x
▯	Glycine clandestina	x
▯	Glycine tabacina	x
▯	Glycine tomentella	
▯	Gonocarpus elatus	
▯	Goodenia pinnatifida	
▯	Hibbertia linearis	
▯	Hibbertia obtusifolia	x
▯	Hypericum gramineum	
▯	Jacksonia scoparia	
▯	Jasminum lineare	
▯	Jasminum suavissimum	
▯	Leptorhynchos squamatus	
▯	Lissanthe strigosa	
▯	Lomandra filiformis	
▯	Melichrus urceolatus	x
▯	Microseris lanceolata	
▯	Notelaea microcarpa	
▯	Olearia elliptica	x
▯	Olearia viscidula	
▯	Oxalis perennans	x
▯	Pandorea pandorana	
▯	Panicum queenslandicum	
▯	Parsonsia eucalyptophylla	
▯	Pimelea curviflora	
▯	Plantago debilis	x

□	Plantago gaudichaudii				
□	Poa labillardieri				
□	Poa sieberiana				
□	Rostellularia adscendens				
□	Rumex brownii		x		
□	Sida corrugata		x		
□	Sorghum leiocladum				
□	Stackhousia monogyna		x		
□	Stackhousia viminea				
□	Swainsona galegifolia				
□	Templetonia stenophylla		x		
□	Themeda australis		x		
□	Wahlenbergia sp		x		
		94		28	28.70%

Appendix 3: Drone shots of red gum dieback along Bohena Creek

Koala survey within PEL 238, October/November 2016 and assessment of significance of impact

Ethical Ecology ABN: 57227012954| December 1, 2016

All information presented in this report is, to the fullest extent of my ability, a true and accurate account.

David C. Paull (M.Res.Sc, B.Sc, Dip.Hum)

Accredited Biobanking Assessor #0019

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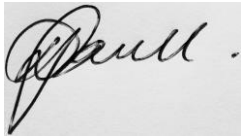

8 December 2016

Contents

Terms & Abbreviations

Abbreviation	Meaning
FBA	Framework for Biodiversity Assessment (NSW)
ha	hectare
DoPE	Department of Planning and Environment
EIS	Ecological Impact Statement
TSC Act	Threatened Species Conservation Act 1995
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
TEC	Threatened Ecological Community
EP&A Act	Environmental Planning and Assessment Act 1979

1. Introduction

Ethical Ecology was engaged by Lock the Gate to undertake a review of data concerning the current status of the koala (*Phascolarctos cinereus*) within the PEL 238 (Santos), to conduct a survey within the PEL 238 and to undertake an assessment of the significance of impact from the proposed Narrabri Project production field would have on the koala.

Currently, the existing gas infrastructure is restricted to privately held land and state forest, though Pilliga East State Conservation Area is located to the south of the current project area on the eastern side of the Newell Highway and the Pilliga National Park is located to the west of the PEL.

The project area covers a substantial area of known koala habitat and the koala was identified by the Commonwealth as Matter of National Environmental Significance (MNES) affected by the Narrabri Project in their Referral Decision (EPBC 2103/6918). In addition, the Critically Endangered Ecological Community (CEEC) 'Yellow Box – White Box – Blakely's Red Gum Woodland and Derived Grassland', preferred Koala habitat, found in the project area, was also identified as another reason the referral was 'called in'. Of note is that neither was identified in the Referral by Santos as being MNES affected by their action.

2. Background

Records of Koalas from BioNet in the Pilliga are shown in Figure 1 along with distribution of veg communities containing food trees for the koala which are shown in a paler green. There are two clusters of historic records within the PEL 238. One in the north associated with Pilliga Box/ironbark woodlands (a), and another associated with the Bohena/Borah/Yaminbah Creek system to the south (b). The approximate Narrabri Project Area is indicated in yellow.

SUMMARY OF HISTORIC RECORDS AND SURVEYS IN THE PEL

There have been a number of surveys for Koalas in this study area in the last five years. All have indicated that low numbers of koalas have persisted in this area at least until recently:

Community Biodiversity survey in 2011. One old scat was located in the central part of the Bohena Creek above the X-Line Road crossing. This scat was very old and could have been in situ for more than a year.

OEH survey 2013/14. Part of an Environmental Trust grant to determine extent of decline of Koalas in the Pilliga. This data has not been published, though is in the preparation stage and records relevant to this study are indicated in the results. In total, four locations with koala scats were detected in the area of the northern population, one of which is located in the PEL while, one location was detected on Borah Creek, just to the south of the PEL. At this time this part of the creek system has large numbers of scats suggesting more than one animal was present at the time.

This results of this unpublished study by OEH has supported earlier evidence that the Pilliga meta-population has declined significantly over the last 15 years, to leave only a few isolated pockets of animals. This contention has been re-iterated by Paull and Hughes (2016) and Predavec (2016).

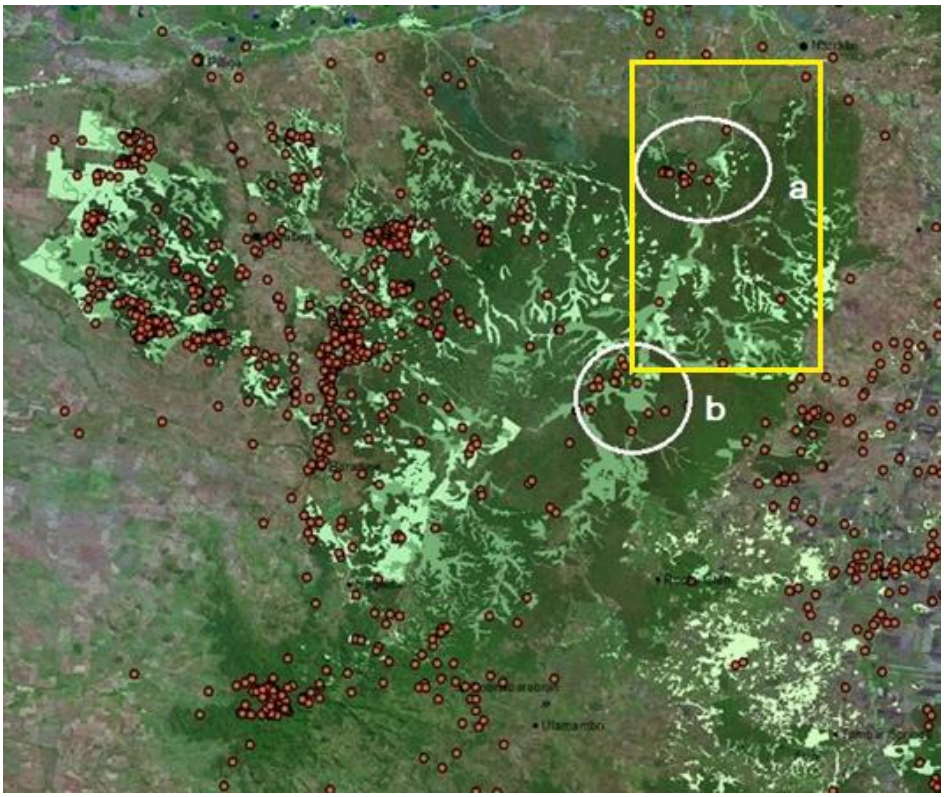

Figure 1. BioNet records of Koalas in the Pilliga Forests with extent of mapped Koala habitat.

Subsequently, there was a sighting of a koala at Cocoboy 2 Dam in August 2014 (M. Rowe NPWS, Coonabarabran, pers. comm.) near where all the scats were detected six months before during the OEH survey. This record has been submitted to the Atlas of New South Wales Wildlife. A photograph was supplied, showing the male animal in a Fuzzy Box tree.

Photo 1: Male Koala at Cocoboy 2 dam in 2014 (M. Rowe).

OWAD survey 2016. conducted a sniffer dog survey in April this year (2016) in both historic population areas, with scats found on Crow Road to the west of the Newell Highway and a likely location on Bohena Creek in the southern end of the PEL. The sniffer dog indicated scat presence though could not be located and so may have perished. Again, this indicates that koala presence in this area has been recent.

Santos conducted a survey for Koalas in the Pilliga late in 2014 (R. Kavanagh, pers. comm.) though these results are not publicly available until the Environmental Impact Statement for the Narrabri Production Field EIS is submitted to the government.

At the time that this study was conducted, the Australian Wildlife Conservancy detected koala(s) in their project area to the west of the PEL in the northern part of the forest (http://www.australianwildlife.org/field-updates/2016/historic-partnership-launched-in-the-pilliga-forest.aspx).

3. Methodology

Two methods were employed for the field survey component of this study. There were targeted SAT searches and road transects. The locations of both are shown in Figures 2 and 3

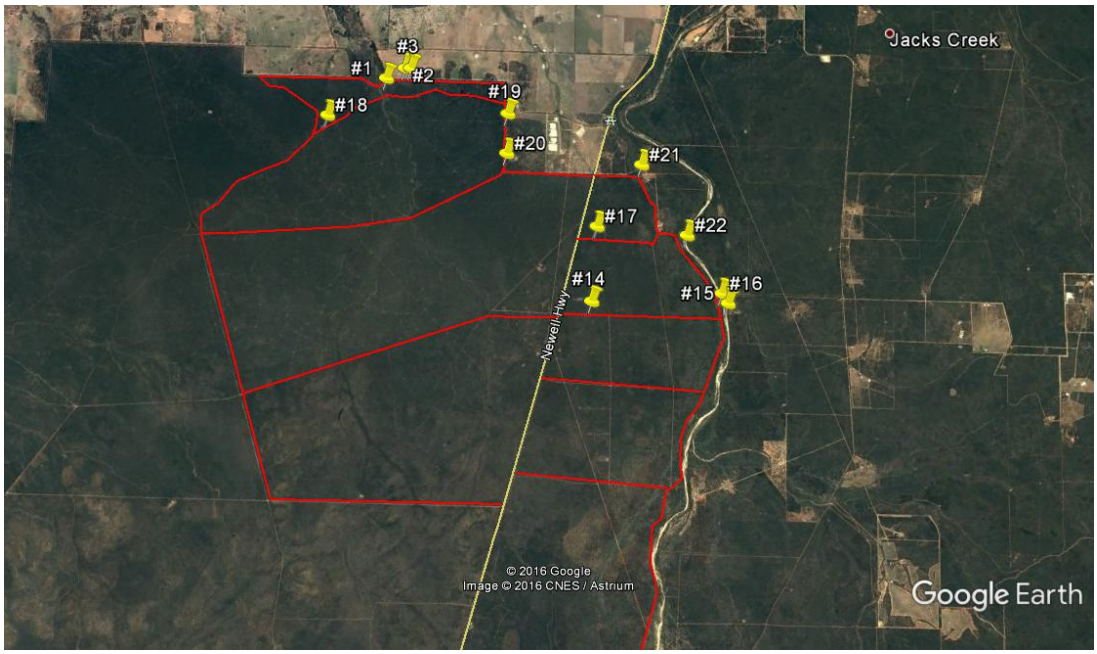

Figure 2. Survey effort northern population

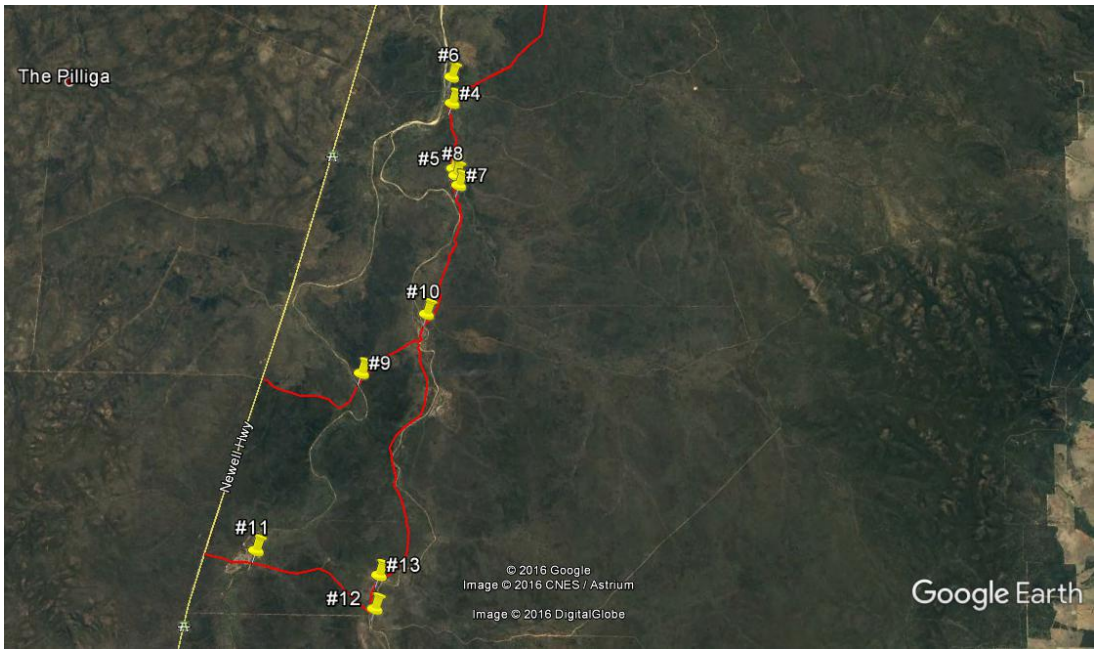

Figure 3. Survey effort in the southern area

TARGETED SAT SEARCHES

These survey generally follow the methodology as outlined in (Phillips and Callaghan 2011), with the following modifications. 22 sites were surveyed and were marked using a GPS.

(a) Sites were selected according to presence of known koala food trees, where these species formed a dominant component in the canopy, confirmed by field inspection. Four koala food trees were identified, Pilliga Box, Yellow Box, Blakely's Red Gum and Fuzzy Box (Date and Paull 2000; Kavanagh and Barrott 2001; Kavanagh *et al.* 2007; NSW Recovery Plan for the Koala, NPWS 2008). Sites were selected from each of the communities, though number of sites dominated by Fuzzy Box and Yellow Box were fewer due to their limited distribution in the study area (2 sites each), compared to the other two species (9 sites each for Pilliga Box and Blakely's Red Gum).

(b) Sites were two hectares in size. All trees greater than 10 cm in diameter and found 50m either side of central transect 200m long. were searched for koala scats. As the emphasis was on the location of more recent scats, no disturbance of the ground was undertaken, just a visual inspection of the area around the base of the trunk in a 2m diameter circle. Searches were undertaken by a team of trained searchers.

(c) Within each site, all trees were also searched for individuals in the canopies and branches.

ROAD TRANSECTS

Taking into account the distribution of previous records, roads were surveyed during daylight hours for individuals, shown in red in Figures 2 and 3. In a forest with little traffic, koalas seem not to avoid roads. However more intense activity, such as logging, will prompt animals to leave particular areas for varying amounts of time (Kavanagh, Stanton and Brassil 2007).

Roads were surveyed by a slow-moving vehicle first along one side of the road and then along the other side. All trees, where possible, were searched for koalas.

4. Results

VEGETATION COMMUNITIES

Four vegetation communities were surveyed during the study, each dominated by a different Koala food tree. White Cypress Pine (*Callitris glaucophylla*) and Bull oak (*Allocasuarina leuhmannii*) often occur as sub-dominant canopy species in all these communities.

- **Pilliga Box (*Eucalyptus pilligaensis*)** is a common species in the western and northern areas of the forest, preferring heavier clayey soils. It also grows with Brigalow (*Acacia harpophylla*) to the north of the Pilliga Forest on the heavier gilgaed soils which retain water well, though in the state forest it occurs either in pure stands or in association with Narrow-leafed Ironbark (*Eucalyptus crebra*). It generally occurs as a grassy woodland, with scattered shrubs, though shrub cover and be higher in more sandy areas.

  Pilliga Box is mapped as 'Pg' in the Lindsay Type mapping for forest (Lindsay 1967), though is distributed much more widely in areas dominated by Narrow-leaf Ironbark where it can occur as a sub-dominant.

Photo 2. Pilliga Box Woodland

- **Blakely's Red Gum (*Eucalyptus blakelyi*)** is another common species in the Pilliga forests, often found in riparian zone associations with Rough-barked Apple (*Angophora floribunda*). This red gum can also occur in mixed associations with both Pilliga Box and Narrow-leaf Ironbark as well as dominating areas of 'sand monkey' and other alluvial features. It occurs as

grassy to shrubby woodland, in riparian areas sometimes forming dense midstorey patches of tea-tree and bottlebrush.

Where it forms a dominant in the canopy and has a grassy understorey this community fits the definition of the Box Gum CEEC at either the State or Commonwealth levels.

Photo 3. Blakely's Red Gum – Rough-baked Apple woodland, Bohena Creek

- **Fuzzy Box (*Eucalyptus conica*)**

Seems to be restricted to sections of the Bohena Creek and major tributaries below X-Line Road and extending down into the state conservation area. It often grows in pure stands or with Yellow Box and Blakely's Red Gum, within the flood zone of the creek where it forms a grassy woodland.

This community matches the description of the NSW endangered ecological community 'Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South bioregions'.

Photo 4. Fuzzy Box woodland, Bohena Creek

- **Yellow Box (*Eucalyptus melliodora*)** is also found throughout the Bohena Creek system, as scattered trees or forming tall Yellow Box-woodland in the southern end of the state forest and adjacent parts of the state conservation area in relatively small patches. It is a grassy woodland, growing on the alluvial soils like the Fuzzy Box.

Photo 5. Yellow Box woodland, Bohena Creek

Where it forms a dominant in the canopy and has a grassy understorey this community fits the definition of the Box Gum CEEC at either the State or Commonwealth levels.

CONDITION OF BOHENA CREEK

The condition of all sites appeared to be good, both in the understorey and the overstorey, particularly since the above average rainfall this winter had contributed to a large amount vegetation growth across the forest. However large lengths of tree dieback were noticed along Bohena Creek, mostly in the larger red gum trees, though other areas showed less tree death but widespread evidence of crown die-back both in the younger and older trees.

The area affected seems to commence with crown die-back in the vicinity of Oil Well Road, to areas where most of large trees have died along the creek bank. In some of the affected areas, recent rains have encouraged good understorey growth, though does not seem to have benefitted the trees.

Th extent of the dieback seems to extend from Oil Well Road to Maude's Road Crossing some 17 km to the north.

Photo 6. Dead red gums on Bohena Creek, south of Maude's Road crossing

What is the cause of this dieback, is it drought? It is difficult to understand why certain sections of the creek appear to be dying back while other areas remain healthy, particularly the section of the creek at Garlands Crossing and to the south of here and the creek at the Newell Highway bridge and going north. Drought would surely create a more uniform effect, if reduced surface flow and rainfall were the main factor for this dieback.

Predavec (2016) in his case study paper to the NSW Chief Scientist and Engineer, suggests that sanding up of the creeks in the Pilliga could be important for reducing habitat suitability for the koala. While creeks have been subject to increased sand movement from agricultural and forestry operations in and around the forest, the peak times of disturbance in the forest was in the early 20th century. It is known that the creeks have been carrying larger volumes of sand for many decades,

first noted in Rolls' historic novel, 'A Million Wild Acres'. During the last period when large numbers of koalas existed in the Pilliga (1990s), creeks have been carrying increased sand loads for some time, while still allowing flow during periods of high rainfall (pers. obs., 2016)

Bohena Creek is mapped as a groundwater dependent ecosystem (GDE) in the Australian GDE Atlas, one that is 'moderately dependent' on surface discharge of groundwater. There are springs and semi-permanent water holes still found in some of the creeks in the Pilliga, both are also present in the PEL. These features are typical of very shallow alluvial aquifers.

Rather than any reduction of conditions upon the surface, such as reduced flow, it seems more likely that such extensive tree death is due to prolonged drops in groundwater level. What else could cause the death of deeper rooted trees while still maintaining a native understorey which is much more dependent on surface water and maintaining healthy sections of creek upstream and downstream?

When the extent of the dieback zone is compared to the distribution of well sites thee is a fairly strong correspondence.

Figure 4. Extent of dieback on Bohena Creek

Further studies are being undertaken by Ethical Ecology to compare the structure and species composition of the native plants from different locations along Bohena Creek. It is evident from studies undertaken so far that there are also differences in the understorey, particularly loss of some species and greater growth of others within the creek-bed in areas affected by dieback compared to other areas which appear healthy.

Besides being an impact upon a listed CEEC, whatever the status of the local koalas in the study area, the death and decreasing condition of a large proportion of food trees for the koala is likely to

restrict movement and dispersal of this species along Bohena Creek, thereby reducing and fragmenting its habitat.

FIELD SURVEY RESULTS

Koalas were detected at only two locations during the surveys, scats were detected at site #12 on Borah Creek and an individual was sighted during a road transect on the northern boundary of the forest on Dog Proof Fence Road. Locations of koala records in and near the PEL recorded during this study or within the last three years are indicated in Figure 4.

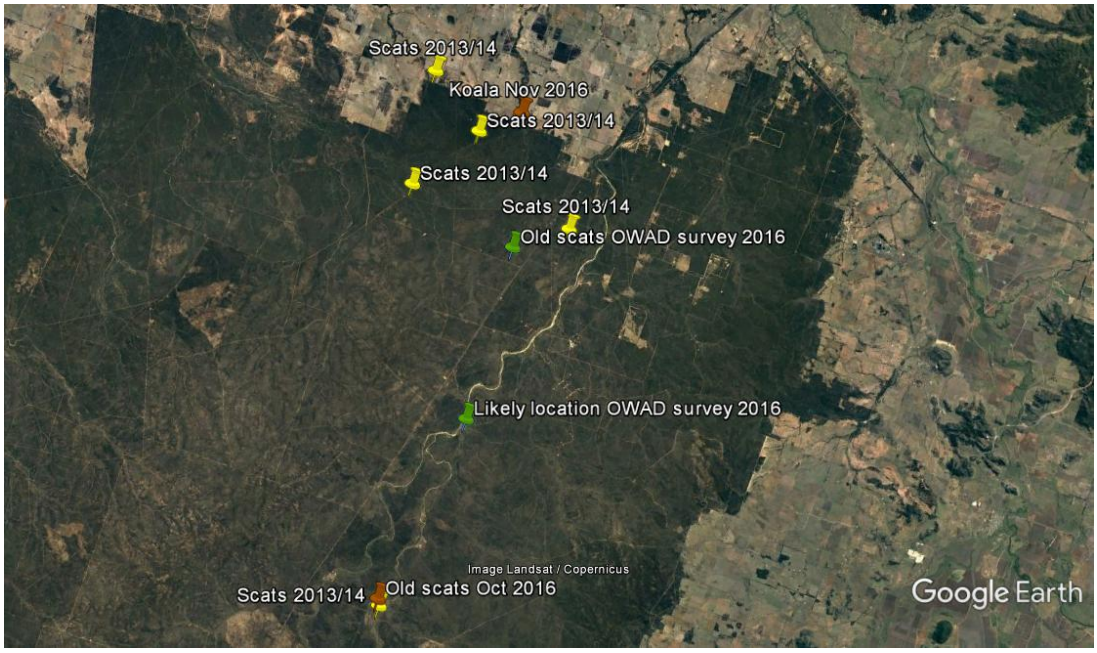

Figure 5. Locations of koala observations (2013-2016)

Photo 7. Probable koala scats, site 12.

A pile of old scats within the size range for koala (up to 3 cm long) were found near a Rough-barked Apple tree on the riverbank of the creek (lat -30.860843 long 149.519351). They could have been a year or more old, judging by their highly weathered condition. Nonetheless traces of the longitudinal ridges can be seen on some of the scats (Photo 7).

A male individual was observed during a road transect on Dog Proof Fence Road on the western side of Bundock Creek (lat -30.477659 long 149.566677)which flows into the Namoi River to the north. He was situated low in a Blakely's Red Gum, was probably asleep when first approached (cover shot and Photo 8).

Photo 8. Koala at Bundock Creek

5. Discussion

Considering both the data from this study and the review of current information from a number of sources outlined in the preceding sections of this report, the following statements can be made about the current status of the koala in the Pilliga forests generally and within the area covered by the PEL in particular.

All historic areas where populations of koalas existed in the Pilliga and Warrumbungles, have declined such that only very low numbers of animals are still to be found in a few refuge areas (Paull and Hughes 2016; Predavec 2016). Factors that have contributed to this decline include:

- Long period of below average rainfall and record number of heatwaves during the 2000s,
- Historic and ongoing disturbance in the forest, mainly from logging which has reduced canopy cover,
- Large fires in the south, east and Warrumbungles,

- Dog attack and vehicle collisions account for some recent deaths (S. Brookhouse. Pers. comm.)

Disease seems to be on the rise in the Liverpool Plains (P. Spark, pers. comm.) though Pilliga animals still seem healthy despite population crash. But overwhelmingly, the population crash of the Pilliga meta-population seems to be chiefly related to the dry period during the 2000s, which presumably has adversely affected tree health and overall habitat conditions for koalas, in similar ways as described for the Liverpool Plains (Lunney et al. 2012).

Recent records of animals in the northern part of the forest from both this study and the recent studies by the AWC indicate that koalas are still present here, and though currently at low numbers, may be dispersing, given above average rainfall experienced this year. Suitable habitat for the koala exists across the northern part of the PEL, from the Pilliga National Park across to Jacks Creek in the east, and their increasing presence in this area cannot be discounted.

The current status of the southern population associated with the Bohena Creek and tributaries is much less clear. While an animal and numerous scats were observed in 2013/14 in this area, subsequent surveys in 2016 has only yielded old scats. While some animals may be persisting in the upper reaches of this system where standing water can be found, the poor condition of Bohena Creek itself due to tree death is likely to lessen the probability of population surviving and re-colonising this area.

6. Assessment of significance of impact according to NSW assessment processes

The Assessment of Significance refers to the factors that must be considered by decision-makers to assess whether a proposal is likely to have a significant effect on threatened biodiversity. These mechanisms are contained in s5A of the EP&A Act and s94 of the TSC Act.

When undertaking a development under Part 4 of the EP&A Act, it is the responsibility of the applicant to provide the consent authority with an Assessment of Significance (as required by Schedule 1 of the Environmental Planning and Assessment Regulation 2000). However, a subsequent regulation has deemed that the assessment of significance should only be given due 'consideration' and decisions should not be bound by whatever outcome may be indicated in this.

Nonetheless an assessment according to s5A EP&A Act 1979 and s94 TSC Act 1995 has been given below. Significant effect on threatened species, populations or ecological communities, or their habitats has been indicated. The same 7 Part test is undertaken for both ecological communities, species and endangered populations. Questions not relevant to the entity being considered have been omitted.

In terms of assessing impact under the current state framework, the Framework for Biodiversity Assessment (FBA) has essentially replaced the Assessment of Significance. In theory, all ecosystems and species credits generated by the impact can be 'retired' by applying offsets or supplementary measures unless intervention by the Minister is triggered because the matter is a 'matters of further consideration' and whose impact cannot be mitigated. The test for matters for further consideration have also been considered here.

WHITE BOX RED GUM YELLOW BOX WOODLAND

Assessing the impact of CSG operations in the Narrabri Project Area should be treated with caution, particularly when dieback impacts upon Bohena Creek are taken into consideration. The link between CSG activities and the deterioration in the condition of the riparian vegetation along Bohena Creek cannot be proven at this stage, though could warrant application of the precautionary principle.

Often known as the Box Gum Woodland EEC, this community is listed as 'endangered' in NSW.

(c) In the case of an endangered ecological community or critically endangered ecological community whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Given current extent of damage to this ecological community possibly from indirect impacts of the CSG operations, further expansion of the well field and associated underground activities may adversely affect the extent of this ecological community.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction. the population is likely to be significantly compromised,

Modification of the ecological community was noticed in areas badly affected by dieback, including the loss of some understorey species, such as tea tree and bottlebrush, penetration of terrestrial species into the creekbed and loss of canopy.

(d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed

There will be small direct impacts of the Narrabri Project upon riparian vegetation through the construction of pipelines, though indirect effects which may contribute to dieback have affected over 15 km of creekbed along Bohena Creek.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Yes, if current trends in riparian dieback continue, upstream habitats in the Bohena/Borah and Yaminbah creek systems will be fragmented from similar these habitats lower downstream outside the state forest.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

If the locality is taken to mean the area covered by the proposed production field, then quite large scale impact upon the main stream in the project area is likely to continue, jeopardizing the survival of this community into the future.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not relevant

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

Activities which may cause significant indirect impact upon endangered ecological communities is not consistent with the objectives of the National Recovery Plan for Box Gum CEEC (DECC 2010).

"Matters for further consideration' under the Framework of Biodiversity Assessment outlined the following matters which need to considered:

(a) impacts on landscape features, being: (i) impacts that will reduce the width of vegetation in the riparian buffer zone bordering significant streams and rivers, important wetlands or estuarine areas in accordance with Subsection 9.2.3, or (ii) impacts that will prevent species movement along corridors that have been identified as providing significant biodiversity linkages across the state in accordance with Subsection 9.2.3, and

This criterion may be relevant to this ecological community as Bohena Creek is a 4th/5th order stream and so any direct impact upon the buffers from the proposed gas field could trigger this criterion. It would depend entirely upon the layout of the field. There are no identified corridors as yet in NSW.

(b) impacts on native vegetation that are likely to cause the extinction of an EEC/CEEC from an IBRA subregion or significantly reduce its viability in accordance with Subsection 9.2.4

The study area straddles two adjacent subregions, the Pilliga Outwash and the Pilliga subregions. Both cover extensive areas of the Brigalow Belt South Bioregion. This community has a wide distribution in this area and so it is unlikely that any impact on this community in the project area would trigger this criterion.

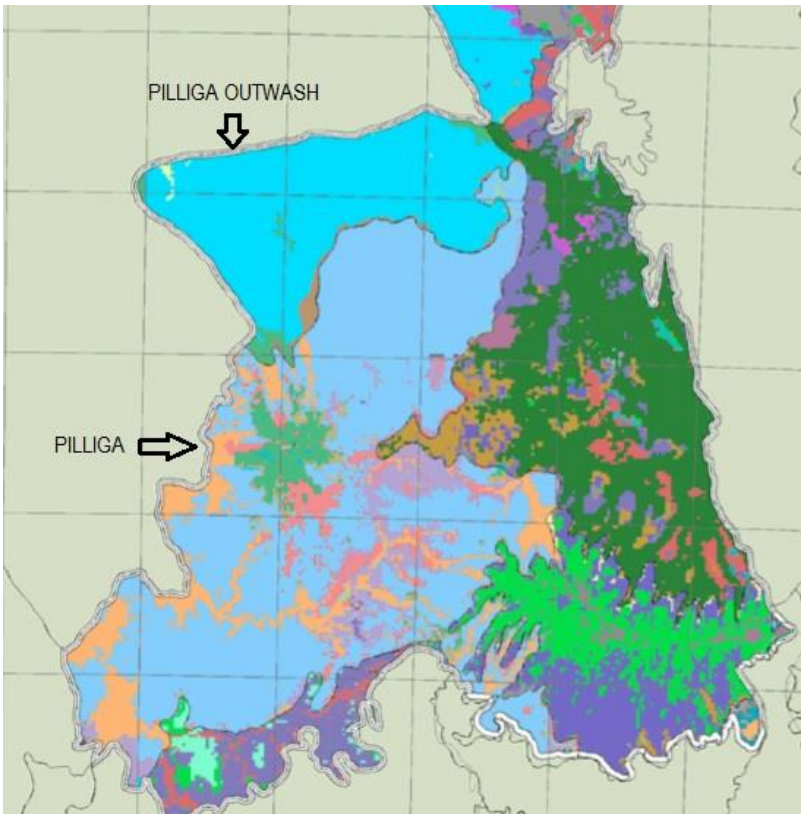

Figure 6. Subregions of the BBS bioregion

Section 9.2.4.1 of the FBA, Impacts on native vegetation, states that:

Impacts on native vegetation that require further consideration include impacts on: (a) any CEEC, unless the CEEC is specifically excluded by the SEARs (b) an EEC specifically nominated in the SEARS as an EEC that is likely to become extinct or have its viability significantly reduced in the IBRA subregion if it is impacted on by development.

This community is listed as an Endangered Ecological Community in NSW while being critically endangered under the EPBC Act. If the state accepts the EPC Act listing under the terms of the Assessment Bilateral Agreement, then this community should be triggered as a matter for further consideration.

There are no matters for further consideration identified in the SEARs (SSD 14_6456) though if this criterion is to be applied, then clearly criterion (b) is not triggered.

KOALA

Assessing the impact of CSG operations in the Narrabri Project Area should be treated with caution, particularly when dieback impacts upon Bohena Creek are taken into consideration. The link between CSG activities and the deterioration in the condition of the riparian vegetation along Bohena Creek cannot be proven at this stage, though could warrant application of the precautionary principle.

The koala is listed as 'Vulnerable' under the TSC Act 1995.

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Given the extent to which habitat would be fragmented increasing vehicle traffic and predator activity, the unknown removal of koala habitat to accommodate the new gasfield, the possible ongoing damage to the Bohena Creek environment and the very low numbers of animals in the project area, equivalent to an endangered or critically endangered status, it is more than likely that the action will jeopardise the survival of these populations.

(d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed

It is not known the extent of direct removal of koala habitat until the EIS is handed in, though koala habitat has been removed with the existing well field.

The tree dieback along Bohena Creek, one of the most important thoroughfares for the koala in the eastern side of the Pilliga has affected by modifying about 1.7 sq km (17km x 100m) of riparian forest. It Is not now how this dieback will continue to progress given the increase in wells that a production field would see.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Koala habitat in the project area is distributed through the forests in the north and mainly along the creeks and associated alluvial areas in the south. All these will lie within the project area and will be fragmented by extra roading, fencing and infrastructure placement. Increased traffic in the forest will see greater risk of vehicle collision. Precise details are not yet known.

Further deterioration of the condition of the riparian vegetation will also increase levels of internal fragmentation within the forest, inhibiting dispersal for this species and leading to greater genetic isolation.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

For the populations on the eastern side of the Pilliga, further habitat fragmentation and loss of habitat condition could jeopardise these populations' chances of recovery and survival. Bohena Creek is the main source of habitat for the southern population which is at most risk, as it is uncertain if any individuals are currently in that area. Though any upstream animals must be consider part of this population.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not relevant.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The NSW Koala Recovery Plan (2008) states that its objectives include:

1. To conserve koalas in their existing habitat, and
2. To rehabilitate and restore koala habitat and populations.

Given the level of threat the gas field poses to both the extent and condition of koala habitat on the study area and the possible impact this may have on populations with an extremely low population size, the action would not be consistent with these objectives.

"Matters for further consideration' under the Framework of Biodiversity Assessment outlined the following matters which need to considered:

(c) impacts on critical habitat or on threatened species or populations that are likely to cause the extinction of a species or population from an IBRA subregion or significantly reduce its viability in accordance with Subsection 9.2.5.

As mentioned above, the project area straddles two very large subregions. This area contains many historic koala populations from Moree to Gilgandra. Paull and Hughes (2016, Figure 7) identified each historic population and its current status based on the best available information. According to this scheme, the Pilliga Meta-population (B) contains 10 sub-populations, five of which can be considered to have a "uncertain status" due mostly to lack of records within the last 20 years, while the other five should be regarded as populations in significant decline. Three other isolated populations to the south, within the Pilliga subregion (#34, 35 and 36) also have their continued presence as being uncertain.

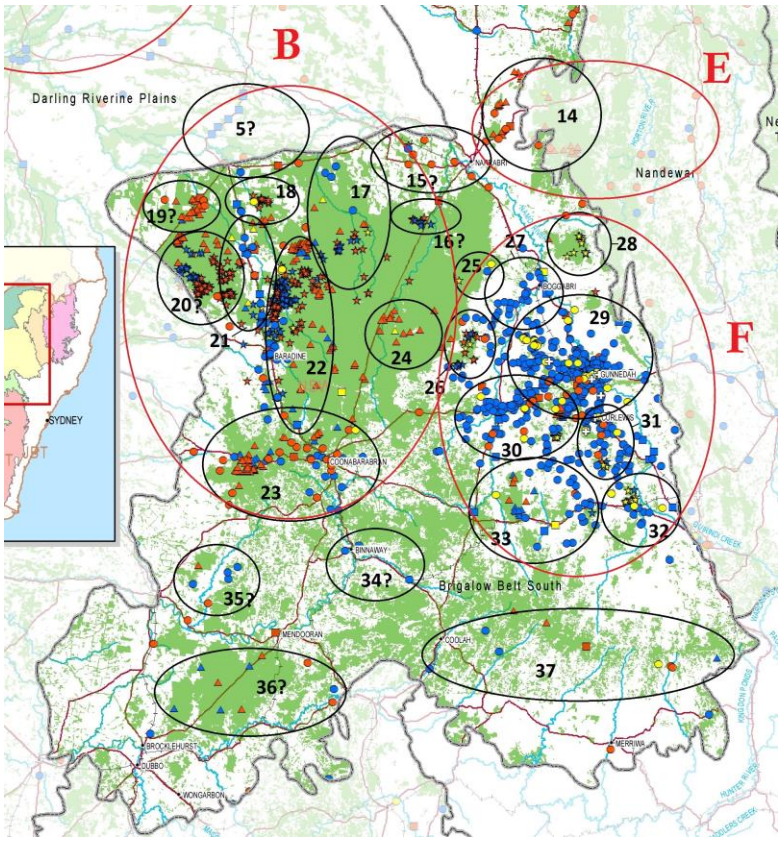

Figure 7. Koala populations in the Pilliga and surrounds (Paull and Hughes 2016)

The two local or sub-populations in question which are directly affected by the production field, will have their viability adversely affected through increased habitat fragmentation with greater intensity of habitat removal, roading and fencing, as well as possible impacts on the creek environment and further decline in the condition of this habitat, if it can be shown that gas infrastructure and usage has contributed to the poor condition of the creek and its endangered ecological community.

While the proposed action will have direct and indirect impacts on these two populations, the lack of certainty about the remaining populations in the subregions indicate that this action will contribute to the loss of this species in the subregions if threatening processes associated with the Narrabri Project are allowed to proceed.

Section 9.2.5.1 of the FBA, 'Impacts on threatened species', states that further consideration of the impacts of development is considered where it affects:

(a) on any critically endangered species, unless the critically endangered species is specifically excluded in the SEARs

The koala is not critically endangered.

(b) on a threatened species or population that is specifically nominated in the SEARS as a species or population that is likely to become extinct or have its viability significantly reduced in the IBRA subregion if it is impacted on by the development, or

No matters for further consideration were mentioned in the SEARs. However, if the advice mentioned above is taken into consideration, then this may be seen to be an omission primarily by the OEH.

(c) where the survey or expert report undertaken in Section 6.6 confirms that a threatened species is present on the proposed development site, and the threatened species has not previously been recorded in the IBRA subregion according to records in the NSW Wildlife Atlas.

This criterion is shamefully hard to meet. While it does take into account new records and extension ranges, criterion (c) has nothing to do with a species vulnerability to likely impacts or key threatening processes. The koala has been known from the Pilliga as a main stronghold for this species in NSW for a considerable time, with hundreds of historic records and so cannot meet this criterion.

KEY THREATENING PROCESSES

The following NSW-listed threatening processes that have been identified for the koala will be exacerbated by the proposed gas production field.

- Loss, modification and fragmentation of habitat
- Vehicle strike
- Predation by roaming or domestic dogs
- Intense prescribed burns or wildfires that scorch or burn the tree canopy
- Heat stress through drought and heatwaves
- Human-induced climate change
- Inadequate support for fauna rehabilitation
- Poor understanding of sources of trauma and mortality
- Poor understanding of population distribution and trend
- Poor understanding of animal movements and use of habitat

7. Assessment of significance of impact according to the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999

WHITE BOX-YELLOW BOX-BLAKELY'S RED GUM WOODLAND AND DERIVED NATIVE GRASSLAND

This ecological community is listed as being critically endangered in Australia. An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

• reduce the extent of an ecological community

The precise configuration of the gas production field is not yet known and so direct impacts cannot be calculated. Past well placement has impinged on this ecological community. Ongoing tree death along the Bohena Creek is a major impact on this CEEC and may be attributable to indirect effects of the existing gas field.

• fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

New roads and gas infrastructure have the potential to increase fragmentation of this CEEC.

• adversely affect habitat critical to the survival of an ecological community

Habitat removal, fragmentation and modification of the project has already affected habitat critical to the survival of the Koala.

• modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns

Depressurisation of aquifers is a major risk of coal seam gas production and pilot well operations as they both use the same methods for accessing underground gas. This has been identified in both the referral by Santos to the Commonwealth and in recent assessments by GISERA of the project. It is suggested by the author that current levels of tree death along Bohena Creek may in part be due to existing aquifer damage as a result of past impacts of the pilot-well projects in the area.

• cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting

Die-back along Bohena Creek represents a significant change in the structure and species composition of the CEEC. As well as tree death, differences in the species composition along the banks of Bohena Creek have been noticed such as the loss of some species (tea tree and bottlebrush) in the worst affected areas and the increase spread of terrestrial species in the creek-bed. These changes seem to signal long-term changes in the vegetation of this community.

Currently studies are being undertaken by Ethical Ecology to quantify the spread and specific changes in the dieback affected area when compared to healthy sections of creek both upstream and downstream.

• cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: - assisting invasive species, that are harmful to the listed ecological community, to become established, or - causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or

There have been a number of water related incidents as a result of activities by gas producers such as aquifer contamination and contamination of surface water environments. Aquifer contamination cannot readily be corrected, while rehabilitation efforts by the proponent of spill sites (of which about 20 exist in the Pilliga) show that these areas have been conduits to the spread of weeds such as Galvanised Burr and Blue Heliotrope in the forest.

• interfere with the recovery of an ecological community.

Direct and possibly indirect impacts that are expected by a production gas field (up to 800 individua wells and associated infrastructure)are not consistent with the objectives of National Recovery Plan for White Box-Yellow Box-Blakely's Red Gum Woodland and Derived Native Grassland

KOALA

This species is listed as being vulnerable in Australia. Given the criteria listed below (page 24), populations in this region should be considered as 'important populations'. An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

• lead to a long-term decrease in the size of an important population of a species

Given the points made below, the action is likely to lead to a long-term decrease of the size of the affected populations, such that their continued presence is uncertain. It is important that the action be placed within the context of a more general population decline in the BBS due mainly to drought though with possible climate change effects. The additional actions of habitat modification, loss and fragmentation may affect important recovery processes for the koala.

• reduce the area of occupancy of an important population

An unknown amount of direct habitat loss is expected as a result of construction of infrastructure for the Narrabri production field. Tree death along Bohena Creek has already resulted in significant loss of habitat for this species. If this phenomenon is linked to gas field activities, this loss is expected to increase.

• fragment an existing important population into two or more populations

Increased levels of gas infrastructure, particularly fencing associated with sites and associated clearing is likely to fragment and disrupt normal koala patterns of usage and dispersal in the forest.

It is possible that tree death along the Bohena Creek as already affected koala dispersal and usage in this area.

• adversely affect habitat critical to the survival of a species

Using the criteria outlined in the Interim Advice concerning significant impact on the koala (DSEWPaC 2012), all the habitats identified in this study may be considered to be 'habitat critical to the survival' of the koala.

• disrupt the breeding cycle of an important population

Interruptions to the dispersal and habitat use of a species is likely to impact on successful breeding by the koala due to more obstacles for koala to find partners and more obstacles to finding suitable habitat or refugia ie. drinking water in drought.

• modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

It is highly likely that a production field developed to the extent that is indicate din the referral to Commonwealth, will have the effect of modifying, destroying and isolating habitat such that the low numbers of koalas surviving in the area may fail to increase. The population in the Pilliga would certainly qualify as an 'endangered population under the TSC Act criteria.

• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

This is not easy to prove or disprove.

• introduce disease that may cause the species to decline, or

No evidence of this so far.

• interfere substantially with the recovery of the species.

Given the recovery actions for this species identified under the NSW Koala Recovery Plan (NPWS 2008) are likely to be affected, the proposed production field is likely to substantially interfere with the re3covery of this species.

What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

• key source populations either for breeding or dispersal

Recent surveys and populations assessments of the Pilliga koalas show that only five sub-populations out of 10 in the Pilliga and surrounds have small remnant numbers of individuals surviving at present. These must be considered source populations for future breeding and dispersal in the region. While some doubt remains about the persistence of Koalas in the Bohena Creek area, recent evidence shows that Koalas in the north of the forest are surviving and dispersing including into areas covered by the PEL 238. Recent scat evidence (this study and

OWAD survey 2016) suggest that some koalas may be persisting in some parts of the upper tributaries of the Bohena Creek.

- populations that are necessary for maintaining genetic diversity, and/or

These remnant populations must be considered to be necessary and important for maintaining genetic diversity.

- populations that are near the limit of the species range.

Given the grievous decline of koalas in the darling Riverine Plains and Brigalow Belt South bioregions, particularly those west of the Pilliga, the remaining Pilliga animals may represent the current western limit of this species distribution n NSW.

8. Conclusions

Existing data has been compiled with the results of this study. Information on koala status in the study area suggests that:

1. Koalas are currently present in the northern part of the Pilliga forest, both outside and within the PEL. Significant koala habitat exists in this area in the form of at least four different vegetation communities.
2. Koalas were known to be present until recently in the Bohena Creek system, though recent surveys have found only old scats. Koalas may still be present in the upper tributaries of this system, though it is equally likely that this population may have become locally extinct in the last few years. Use of the precautionary principle would suggest that this population should be regarded as being still present when undertaking impact assessments.
3. Significant tree die-back along Bohena Creek has resulted in a highly modified riparian woodland in some parts. Others are being affected by a more recent crown die-off suggesting an on-going phenomenon. This is also a considerable loss of koala habitat in the PEL. Potential causes for this worsening condition of the riparian woodlands, such as possible effects of aquifer depressurization and /or drought, warrant urgent investigation.

An assessment of the potential impact of a production field upon the Box Gum CEEC and koala show that:

4. Under the NSW legislation, there may be grounds for strong cases for a 'significant impact' upon these listed matters using the 'assessment of significance' pursuant to s5A of the EP&A Act and s94 of the TSC Act.
5. However, testing whether these two matters can be considered to be 'matters for further consideration' under the FBA, in a large part rests with any connection between the tree dieback and past gas field operations.
6. Under the FBA, there may be direct impacts on important streams depending on where the gas infrastructure is to be located.
7. Under guidelines within the EPBC Act, there is likely to be a significant impact upon both the Box Gum CEEC and the koalas a result of any production-scale gas field. This does not take into account any mitigating or offsetting actions the proponent wishes to pursue.

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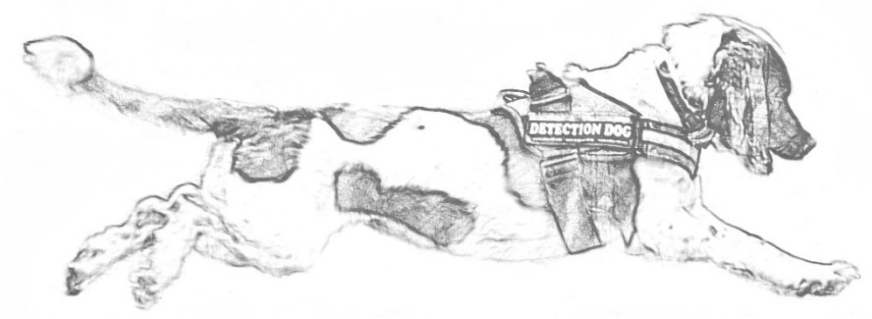
Appendix 1. Sites Register

Site	Tree association	Location	Lat (-)	Long (+)
1	E. blakelyi/A. floribunda	Dog Proof Fence Road	30.480316	149.574195
2	E. pilligaensis	Dog Proof Fence Road	30.478475	149.579739
3	E. pilligaensis	Dog Proof Fence Road	30.478662	149.581354
4	E. blakelyi/A. floribunda	Borah Creek Road	30.714915	149.566877
5	E. melliodora	Borah Creek Road	30.735112	149.564432
6	A. floribunda/E. blakelyi	Borah Creek Road	30.706723	149.567867
7	E. conica/E. blakelyi	Borah Creek Road	30.740387	149.565515
8	E. conica/E. blakelyi	Borah Creek Road	30.737337	149.564886
9	E. blakelyi/A. floribunda	Delwood Road	30.792691	149.524022
10	E. blakelyi/A. floribunda	Creaghs Road	30.777787	149.548754
11	E. blakelyi/A. floribunda	Kerringle Road	30.839746	149.481685
12	E. blakelyi/A. floribunda	Borah Creek Road	30.860843	149.519351
13	E. melliodora/E. blakelyi	Borah Creek Road	30.851583	149.522005
14	E. pilligaensis/E. crebra	Plumb Road	30.540673	149.622656
15	E. blakelyi/A. floribunda	Borah Creek Road	30.545459	149.659684
16	E. pilligaensis/E. crebra	Borah Creek Road	30.542965	149.658424
17	E. pilligaensis/E. crebra	Sawpit Road	30.523078	149.627016
18	E. pilligaensis/E. crebra	Cherry Road	30.487494	149.556641
19	E. pilligaensis/E. crebra	Dog Proof Fence Road	30.492973	149.606673
20	E. pilligaensis/E. crebra	Dog Proof Fence Road	30.502608	149.604898
21	E. pilligaensis/E. crebra	Old Mill Road	30.509702	149.641671
22	E. blakelyi/A. floribunda	Borah Creek Road	30.528087	149.651318

PILLIGA EAST STATE FOREST KOALA SURVEY

Prepared by OWAD Environment

for Western Woodlands Alliance



DOCUMENT CONTROL SHEET

Project Number: 160602

Client: Western Woodlands Alliance

Report Title: Pilliga East State Forest Koala survey

Report Author: Olivia Woosnam

Report Reviewer: Alex Dudkowski

Project Summary: This report presents the findings of a one-day Koala survey conducted with a professional detection dog in June 2016 in Pilliga East State Forest, New South Wales, Australia.

Document preparation and distribution history

Report Version	Date Completed	Checked By	Issued By	Date sent to client
Version 1	14/06/2016	Alex Dudkowski	Olivia Woosnam	17/06/2016
Version 2	20/06/2016	Olivia Woosnam	Olivia Woosnam	20/06/2016

Signed on behalf of OWAD Environment

Olivia Woosnam
Director
Date: 20/06/2016

Pilliga East State Forest Koala survey

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Figures

1.0 BACKGROUND AND PURPOSE OF THIS REPORT

OWAD Environment was engaged by Western Woodlands Alliance (WWA) to conduct a one-day survey of Koala *Phascolarctos cinereus* in Pilliga East State Forest, New South Wales, using Taz the professional Koala scat detection dog.

The purpose of this study was to gain an initial understanding of current presence/absence of Koalas across the areas assessed, based on presence/absence of the marsupial's characteristic scats (faecal pellets).

This report presents the findings of this study.

2.0 STUDY AREA

The Pilliga East State Forest is located in Narrabri Shire Council local government, New South Wales. It is situated 30km south of Narrabri and 60km northwest of Gunnedah (see **Figure 1**). The State Forest is approximately 1,350km^2 in size. At its widest, it is 70km East to West and 40km North to South.

3.0 METHODOLOGY

Koala presence/absence was inferred based on the presence/absence of the marsupial's characteristic scats. In order to (1) maximise the chances of detecting scats, (2) minimise bias and (3) assess a maximum amount of surface area, the field survey was conducted with the help of a professional Koala scat detection dog.

3.1 Selection of search areas

Prior to field survey, OWAD Environment discussed with local ecologist David Paull to determine where to concentrate the search effort. David had previously conducted Koala surveys through the region, and it was decided he would accompany OWAD Environment to take the study team to areas with the best chance of finding Koala presence. These areas included areas where Koala presence had been found in the past, or areas traditionally viewed as holding good Koala habitat values.

The objective was to conduct a maximum amount of searches in one day. As a result, search areas would have to be close to tracks accessible by car. Fortunately the Pilliga East State Forest has numerous 4WD access tracks throughout.

3.2 Field assessment

The field assessment was conducted by Olivia Woosnam (Senior Koala Ecologist), Alex Dudkowski (Field Ecologist) and Taz the professional detection dog on 7 June 2016. David Paull and Tania Marshall accompanied the study team for most of the day.

The study team used a handheld GPS (model Garmin GPSMap 78) to record the locations surveyed and the coordinates of any scats found.

This field assessment was conducted under OWAD Environment's Animal Ethics Permit № TRIM 15/2129 (NSW Department of Primary Industries), Scientific Licence № SL101634 (NSW Parks & Wildlife Service) and Research Permit № HF54587 (NSW Forestry Corporation).

Taz is a 4 year old English Springer Spaniel trained to detect and indicate on Koala scats. Taz was professionally trained by conservation dog expert Steve Austin. Olivia is the primary handler of Taz; Alex is her second handler. Both Alex and Olivia have received professional training and obtained certification to handle Taz.

Taz works off leash and starts searching when prompted by the handler. At each survey location, a search consisted in the detection dog scanning the ground layer for scats, as well as above the ground for any scats that may be stuck in branches/in bark along tree trunks/or actual Koalas in trees. (Note: when Taz indicates on Koalas, she is actually indicating on the scent of fresh faecal matter attached to the Koala's fur). Each search is timed and consists in the detection dog actively searching for 5 minutes. Where Koala scats are found, the time of the find is recorded and the timer is paused while the study team records details; the timer is resumed when the search resumes.

Taz searches non-discriminatorily at each location; she is not directed to any specific trees or tree species. On occasions she may be recalled by the handler e.g. if humans observe potential Koala scratch marks on a tree not assessed by the dog yet; or for safety reasons e.g. if approaching traffic or if going out of direct sight.

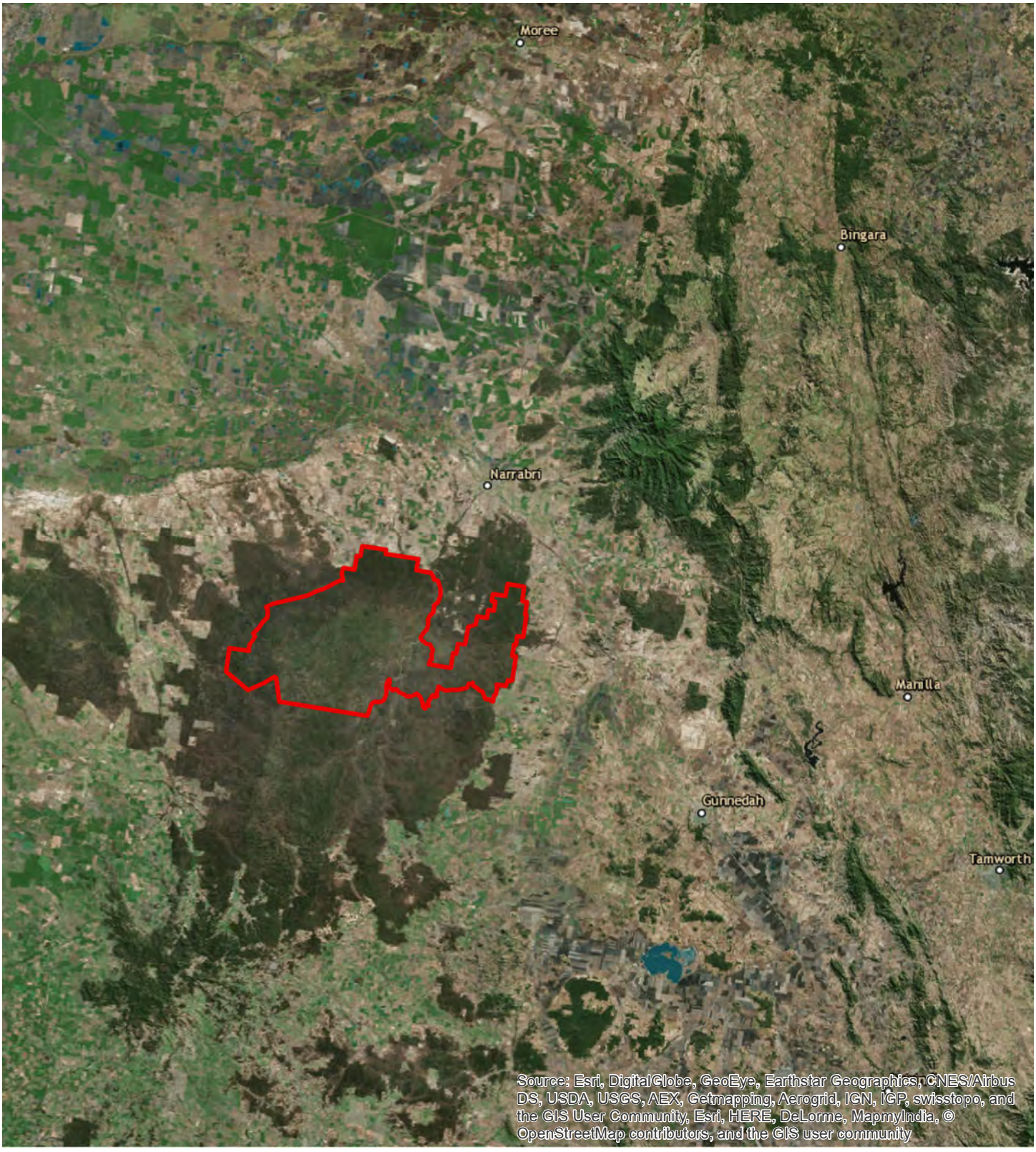
When Taz indicates on Koala scats, the study team retrieves and collects all or a representative sample of the scats for later photography, and records the GPS coordinates and any other relevant information. Where found under tree canopies, the tree species under which the scats are found are also recorded.

Please note:

- Taz also indicates on pap. Even though pap is not faecal matter *per se*, it has the same scent signature as scat and as a result Taz also indicates on it; and
- Even though Taz is capable of detecting the scent of Koala scats/pap long after these have decomposed, Taz is trained to ignore 'residue scent' (that is, odour that is so faint that the scat/pap has long decomposed and lost all physical integrity). This threshold does vary between locations depending on a number of factors (local weather conditions, insect predation, soil type, activity of microorganisms, etc.).

3.3 Data entry and analysis

At the completion of fieldwork, the data recorded was downloaded from the GPS and converted to ArcGIS format. Handwritten fieldwork notes were entered electronically and photos of all scats and pap collected were taken.



0 30 60 120 Kilometers

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LEGEND

Pilliga East State Forest

FIGURE 1
STUDY AREA LOCATION

Pilliga East State Forest
Koala survey

OWAD ENVIRONMENT

4.0 STUDY RESULTS

4.1 Search effort

A total of 24 survey locations were searched with the detection dog.

The detection dog actively searched for a total time of 120 minutes. In total, over 18 km of transect were searched by the dog.

On the day of survey, there was a sustained light breeze (estimated 5-10km/h). In such conditions, the dog would have been perceiving scents from approximately 30-40 meters away travelling with the breeze.

4.2 Results

Koalas are confirmed to be present in the Pilliga East State Forest. The dog indicated and Koala scats were found at one site; and the dog indicated but the study team was unable to recover/retrieve scats at a second location.

Figure 2 shows the location of all areas surveyed, and the survey results.

4.2.1 Koala presence confirmed

Koala scats were found at one survey location (№ 19). These scats were relatively old (estimated 9+ months old). Even though only a few scats were found, the two intact ones appear to be of sufficiently different size class to assume that they likely originate from two distinct individuals. Given that they appear to be of the same age class, they could possibly originate from a female with joey. Alternatively, they could originate from a mature male chasing a mature female for reproduction. See **Plate 1** for a photography of the scats. Note, there was little to no leaf litter or ground vegetation at that location: it was mostly compacted bare ground. These scats were found in a vegetation community best described as Narrow-leaved Ironbark *(Eucalyptus crebra)* open forest, with Sheoak (*Allocasuarina* spp.) understorey. **Plate 2** is a photography of the habitat where the scats were found, with the exact location marked.

Plate 1: Scats found at survey location № 19

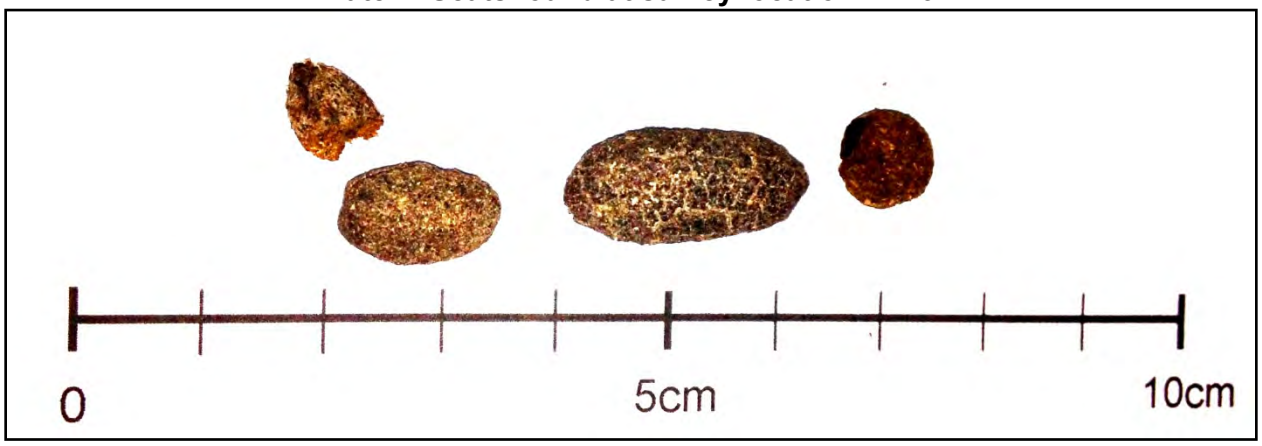
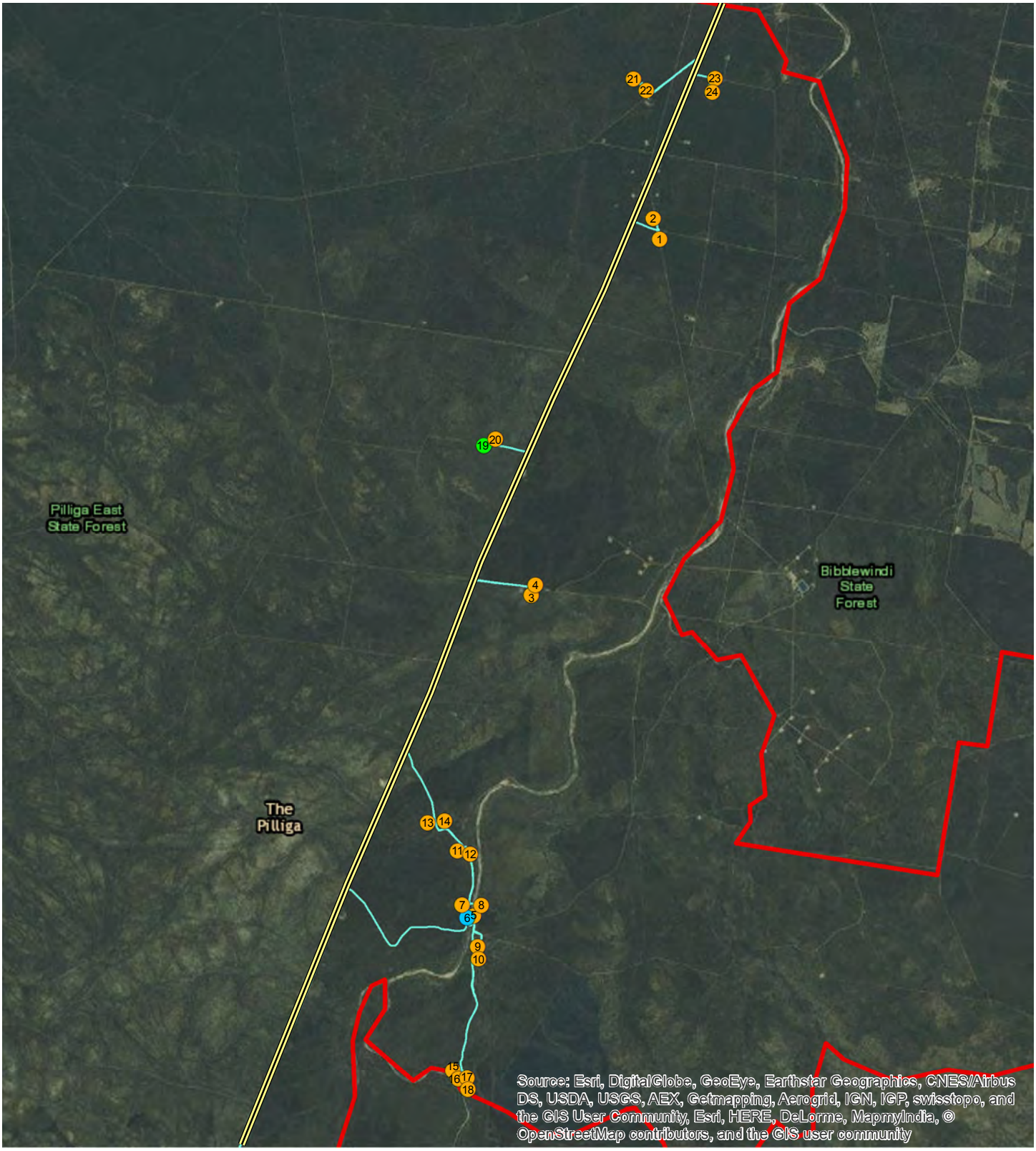


Plate 2: Habitat where Koala scats were found (with exact location shown)

4.2.2 Likely Koala presence

At site № 6 (see **Figure 2**), the detection dog repeatedly indicated on a very precise spot at the base of a large Eucalypt along an intermittent creek (Bohena Creek). Unfortunately the study team was unable to recover a Koala scat. Unlike survey location № 19 where the scats were found on very hard bare ground, at site № 6 where the dog indicated there was a soft layer of rich top soil. There was a significant amount of decaying debris at the base of that tree; it is most likely that there was still sufficient scent for the dog to indicate, yet the scats had already lost their physical integrity / or only fragments remained that humans were unable to distinguish from other organic matter. A relevant limiting factor in this instance is that there had been three significant rain events in the weeks preceding the survey. One event on 2-3 May (total 20mm), a second one 27 May 2016 (total 20mm), and third event just a few days prior to survey (on 2-3-4 June 2016) totaling 50mm. Given the location where the dog indicated, the soil and organic matter would have retained moisture therefore it is very likely that the recent rains precipitated the physical disintegration of the scats.

In the absence of being able to retrieve scats or fragments thereof, the study team is unable to estimate the date of the Koala visitation. However it expected that it would date less than 2 years prior to survey. Of note, David Paull informed the study team that Koala presence had been confirmed in the general area approximately 10km south of site №6, approximately 2-3 years prior (in 2013/2014).



0 2.5 5 10 Kilometers

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On: 13/06/2016

LEGEND

Pilliga East State Forest

Newell Highway

Fieldwork Tracks

Survey locations and results:

- No Koala presence detected (and survey location number)
- Koala presence confirmed (and survey location number)
- Likely Koala presence (and survey location number)

FIGURE 2
SURVEY RESULTS

Pilliga East State Forest
Koala survey

OWAD ENVIRONMENT

5.0 STUDY LIMITATIONS

As with any faecal pellet survey, the two major limitations of this study are pellet detectability and inferring absence.

5.1 Pellet detectability

The use of a purpose-trained professional detection dog greatly minimises the risk of not detecting scats when they are in fact present. Taz the dog used for this survey has been extensively trained by a professional scent detection dog specialist for several years; and then extensively and continuously trained and tested by OWAD Environment. In recent trials conducted specifically to test her detection abilities in varying groundcover complexities, Taz was found to have a 100% detection rate. That is, in every single instance she was able to detect at least one Koala scat within 5 minutes when there were known scats present within 100 metres or more. Vegetation structure and groundcover complexity do not affect her detection abilities.

Even though Taz is capable of detecting the scent of Koala scats long after these have decomposed, OWAD Environment takes the approach to always retrieve at least one scat. As a result, scats must have sufficient physical integrity to be recovered. The rate at which pellets decay can vary significantly between areas due to factors such as varying ground layer structure, composition, moisture, sunlight, local weather events and invertebrate activity (Rhodes *et al.* 2011, Cristescu 2011, Witt and Pahl 1995). As a result, in some instances Koala scats may lose integrity within a few months, and in other places scats as old as a year or more can be recovered.

Taz is trained to ignore residue scent and technically should not indicate on scats that are so old that they have lost their physical integrity. In the rare occasions where she does indicate on scats that have lost all physical integrity to be recovered, she is made to search further until the study team finds at least one scat with sufficient integrity. In this study, there was one instance where the dog indicated yet the study team was unable to retrieve a scat with sufficient integrity (survey location № 6, see **Figure 2**).

5.2 Inferring absence

While for the purpose of this study recovering a single Koala scat is an absolute finding, failure to detect Koala scats in an area is not necessarily conclusive. That is, absence of evidence is not evidence of absence. While the risk of 'false negative' was minimised as far as possible, failure to detect Koala scats may suggest either of the following:

- Koalas are not present in the area (i.e. true absence);
- Koalas occur in the area, however scats were not detected because:
  - No scats were deposited in the areas sampled (Koalas can pass through an area without defecating);
  - There were scats in the vicinity, however these were outside of the properties the subject of this study. The fact that no scats were found at survey locations № 15, 16, 17 and 18 (see **Figure 2**) does not mean that there were no scats to the south outside of the State Forest boundaries;

- Scats were deposited in the past at the sites sampled, but were too decomposed for the dog to indicate (whether residue odour perceivable by the dog but below the threshold for indication, or so old that even residue odour has disappeared). There is potential for this to have occurred in this study;
- The dog indicated on a scat, but it was too decayed to have sufficient physical integrity for humans to locate and collect it. This instance did occur at survey location № 6 (see **Figure 2**);
- Scats were deposited at the sites sampled, but were dispersed or obscured by exceptional physical disturbance and the dog could not locate the scats themselves as the scent was dispersed (e.g. significant surface water flow resulting in the dog indicating on a large area rather than a precise location). This instance was not observed to have occurred in this study.

Finally, it must be noted that as with any scat-based survey, the absence of scats at time survey does not negate the possibility of the target animal visiting the site and depositing scats in the future.

In this study, the risks of false negative were minimised by:

1) The geographical spread of areas searched across the study area: the search locations were spread over 8 different locations;
2) Using Taz the professional detection dog, who is significantly more efficient at detecting scats than humans alone[1]; and
3) The timing of this survey: conducted during the drier months with general lower ambient humidity.

5.3 Data interpretation

This study provides an indication on Koala presence/absence only in the areas surveyed as part of this study. Where no Koala scats have been found, if necessary/relevant it is recommended to consult other sources of information in order to determine whether Koalas may in fact be present in those areas.

At location № 19, scats were found in a patch of Narrow-leaved Ironbark *(E. crebra*). This is only an indicator that a Koala/or Koalas was/were in that area when it/they defecated. It must be noted that roost trees are not necessarily a valid indicator of Koala diet (Cristescu *et al*. 2011). Indeed, there isn't necessarily any correlation between the location of Koala scats/which trees they are found under, and that individual animal's diet. The only valid indicator of a Koala's diet is to analyse scats in a specialised laboratory.

[1] In scientific trials conducted in 2015 (to be published), on average Taz & Olivia found scats in 357% more instances than humans alone searching for Koala scats at the same sites.
When analysing results across easy, medium and hard groundcover complexities, Taz & Olivia found scats:
- in 84% more instances in easy groundcover complexities e.g. very open forest with very little to no ground vegetation or leaf litter, or mown parkland setting;
- in 1,100% more instances in medium groundcover complexities e.g. patchy grass cover, some leaf/bark litter/branch debris, small sparse shrubs; and
- in infinitely more instances in hard groundcover complexities e.g. thick tall grass, dense shrubs, thick leaf/bark litter/ branch debris (Taz found scats at 9 of 15 sites; humans did not find any scats at any of those 15 sites).

5.4 False negative due to sampling

When the study area is too large to sample in its entirety, the study team has to resort to sampling. There is a strong negative correlation between false negative rate and survey effort: the more limited/restricted the search effort, the higher the risk of false negative.

In this study, the study team sampled a large area (Pilliga East State Forest) over only one day, hence the false negative due to sampling is considered to be very high. Indeed only a minuscule fraction of the Pilliga East State Forest was sampled, therefore extrapolation of this study's results to the State Forest as a whole would not be deemed scientifically valid in any way.

6.0 CONCLUSION AND RECOMMENDATIONS

This report provides a baseline of current Koala presence/absence across the areas surveyed as part of this study.

The study team confirms the presence of Koalas in Pilliga East State Forest

A total of 24 locations were surveyed. Koala presence was confirmed at one location, and Koala presence is considered likely at a second location (see **section 4.2** for further detail). This equates to Koala presence confirmed or likely at 8% of location sampled.

Unfortunately, no assessment of 'activity levels', movement patterns or habitat preferences is possible due to the very limited survey effort.

Although at the majority of sites sampled there was no indication of Koala presence, in this study the potential for false negative due to sampling is considered to be extremely high (very limited search effort for a very large area).

OWAD Environment has on many occasions surveyed areas as large as or even larger than Pilliga East State Forest but with more intensive search effort. It is not uncommon for the study team to find very little to no evidence of Koala presence for whole days at a time, yet overall find Koala presence at 30% or more of sites sampled. So the findings of this study are not necessarily representative: with a more intense search effort, Koala presence may be found at more than the current 8% of locations sampled.

Where a more detailed understanding may be required or desirable, it is recommended to conduct a more extensive survey. Such survey should target all habitat types represented in the landscape. Indeed in OWAD Environment's extensive experience conducting Koala surveys, the detection dog regularly finds Koala scats in areas not traditionally viewed or thought of as Koala habitat. If additional surveys are envisaged, Western Woodlands Alliance could also consider Koala scat analysis. OWAD Environment partners with Federation University (Victoria) who is able to do DNA profiling from scats (gender, relatedness of Koalas sampled, gene flow, population structure) as well as determine presence/absence of *Chlamydia* (and strain) and of Koala Retrovirus. Scats for such analyses do have to be in sufficient physical condition and hence relatively fresh (up to 2 weeks old). Additionally, if local tree leaves are sampled and sent with scats, Federation University may also be able to determine diet. For diet analysis the scats can be up to several weeks old.

7.0 REFERENCES

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Expert Review: Narrabri Gas Project, Terrestrial Ecology

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4 May 2017

Summary

Following review of the terrestrial ecology components of the Narrabri Gas Project (NGP) Environmental Impact Statement (EIS), a number of serious omissions within the assessment are evident, and several questions regarding the adequacy of the assessment remain unresolved, in particular:

- The adequacy of the methodology used to describe direct impacts is questionable. The lack of a development footprint by which impact could be measured according to 'whole of government' guidelines gives uncertainty to the ecological outcomes.
- Levels of indirect impact have been significantly under-estimated. Using fox predation as a measure, pre-mitigation levels of indirect impact should be at least doubled in magnitude, based on available evidence.
- Survey effort for some key fauna species appears to be deficient and would have adversely affected the ability of the EIS to adequately account for some species.
- A NSW and Commonwealth-listed threatened ecological community *White Box Blakely's Red Gum-Yellow Box Woodland (and derived native grassland*) has been mis-identified and presumed to be not present in the study area. New data confirms its presence along Bohena Creek.
- The description of important habitat for a number of key fauna species, such as the Regent Honeyeater, Pilliga Mouse, Koala, Black-striped Wallaby and Five-clawed Worm-skink is not accurate.
- New information regarding the presence of the Koala in the study area discounts the assertion made in the EIS that it is not currently present.
- Due to deficiencies in the survey and assessment for two 'matters for further consideration' (Regent Honeyeater and Five-clawed Worm-skink), the Secretary's Requirements and requirements under the NSW Biodiversity Offset Policy have not been met. The Black-striped Wallaby also meets the requirements of being a MFFC.
- Direct impacts upon Brigalow Park State Conservation Area remains uncertain as do the magnitude of indirect impacts upon the adjacent Nature Reserve and existing biodiversity corridors.
- A Biodiversity Offset Strategy does not provide any surety for how well it will 'retire' the impact of the Project because the strategy provided in the EIS does not provide any like-or-like land-based offsets apart from an unproven rehabilitation plan and rests on the hypothetical efficacy of a feral animal control proposal. The suitability of the offset package with respect to the statutory requirements under the NSW Biodiversity Offset Policy is poor. The offset proposal is also not consistent with the requirements of the Commonwealth Offset Policy.

Based on these findings, this part of the Project assessment should be rejected as being data-deficient in relation to the Secretary's Requirements, and inadequate under the terms of NSW and

Commonwealth Biodiversity Offset Policies. The matters outlined above should be addressed by the proponent before any further assessment is undertaken.

Review of Methodology

Database and literature review

These are essential components of any EIS particularly for investigations in relation to biodiversity and threatened species. The key databases are BioNet, the Commonwealth's Protected Matters Search Tool, the VIS database for plant communities, and the relevant state and Commonwealth listings of threatened ecological communities which are available on the departmental websites. Searches which are conducted some time prior to the submission of the documentation, should be updated prior to submission to take account of recent additions and changes to the databases, e.g. some species may be listed or new records made public between the time the report is written and when it is submitted. Any due diligence review should update the findings in the report, particularly if new information regarding key species in the EIS warrants consideration. Failure to do so may lead to misleading information in the documentation when it is submitted to the consent authority. There are a number of important data omissions in the EIS. These will be highlighted in the relevant sections of this report.

Similarly, any literature review should include up to date searches of the scientific and relevant 'grey' literature. There are a number of instances where key scientific information has not been acknowledged in the NGP EIS. This is a failure of due diligence. Any scientific inquiry should acknowledge all relevant facts, particularly in relation to key issues. These failures are also highlighted throughout this report.

Field Surveys

Field surveys conducted by consultants EcoLogical Australia (ELA) on the whole seem to be consistent with state and Commonwealth guidelines, though a number of survey shortcomings are documented in the EIS.

For targeted threatened flora surveys, surveys were undertaken between 2010 and 2014, mostly in the spring time which suits a majority of flowering times for key threatened flora, though the information provided in the EIS does not show which species were surveyed and when, or the effort undertaken for each species. Often some species such as orchids flower more profusely following rain, though no account is given on how weather influenced the timing of surveys.

Fauna surveys were generally undertaken at appropriate times to maximise detection of key fauna species, though the effort and timing of surveys is not sufficient or is inappropriate for some key species.

For the critically endangered Regent Honeyeater *Anthochaera phrygia,* only one survey (October 2012) appears to have been undertaken over the five years of the field survey period prior to the submission of the EIS. Commonwealth guidelines (DEWSaP 2010) recommend surveys take into account eucalypt flowering events and should amount to at least 20 hours over five days. This has clearly not been accounted for in the EIS. Similarly, surveys for the Swift Parrot *Lathamus discolor*, with only one survey conducted, in July 2013, should also be linked to flowering events for 20 hours over eight days.

81 'trap nights' were used for a 'Song Meter' to record birdcalls, supposedly targeting the Regent Honeyeater, though without appropriate call playback, this method is unlikely to yield results. The

large amounts of data this methodology creates would need a Regent Honeyeater song algorithm (a digital call signature), from local animals in order to be able to maximise the detection of this species.

Targeted surveys for the endangered Five-clawed Worm Skink *Anomalopus mackayi* were undertaken in April 2014. The Commonwealth guidelines (DEWSaP 2011) for this species state that,

"Peak activity is likely to be late spring and early summer under warm but not overly dry conditions. Not active on the ground surface by day and would only be active between sheltering sites at night."

Surveys should be conducted at this time of year. The methods used should meet the following requirements:

"*Appropriate survey methodology for detecting the presence of the long-legged worm skink is searching sheltering sites in combination with pitfall trapping at a time of year when the species is most likely to be active. If the survey is a targeted search for this species, a series of pitfall trap lines each comprising six 10 litre buckets spread along a 15 metre fence could be employed, however the species is more likely to burrow between the soil and the bucket. A successful technique has been to deploy artificial structures, such as bales of hay of different thicknesses, over a long period (over 6 months) and periodically check underneath*."

Table 15-5 shows that 57.1 hours of 'reptile surveys' were undertaken for this species. If undertaken at the wrong time of year, the efforts are bound to be fruitless, even if taken after a 'significant rainfall event' (Table 15-6). A map of the survey effort however shows that only 12 of the 30 reptile surveys were conducted in areas north of the forest more likely to support habitat for this species (Figure 9, Appendix J1). So less than half of the total effort in reptile surveys could have targeted this species, although p. 74 of Appendix J1 states only three sites had habitat potentially suitable for the Five-clawed Worm-skink, R21, R27, R31.

Within the project area, the EIS states that survey effort for the Koala *Phascolarctos cinereus* between 2011 and 2014 include call playback (27 person hours), nocturnal surveys (31 person hours) and scat searches (38 plots) in Table 15-6. However, Figure 12 of Appendix J1 only shows four Scat Assessment Technique survey locations, three of which are clustered. Koala habitat in the project area amounts to some 30,000 ha according to the EIS if the 'secondary' habitat is taken into account. Minimum survey effort as outlined in the NSW threatened species survey guidelines (DEC 2006) has not been met. There are currently no Commonwealth guidelines on how Koalas should be surveyed.

A 'Regional survey' for the Koala was undertaken in April/May of 2014. Effort shown in Table 15-6 states that sites were selected using information from a recent Koala survey in the Pilliga and that 1,654 ha of koala habitat was searched over 112 km. However, information provided in Appendix J1 (within Appendix F7 thereof) has a lack of detail with regard to the effort expended in the project area compared to the effort outside.

Ecological sensitivity analysis

An ecological sensitivity analysis protocol tries to avoid areas where threatened ecological communities, threatened species habitat and riparian areas are located. A combination of mapping, models of habitat, and riparian buffer zones have been used. Given the first two require field verification and the latter does not automatically protect all threatened ecological communities or threatened species habitat which are associated with drainage lines, there are limits to how well modelled products can reduce impact.

As stated in the EIS, pipelines will still have to be built across creeks and given the uncertainty around the location of well sites and tracks, there is still great uncertainty as to what future impacts may look like.

Direct Impact Assessment

While approximately 1,000 ha of native vegetation is estimated to be directly affected by the development of the project area over time, my main concern with the assessment provided in the EIS, is the level of impact on the various ecological communities and threatened species habitat. The Secretary's Requirements state in relation to the impact assessment:

"an assessment of the likely biodiversity impacts of the development, in accordance with the Framework for Biodiversity Assessment (OEH, 2014), unless otherwise agreed by OEH, and having regard to the OEH's and DPI's requirements (see Attachments 3A and 3B)"

As stated throughout the EIS, due to the nature of the necessary exploration and appraisal that is required prior to production, a development footprint has not been identified at the time of the lodgement of the EIS as it is not 'practical'. An 'indicative footprint' has been provided but the sites carry no locational information. It seems Santos has left the gate open with regard to future location of the footprint. This has a number of consequences for assessing the impact on biodiversity:

(a) The location, type and area of ecological communities and their habitats affected by the project cannot be accurately determined, making assessment of impact difficult,
(b) The quantum of biodiversity credits (both ecosystem and species credits) cannot be accurately determined affecting the ability of the EIS to predict credit liability,
(c) No opportunity exists for any kind of field verification of the communities affected by the development, and
(d) The actual impact assessment will be left until after any consent for the project has been given.

The EIS states it has utilised a 'modelled development footprint' to determine the extent and types of biodiversity credits that the project will need to retire to meet the requirements of the FBA and the conditions of consent. How the total quantum of impact upon each vegetation community was achieved in the EIS was by use of a 'probalistic' methodology which used a geographic grid overlay with an algorithm to determine 'maximum probable disturbance' and an ameliorated probable disturbance. This is detailed in Appendix F3 of Appendix J2. How well this algorithm works however is not entirely clear.

The methodology was developed by an American academic, apparently to deal with diffuse impacts such as gas fields in the United States. Professor Small is also a reviewer of the methodology used for this project as outlined in Appendix F3. The other reviewer is also an environmental engineer with a career in the petroleum sector.

Whatever the merits of the modelled approach to describe the impacts and biodiversity credit liability of the NGP, given the uncertainty around what actually may be impacted by the NGP and despite the site avoidance methodology proposed by Santos, it may be that the actual extent of impact upon vegetation communities may be very different to what has been outlined in the EIS.

The impact assessment approach has some issues, particularly in the context of its consistency with the Framework for Biodiversity Assessment (FBA) which states that the Biodiversity Assessment Report (BAR) requires a site map and a location map which shows the 'boundary of the development site' as well as maps showing the intersection of the site boundaries with the mapped vegetation

communities. This allows accurate assessment of the actual impact because it takes into consideration differences with mapped aerial extent of vegetation communities and variations in condition, all of which can affect biodiversity credit liability.

In my opinion, Santos have not met the SEARs by not providing a BAR which meets the requirements of the FBA. ELA did undertake biometric vegetation plots as per the methodology within each of the vegetation communities but this was undertaken across the project area and may not actually contain any sites which form part of the development footprint.

Once consent is given, it is proposed that the main way that impact is to be minimised is by the utilisation of a post-approval 'field development protocol' in conjunction with a 'ecological scouting framework', designed to signal on-the-ground issues which warrant avoidance. It is assumed that well and pipeline placement has some flexibility and some sensitive matters may be avoided by minor adjustment of the site location. But this may not always be the case and limits may occur as to how much particular pipe routes, exploration and appraisal well sites can be moved to avoid, for example, Pilliga Mouse habitat. But given the placement of the well sites is uncertain anyway, this protocol does not offer much re-assurance in terms of how well avoidance can be achieved.

There is also the issue that given Santos apparently don't know exactly where the wells are best located, it may be that some pilot, 'appraisal', wells will be unproductive, leading to a need to increase in the total number of sites being established to meet production targets over time. Currently 2 out of 5 well sites in the Pilliga have been capped due to their unproductiveness. Future incremental changes to the development footprint will only add to the post-approval impact.

Instead of proposing modelled 'upper disturbance limits' for each community and habitat type, a more transparent approach which could have been adopted by Santos and given better surety to the extent of possible impact and if those impacts could be managed, would have been to create a 'worst case scenario' that uses actual sites with locations. If those sites proved to be in the wrong location, then additional sites could be found which have a similar or less level of impact through a protocol that has additional regulatory oversight.

Indirect Impact

It is claimed in the EIS that indirect impacts, which take into account a range of offsite and flow-on effects on local ecological communities, have been accommodated in the impact modelling. There are two key issues with this assessment.

Santos are proposing a 50 or 20m 'buffer' around all infrastructure to accommodate off-site impacts such as site noise, traffic movements, light and dust pollution, gaseous emissions and increased impact of feral predators. Buffers are important when infrastructure is placed near sensitive ecological areas, such as streams, threatened species habitat and reserve boundaries.

In the EIS, streams will have buffers, but the EIS gives no surety that buffer zones will exclude areas of important habitat, particularly where subsequent location of wells impinges on habitat identified as being important for certain species. But most importantly, there is no evidence provided verifying the likely spatial extent of most of these offsite impacts in the EIS. 50m seems hardly adequate to cater for airborne pollutants, dust, light and noise and potential impacts on wildlife and ecosystems. This is particularly relevant for the Brigalow Park Nature Reserve, and State Conservation Area, the latter included within the project area.

While a 50m buffer is proposed around well sites and pipelines, ELA have calculated what the indirect impacts means in terms of additional biodiversity credit liability. It is stated in the EIS that

unmitigated offsite impacts only affect, on average, a 12m metre distance around the infrastructure and with mitigation actions the affected zone will be reduced by five metres for well pads and only 1m for tracks. Only this 1-5m indirect impact area has been added to the direct impact and biodiversity credit liability.

There is no literature review of these types of impacts provided in the EIS and it is not intended to provide one here. However, if we look at just one type of impact, feral animal (fox) predation, it will be realised that modelled assertions made in the EIS are questionable. Foraging patterns of foxes were studied in Jervis Bay:

"As in other studies, roads, beaches and creeks were used by foxes as thoroughfares and boundaries to their territories … Foxes were recorded within 15 m of roads on 33% of all fixes. Similarly, many European studies have found home-range boundaries of foxes to be defined by man-made features such as roads, playing fields and railway lines (Macdonald 1981; Kolb 1984; Doncaster and Macdonald 1991; Saunders et al. 1993)" (Meek and Saunders 2000).

Studies have shown that roads are good predictors of local fox activity, they use them to mark their boundaries, and as hunting routes;

"*On nightfall foxes would increase their activity and begin to use the roads to patrol their home range*." (Meek and Saunders 2000)

Foxes do not confine their activity to the road itself but stay close, within 15 m to the road, which seems to act as a maker for their foraging bouts. The fact that foxes spend a third of their total foraging time within close proximity to a road is probably for several reasons, most likely to do with ease of movement and visual amenity to detect prey. Additional roading, well pads and pipeline easements are going to add to the hunting success for the fox and may allow greater density of foxes to persist in the area because adding new cleared strips is effectively adding more hunting space.

As well as strong visual abilities, foxes have acute olfactory and auditory senses (Peterson *et al.* 1969; Malkempera *et al.* 2015). Using sound clues, a Red Fox can detect earthworms under the ground surface (MacDonald 1980) and rodents under feet of snow with relative ease and with precision (Cerveny *et al.* 2011). An individual moving at a distance of 15m from a road or track would have the ability to hear animals moving for some distance into the bush away from the road. Exactly how far is not certain, though a 10m distance would not be far for a fox to detect a small vertebrate using sound clues. So, to account for the effective 'indirect' impact that new infrastructure would realistically have in relation to fox activity prior to mitigation would be a distance of 20-30m, particularly for tracks.

To claim that impacts like noise, air pollution and increased levels of feral predator predation could be mitigated to an area of 1-5m from infrastructure sites is unrealistic in my view and has not been supported by any strong evidence. To mitigate fox predation, Santos have proposed a 'regional feral predator control program' though key details that would add weight to the assertion has not been provided.

Assessments of Significance

These are outlined in Appendix J of Appendix J1 for the 'seven-part test' under the EPA Act and Appendix K for Commonwealth assessments of significance. Given the uncertainties outlined above regarding the accuracy of the direct and indirect impacts on particular matters, these assessments should be treated with caution by the consent authorities.

Identified plant and threatened ecological communities

There are 22 plant communities and four threatened ecological communities identified within the project area, all of which may suffer some direct and indirect impact. A number of plant communities in the project area which are threatened ecological communities (TECs) have not been adequately taken into account in the EIS.

Brigalow woodlands

There are 6,695 ha of Brigalow dominant woodlands in the project area (Plant Community Type (PCT) ID 35), though only 2,268 ha have been classified as being consistent with the definition of the state and commonwealth-listed threatened ecological communities (TEC).

ELA have stated that further areas of this community which contain regrowth 'may' be considered to be part of this listed ecological community but that this has not been confirmed by field assessments, rather an approach was taken whereby any site cleared less than 15 years ago was classified as being 'regrowth' under the *Native Vegetation Act 2003*. However, if adequate field surveys or cross-checking with recent satellite imagery were not possible within time and access-constraints, a precautionary approach should have been adopted to include this larger area under the category of the TEC both at the state and federal levels as many of these areas may contain regrowth which met the definition of this community, despite a poor condition.

Brigalow is an Acacia, and despite its size and longevity, is capable of growing to a significant size within ten years following clearing.

Riparian red gum/Angophora/Callitris woodlands

There are over 1,000 ha of the riparian redgum /angophora community in the project area, which is described as being dominated by Blakely's Red Gum *Eucalyptus blakelyi* and Rough-barked Angophora, *Angophora floribunda.* This community in the EIS is given as PCT ID 399 *Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion*, with the Biometric Vegetation Type (BVT) for this community given as NA197 *Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion*, a grassy woodland.

Field verification surveys conducted by Ethical Ecology (EE) along Bohena Creek show this community (see Appendix 1) is a grassy woodland which best suits the plant community type, PCT ID 544:
(http://www.environment.nsw.gov.au/NSWVCA20PRapp/DataEntry/PlantCommunity.aspx?M=E&PID=544)

(a) Verification surveys within the community mapped by ELA as being PCT ID 399 along the length of Bohena Creek show it meets the criteria of the Keith Formation of 'Grassy Woodlands'. The riparian woodland in question was found generally to contain a low overstorey height of 10-20 m, an open understorey with relatively little mid-storey (0-15%) or understorey shrub cover (5-30% cover), a lack of sclerophyllous shrubs, and having a high litter cover with groundcover dominated by grasses and forb species.
(b) The species composition of this community was found to be more consistent with the grassy woodland PCT ID544, always containing White Cypress Pine *Callitris glaucophylla* and sometimes Yellow Box *Eucalyptus melliodora* in the overstorey; a mid-storey dominated by

the soft-leaved wattle *Acacia deanii* with only scattered sclerophyllous species, such as *Persoonia*; a low shrub cover mostly dominated by *Lomandra longifolia*; sometimes aquatic plants are present, eg, *Juncus* and *Cyperus*, though never dominant in the understorey; and a groundstorey containing species typically found in North-west Slopes and New England grassy woodlands, such as *Dichondra repens, Chrysocephalum, Glycine, Wahlenburgia, Chielianthes, Austrostipa, Micloeana* and *Aristida* grass spp. In the spring, this community typically contains high numbers of greenhood *Pterostylis* and *Diuris* orchids, while in autumn providing habitat for the lily *Crinium flaccidum.*

PCT ID 399 is present in the project area and it seems this type was specifically created to take into account riparian communities in the Pilliga region (Benson *et al.* 2010*)*. However, while the sclerophyllous shrubs, Tea-tree *Leptospermum polygalifolium*, Bottle-brush *Callistemon linearis* are common along the creek systems in the Pilliga, along the greater part of the extent of Bohena Creek (a 5th order stream) these species are mostly restricted to the creek-bed itself and along a thin margin bound by the bank of the creek, if present at all.

Field surveys conducted by EE took into account the presence of these species by setting transects (n=16) with one edge along the top of the creekbank. A methodology consistent with the FBA was adopted, taking into account the contribution of all mid-storey species in the vegetation cover within the site assessments, including the tea-tree and bottlebrush. Of note is that the description of the riparian woodland community in question provided by the consultants in the EIS (p.151, Appendix J2) is not that different to that provided by EE, in Appendix 1.

ELA conducted 20 survey plots and found this community to have an overstorey cover of 2-18%, midstorey cover of 0-10%, grass cover of 0-50%, other ground vegetation cover of 8-30%, understorey shrub cover of 0-6%, litter cover of 9-55% and bare ground cover of 2-38%. Plots undertaken by EE tended to have a lower grass and groundstorey veg cover, a higher litter cover, and a higher understorey shrub cover (up to 30% at some sites), though generally data fell within the range of error provided by ELA for their sites.

The PCT description of the two communities in question is given below using an extract from the VIS database.

1. *PCT ID 399*

Figure 1(a) Sandy Creek spring, in project area (b) Groundwater seepage zone, Flaggy Creek

Considerable ground-truthing in the project area by Ethical Ecology has shown that PCT ID 399 is present, generally found to be associated with lower order streams where the banks are less developed or absent. This describes the majority of streams in the Pilliga forests. Tea-tree and

bottlebrush seem to grow as dominant parts of the understorey where there are relatively high levels of surface or shallow groundwater flow (hence its description as a 'wetland' in the VIS database). Some areas of the creekbed, particularly containing waterholes, conform to this community, though most of Bohena Creek has little aquatic vegetation, except on within creek 'islands'.

2. *PCT ID 544*

This community was found at all but one of the transects (n=15) surveyed by EE. It is characterised as being found along the length of Bohena Creek, on flat or gently sloping ground (creek terrace) restricted on the creek edge by a distinct bank, which generally was not very high. While some doubt could be raised to the classification of this community, which typically occurs in the New England Tablelands and Nandewar bioregions, it is not uncommon to use PCTs from neighbouring regions to classify communities on the ground. The EIS also uses PCTs from neighbouring bioregions, such as the description of this same community as being in BVT *NA 197 Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion* in some parts of the EIS. Apart from a lack of the Native Olive, *Notolaea microcarpa,* all the species listed as being typical of PCT ID 544 matches the species composition found in the field.

Figure 2 (a) Near Oil Well Road (b) Near Garlands Crossing

While Benson *et al.* (2010) identified PCT ID 399 as the predominate riparian community in the Pilliga Forests, it simply does not describe the grassy woodland and creek terrace structure encountered along Bohena Creek. From my own observations over 25 years, the other major Pilliga creeks, Baradine and Etoo, also support the same community.

Correspondence with TEC definitions for Box Gum Woodland

This grassy riparian woodland community (PCT ID 544, BVT equivalent of NA342) is considered to meet the requirements of both the *Threatened Species Conservation Act 1997* (TSC Act)-listed and the EPBC Act-listed threatened ecological community *White Box Blakely's Red Gum-Yellow Box Woodland (and derived native grassland*) according to the VIS database, while PCT ID 399 does not as it is belongs to the 'dry sclerophyll forest' Keith Formation.

But the real test as to whether this community matches the description of Box Gum Woodland is to compare the field data with the definitions provided in the listings for this TEC, both at state and commonwealth levels.

1. *TSC Act listing*

The White Box Yellow Box Blakely's Red Gum Woodland endangered ecological community (TSC Act) is described below via the OEH website:

http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10837

This community is present in the Pilliga sub-regions according to the OEH database. Criteria which define this community are summarised as being:

- *Characterised by the presence or prior occurrence of White Box, Yellow Box and/or Blakely's Red Gum.*
- *The trees may occur as pure stands, mixtures of the three species or in mixtures with other trees, including wattles.*
- *Commonly co-occurring eucalypts include Apple Box (E. bridgesiana), Red Box (E. polyanthemos), Candlebark (E. rubida), Snow Gum (E. pauciflora), Argyle Apple (E. cinerea), Brittle Gum (E. mannifera), Red Stringybark (E. macrorhyncha), Grey Box (E. microcarpa), Cabbage Gum (E. amplifolia) and others.*
- *The understorey in intact sites is characterised by native grasses and a high diversity of herbs; the most commonly encountered include Kangaroo Grass (Themeda australis), Poa Tussock (Poa sieberiana), wallaby grasses (Austrodanthonia spp.), spear-grasses (Austrostipa spp.), Common Everlasting (Chrysocephalum apiculatum), Scrambled Eggs (Goodenia pinnatifida), Small St John's Wort (Hypericum gramineum), Narrow-leafed New Holland Daisy (Vittadinia muelleri) and blue-bells (Wahlenbergia spp.).*
- *Shrubs are generally sparse or absent, though they may be locally common.*
- *Remnants generally occur on fertile lower parts of the landscape where resources such as water and nutrients are abundant.*
- *Sites with particular characteristics, including varying age classes in the trees, patches of regrowth, old trees with hollows and fallen timber on the ground are very important as wildlife habitat.*
- *Sites in the lowest parts of the landscape often support very large trees which have leafy crowns and reliable nectar flows - sites important for insectivorous and nectar feeding birds.*

ELA test the correspondence of site values they encountered with the above criteria in Appendix F1 of Appendix J1. They found enough lack of correspondence to not regard the community as conforming to Box Gum Woodland. These points are addressed below.

The ecological community is either dominated by *Eucalyptus blakelyi* or has it a canopy co-dominant. It does not matter if the either species Yellow Box or White Box are present or not. In fact, Yellow Box is present at a low density, ELA just failed to detect it. The lack of the other occasional co-dominants within the community does not negate it being the endangered ecological community (EEC). Likewise, the presence of Rough-barked Apple and White Cypress Pine do no not negate the community being an EEC.

The understorey in this community was found to be dominated by native grasses and forbs, though with usually high levels of leaf litter. Diversity at the transects showed some variance, with poorer condition areas with low diversity and higher levels of weed cover. Total diversity of native understorey showed 14 common grasses and 27 forbs and herbs. Levels of species correspondence for the listed 'characteristic species' in the scientific determination found of the 69 species identified in this study as being part of the riparian woodland community, 25 (36.7%) of these are listed as characteristic species under the Box Gum Woodland NSW Scientific Committee determination. Of the 94 characteristic species listed in the determination, 28 (28.7%) were found within the targeted

riparian community. In both regards this measure of correspondence with the scientific determination is high, supporting the notion that the dominant community described here matches the listing of Box Gum Woodland under the TSC Act.

In contrast, ELA found only a 5-12% correspondence with the characteristic species. This seems difficult to understand, given most of the same species were identified in the two surveys. If ELA were checking only each set of site data against the determination this result may be achieved. However, a more accurate community comparison against the determination should have used the full list of species found in this community. This information is not easily gleaned from the EIS because the different plant communities are not linked with the site floristic data in Appendix J1.

In contrast, the understorey shrub layer was species poor, mostly dominated by *Lomandra longifolia, Gahnia aspera* and occasionally rushes. The mid-storey was also species poor, dominated by *Acacia deanii* and sometimes Tea tree and Bottlebrush. In both cases, the cover by these layers was found to be generally sparse to common in patches.

ELA state that a chief reason why the community is not the EEC is because it does not have 'relatively fertile soils'. Soils in this habitat are said to be sands and sandy loams. The soils on which this community survives, while some sand wash can occur over the creek-terraces during times of high flow, are better described as being 'sandy loams', often with humic layers promoted by the high levels of leaf litter and clayey B horizons which retain moisture. This community is part of an alluvial system where the nutrients in the landscape are highest, certainly relative to the rest of the landscape. ELA may contend these areas are nutrient poor, but they have enough nutrient to support relatively high densities of large apple, box and gum trees. Other studies have shown that the density of large trees is highest in the 'gully' zones in the Pilliga (Date and Paull 2000) and that these sites supported the greatest diversity of birds, favoured by nectivorous species (Date et al 2002).

All sites supported old growth features such as high level of hollow development and large logs. The canopy was generally of a mixed age with regrowth locally common.

The ecological community dominated by Blakely's Red Gum – Rough-barked Apple - White Cypress Pine, a 'riparian woodland' described here as PCT ID 544, matches strongly the criteria above and should be regarded as being consistent with the definition of this EEC.

2. *EPBC Act listing*

The description of the EPBC-listed *White Box - Yellow Box - Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands* is found at the Commonwealth website below.

http://www.environment.gov.au/biodiversity/threatened/conservation-advices/white-box-yellow-box-blakely%27s-red-gum-grassy-woodlands-derived-native-grasslands

The advice to the Minister states that, "*In its pre-1750 state, this ecological community was characterised by:*

• *a ground layer dominated by tussock grasses;*

• *an overstorey dominated or co-dominated by White Box, Yellow Box or Blakely's Red Gum, or Grey Box in the Nandewar bioregion; and,*

• *a sparse or patchy shrub layer.*

"Associated, and occasionally co-dominant, trees include, but are not restricted to: Grey Box (Eucalyptus microcarpa), Fuzzy Box (E. conica), Apple Box (E. bridgesiana), Red Box (E. polyanthemos), Red Stringybark (E. macrorhyncha), White Cypress Pine (Callitris glaucophylla), Black Cypress Pine (C. enderlicheri), Long-leaved Box (E. gonicalyx), New England Stringybark (E. calignosa), Brittle Gum (E. mannifera), Candlebark (E. rubida), Argyle Apple (E. cinerea), Kurrajong (Brachychiton populneus) and Drooping She-oak (Allocasuarina verticillata) (Austin et al. 2002; Beadle 1981; Fischer et al. 2004; NSW National Parks & Wildlife Service 2002; Prober & Thiele in press). This ecological community occurs in areas where rainfall is between 400 and 1200 mm per annum, on moderate to highly fertile soils at altitudes of 170 metres to 1200 metres (NSW Scientific Committee 2002).

"Shrubs can occur naturally in grassy woodlands, and can form an important part of the Box – Gum Grassy Woodland and Derived Grassland ecological community… In shrubby woodlands, the dominance of native tussock grasses in the ground layer of vegetation is lost. Therefore, a remnant with a continuous shrub layer, in which the shrub cover is greater than 30%, is considered to be a shrubby woodland and so is not part of the listed ecological community. Remnant attributes, such as shrubbiness, should be measured on a scale of 0.1 hectares or greater.

"The size and life-form of understorey species are such that viable populations can exist in very small areas (Prober & Thiele 1993). Therefore, in order to be the listed ecological community, an understorey patch, in the absence of overstorey trees, must have a high level of native floral species diversity, but only needs to be 0.1 hectares or greater in size. A patch in which the perennial vegetation of the ground layer is dominated by native species, and which contains at least 12 native, non-grass understorey species (such as forbs, shrubs, ferns, grasses and sedges) is considered to have a sufficiently high level of native diversity to be the listed ecological community.

"At least one of the understorey species should be an important species (e.g. grazing-sensitive, regionally significant or uncommon species; such as Kangaroo Grass or orchids) in order to indicate a reasonable condition. Areas with both an overstorey and understorey present are also considered of sufficiently good condition to be part of the listed ecological community if the understorey meets any of the conditions above, or if they have a predominantly native understorey, are two hectares or above in size, and have either natural regeneration of the overstorey species or 20 or more mature trees per hectare."

In Table 2, Appendix F1 of Appendix J1, ELA provide an assessment on how well the community in question meets the definition criteria of the EPBC Box Gum Woodland CEEC. My responses to their comments are below:

Some importance is placed on the contention that the groundlayer is not "*dominated by tussock grasses*." Many of the grasses present in this community such as wire grasses, wallaby grass, spear grass are regarded as 'tussock grasses'. While the overall cover of these grasses does not constitute a majority of cover, the groundcover may be described as a mixture of forbs, grasses and leaf litter. The tussock grasses are the dominant type of cover in the groundlayer in that they are taller and more conspicuous. Other species such as Bladey Grass *Imperata* and Reed Grass *Arundinella nepalensis* occurred in patches, though were not present at all sites. Other grasses present at most sites were the damp loving species Couch and Weeping Grass. ELA also include the species *Lomandra longifolia* and *Gahnia aspera* as groundcover, though I regarded them as a low shrub for the analysis in this study, due to their large size (up to a metre).

"*Tree cover in the subject plots range from discontinuous on the larger creeks like Bohena Creek and continuous on the smaller tributaries*." This statement by ELA confirms the notion that the plant

community along Bohena Creek is a woodland and is different to that on the smaller creeks which support PCT ID 399.

ELA again contend the soils are not 'moderate to highly fertile soils' as defined in the EPBC determination, but rather more on the 'low to moderate' scale. This is debatable as to whether the definition under the EPBC Act does not include soils which have a 'low to moderate' fertility.

The project area being outside the zone mapped by Prober and Thiel (1995) by itself does not constitute a reason why the community here should not be regarded as the CEEC, nor should presence or absence of White Box.

ELA have confused the term 'eastern slopes' with the slopes east of the divide. This was not the intention of this term which is referring to the slopes on the eastern side of the distribution of this community, ie. the north-west slopes. The Pilliga is regarded as being partially within the general 'slopes' region.

The discussion in the EPBC determination about Kangaroo Grass and Snow Grass is made in the context of their grazing susceptibility. It clearly states in the determination that these species were, "*originally the dominant grasses across a large part of the ecological community's range*" not the whole range of where this community is found. There should be no expectation from ELA that these species are found in this community in the project area.

With an understorey diversity ranging from 20 to 35 species per plot, these are not species-poor habitats, though some variation in condition was encountered by EE, with a number of plots lacking sufficient diversity to meet the conditions in the EPBC definition. The soils this community occurs on is alluvial in nature, relatively deep, have clay zones which trap water and high levels of leaf litter promoting humic conditions. As ELA have conceded the level of shrub cover in this community is only sparse to patchy. None of these matters supports the contention that this community is not the CEEC.

Due to the variation in the condition of this community along Bohena Creek, only 8 of the 16 sites sampled meets the EPBC criteria in terms of structure, species composition and species diversity. Beside the one site found on the eastern bank of Bohena Creek at Site 5 which was a shrubby woodland (PCT ID 408), the other transects failed to meet the definition of the EPBC Box Gum woodland due to their poor groundstorey condition and lack of forb and herb species (<12 as required in the definition above).

Interestingly, the Commonwealth flagged the possible presence of Box Gum Woodland CEEC in the study area in their response to the referral submitted 2014. But in the SEARs, the OEH have removed this community as a 'matter for further consideration' on the basis that it was presumably thought not to be present.

Despite the variation in condition and based on the information above, the community identified here as PCT ID 544 should be regarded as being consistent with the definition of this critically endangered ecological community.

PCT ID 401

There is actually very little difference in the structure and species composition of this community and the PCT ID 544 (see p. 152, Appendix J2), except the red gum in this community is said to be *E. chloroclada* in the EIS and the absence of Yellow Box and Kurrajong. But as this community also contains *E. blakelyi* and given the recognised extent of hybridisation in the Pilliga forests among red

gums (Benson *et al.* 2010), the distinction between the two may not be so clear. Observations of this community type (PCT ID 401) in the field, suggest it could be lumped with the previously discussed PCT ID 544. In fact ELA has assigned these two communities the same Biometric Vegetation Type, *NA 197 Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion,* a grassy woodland.

This similarity was acknowledged in the EIS, as Appendix B of Appendix F2 of Appendix J1 states, "*ID 399 and ID 401 generally occur adjacent to one another and intergrade along riparian corridors … These communities are relatively similar and it was often difficult to delineate the boundary between these two communities*."

However, without any independent verification, it is not possible to confirm whether or not PCT ID 401 should include all the red gum – rough barked apple communities in the study area and how much of this combined type also conforms to the state and Commonwealth-listed ecological community. Further verification should be required to clarify this issue.

Identified Threatened flora

Appendix F4 of Appendix J1 (Flora Modelling Technical Report) details much of the rationale, effort and results for the targeted threatened flora surveys. The models used to estimate population size seem appropriate and the estimates given appear to be the best possible given the limited data available in some instances.

Nonetheless, the margin of error in the estimates is considerable, up to 100%, which does not provide great certainty as to the predictive accuracy of some of these models, necessary for accurate impact assessment.

Identified Threatened fauna

"*In the study area, 16 birds, 10 mammals and one reptile listed as threatened under the TSC Act, three mammals one bird listed under the EPBC Act and five birds listed as migratory under the EPBC Act were recorded during this assessment*." (Appendix J1, p. 105).

A review of statements made of the habitat preferences and distribution of some of the key species for this EIS is provided below. Species identified by the Secretary as being "matters for further consideration" within the SEARs are discussed separately.

Pilliga Mouse

Habitat preferences of the Pilliga Mouse and habitat modelling undertaken for this species is discussed in Appendices F5 and F6. The most accurate statement about the habitat preferences of the Pilliga Mouse is provide on p.15 of Appendix F6;

"Consistent characteristics of Pilliga Mouse habitat include a high cover and diversity of low shrubs as well as a sandy soil substrate in woodland and forest communities."

Except that the Pilliga Mouse is not restricted to woodland habitats and also occurs in treeless heaths when suitable conditions arise. The most detailed habitat descriptions of this species are contained within Paull (2009) and Paull *et al.* (2014) who describe a number of statistically significant relationships:

- In mature habitats in the central parts of the Pilliga, Pilliga Mice prefer a high ground cover of litter and ground-plants, while in fire affected sites prefer a low shrub cover of over 30% with burrow sites located in patches of high leaf litter cover. This trend for selection of a dense low shrub cover was recorded again in breeding habitat in the eastern Pilliga.
- In the central Pilliga, Pilliga Mice strongly avoided areas with a dense mid-storey cover 2 m or greater in height. Breeding sites in the eastern Pilliga also did not support this kind of mid-storey.
- Tree cover was not found to be a factor affecting Pilliga Mouse presence in the central Pilliga, with highest numbers recorded from treeless areas. However, in the eastern Pilliga, all breeding sites were found within woodland habitats. Therefore tree cover is not a predictive factor.
- A preference for a relatively deep (at least 30cm) sandy substrate was recorded across all sites.

The Canopy Height Model proposed by ELA identified five categories of habitat (Appendix F5 of Appendix J1). CAT 1 (Dense Heath) and CAT 2 (open heathy woodland) are regarded as 'primary'. Three others require further field verification and are regarded as 'secondary'.

From observations made by Paull *et al.* (2014), based on over 30 captures in the eastern Pilliga, important habitat for the Pilliga Mouse may also be found in 'woodland' as opposed to 'open woodland'. Whether the LIDAR-based Canopy Height Model employed by ELA can detect a low shrub cover under this density of canopy appears unlikely.

Pilliga Mice have also been trapped in riparian woodlands (RACD 2001), again, type of use by Pilliga Mice is likely to be dependent on suitability of local ground and understorey conditions.

ELA don't regard Broombush scrub as habitat for the Pilliga Mouse, citing shallow clay layer as a barrier to burrowing. This is despite the clear preference for this community type in the central Pilliga (Paull 2009) where a clay layer is present though deep enough below the sandy A horizon to allow burrows to be constructed. The 'clay dome' which underlies most areas which are treeless and prone to water-logging can vary in depth below the surface, though to exclude the Broombush community in its entirety from the habitat model as 'primary habitat' would not be prudent in relation to the conservation of this species.

For the purpose of the both the EPBC and TSC Acts, the species listed as *Pseudomys pilligaensis* in the list of threatened species is currently treated as a valid taxon and so conjecture regarding its taxonomic status in the EIS is a moot point.

In fact, despite a recent move to have the Pilliga Mouse de-listed as a threatened species due to this question regarding its taxonomic status, the Pilliga Mouse has been retained on the Commonwealth listing and the current position of the current Commonwealth Threatened Species Scientific Committee with regards to this issue is given below from the Commonwealth website.

"The available genetic evidence (i.e. presence of mitochondrial DNA similar to both P. delicatulus and P. novahollandiae in specimens of P. pillagaensis) indicates that P. pilligaensis is either a stabilised natural hybrid or a hybridised population of P. delicatulus or P. novahollandiae (Eldridge 2015, pers. comm.). This evidence has led some authorities to treat the Pilliga Mouse as a southern population of the non-significant Delicate Mouse (Pseudomys delicatulus) (AFD 2015; Breed & Ford 2007; Van Dyck & Strahan 2008; Woinarski et al. 2014). The Australian Museum, however, argues that the current data is insufficient to distinguish amongst these options and that a more detailed study is required to resolve the matter (Eldridge 2015, pers. comm.)."

This is re-iterated by the IUCN who have listed this species as Data Deficient in view of recent doubts as to its taxonomic validity. This summarises the current scientific position on this issue. That is, while the work of Ford (2003) raised questions about the taxonomic status of the Pilliga Mouse, he did not resolve them.

Further, the Red List states, "*should this taxonomic issue be resolved such that* P. pilligaensis *is again widely accepted as a full species, it would need to be reassessed. At present, it may be considered Endangered under this scenario because its extent of occurrence is less than 5,000 km^2, its distribution may be severely fragmented, and there is continuing decline in the quality of habitat due to mining and logging."*

http://www.iucnredlist.org/details/full/18555/0

At no time has the NSW Scientific Committee considered removal of the species from its listing under the TSC Act, recognising the genetic uniqueness of the population, having more than one haplotype within its gene pool. Even if at some time the population becomes regarded as a Delicate Mouse after further taxonomic investigation that uses genome testing rather than a mitochondrial analysis, this is still a threatened species under the TSC Act.

Koala

"*Note that Koala has been included in this list as Koala scats (Landmark Ecological Services and Wilderness Society 2012) and a Koala skull was recorded during survey for this assessment in 2011. Due to the similarity between Brushtail Possum and Koala scats, and the fact that no Koala sightings in the study area can support these records, the current evidence does not indicate presence of a current population in the study area*." (Appendix J1, p. 105).

Brushtail Possum scats and Koala scats may be similar in some respect, but there is no doubting the accuracy of a trained sniffer dog and sightings of animals. Both types of detection of Koalas have been made within the study area in the last year. New evidence is provided here (reports attached) which show 5 records of Koalas in the study area and nearby in the period 2013-2016.

OWAD Environmental conducted a Koala scat trained detection dog survey in 2016. Two 'hits' were made. One on Crow Road of scats in an area of Narrow-leaf Ironbark (*E. crebra*) and another near the study area southern boundary on Bohena Creek Road in Red Gum and Yellow Box woodland, but the scats here was not located. More recently, a male individual was observed on Dog Proof Fence Road within the western boundary of the study area. He was located in a Red Gum, near Bundock Creek in November 2016. This stream is surrounded by Pilliga Box woodland, with more scats found to the south of the Project area on Borah Creek.

Prior to this, Koala scats were observed on Bohena Creek (Lunney *et. al.* submitted to Pacific Conservation Biology) another individual was observed in August 2014 near Cocoboy 2 Dam, in the Pilliga East SCA. All these records have been submitted to the NSW Wildlife Atlas.

The record contained in Lunney et al. (submitted) was part of an Environmental Trust funded project to replicate historical surveys conducted by teams of experts who had surveyed Koalas previously in the Pilliga. The findings of this study along with the work conducted by Niche (Appendix F7 of Appendix J1) show that the Koala distribution and abundance has declined significantly since times of peak numbers in the 1990s (Kavanagh and Barrott 2001). Niche found 14 animals in the Etoo and Baradine Creek drainages across an area where perhaps hundreds were resident 20 years ago.

There have been other recent records of the Koala in the northern Pilliga, with more than one detected from the Australian Wildlife Conservancy (AWC) lands (R. Kavanagh, pers. com.) last year. In this light, the recent observation on Bundock Creek should not be a surprise, given there is more or less continuous habitat for the Koala from the AWC area to the eastern side of the Newell Hwy, if the preferred food tree Pilliga Box *Eucalypts pilligaensis* is taken into account (see below).

In summary, the current status of the Koala in the study area (and throughout the Pilliga) is dire with numbers desperately low. Any records of where Koalas are currently should be treated with the highest priority. While presence of the Koala in the Bohena Creek area is uncertain, records from the northern Pilliga suggest very low numbers are still persisting this area. Considerably more monitoring needs to be undertaken of Koalas in the project area and beyond to ascertain if current trends of decline will continue and what actions need to be done to ensure the local and regional Koala's survival.

The EIS claims to have modelled 'primary' and secondary' habitat for the Koala in the project area by reference to the NSW Koala Recovery Plan (2008) which identifies a number of primary and secondary species. However, it is widely accepted, and based on scientific evidence, that this list does not accurately reflect feed preferences from the Pilliga and the Liverpool Plains.

Work by Kavanagh *et al.* (2007) clearly show that the preferred feed species of the Pilliga koalas at a time of high population density were Blakely's Red Gum and Pilliga Box. This was re-iterated within the EIS itself within Appendix F7 of Appendix J1. Areas dominated by preferred feed species should constitute primary habitat as defined under Callaghan (cited in DECC 2008), that is, all areas dominated by Blakely's Red Gum, Pilliga Box and River Red Gum would constitute primary habitat or habitat critical to the survival of the koala.

Despite this, the EIS identifies only 10.5 ha of primary habitat, River Red Forest in the vicinity of Yarrie Lake. By adding the areal extent covered by the communities identified as 'secondary' in the EIS, (29,942.5 ha), the total area of Koala habitat in the study area covers 29,953 ha. However, if the approach outlined in the Commonwealth guidelines or that outlined in the NSW Recovery Plan is used, primary habitat in the study area could cover at least 7,050.6 ha. Most of the records in the study area from the BioNet database are from the northern Pilliga Box woodlands as mapped by ELA.

While it has been common practice among ecological consultants in NSW to use the now defunct Recovery Plan's (DECC 2008-13) regional categories of tree preference provided in the Plan as scientific proof, any guidelines such as these should be subject to scientific scrutiny. The approach taken by ELA ignores common scientific practice of reviewing the relevant literature. After all, ecology is a science, not just a tick-the-box exercise.

ELA goes on to state that there is no 'core' Koala habitat in the study area using the definitions provided in the SEPP44 – Koala Habitat guidelines. SEPP44 outlines an 'activity-based' approach to determining koala use of land parcels. The use of these guidelines is only appropriate and has statutory meaning for developments where local government is the consent authority and where developments are local in scale. It is certainly not appropriate to use this approach for regional scale developments where local populations may be at very low densities, such as in the Pilliga forests. The survey intensity of scat assessments in the EIS is certainly of not enough quantity to cover all of the extent of koala habitat in the study area (4 mapped plots over 30,000 ha) and the Secretary of the Environment should disregard any statements using definitions under the SEPP44.

Black-striped Wallaby

ELA recorded this endangered species at 12 locations, however, the importance of the affected population to this species and the potential impact on it from the gas field is understated in the EIS. This is despite the fact that:

- Seven records in the EIS are from the Pilliga forests effectively doubling the number of times this species has been recorded from the Pilliga.
- The current distribution of this species is wholly within the project area.
- This population is spread between two areas, one centered around Brigalow Park Nature Reserve and State Conservation Area and the Pilliga Forests. Connecting vegetation is found along Bundock Creek. These important areas may be surrounded by gas wells, degrading habitat conditions and hindering dispersal or movement of this species.
- The Black-striped wallaby is endangered in NSW. The western slopes population is isolated from other populations on the eastern seaboard. Arguably this species should have been identified as a 'matter for further consideration' under the FBA due to potential impacts upon landscape features or significant reductions in population viability in the IBRA subregion (s. 9.2.1.3 of the FBA).

Appendix A5 of Appendix J1 describes the habitat preferences of this species as being wide, selecting all habitats except for heath. However, in Appendix I of Appendix J1, the habitat requirements of the Black-striped Wallaby in the study area is described as:

"*Preferred habitat is characterised as dense woody or shrubby vegetation within 3 m of the ground. This dense vegetation must occur near a more open, grassy area to provide suitable feeding habitat. On the north-west slopes it is associated with dense vegetation including brigalow, ooline and semi-evergreen vine thicket*."

These are quite specific requirements as compared to a more general one, which raising questions about the accuracy of the impact assessment on this species. Key to this is that this assessment ignores this species' presence in the Pilliga, which does not contain the vegetation communities mentioned in Appendix I, but does have areas of forest with thick understorey vegetation. This wallaby is most well-known from Brigalow Park Nature Reserve (NR) and State Conservation Area (SCA) about 20 km to the north of the Pilliga forest, these areas are dominated by Brigalow, small remnants of the 5% of this community which remains in NSW. Normally, this wallaby occupies territories of over 90 ha, though it is capable of longer distance movements (Evans 1996). There is only limited space the very small reserves to the north of the Pilliga forest can afford the Black-striped Wallaby which it shares with other macropods, such as the Red-necked Wallaby.

Recent evidence has shown that in fact this population is regularly using the northern sections of the Pilliga forest and are particularly using a corridor running along Bundock Creek. Besides records from Landmark Ecological Services (2012) and the data provided in this EIS, survey by the North West Local Land Service has recorded dozens of images of Black-striped Wallabies at the state forest northern boundary using holes in the wire fence to gain access (Reegan Walker, NW LLS pers. comm.). Much emphasis is often placed on the forging requirement of 'open, grassy areas' as needed by this species, though the Pilliga forest itself has significant grass cover, and supports thousands of kangaroos.

In the EIS there has been no attempt to describe the locations or habitat use of this endangered species, in what seems like a considerate oversight. But from what we know, an initial habitat model would include the following.

- Forest with high canopy cover – consistent with its preference for 'denser forest'.
- Forest on heavier soils – records from the Pilliga suggest this species is restricted by heavier soils associated with box/ironbark vegetation in the north of the forest, these areas are characterised by a clay soil horizon.
- Refuge sites containing areas of dense understorey up to 3m – Pilliga has much cypress and bull oak regrowth, as well as dense patches of wattle.
- Some records suggest wallabies are also grazing along creeks, with a record in the EIS from near Bohena Creek.

Given the very inaccurate characterisation of the habitat of this species, the poor assessment of indirect impacts and the general lack of consideration in the EIS, the Secretary should disregard any impact assessment undertaken on this species as being an accurate account.

Special consideration should be given to this species under the terms of s.9.2.5.2 of the FBA.

Impact assessment

It is stated in the EIS that there will be 1,701.51 ha of cumulative impact on native vegetation (including derived native grasslands) – 1.79% of the study area. The modelled impact assessment also found that there would be less than 3% of fauna habitat for all threatened fauna and less than 2% of threatened flora individuals affected by the gas field.

What is remarkable about the predicted impacts is the evenness of impact that the probabilistic modelling creates. For example, nearly all modelled impacts on threatened flora species predicts an impact of around 1.57% for direct impacts. This is despite very different levels of occupancy and density exhibited by the different species. Similar patterns also exist for fauna habitat and vegetation communities, exhibiting a high level of similarity of magnitude of impact within the model.

Is this an artefact of the type of modelling that has been undertaken? Or just a remarkable co-incidence.

Similarly, the assessments of significance of impact as per the tests in the EPA and EPBC Acts suffer from a lack of transparency due to questions regarding the modelled impact.

Matters of further consideration

The SEARs identify three 'matters for further consideration' and require particular assessment approach as detailed at s.9.2.5.2 of the FBA. Consideration has to be given as to whether the matter under consideration is 'directly and/or indirectly impacted by the development'.

The EIS has called this the 'disturbance site' which is the area contained within the 'disturbance boundary', including buffer zones, but in reality these remain hypothetical.

Reference in Appendix D of the Biodiversity Assessment Report (Appendix J2) refers to expected impacts which may arise as a result of the development. Some reliance seems to have been made as to whether or not the two fauna species in question have 'breeding habitat' in the 'study area' but this assessment is primarily based how much this habitat overlaps with the likelihood of it being affected by an imaginary footprint based on the 'probabilistic' methodology described in Appendix F3.

It should be viewed by the Secretary that as the proponent has not identified a development footprint, the requirements of s.9.2.5.2 have not been met and that statements made in the EIS such as 'outside the disturbance area' should not be taken literally.

Regent Honeyeater *Anthochaera phrygia*

The EIS states that there is no breeding habitat for the Regent Honeyeater within the study area, but there must be some doubt as to the accuracy of this assertion. Bohena, Borah and Yaminbah Creeks all support grassy woodland containing red gums, Yellow Box and Mugga Ironbark and it is not necessary that breeding habitat contain River Oak *Casuarina cunninghamiana*. Areas close to the main streams in the Bohena Creek system also contain box and ironbark woodlands. Previous records of this species from the Pilliga and Warrumbungles were from riparian habitats (Dr Liz Huxtable, pers. comm.).

The National Recovery Plan for the Regent Honeyeater states that:

"*… riparian habitat is also selected as breeding habitat in some years (Geering and French, 1998; Oliver et al., 1998; Oliver et al., 1999). Often this is adjacent to box-ironbark woodland. Remnant stands of timber, roadside reserves, travelling stock routes and street trees also provide important habitat for regent honeyeaters at certain times (Franklin et al., 1987, 1989; Ley & Williams, 1992; Webster & Menkhorst, 1992; Oliver, 1998*)."

Mugga (or Red) Ironbark, *Eucalyptus sideroxylon* and Yellow Box are identified as key tree species for the Regent Honeyeater. Both are present in the study area. The Recovery Plan states that 'habitat critical to the survival of the Regent Honeyeater' includes:

- *Any breeding or foraging habitat in areas where the species is likely to occur; and*
- *Any newly discovered breeding or foraging locations.*

While there are no records of this critically endangered bird in the study area, the red gum angophora woodlands of the Bohena Creek (which contains Yellow Box) and adjacent areas of Mugga Ironbark could potentially be 'habitat critical to the survival'.

"Key areas include the Bundarra-Barraba, Pilliga Woodlands, Mudgee-Wollar and the Capertee Valley and Hunter Valley areas in New South Wales, and the Chiltern and Lurg-Benalla regions of north-east Victoria." The National Recovery Plan (DoE 2016) regards the Pilliga as a breeding area for the Regent Honeyeater.

Given the confusion about the definition of breeding habitat for this species and, as discussed previously, a lack of sufficient effort to detect this species, the Secretary should determine that specific assessment conditions outlined in s.9.2.5.2 have not been adhered to.

Five-clawed Worm-skink *Anomalopus mackayi*

There are two important aspects for the impact assessment undertaken on this species which have been overlooked by ELA. A summary by ELA on the ecology and presence of this species in the project area is as follows:

"The Five-clawed Worm-skink is known to occur on the floodplains of the Namoi River, and its likely distribution within the Namoi Catchment extends to just north of the study area (North-west Ecological Services 2010). Its preferred habitat on deep cracking clay soils is not present in the study area. The northern portion of the study area supports limited potential habitat in closed forest habitat". (p. 112, Appendix J1).

A due diligence assessment of the known information on this skink shows it is not restricted to 'deep cracking clay soils'. The Queensland Government's description of this species states the following:

"The habitat of the long-legged worm-skink is eucalypt open woodland and low open grassland. Three specimens have been found beneath logs on red-black to black clay-loam soils in a gently sloping open paddock with even, low (approximately 5-10 cm) grass cover and scattered eucalypts."

https://www.ehp.qld.gov.au/wildlife/animals-az/longlegged_wormskink.html

The study undertaken by North-west Ecological Services (2010) on this species within the Namoi and Gwydir floodplain also found one specimen on 'basaltic soils' within box woodland.

There is also a record of a specimen found just outside the study area in 2015. ELA deal with this by stating that the location was someone's 'property' and the location is not certain. A review of the circumstances of this record show it was found dead on a road and handed to NPWS for verification. A check of the BioNet database shows that location data has been provided (Figure 3).

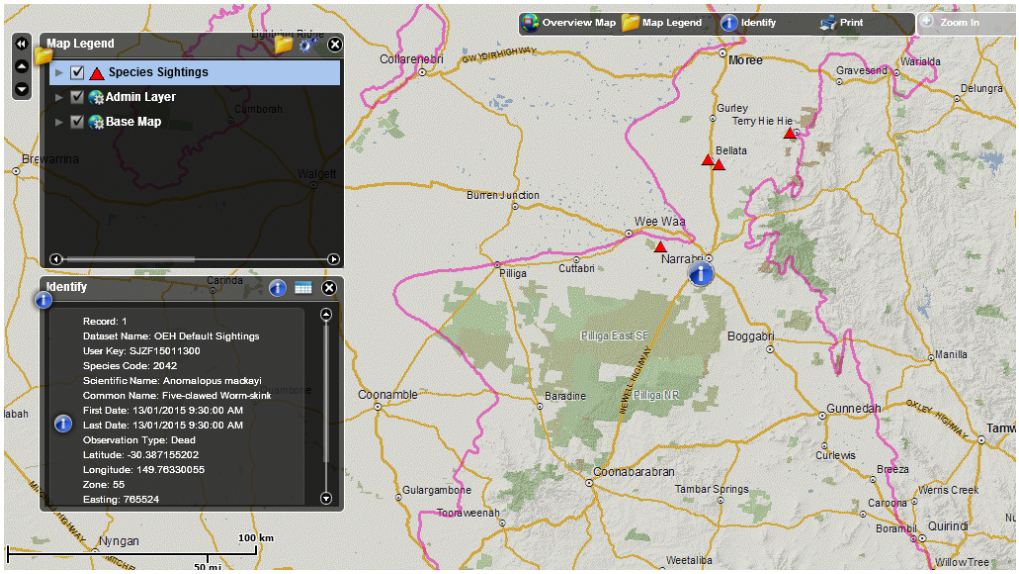

Figure 3. Records of A. mackayi from the BioNet database (accessed March 2017). The 'i' is the record from 2015 near the study area boundary

While ELA have dismissed any closer examination of this record, if the latest soil type mapping from Geoscience Australia is overlain, the record provides some indication of the soil types associated with it. The specimen was found in an area of Grey Brown Podzols/Earthy Sands. The extent of the heavy 'Black Earths' is shown as medium grey to the north and west of the location. Its distribution is well into the study area.

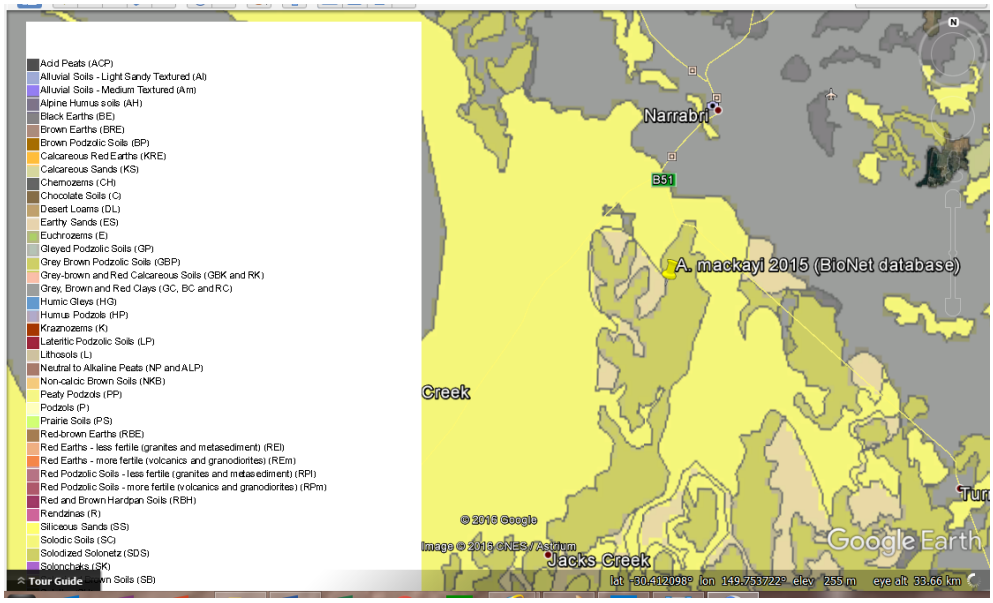

Figure 4. 2015 location with Soil type mapping from GeoScience Australia

The Black Earths can be found all the way through the study area, to include the heavy gilgaed (Brigalow) soils. The category of 'cracking clays' is not used in the latest soils mapping as the inclusive category 'Black Earth' include a variety of types, all with a similar physical properties, including cracking. What is clear is that statements made by ELA that there is no preferred habitat in the study area cannot be supported by the available evidence. Assessments of the site suitability for this species during field surveys in fact identified three sites which were thought to be suitable for this species.

Given the confusion about the habitat for this species, an unwillingness to consider key data and, as discussed previously, a lack of sufficient effort to detect this species, the Secretary should determine that specific assessment conditions outlined in s.9.2.5.2 have not been adhered to.

Impacts on NPWS estate

While Santos has proposed a 'no drill zone' within the Brigalow Park State Conservation Area (SCA), this does not carry any regulatory restriction as gas exploration activities are allowed in Sate Conservation Areas. In addition, the Brigalow Park Nature Reserve and the Brigalow Park SCA – (both sections) may be completely surrounded by gas infrastructure as a result of the NGP. As both these reserves are small, impacts such as additional noise and light pollution, increased traffic, fencing, infrastructure and habitat removal are likely to decrease the habitat value within these areas, increasing levels of 'edge-effect'. This is particularly significant for the endangered Black-striped Wallaby, a species barely mentioned in the EIS itself. These reserves are two of the last refuges for this endangered animal, and NPWS conduct routine surveys to check on numbers.

However, if the construction of gas infrastructure occurs in the vicinity of the reserves or Bundock Creek, the safe refuge and dispersal of this wallaby may be hindered and the current conditions which promote the relatively safe and quiet conditions around the reserves may be compromised.

But again, without knowing the location of the infrastructure, it is impossible to provide an accurate assessment of the magnitude of indirect impacts on these reserves. And given the very poor

modelling of indirect impact to 5 effective metres, the EIS does not take into account the effects of lighting, dust etc.

Environmental Risk Assessment

The proposed limits to indirect impact will be further explained within a Biodiversity Management Plan and a Significant Species Management Plan, but these are currently not available. Given the mitigating actions proposed in Table 15-22 in Chapter 15, there are only three which could minimise the risk of impact offsite, the Dark Sky Planning Guidelines, 'minimisation' of driving when it's dark and a proposed regional feral predator control program.

Foxes are notoriously difficult to control, neither baiting or shooting has been shown to be effective in the long-term if animals are allowed to re-colonise controlled areas (Newsome et al. 2014). This is particularly true for large scale feral animal control programs as gaps in baiting events and lack of coverage in adjacent areas will lead to ongoing fox dispersal into the study area. The potential impact in the most biodiverse sections of the project area are mostly restricted to state forest. No level of 'integration' can ignore the fact that this is large area is managed by one agency (Forests NSW). This also has to be placed within the context of the high risk of the project increasing levels of feral animal predation (particularly the fox) within the state forest. Fox numbers in the Pilliga are already high, a camera trap survey using 90 cameras throughout the Pilliga detected foxes at over 50% of cameras (D. Paull unpbl. data). No details of the control program are given in the EIS except for a number of objectives.

The Dark Sky Planning Guidelines will reduce onsite lighting at some facilities by aiming the light fixtures towards the ground, though flares are exempt under the guidelines. Placing rows of trees around the flare sites will reduce some light cover in time, if the flare stacks are low enough, though will not reduce total penetration of light.

Minimising vehicle movements at night may help reduce off-site impacts, though little detail is available as to what this really means in terms of number of vehicle movements. The fact remains that increased truck movements will result in a net increase in overall impact.

The mitigating actions with respect to direct impacts are conventional measures and the clearing protocol for example may save some individuals, but the impact itself cannot be avoided.

The field scoping protocol for sites may also assist in reducing local impact on a limited number or amount of listed matters, but there are limits to avoidability in the field due to issues relating to the necessity of the particular location and the extent of sensitive matters in the local area. Undertaking desktop searches prior to construction may identify some threatened species records, though to assume that they will for all threatened species in the location is not justified. Issues with some of the habitat mapping noted above reduce the reliability of this approach.

A number of the risks were given a 'High' rating, (impacts of clearing for example). It is unclear how this could be reduced to a medium risk given the above considerations. The risk posed by increased feral predation is also said to be mitigated by site rehabilitation measures. However, at present there is no evidence that site rehabilitation measures offer any protection from feral predators at sites already cleared across the Pilliga. These are generally still largely bare, or mulched with some grass and scattered low shrub cover (including Galvanised Burr) and sites with stands of Mudgee Wattle *Acacia spectablis*. Many of these have been established for over 10 years. The predation risk at these sites should be regarded as 'High' and this rating would not have changed in this time.

Weed control measures have been poor at existing well sites, even with rehabilitation plans, with noxious weeds present at some. Weeds may provide some habitat use for native fauna, but in terms of restoring natural landscapes become a hindrance. In general, there is little surety that stated objectives in the Rehabilitation Plan (Appendix V) can be achieved (see below).

There is no bushfire risk management plan for the public to see or any assessment of the bushfire risk of the development.

Biodiversity Offset Strategy

Perhaps the biggest failure of the terrestrial ecology assessment is the lack of a credible offset strategy. In fact, p. 15-54 states that there has been no investigation of the merits of the different offset proposals provided in the EIS and that these issues would be sorted out post-approval.

All Biodiversity Assessment Reports need to follow the FBA under the current NSW Biodiversity Offset Policy for Major Projects (the Policy). This requires proponents to provide a transparent retirement of biodiversity credits using offsets showing how many credits each action will generate. Only estimations have been provided. The SEARs for this project states the following must be provided;

"… a strategy to offset any residual impacts of the development in accordance with the NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014), unless otherwise agreed by OEH."

Appendix J2 states that over 56,000 ecosystem credits will require retirement, similarly, about 115,000 fauna species credits and about 340,000 flora species credits.

Offset packages can have a range of measures under the Policy and in the past have focussed on land-based outcomes, such as transferral of land to the National Park estate or setting up of conservation agreements over land parcels. However, no land parcels for offsets have been identified in this EIS (which would demonstrate the adequacy of the proposal in terms of both ecosystem and species credits), instead the offset strategy states it will adopt a mixture of approaches:

- Like-for-like land based offsets (including an extensive rehabilitation program),
- Supplementary measures (Feral predator control program),
- Compensatory measure (Koala Research),
- Contribution to the Biodiversity Fund.

While Santos have not provided any clear actions to implement their offset strategy, the EIS emphasises two main offset measures; a site rehabilitation program (said to account for 50% of the credit liability) and a 'regional' feral animal control program, accounting for 30% the credit liability from the impacts of the project.

Rehabilitation program

Of the nearly 1,000 ha of direct impact expected to occur as result of the NGP, Santos intends to rehabilitate approximately half of this area. This is because legacy well sites will still need to be maintained and well-pads and other infrastructure will remain following the project's completion.

With this 500 ha of rehabilitation Santos claims to be able to offset half of its credit liability in upfront credits of the project (by generating 23,500 credits). The current Policy allows for mine

rehabilitation with upfront and delayed credits, the latter can be enacted following the return of the original bond to the proponent. Rehabilitation cannot generate species credits without specific actions.

"Under the policy, proponents will need to return a recognisable plant community to the site in order to generate biodiversity credits. The method for calculating the contribution of rehabilitation to an offset requirement recognises that full ecological restoration of a site may not be possible. It also recognises that biodiversity gain achieved through rehabilitation often occurs much more slowly than biodiversity gain at an offset site." (NSW Biodiversity Offset Policy).

But statements made about the certainty of the outcomes for the rehabilitation program as outlined in Appendix V seem far-fetched given the current record of such actions in PEL238.

Currently, most sites have large areas of bare ground or mulched surface, some with some ground cover of grasses and scattered low shrubs. A high proportion of the shrubs are weeds, particularly Galvanised Burr is common across the sites. The areas of natural regeneration including some young trees and wattles, particularly *Acacia deanii* and *A. spectablis* (Mudgee Wattle). Mudgee Wattle is a poor condition site specialist, favoured for mine rehabilitation by industry and is one species which has regenerated at the sites, sometimes in dense stands.

About 20 sites have had some sort of identified spillage from past operations that has left the well site, it is fair to say that most existing well sites would have some localised spillage during the course of operations as current water control measures are only designed to prevent spillage leaving the site. A look at the two large spill zones, at Bibblewindi and Bohena 2 show poor level of natural regeneration 5 and 16 years following the spill respectively.

Figure 5. Bibblewindi spill zone (5th April 2017)

Figure 6. Bohena 2 spill zone (5 April 2017)

A key issue at the well sites are the high levels of background alkalinity in the soil (up to a pH of 10 at Bibblewindi spill zone, Golder and Associates 2012, attached), most likely arising from presence of groundwater spillage at the sites. The application of high levels of carbonates in the form of gypsum, as is current practice at the spill sites, has the potential to exacerbate this situation.

Surface soils in the Pilliga are generally acidic in nature (Appendix I) and species of Cypress Pine in particular prefer acidic soil conditions (pH 5-7, Lacey 1973). The legacy sites in the Pilliga are without any cypress pine regeneration, along with most species present in the surrounding vegetation.

The prospects of achieving a native vegetation community that could be regarded as 'like-for-like' at present seem low. The actions proposed in Appendix V do not address some of the key issues in relation to soil conditions identified here as being a key constraint.

'Regional' feral animal control program

Despite the NSW Offset Policy stating that *"Supplementary measures can only be used in lieu of offsets when offsets are not feasible and other options are needed',* Santos have highlighted one such measure without any evidence of effort demonstrated to obtain land-based offsets, a regional predator control program.

There is little detail about this program or how it will meet specific recovery plan objectives for different species, just some objectives in the EIS. It is assumed that this action will reduce the biodiversity credit liability by about 30%.

But there are two levels of predator intensity to be considered, the pre-impact (current) intensity, which is high, and the post impact intensity which will see an extensive increase in net fox foraging area, particularly within the state forest itself, a large area managed by one agency. The question is will the action proposed be able to deal with the increase in fox forage area and activity? If not, the fox program proposed may not see any net benefit to the ecosystem in its current level of disturbance.

Will it result in a reduction in overall impact of the project by 30%? Given the shortcomings in the indirect impact assessment, lack of detail about the program itself including the chances of success, this proposition in not supported by available evidence.

Biodiversity credits

With the 1 and 5m effective indirect areas modelled by ELA the total area of indirect impact has been calculated to be 181 ha. However as demonstrated here, the unmitigated impact from foxes alone should be twice the size of what the EIS estimates, giving a total impact area of 724 ha – 1,086 ha. It is questionable, as outlined above, if fox impacts could be mitigated to pre-impact levels with the increase in fox foraging quality throughout the study area. Given the extent of other unmitigated impacts, the effective impact areas of 1 and 5m should be considered well short of what an indirect impact would look like in the study area as a result of the project. As such the biodiversity credit liability detailed in the EIS has been under-estimated.

With the commitment to pay into the Biodiversity Fund to finalise their offset commitment, which is not yet in place, it seems Santos is taking an approach which seems to rely on its rehabilitation and feral predator control programs. Given the lack of certainty for the effectiveness of the outcomes in these two measures proposed, a lack of measurable land-based outcomes, no actions proposed to retire the flora species credits liability, and a lack of any evaluation of contingency actions, the offset package as proposed falls short of meeting the requirements of the current NSW Biodiversity Offset Policy and the Secretary's Requirements for this project, unless of course agreed to by the Office and Environment and Heritage (OEH).

This discretionary power to OEH in the SEARs to be able to disregard the statutory guidelines, after 10 years of development to achieve a 'whole-of-government' set of assessment methodologies, flies in the face of a transparent biodiversity outcome for this and future major projects.

Commonwealth requirements

Appendix 3 of the EPBC Act Environmental Requirements for the NGP outlines the information requirements for EPBC Act offset proposals. The offset strategy outlined in the EIS has a low level of compliance with these requirements, as it does not provide any detail regarding the following for the Bilateral approval:

i. the location of any offsets as the location of well sites is not known, though it is estimated that each well pad will be 2 ha in size. The only land-based offsets Santos have provided are the rehabilitation undertaken at the well-pads.

ii. maps for each offset site are not available.

iii. confirmed records of presence (or otherwise) of relevant protected matter(s) on the offset site(s) cannot be determined nor can details of studies and surveys used to confirm the presence of individuals and or likely habitat within offset site(s). The quality of habitat cannot be assessed.

iv. information and justification regarding how the offsets package will deliver a conservation outcome that will maintain or improve the viability of the protected matter(s) consistent with the EPBC Act Environmental Offsets Policy (October 2012) has not been undertaken other than via a rehabilitation methodology provided by the NSW Government.

v. the risk of damage, degradation or destruction to any proposed offset site(s) in the absence of any formal protection mechanism is high considering the risks posed by ongoing mining leases and

future development applications in the area. State Forests are open to mining and gas activities in NSW and no formal protection measures have been proposed for rehabilitation sites.

vi. it is unclear whether the rehabilitation of mine sites be regarded as being 'additional' to existing requirements by the Commonwealth. Such activities are usually obligations contained within a Mine Plan, though now the NSW Government has determined that rehabilitation on mine sites can generate biodiversity credits.

vii. no costings of the proposed offsets package in the EIS.

Considerably more information is required by the Commonwealth before any decision can be made about the efficacy of the offset package.

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Attachments

1. Ethical Ecology (2017). Survey of Bohena Creek riparian plant communities. Report for Upper Mooki Landcare Inc
2. Ethical Ecology (2016). Koala survey within PEL 238, October/November 2016 and assessment of significance of impact. Report to Lock the Gate Pty Ltd
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