



ENERGY NSW COAL SEAM GAS (CSG) EXPLORATION AND APPRAISAL PROGRAM

IMPACT ASSESSMENT UNDER THE EPBC ACT

Prepared for:
Santos Limited

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Abbreviations

ABBREVIATION	DESCRIPTION
BWTP	Bibblewindi Water Treatment Plant
CAMBA	China-Australia Migratory Bird Agreement
CEEC	Critically Endangered Ecological Community
CSG	Coal Seam Gas
CUCCLG	Coonabarabran and Upper Castlereagh Catchment and Landcare Group
DTIRIS	NSW Department of Trade & Investment, Regional Infrastructure and Services
ELA	Eco Logical Australia Pty Ltd
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
ESG	Eastern Star Gas (now Santos Limited)
Ha	Hectares
JAMBA	Japan-Australia Migratory Bird Agreement
MNES	Matters of National Environmental Significance
NGDP	Narrabri Gas Development Project
NICE	Northern Inland Council for the Environment
NPWS	NSW National Parks and Wildlife Service
NW Act	NSW <i>Noxious Weeds Act 1993</i>
OEH	NSW Office of Environment and Heritage
PAL	Petroleum Assessment Lease
PEL	Petroleum Exploration Lease
REF	Review of Environmental Factors (Under Part 5 of the NSW EP&A Act)
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RVC	Regional Vegetation Community
SSD	State Significant Development
TSC Act	NSW <i>Threatened Species Conservation Act 1995</i>

1 Introduction

1.1 ENERGY NSW COAL SEAM GAS (CSG) EXPLORATION AND APPRAISAL PROGRAM

Santos NSW (Eastern) Pty Ltd (Santos) is proposing to undertake the Energy NSW Coal Seam Gas (CSG) Exploration and Appraisal Program in the Narrabri area within Petroleum Exploration Licence (PEL) 238 and Petroleum Assessment Lease (PAL) 2 (hereafter referred to as the program). The program is scheduled to commence in 2013 and will take two to three years. The program includes recommencing operation of a number of existing pilot wells, drilling and operating new pilot wells and constructing and operating water and gas management facilities to support the program.

Eastern Star Gas (ESG) was the operator of the PEL 238 from 2002 to 2011 on the back of early stage exploration undertaken by various US based companies in the period 1998-2002. During that period, ESG carried out exploration and appraisal activities across much of PEL 238 and PAL 2, which in the period 2006-2011 focused more closely on the CSG resources underlying Pilliga East and Bibblewindi State Forests and surrounding freehold lands. The impacts associated with these early stage reconnaissance and exploration and appraisal activities were assessed under Part 5 of the *Environmental Planning and Assessment Act 1979 (NSW)*.

In 2011, ESG lodged a major project application for up to 550 well sets within PEL 238 and PAL 2, known previously as the Narrabri Gas Development Project (NGDP), to the NSW State Government. Following a series of field based ecological surveys in late 2010 and early 2011, the production project was referred to the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 12 April 2011 (EPBC 2011/5914).

Santos acquired ESG in November 2011 and commenced a full review of ESG's operations. Following the acquisition of ESG, Santos withdrew both the major project application and referral for the NGDP and commenced the decommissioning and progressive rehabilitation at thirty two well sites, the Bibblewindi Water Treatment Plant (BWTP) and a number of ponds within the PEL 238 and PAL 2 area (inclusive of PAL 2, hereafter referred to as the PEL 238 area). The objective of the rehabilitation activities is to rehabilitate these sites to natural pre-disturbance vegetation condition and improve the ecological values of the PEL 238 area.

Santos is now proposing to undertake an exploration and appraisal program to determine the viability of a gas production project in PEL 238 and PAL 2. This is dependent on geology, resource availability, environmental and land access constraints which will be investigated through early stage exploration and appraisal activities.

1.2 PURPOSE OF THIS REPORT

This report assesses the impact of the proposed program on MNES. The report includes an assessment of clearing undertaken for CSG activities within the Pilliga Forest to date and provides a cumulative assessment as to whether the proposed program, when added to the CSG clearing undertaken to date, would be likely to have a significant impact on MNES.

2 Description of activities

2.1 GENERAL LOCALITY

For the purpose of this report, the 'study area' is defined as an area covering approximately 48,000 ha and includes (in part) Pilliga East State Forest, Bibblewindi State Forest, Jacks Creek State Forest and Pilliga East State Conservation Area as well as Crown Land and privately owned land. The study area is being utilised for this report as it is the boundary of ESG's former NGDP, within which detailed studies into the biodiversity values of the north-east Pilliga Forest were conducted. The study area contains all existing and proposed exploration and appraisal activities for the program within the Pilliga Forest.

At least seven distinct vegetation types (in accordance with the NSW Vegetation Types Database, OEH 2012) are present within the study area including large contiguous remnants and patches of endangered ecological communities (State listed only).

Table 1: Vegetation types within the study area

VEGETATION TYPES	TOTAL AREA (HA)
Broombush shrubland of the sand plains of the Pilliga region, subtropical sub-humid climate zone (Benson 141)	1,217
Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion	33,556
Fuzzy Box on loams in the Nandewar Bioregion and northern Brigalow Belt South Bioregion (Benson 202)	289
Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone (Benson 88)	547
Red Ironbark - Brown Bloodwood shrubby woodland of the Brigalow Belt South Bioregion	13,668
Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion	6,609
White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion	22,878
Total	48,764

The vegetation across the study area has been variously affected by a long history of forestry, fires and small-scale agriculture. Forestry tracks (both formal and informal) form a fragmented network across the site; however, there are large patches (>1,000 ha) of contiguous vegetation which have not been dissected by forestry. Areas which have been spared from high intensity crown fires generally support large hollow-bearing trees.

A severe fire in 2006 consumed approximately 30% of the study area from the south-west through to the central portion. This fire has temporarily reduced the overall condition of heavily burnt areas through the alteration of vegetation structure and reduction in availability of hollow bearing canopy trees; however, it is expected that these areas will return to benchmark condition over time.

Within the study area, a number of small unmapped areas of derived grassland occur as a result of the removal of canopy, mid and shrub layers. These areas of derived grassland are all located on private or crown land outside of state forest and are generally associated with current or past agricultural activities.

The remainder of the vegetation within the study area is generally considered to be in good condition. Few weeds are present within the study area, with weeds currently present primarily within riparian zones and along the Newell Highway.

2.2 EXPLORATION ACTIVITIES

In order to determine the viability of a gas production project within PEL 238 and PAL 2, exploration and appraisal of aspects such as geology, resource availability, environmental and land access constraints are necessary.

Existing exploration activities undertaken within the study area have included seismic surveys, stratigraphic corehole drilling, pilot well drilling and production appraisal activities including management of water and gas products. Existing disturbance associated with these works includes vegetation clearing for coreholes, well leases, water and gas flow lines and water management (ponds).

Figure 1 details the location of all previous exploration activities and the proposed program that Santos plans to undertake as follows:

- Pre 2002 Footprint – these areas were cleared prior to ESG's involvement in the Pilliga and are not included in this report
- 2002 – 2012 Footprint – exploratory activities that were undertaken by ESG. The impacts of these works have been considered as part of this report
- Proposed Program Footprint (2013 onwards) – exploratory activities and appraisal activities which are proposed to be undertaken in the program. Impacts of the proposed program are the primary subject of this report.

The following reconnaissance and exploration and appraisal activities have been undertaken to date within the current study area. Environmental assessments in the form of Review of Environmental Factors (REFs) were submitted to the NSW State Government regulators for all of the activities listed below and undertaken in accordance with the consent of that agency and the landholder, the Forestry Corporation of NSW.

2004 - 2006		
Dampier Seismic Survey	May-04	seismic survey
Bohena South-1C	Jul-04	corehole
Bohena-4L	Jul-04	production pilot well
Bohena-9	Aug-04	production pilot well
Bohena South-1	Sep-04	production pilot well
Bibblewindi CSG Pilot	Mar-06	production pilot wells and flow lines

2007 - 2008		
Bibblewindi North-1C	Mar-07	corehole
Bohena-12C	May-07	corehole
Bohena South-2C	Jul-07	corehole
Bibblewindi West-1C	Aug-07	corehole
Bohena-13C	Aug-07	corehole
Bibblewindi-11	Oct-07	corehole
Dewhurst-2	Mar-08	corehole
Dewhurst-3	Apr-08	corehole
Dewhurst-4	May-08	corehole
Dewhurst-7	Jul-08	corehole
Dewhurst Seismic Survey	Aug-08	seismic survey
Dewhurst-5	Sep-08	corehole
Bibblewindi Multilateral pilot	Dec-08	production pilot wells and flow lines

2009 - 2010		
Bibblewindi Multilateral Pilot (cont'd)	Jan-09	production pilot wells and flow lines
Dewhurst-6	Apr-09	appraisal well
Bibblewindi-19H	Apr-09	production pilot well
Dewhurst-8	May-09	exploration well
Bibblewindi West Pilot	May-09	production pilot wells and flow lines
Dewhurst-9	Jul-09	appraisal well
Dewhurst-10	Jul-09	appraisal well
Bibblewindi-20	Jul-09	appraisal well
Bibblewindi Multilateral Pilot (cont'd)	Aug-09	production pilot well and flow lines
Bibblewindi-21H	Sep-09	production pilot well
Dewhurst 8 Pilot	Oct-09	production pilot well and flow lines
Bibblewindi Water Treatment Plant	2009	Water Treatment Plant

2010 - 2013		
Bohena-14	Feb-10	corehole
Dewhurst/Coghill Seismic Survey	Apr-10	seismic survey

Dewhurst-19	Apr-11	corehole
Leewood Produced Water Facility	2013	Produced Water Facility

2.2.1 Proposed program

The activities included as part of the proposed program are:

- operation of the existing Bibblewindi Multi-Lateral Pilot (Bibblewindi 12, 13, 14, 15, 16, 17, 18H, 19H, 21H, 27, 28H and 29), construction, drilling and operation of two additional pilot wells (Bibblewindi 31 and 32), and the operation of existing water flow lines from Bibblewindi Multi-Lateral Pilot to the Bibblewindi Water Transfer Facility
- operation of the existing Bibblewindi West Pilot (Bibblewindi 22, 23, 24, 25 and 26) and operation of existing water flow lines from the Bibblewindi West Pilot to the Bibblewindi Water Transfer Facility
- operation of the existing Dewhurst 13-18H Pilot (Dewhurst 13, 14, 15, 16H, 17H and 18H) and the construction, drilling and operation of additional lateral wells from well casing within Dewhurst 16H, 17H and 18H
- construction, drilling and operation of the Dewhurst 22-25 Pilot (Dewhurst 6, 22, 23, 24 and 25)
- construction, drilling and operation of the Dewhurst 26-31 Pilot (Dewhurst 26, 27, 28, 29, 30 and 31)
- construction of the Dewhurst Northern Water and Gas Flow Lines and operation the Dewhurst Northern Water Flow Line
- construction of the Dewhurst Southern Water and Gas Flow Lines and operation of the Dewhurst Southern Water Flow Line
- operation of a produced water tank at the Bibblewindi Water Transfer Facility (Bibblewindi Water Transfer Tank) to facilitate the transfer of produced water from the pilot wells to the Leewood Produced Water Facility
- operation of the Leewood Water Pipeline to transfer water produced by the operation of the above pilot wells from the Bibblewindi Water Transfer Facility to the Leewood Produced Water Facility
- operation of the Leewood Produced Water Facility to store water produced by the operation of the above pilot wells
- transport of produced water from Leewood Produced Water Facility to an appropriately licensed facility
- construction and operation of ancillary and supporting infrastructure to facilitate the above activities and ongoing maintenance.

The proposed program is essential to determine whether commercial gas production in the Pilliga is economically viable. Further information is required on the effectiveness of drilling and operating the tri-stacked lateral well design, coal fines and gas composition before any decision to progress to gas production can be made.

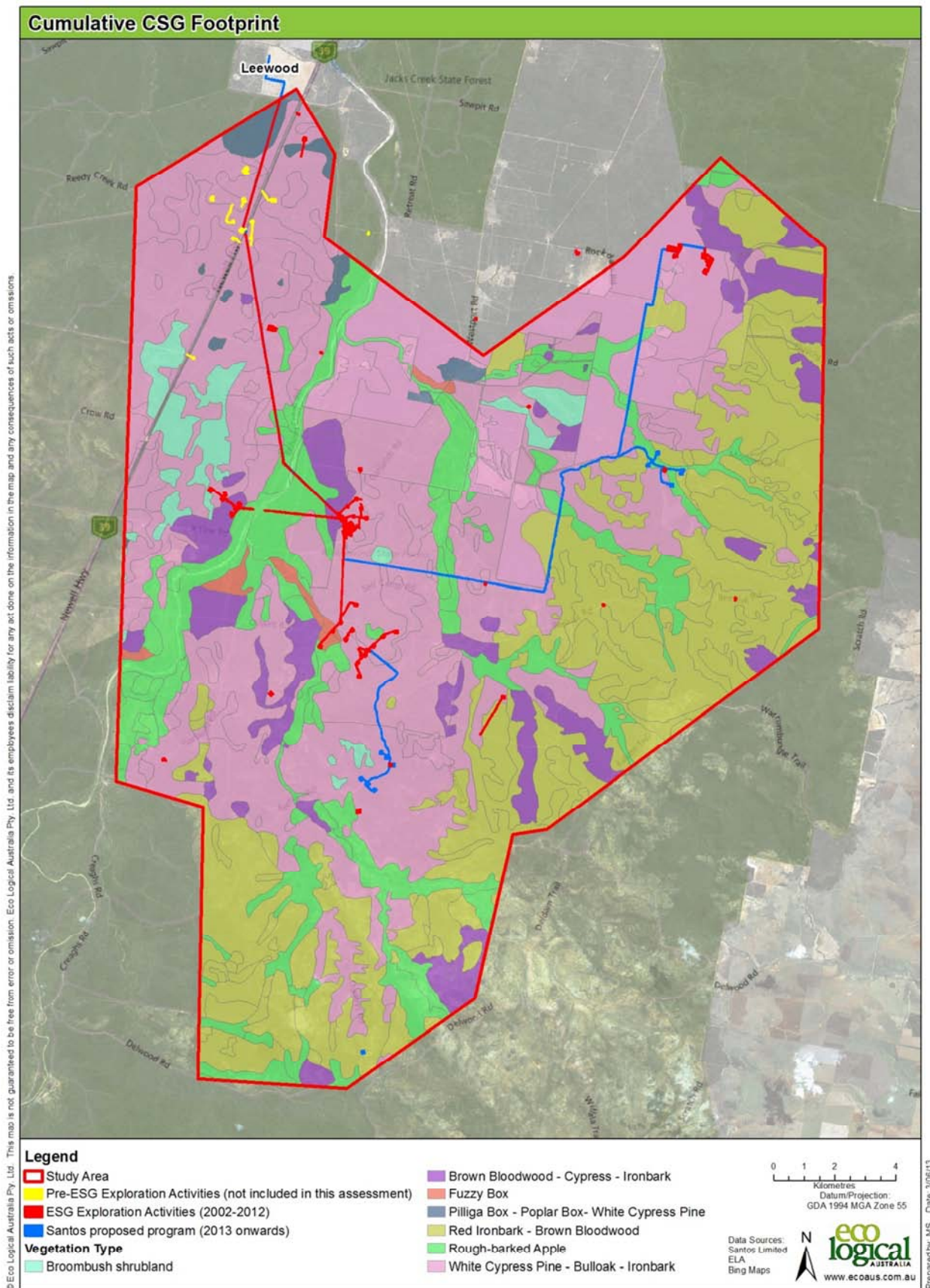


Figure 1: Cumulative CSG footprint within the Pilliga

3 Legislative framework

3.1 NSW PLANNING AND APPROVALS

Exploration and production appraisal activities require environmental assessment under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Part 5 of the EP&A Act applies to most exploration and appraisal activities, with assessments undertaken by the NSW Department of Trade & Investment, Regional Infrastructure and Services (DTIRIS, formerly I&I NSW, Department of Primary Industries and other iterations). DTIRIS is responsible for assessing the environmental impacts of activities within titles issued under the *Petroleum (Onshore) Act 1991* that fall under Part 5 of the EP&A Act.

To assess the impacts, DTIRIS requires the titleholder to undertake an activity specific environmental assessment such as an REF. A REF details the environmental impact assessment of activities taking place within petroleum title and the measures taken to avoid, minimise and mitigate impacts. The consent of the agency is required prior to any activity being undertaken.

Some exploration activities require assessment and approval by the Minister for Planning and Infrastructure as State Significant Development (SSD) under Part 4 of the EP&A Act. These exploration activities include the drilling or operating petroleum exploration wells not including:

- (a) stratigraphic boreholes;
- (b) monitoring wells; or
- (c) a set of 5 or fewer wells that is more than 3 kilometres from any other petroleum well (other than an abandoned petroleum well) in the same petroleum title.

Santos is proposing to seek development consent under Part 4 of the EP&A Act for the drilling and operation of sets of more than 5 wells proposed to be undertaken as part of the program.

REFs have been, or are in the process of being, prepared for each other activity within the program as required under Part 5 of the EP&A Act.

3.2 COMMONWEALTH EPBC ACT

The EPBC Act establishes a need for Australian Government environmental assessment and approval of (amongst other things), actions that are likely to have a significant impact on MNES. There are eight MNES listed under the EPBC Act which are:

- world heritage sites
- national heritage places
- wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
- nationally threatened species and ecological communities
- migratory species

- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions.

Of these, the matters relevant to the exploration and appraisal activities within PEL 238 and PAL 2 are 'nationally threatened species and ecological communities' and 'listed migratory species'.

Actions that may have a significant impact on one or more MNES need to be referred under the EPBC Act. SEWPaC have issued significant impact guidelines to help clarify what may constitute a significant impact on MNES (DEWHA 2009). These guidelines outline a set of criteria for each MNES and outline the types of actions and impacts that may be considered significant.

The significant impact guidelines also provide industry specific guidance for a number of sectoral activities, including mineral exploration activity. While it is clear that the guidance offered is not conclusive, it does specifically address seismic surveys and exploratory drilling and suggests that these activities would not be expected to have a significant impact on MNES. The guidelines state that a seismic survey or exploratory drilling may have a significant impact if, for example, it is likely to damage habitat critical to the survival of a species or disrupt the breeding cycle of a population of the species.

The program has been assessed against these guidelines and the assessment forms the basis of the EPBC Act Referral.

4 Ecological assessment

4.1 ECOLOGICAL SURVEYS UNDERTAKEN

A number of flora and fauna surveys have been carried out within the study area since 2002, totalling more than 3,000 person-hours in the field. The majority of the 48,000 ha study area has been covered by one or more of these surveys over this time.

The most recent flora and fauna surveys undertaken (RPS 2012a-c, 2013a-c), address the potential impacts of the proposed program on MNES. An outline of survey undertaken for each activity and relevant survey dates is included in **Table 2**.

Table 2: Ecological assessments, survey dates and effort for the proposed program

ACTIVITY	SURVEY DATES	SURVEY EFFORT
Bibblewindi Multi-Lateral Pilot	27 November 2012	Bibblewindi 31 and 32: • Flora survey • Fauna habitat assessment • Targeted survey for threatened flora species Supplementary survey was not required for existing infrastructure as no additional habitat disturbance is proposed.
Bibblewindi West Pilot	N/A	• N/A – survey was not required for existing infrastructure as no additional habitat disturbance is proposed.
Dewhurst 13-18H Pilot	24 January 2013	Water and gas gathering system: • Flora survey • Fauna habitat assessment • Targeted survey for threatened flora species Supplementary survey was not required for existing infrastructure as no additional habitat disturbance is proposed.
Dewhurst 22-25 Pilot	17 and 19 September 2012 8 – 12 October 2012 24 January 2013	• Flora survey • Fauna habitat assessment • Detailed fauna trapping program - o Diurnal bird surveys - o Spotlighting - o Active searches

ACTIVITY	SURVEY DATES	SURVEY EFFORT
		- o Anabat detection - o Terrestrial trapping (Elliot, Cage, Camera and Hair Tube) • Targeted survey for threatened flora species
Dewhurst 26-31 Pilot	12 - 16 November 2012	• Flora survey • Fauna habitat assessment • Detailed fauna trapping program - o Diurnal bird surveys - o Spotlighting - o Active searches - o Anabat detection - o Terrestrial trapping (Elliot, Cage, Camera and Hair Tube) • Targeted survey for threatened flora species
Dewhurst Northern Water and Gas Flow Lines	8 - 12 October 2012 4 – 9 November 2012	• Flora survey • Fauna habitat assessment • Detailed fauna trapping program - o Diurnal bird surveys - o Spotlighting - o Active searches - o Anabat detection - o Terrestrial trapping (Elliot, Snake Funnel, Camera, Hair Tube and Pitfall) • Targeted survey for threatened flora species
Dewhurst Southern Water and Gas Flow Lines	11 – 16 November 2012	• Flora survey • Fauna habitat assessment • Detailed fauna trapping program - o Diurnal bird surveys - o Spotlighting - o Active searches - o Anabat detection - o Terrestrial trapping (Elliot, Snake Funnel, Camera, Hair

ACTIVITY	SURVEY DATES	SURVEY EFFORT
		Tube and Pitfall) Targeted survey for threatened flora species

4.2 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

Based on searches of SEWPaC's Protected Matters Search Tool (SEWPaC 2013a), the Atlas of NSW Wildlife (OEH 2013), review of relevant literature, vegetation mapping, constraints analysis, flora and fauna survey results, and professional judgement, a number of EPBC listed species have been identified as having the potential to be impacted by the proposed program.

The likelihood of presence or absence of species and ecological communities has been assessed. The assessment took into account results of field surveys, suitable habitat presence, geographic features of the study area, searches of the Atlas of NSW Wildlife and professional judgement by qualified and experienced ecologists.

Three terms for the likelihood of occurrence of species and communities are used and are defined as follows:

LIKELIHOOD OF OCCURRENCE	DEFINITION
Known	the species was or has been observed within the site
Likely	a medium to high probability that a species uses the site
Potential	suitable habitat for a species occurs on the site, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur

Seven bird species, five mammals and two plants which are listed as MNES are determined to have a likelihood of occurrence of 'known', 'likely', or 'potential' within the area impacted by the proposed action (**Table 3**). Impacts to these (and other) species have been considered in the ecological assessments for the proposed program. A number of other species have been considered in relation to their likelihood of presence within the study area and determined to be unlikely to occur, as the study area is outside of their distribution, and/or there is not suitable habitat present. These species are not addressed in this report, but have been considered in supporting ecological reports and include species such as the Murray Cod, Malleefowl and Satin Flycatcher.

Table 3: MNES identified as having a likelihood of occurrence of 'known', 'likely' or 'potential' within the area impacted by the proposed action

SCIENTIFIC NAME	COMMON NAME	EPBC LISTING STATUS	LIKELIHOOD OF OCCURRENCE	SIGNIFICANT IMPACT LIKELY?
Birds				
<i>Anthochaera phrygia</i>	Regent Honeyeater	Endangered, Migratory	Potential	No
<i>Apus pacificus</i>	Fork-tailed Swift	Migratory	Potential	No
<i>Ardea alba</i>	Great Egret	Migratory	Unlikely	No
<i>Ardea ibis</i>	Cattle Egret	Migratory	Unlikely	No
<i>Botaurus poiciloptilus</i>	Australasian Bittern	Endangered	Unlikely	No
<i>Calyptorhynchus banksii</i>	Red-tailed Black-Cockatoo	Endangered, Migratory	Unlikely	No
<i>Erythrorhynchus radiatus</i>	Red Goshawk	Vulnerable	Unlikely	No
<i>Geophaps scripta</i>	Squatter Pigeon	Vulnerable	Unlikely	No
<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle	Migratory	Potential	No
<i>Hirundapus caudacutus</i>	White-throated Needletail	Migratory	Known	No
<i>Lathamus discolor</i>	Swift Parrot	Endangered, Migratory	Potential	No
<i>Leipoa ocellata</i>	Malleefowl	Vulnerable, Migratory	Unlikely	No
<i>Merops omatus</i>	Rainbow Bee-eater	Migratory	Known	No
<i>Polytelis swainsonii</i>	Superb Parrot	Vulnerable	Potential	No
<i>Rostratula australis</i>	Australian Painted Snipe	Vulnerable	Unlikely	No
Mammals				
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Vulnerable	Potential	No
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	Endangered	Potential	No

SCIENTIFIC NAME	COMMON NAME	EPBC LISTING STATUS	LIKELIHOOD OF OCCURRENCE	SIGNIFICANT IMPACT LIKELY?
<i>Nyctophilus corbeni</i> (formerly <i>N. timoriensis</i>)	South-eastern/South-eastern Long-eared Bat	Vulnerable	Known	No
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	Vulnerable	Unlikely	No
<i>Phascolarctos cinereus</i>	Koala	Vulnerable	Known	No
<i>Pseudomys pilligaensis</i>	Pilliga Mouse	Vulnerable	Known	No
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Vulnerable	Unlikely	No

Reptiles

<i>Underwoodisaurus sphyrurus</i>	Border Thick-tailed Gecko	Vulnerable	Unlikely	No
<i>Delma torquata</i>	Collared Delma	Vulnerable	Unlikely	No
<i>Anomalopus mackayi</i>	Five-clawed Worm-skink	Vulnerable	Unlikely	No
<i>Aprasia parapulchella</i>	Pink-tailed Legless Lizard	Vulnerable	Unlikely	No

Amphibians

<i>Litoria booroolongensis</i>	Booroolong Frog	Endangered	No	No
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Fish

<i>Maccullochella peelii</i>	Murray Cod	Vulnerable	No	No
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Invertebrates

<i>Jalmenus eubulus</i>	Pale Imperial Hairstreak	Endangered	Unlikely	No
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Plants

<i>Bertya opposens</i>	Coolabah Bertya	Vulnerable	No	No
<i>Boronia granitica</i>	Granite Boronia	Endangered	No	No
<i>Cadellia pentastylis</i>	Ooline	Vulnerable	No	No

SCIENTIFIC NAME	COMMON NAME	EPBC LISTING STATUS	LIKELIHOOD OF OCCURRENCE	SIGNIFICANT IMPACT LIKELY?
<i>Dichanthium setosum</i>	Bluegrass	Vulnerable	No	No
<i>Digitaria porrecta</i>	Finger Panic Grass	Endangered	No	No
<i>Haloragis exalata</i>	-	Vulnerable	No	No
<i>Homopholis belsonii</i>	Belson's Panic	Vulnerable	No	No
<i>Lepidium aschersonii</i>	Spiny Peppergrass	Vulnerable	No	No
<i>Lepidium monoplacoides</i>	Winged Peppergrass	Endangered	Unlikely	No
<i>Philotheca ericifolia</i>		Vulnerable	Unlikely	No
<i>Pterostylis cobarensis</i>	Cobar Greenhood Orchid	Vulnerable	Known	No
<i>Rulingia procumbens</i>		Vulnerable	No	No
<i>Swainsona murrayana</i>	Slender Darling Pea	Vulnerable	No	No
<i>Thesium australe</i>	Austral Toadflax	Vulnerable	No	No
<i>Tylophora linearis</i>		Endangered	Known	No

Endangered Ecological Communities

Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions	Endangered	No	No
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	No	No
Grey Box (<i>Eucalyptus microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of south-eastern Australia	Endangered	No	No
Myall Woodlands in the Darling Riverine Plains, Brigalow Belt South, Cobar Penplain, Murray-Darling Depression, Riverina and NSW south western slopes bioregions	Endangered	No	No
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and	Critically Endangered	No	No

SCIENTIFIC NAME	COMMON NAME	EPBC LISTING STATUS	LIKELIHOOD OF OCCURRENCE	SIGNIFICANT IMPACT LIKELY?
southern Queensland				
Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions		Endangered	No	No
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland		Critically Endangered	No	No

5 Impact Assessment

This section of the report outlines the potential impacts from the proposed program on MNES. It also provides information on cumulative impacts of exploration and appraisal activities within the study area and a detailed fragmentation analysis. Measures to avoid, minimise and mitigate the impacts of the proposed program were considered prior to the assessment of impacts. Measures include:

- Consideration of alternative options
- Locating infrastructure adjacent to existing roads wherever possible to minimise disturbance to vegetation and reduce fragmentation
- Avoidance of habitat trees where possible
- Minimising clearing to the maximum extent possible and demarcation of works areas
- Vehicle speed limitations to minimise fauna collisions and dust
- Presence of a fauna ecologist/spotter during clearing works
- Adequate storage and appropriate disposal of all liquids and implementation of erosion and sediment control measures
- Rehabilitation including replacing topsoil, re-installing habitat features such as fallen timber and bush rock, natural re-establishment of slashed and cleared native vegetation and direct seeding where required.

5.1 IMPACTS TO VEGETATION

The proposed program has a total disturbance footprint of 58.5 ha which includes 36.42 ha in remnant vegetation and 22.08 ha to be located within previously disturbed flow line corridors (**Table 4**). The proposed program (excluding the previously disturbed flow line corridors) represents a loss of approximately 0.08% of vegetation within the study area.

The impact associated with exploration and appraisal activities in the Pilliga Forest from 2002 to present is 150.5 ha, which includes 48.2 ha for the Leewood Produced Water Facility for which construction has commenced, but vegetation has not yet been cleared (**Table 5**). The Leewood Produced Water Facility will result in the removal of 48.2 ha of vegetation, 41.4 ha of which is derived native grassland (low condition vegetation resulting from the removal of canopy and shrub layers of Pilliga Box - Poplar Box-White Cypress Pine grassy open woodland). The pre-2002 footprint (12.2 ha) was cleared prior to ESG's involvement in the Pilliga and has not been included in the total. The impact of 150.5 ha represents a loss of approximately 0.31% of vegetation within the study area.

The cumulative impact associated with the proposed program and existing exploration and appraisal activities (from 2002 to present) is 186.92 ha which represents a loss of approximately 0.39% of consolidated vegetation within the study area (**Table 6**).

Wherever possible, the exploration and appraisal activities have utilised existing tracks for access, for conducting seismic surveys and for the installation of flow line infrastructure. Some of the exploration

has taken place in areas that have previously been cleared and are used for activities such as farming and grazing. Impacts are largely linear in nature, and within a context of a well vegetated landscape predominately managed for forestry. Given the relatively small amount of clearing as a proportion of available habitat, the current land uses and extent of rehabilitation, exploration impacts are not expected to significantly fragment or reduce the availability of habitat in a way which will adversely affect species within the study area.

Table 4: Areas of clearing of proposed program

VEGETATION TYPE	AREA OF CLEARING (HA)
Areas of clearing within remnant vegetation	
Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion	3.36
Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion	1.37
White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion	31.69
Total	36.42
Areas of clearing within previously disturbed flow line corridors (regenerating)#	
Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion	1.20
Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone (Benson 88)	2.14
Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion	3.90
White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion	14.84
Total	22.08

These areas were cleared approximately 5 years ago and have since been allowed to naturally regenerate. The current condition of these areas approximates 50% of values in adjoining areas. Due to previous clearing, these areas support little to no potential breeding habitat for MNES.

Table 5: Areas of clearing for exploration and appraisal activities undertaken from 2002 to present

VEGETATION TYPE	AREA OF CLEARING (HA)
Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion	9.08
Fuzzy Box on loams in the Nandewar Bioregion and northern Brigalow Belt South Bioregion (Benson 202)	1.78
Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone (Benson 88)#	8.82
Derived Native Grassland (from Pilliga Box - Poplar Box- White Cypress Pine grassy open	41.4

VEGETATION TYPE	AREA OF CLEARING (HA)
woodland on alluvial loams mainly of the temperate (hot summer) climate zone (Benson 88) [#]	
Red Ironbark - Brown Bloodwood shrubby woodland of the Brigalow Belt South Bioregion	1.66
Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion	9.66
White Cypress Pine - Bullock - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion	78.1
Total	150.5

[#] The Leewood Produced Water Facility will result in the removal of 48.2 ha of vegetation, 41.4 ha of which is derived native grassland, the remaining 6.8 ha consists of scattered paddock trees conforming with Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland.

Table 6: Cumulative areas of clearing

VEGETATION TYPE	AREA OF CLEARING (HA)
Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion	12.4
Fuzzy Box on loams in the Nandewar Bioregion and northern Brigalow Belt South Bioregion (Benson 202)	1.8
Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone (Benson 88) [#]	8.8
Derived Native Grassland (from Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone (Benson 88) [#]	41.4
Red Ironbark - Brown Bloodwood shrubby woodland of the Brigalow Belt South Bioregion	1.7
Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion	11.0
White Cypress Pine - Bullock - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion	109.8
Total	186.9

5.2 IMPACTS TO THREATENED FAUNA HABITAT

The total amount of potential foraging, breeding and roosting/sheltering/dispersing habitat has been calculated for the proposed program, to inform the formal significant impact assessment under the EPBC Act (**Section 6**). The amount of loss of potential habitat in relation to the vegetation present in the study area and the Namoi CMA region has also been calculated.

Determination of the different types of habitat (foraging, breeding, roosting/sheltering/dispersing) for individual threatened fauna species was made by first allocating vegetation types that would be used for foraging, breeding, and roosting/sheltering/dispersing to individual species. The areas impacted were then summed for all vegetation types representing the type of habitat used by individual species.

Table 7 provides details on the potential impacts of the proposed program on threatened fauna habitat, while the impacts associated with exploration and appraisal activities in the Pilliga from 2002 to present is provided in **Table 8**. The cumulative impact associated with the proposed program and existing exploration and appraisal activities (from 2002 to present) on threatened fauna habitat is outlined in **Table 9**.

Table 7: Impacts of the proposed program to threatened fauna habitat

SPECIES	FORAGING (HA) / LOSS IN STUDY AREA (%)	BREEDING (HA) / LOSS IN STUDY AREA (%)	ROOSTING / SHELTERING / DISPERSING HABITAT (HA) / LOSS IN STUDY AREA (%)
Swift Parrot	36.4 / 0.08	N/A	36.4 / 0.08
Superb Parrot	1.4 / <0.01	N/A	1.4 / <0.01
Regent Honeyeater	36.4 / 0.08	N/A	36.4 / 0.08
South-eastern Long-eared Bat	36.4 / 0.08	36.4 / 0.08	36.4 / 0.08
Large-eared Pied Bat	36.4 / 0.08	N/A	N/A
Koala	1.4 / 0.02	1.4 / 0.02	5.4 / 0.05
Pilliga Mouse	4.7 / 0.04	4.7 / 0.04	36.4 / 0.08
Spotted-tailed Quoll	36.4 / 0.08	36.4 / 0.08	36.4 / 0.08

Table 8: Impacts of existing CSG infrastructure to threatened fauna habitat (undertaken from 2002 to present)

SPECIES	FORAGING (HA) / LOSS IN STUDY AREA (%) [#]	BREEDING (HA) / LOSS IN STUDY AREA (%) [#]	ROOSTING / SHELTERING / DISPERSING HABITAT (HA) / LOSS IN STUDY AREA (%) [#]
Swift Parrot	109.1 / 0.23	N/A	109.1 / 0.23
Superb Parrot	9.7 / 0.02	N/A	9.7 / 0.02
Regent Honeyeater	109.1 / 0.23	N/A	109.1 / 0.23
South-eastern Long-eared Bat	109.1 / 0.23	109.1 / 0.23	109.1 / 0.23
Large-eared Pied Bat	109.1 / 0.23	N/A	N/A
Koala	20.3 / 0.27	20.3 / 0.27	30.1 / 0.3
Pilliga Mouse	18.7 / 0.16	18.7 / 0.16	109.1 / 0.23
Spotted-tailed Quoll [#]	150.5 / 0.31	109.1 / 0.23	109.1 / 0.23

Table 9: Cumulative impacts to threatened fauna habitat

SPECIES	FORAGING (HA) / LOSS IN STUDY AREA (%)	BREEDING (HA) / LOSS IN STUDY AREA (%)	ROOSTING / SHELTERING / DISPERSING HABITAT (HA) / LOSS IN STUDY AREA (%)
Superb Parrot	11 / 0.02	N/A	11 / 0.02
Swift Parrot	145.5 / 0.31	N/A	145.5 / 0.31
Regent Honeyeater	145.5 / 0.31	N/A	145.5 / 0.31
Greater Long-eared Bat	145.5 / 0.3	145.5 / 0.31	145.5 / 0.31
Large-eared Pied Bat	145.5 / 0.3	N/A	N/A
Koala	21.6 / 0.29	21.6 / 0.29	35.5 / 0.35
Pilliga Mouse	23.5 / 0.21	23.5 / 0.21	77.1 / 0.16
Spotted-tailed Quoll	186.9 / 0.39	145.5 / 0.31	145.5 / 0.3

5.3 IMPACTS TO THREATENED FLORA HABITAT

The total number of threatened flora individuals potentially impacted and their habitat has been calculated for the proposed program, to inform the formal significant impact assessment under the EPBC Act (**Section 6**). The amount of loss of potential habitat in relation to the vegetation present in the study area and the total modelled species' population has also been calculated.

Table 10 provides details on the potential impacts of the proposed program on threatened flora individuals and habitat, while the impacts associated with exploration and appraisal activities in the Pilliga from 2002 to present is provided in **Table 11**. The cumulative impact associated with the proposed program and existing exploration and appraisal activities (from 2002 to present) on threatened flora individuals and their habitat is outlined in **Table 12**.

The potential impacts of the proposed program and existing exploration activities on threatened flora individuals relies on modelled data, except for *Tylophora linearis* for the proposed program which consists of a combination of both known records and modelled data (ELA 2012).

Table 10: Impacts of the proposed program to threatened flora habitat

SPECIES	NUMBER OF INDIVIDUALS POTENTIALLY IMPACTED / LOSS IN STUDY AREA (%)	HABITAT (HA) / LOSS IN STUDY AREA (%)
<i>Pterostylis cobarensis</i>	185 / 0.05	35.05 / 0.09
<i>Tylophora linearis</i> [#]	30 / 0.17	35.05 / 0.09

Table 11: Impacts of existing CSG infrastructure to threatened flora habitat (undertaken from 2002 to present)

SPECIES	NUMBER OF INDIVIDUALS POTENTIALLY IMPACTED	HABITAT (HA) / LOSS IN STUDY AREA (%)
<i>Pterostylis cobarensis</i>	468 / 0.14	96.00 / 0.24
<i>Tylophora linearis</i>	28 / 0.16	96.00 / 0.24

Table 12: Cumulative impacts to threatened flora habitat

SPECIES	NUMBER OF INDIVIDUALS POTENTIALLY IMPACTED	HABITAT (HA) / LOSS IN STUDY AREA (%)
<i>Pterostylis cobarensis</i>	653 / 0.19	131.05 / 0.32
<i>Tylophora linearis</i>	58 / 0.33	131.05 / 0.32

5.4 FRAGMENTATION ANALYSIS

Habitat fragmentation is the division of a single area of habitat into two or more smaller areas, with a new habitat type occurring in the area between the fragments. The proposed program requires the clearing of vegetation within a largely intact landscape, resulting in a degree of habitat fragmentation which needs to be considered in both the local and regional context. The potential fragmentation impacts of the proposed program also need to be considered against the existing exploration and appraisal activities to assess the cumulative impacts.

The process of fragmentation could potentially impact on MNES within the newly created fragments by creating barriers to fauna movement or impediments to processes such as pollination, which could result in genetic isolation of flora and fauna populations. Fragmentation could also impact on MNES by creating edge effects. Edge effects can be particularly detrimental to flora and fauna species that are “core sensitive” rather than “edge” species if habitats are heavily fragmented by a series of new habitat types e.g. a network of roads compared to a single road.

The following section identifies the MNES potentially impacted by habitat fragmentation from exploration and appraisal activities and assesses the degree of habitat fragmentation for impacted species from existing disturbances and impacts from the proposed program within the study area.

5.4.1 Methods

An assessment of whether any of the identified MNES (**Table 3**) have been potentially impacted by the exploration and appraisal activities was made based on knowledge of the species' ecology. Considerations included the movement potential and habitat requirements of species (e.g. do species rely on particular habitat elements that may have been potentially impacted, or are species dependant on large, intact patches), and whether species used the study area for life stages such as breeding.

Identification of habitat for MNES impacted and habitat mapping

Habitats present in the study area, such as breeding, foraging, and dispersing habitats in the case of fauna species, were determined for those species identified as potentially impacted by the exploration and appraisal activities. Determination of habitat was made through reviews of threatened and migratory species profiles (OEH 2013b, SEWPaC 2013b), as well as reviews of available literature on the species impacted, such as research papers on the species and results of previous flora and fauna surveys for the species within, or in the vicinity of, the study area.

Habitat types for MNES impacted were then mapped in the study area. Habitat mapping was based on Biometric vegetation types mapped and validated for the study area. Biometric vegetation types were considered appropriate for use as the basis of habitat mapping given that, along with specific structural habitat elements and microhabitats, flora and fauna species are associated with broad vegetation types, which have specific associations with attributes such as soil types, geology, water, aspect and slope. It is important to note however, that due to specific micro-habitat requirements within each vegetation type for MNES, the calculations provided are likely to be conservative.

Fragmentation analysis

Analyses of habitat fragmentation in the locality and region utilised a two-step process:

1. Identify movement pathways
2. Assess levels of fragmentation.

The first step identified potential movement pathways for potentially impacted fauna or potential pollination/dispersal routes for potentially impacted flora across the study area. Potential fauna movement pathways focussed on paths between areas representing potential breeding and foraging habitat, and were less focussed on paths within dispersing habitat, since there are likely to be an innumerable number of potential paths that fauna species could take across the landscape. Potential paths were drawn as visual representations over habitat maps for MNES impacted.

The second step quantified the number of breaks / barriers currently present in the study area, as represented by natural breaks in the landscape, such as creek lines, and by artificial structures or clearings, such as roads, tracks and trails, by tallying the number of natural and artificial breaks within potential paths identified. The number of existing breaks and breaks due to the proposed program and existing exploration and appraisal activities was identified for each potential path.

Breaks due to the proposed program and existing exploration and appraisal activities were considered as either short-term (<5 years) or long-term impacts due to the nature of the disturbances involved in exploration and appraisal activities.

Short-term impacts are associated with water and gas flow lines that require temporary removal of vegetation within a construction corridor via slashing. Vegetation is allowed to naturally regenerate following the installation of pipelines over 60% of the width of the flow line corridor. Other than directly where the flowlines are installed (approximately 4 m width within the corridor), short-term impacts do not disturb the soil layer/seed bank.

Long-term impacts are associated with pilot wells, water storage and gas compression facilities and access roads which compact surfaces and require the complete removal of vegetation.

5.4.2 Results

Potential MNES impacted

Given the nature of habitat fragmentation from exploration and appraisal activities, where vegetation clearing occurs within a contiguous, mostly open woodland landscape which does not split contiguous habitat into two or more distinct patches, habitat fragmentation from the proposed program and existing exploration and appraisal activities is not considered to be a significant issue for the majority of MNES.

The proposed program and existing exploration and appraisal activities fragment previously contiguous habitat at pilot well locations (by a distance of up to 100 m) and along roads/gas pipelines (by a maximum distance of up to 20 m). Pilot well locations (the source of the largest breaks) are surrounded

by areas of contiguous habitat and therefore fragmentation at these locations is unlikely to disrupt processes such as pollination and dispersal for threatened flora species.

Of the threatened and migratory fauna that are considered likely to be affected by habitat fragmentation, only Pilliga Mouse was considered further due to the species' dependence on a moderate to high level of low shrub cover and preference for a moist groundcover of plants, leaf litter and fungi (OEH 2013b) and its previously recorded movement distances (average movement distances recorded as 40 m within a range of 0-181 m; Tokushima and Jarman 2008). The remaining threatened and migratory fauna are highly mobile and can traverse large distances across modified and cleared landscapes. The South-eastern Long-eared Bat may make less extensive movements across modified and cleared landscapes given its preference for large intact patches of habitat (SEWPaC 2013), however the proposed program and existing exploration and appraisal activities are not considered likely to completely fragment South-eastern Long-eared Bat habitat, with this species recorded moving up to 5 km between roosts (Schulz and Lumsden 2010).

Habitat fragmentation is unlikely to significantly affect any threatened flora species as the proposed program and existing exploration and appraisal activities are unlikely to split contiguous habitat into two or more distinct patches with pollination and dispersal mechanisms able to continue largely unimpeded.

The following sections provide an overview of Pilliga Mouse ecology which is followed by an analysis of potential habitat fragmentation on this species.

Pilliga Mouse habitat and ecology

It is important to note that the Pilliga Mouse is now considered a southern population of the widespread *Pseudomys delicatulus* (Delicate Mouse) based on genetic analyses, morphological studies and recent surveys which revealed a continuous distribution of the Delicate Mouse to the Pilliga region (Breed and Ford 2007; Ford 2008, as cited in SEWPaC 2011). It is important to note that this taxonomic change has not yet been formally recognised under the EPBC Act (SEWPaC 2011), hence this report considers the Pilliga Mouse as currently listed.

Review of available information revealed that knowledge of Pilliga Mouse habitat is limited. The most recent study on Pilliga Mouse habitat selection published in scientific literature was conducted by Paull (2009), with other studies conducted by NPA (2002), NPWS 2000a, and Tokushima *et al.* (2008). Vegetation associations in which the Pilliga Mouse was previously recorded by NPA (2002), NPWS 2000, and Paull (2009) are provided in **Table 13**. Of these studies, Paull (2009) identified vegetation associations likely to be used as breeding versus other habitat. Important vegetation associations for the Pilliga Mouse, which are likely to be used as breeding habitat are:

- Moist gullies in areas recently burnt by wild fire
- Broombush complex (predominantly *Melaleuca uncinata* but also *M. erubescens*)
- Kurricabah / Brown Bloodwood (*Acacia burrowii* / *Corymbia trachyphloia*) complex.

The understorey and shrub species found to be present in these vegetation associations were *Acacia triptera*, *Cassytha pubescens*, *Philotheca ericifolia*, *Eucalyptus dwyeri*, *Hibbertia sericea*, *H. riparia*, *H. circumdans*, *H. covenyana*, *Melaleuca erubescens*, *M. uncinata*, *Micromyrtus sessilis*, *Phebalium glandulosum*, *Bursaria spinosa*, *Cryptandra longistaminea*, *Dodonaea falcata*, and *Prostanthera leichhardtii*. Vegetation associations, likely to be used as foraging and / or dispersing habitat by the Pilliga Mouse, were also identified, with some vegetation associations identified as not used by Pilliga Mouse (**Table 13**).

Table 13: Vegetation associations in which the Pilliga Mouse has been previously recorded

VEGETATION ASSOCIATION	NPA (2002)	NPWS (2000)	PAULL (2009)	NICE and CUCCLG (2012)	RPS (2012b)
Bloodwood-Broad leaf Ironbark shrubby woodland (dominant canopy species: <i>Eucalyptus fibrosa</i> and <i>Corymbia trachyphloia</i>)	Y	-	-	Y	Y
She-oak scrub (dominant canopy species: <i>Eucalyptus fibrosa</i> and <i>Corymbia trachyphloia</i>)	Y	-	-	-	-
<i>Eucalyptus albens</i> shrubby woodland	N	-	-	-	-
Bloodwood woodland (dominant canopy species: <i>Corymbia trachyphloia</i> , <i>Eucalyptus fibrosa</i> , <i>E. dwyeri</i>)	N	-	-	Y	Y
<i>Angophora leiocarpa</i> woodland (dominant canopy species: <i>Callitris endlicheri</i> , <i>Angophora leiocarpa</i> , <i>Eucalyptus chloroclada</i> , <i>E. crebra</i>)	N	-	-	Y	-
<i>Eucalyptus rossii</i> woodland with heathy understorey (dominant canopy species: <i>E. rossii</i> and <i>Angophora floribunda</i>)	N	-	-	Y	-
Narrow-leaved Ironbark woodland (dominant canopy species: <i>Eucalyptus crebra</i> , <i>E. fibrosa</i> , <i>Callitris endlicheri</i>)	N	-	-	-	-
Gully Narrow-leaf Ironbark (<i>Eucalyptus crebra</i>) with Red Gum (<i>E. blakelyi</i>) woodland	-	Y	-	-	-
Broad-leaf Ironbark (<i>Eucalyptus fibrosa</i> / <i>Corymbia trachyphloia</i> / <i>Callitris endlicheri</i>) forests	-	Y	-	Y	-
Red Gum/Rough-barked Apple (<i>Eucalyptus blakelyi</i> / <i>Angophora floribunda</i>) woodlands	-	Y	-	Y	Y
Heath/Scrubland/Mallee (<i>Melaleuca uncinata</i> / <i>Acacia triptera</i> / <i>Eucalyptus dumosa</i> / <i>E. dwyeri</i> / <i>E. chloroclada</i>)	-	Y	-	Y	-
Narrow-leaf Ironbark (<i>Eucalyptus crebra</i> / <i>Allocasuarina luehmannii</i> / <i>Callitris glaucophylla</i> / <i>C. endlicheri</i>) forests	-	N	-	-	-
Blue-leaf Ironbark (<i>Eucalyptus nubila</i> / <i>Callitris endlicheri</i>) forests	-	N	-	-	-
Pilliga Box (<i>Eucalyptus pilligaensis</i> / <i>Callitris glaucophylla</i>) woodlands	-	N	-	-	-
Bimble Box (<i>Eucalyptus populnea</i>) woodlands	-	N	-	-	-
Red Gum (<i>Eucalyptus blakelyi</i>) woodlands	-	N	-	-	-
Belah (<i>Casuarina cristata</i>) woodlands	-	N	-	-	-
Moist burnt gully	-	-	Y	-	-
Broombush scrub/heath (<i>Melaleuca uncinata</i>)	-	-	Y	-	-

VEGETATION ASSOCIATION	NPA (2002)	NPWS (2000)	PAULL (2009)	NICE and CUCCLG (2012)	RPS (2012b)
Kurricabah/Bloodwood (<i>Acacia burrowii</i> / <i>Corymbia trachyphloia</i>) scrub	-	-	Y	-	-
Shrubby mixed woodlands (<i>Eucalyptus blakelyi</i> , <i>E. crebra</i> , <i>E. fibrosa</i> , <i>E. pilligaensis</i> , <i>Corymbia trachyphloia</i>)	-	-	Y	Y	-
Mallee (<i>Eucalyptus viridis</i>) Scrub	-	-	Y	-	-
<i>Acacia tindaleae</i> with <i>Eucalyptus crebra</i> overstorey (may contain <i>Callitris glaucophylla</i> and <i>Allocasuarina luehmannii</i>)	-	-	Y	-	-
Burnt flat scrub	-	-	N	-	-
<i>Eucalyptus crebra</i> / <i>Callitris</i> forest (grassy understorey with <i>Allocasuarina luehmannii</i>)	-	-	N	-	-
<i>Eucalyptus fibrosa</i> / <i>Callitris</i> woodland (heathy understorey, lower and more open canopy than previous)	-	-	N	Y	-
Crown Wattle scrub (<i>Acacia tindaleae</i>)	-	-	N	-	-
Red Gum (<i>Eucalyptus camaldulensis</i> , <i>E. chloroclada</i>) woodlands	-	-	N	-	-
Rocky area (<i>Eucalyptus fibrosa</i> , <i>Callitris endlicheri</i> canopy)	-	-	N	-	-

NB: Y = recorded, N = not recorded, - = not applicable

In terms of Pilliga Mouse habitat in general, Paull (2009) concluded that vegetation associations with over-storeys of *Eucalyptus fibrosa* / *Corymbia trachyphloia*; *Eucalyptus crebra* / *Corymbia trachyphloia*; *Eucalyptus dwyeri* / *Melaleuca uncinata/erubescens*; and *Acacia burrowii* / *Corymbia trachyphloia* represented habitat for the Pilliga Mouse, particularly if topsoil depth was > 20 cm; the time since fire was either 18 months to 5 years or > 25 years; the low understorey cover (at 50 cm height) was high (> 50 %); the high understorey cover (at 2 m height) was low (< 25 %); ground layer cover (litter and ground-storey) was moderate to high (45-80%); and key understorey shrub species (listed above) were present.

In addition to Paull (2009), NPWS (2000) reported that an important vegetation association for Pilliga Mouse was that which comprised a *Eucalyptus blakelyi*/*Angophora floribunda* over-storey with a well-developed under-storey cover of low shrubs with an extensive leaf litter cover.

Recent studies undertaken by NICE and CUCCLG (2012) and RPS (2012b) identified the Pilliga Mouse in a broader range of vegetation associations than previously known. Vegetation associations within the study area where Pilliga Mouse has been recorded are generally characterised by a high diversity, moderate density, and a low (<1 m) sclerophyllous shrubby layer. The structure of vegetation where Pilliga Mouse has been recorded ranges from heathland to open forest (**Table 13**).

Given the findings of previous studies, Pilliga Mouse breeding, breeding/foraging and dispersing habitat were mapped in the study area. **Table 13** shows the vegetation types in the study area that represent potential Pilliga Mouse habitats. **Figure 2** shows the locations of Pilliga Mouse habitat in the study area.

Pilliga Mouse habitat has been divided into 'Breeding', 'Breeding/Foraging' and 'Dispersing' habitats. There is potential for the Pilliga Mouse to breed in discrete areas within mapped 'Breeding/Foraging Habitat', however due to the scale of the mapping currently available these areas cannot be adequately delineated at this time, therefore a precautionary approach has been undertaken.

Table 14: Pilliga Mouse breeding, foraging and dispersing habitats by Biometric vegetation types

BIOMETRIC VEGETATION TYPES	BREEDING HABITAT	FORAGING HABITAT	DISPERSING HABITAT
Broombush Shrubland of the Sand Plains of the Pilliga Region, Subtropical Sub-humid Climate Zone (Benson 141)	Yes (Paull 2009, NPWS 2000)	Yes (Paull 2009, NPWS 2000)	Yes
Brown Bloodwood - Cypress - Ironbark Heathy Woodland in the Pilliga Region of the Brigalow Belt South Bioregion	Yes (NICE and CUCCLG (2012), RPS 2012b)	Yes (NPWS 2000)	Yes
Red Ironbark - Brown Bloodwood Shrubby Woodland of the Brigalow Belt South Bioregion	Yes [#]	Yes (although not recorded by Paull 2009, the species was recorded in this vegetation association (NPA 2002, Tokushima <i>et al.</i> 2008). Patches within the vegetation type contain indicator species listed by Paull 2009 - <i>Acacia triptera</i> and <i>Dodonaea falcata</i>)	Yes
Rough-barked Apple Riparian Forb/Grass Open Forest of the Nandewar Bioregion	Yes [#]	Yes (NPWS 2000)	Yes
White Cypress Pine - Bulloak - Ironbark Woodland of the Pilliga Area of the Brigalow Belt South Bioregion	No	No	Yes
Fuzzy Box on Loams in the Nandewar Bioregion and Northern Brigalow Belt South Bioregion (Benson 202)	No (box habitats not preferred; NPWS 2000)	No (box habitats not preferred; NPWS 2000)	Yes
Pilliga Box - Poplar Box- White Cypress Pine Grassy Open Woodland on Alluvial Loams Mainly of the Temperate (Hot Summer) Climate Zone (Benson 88)	No (box habitats not preferred; NPWS 2000)	No (box habitats not preferred; NPWS 2000)	Yes

[#] Only areas within these vegetation types characterised by a high diversity, moderate density, low (<1 m) sclerophyllous shrubby layer.

The proposed program requires the removal of 36.4 ha of potential breeding, foraging and dispersing habitat for this species while the existing exploration and appraisal activities have involved the removal of 109.1 ha of potential breeding, foraging and dispersing habitat. Of the 145.5 ha of breeding, foraging and dispersing habitat for this species, a maximum of 23.5 ha constitutes potential breeding/foraging habitat and 122 ha constitutes dispersing habitat. It is important to note that only 4.7 ha of the 23.5 ha of

potential breeding habitat for the Pilliga Mouse has been identified through on-ground assessment, the remainder has been identified through broad scale vegetation type mapping and does not necessarily equate to optimal breeding habitat as identified through micro-habitat characteristics on the ground due to the scale of the study area. This equates to a reduction of approximately 0.07% of potential breeding habitat within the study area.

Analysis

The fragmentation analysis has determined that seven out of twenty-five potential movement pathways for Pilliga Mouse are likely to be potentially impacted by the proposed program, however all of these are short-term impacts (flow lines) rather than long-term (pilot wells).

Six of the twenty-five potential movement pathways for Pilliga Mouse have been potentially impacted by the existing exploration and appraisal activities, however five of these are short-term impacts (flow lines) rather than long-term (pilot wells).

The analysis has determined that twelve out of twenty-five potential movement pathways for Pilliga Mouse are likely to be potentially impacted by the cumulative impacts of the combined proposed program and existing exploration and appraisal activities, although eleven of these twelve are short-term impacts (flow lines) rather than long-term (pilot wells) (**Figure 3**). It is important to note that the cumulative impact will not result in the direct long-term fragmentation of one area of breeding habitat into two smaller areas; rather only one movement pathway (dispersal and foraging) between different patches of habitat has been fragmented in the long-term.

Table 15 details presents the results of the fragmentation analysis including the number of existing roads, trails, creeklines, as well as the number of breaks that have occurred as a result of exploration and appraisal activities. The **dark colouration** in **Table 15** represents long term fragmentation impacts as a result of exploration and appraisal activities while the **lighter colouration** represents short term impacts. **Table 15** also details those existing exploration and appraisal activities, and those proposed (yet to be undertaken).

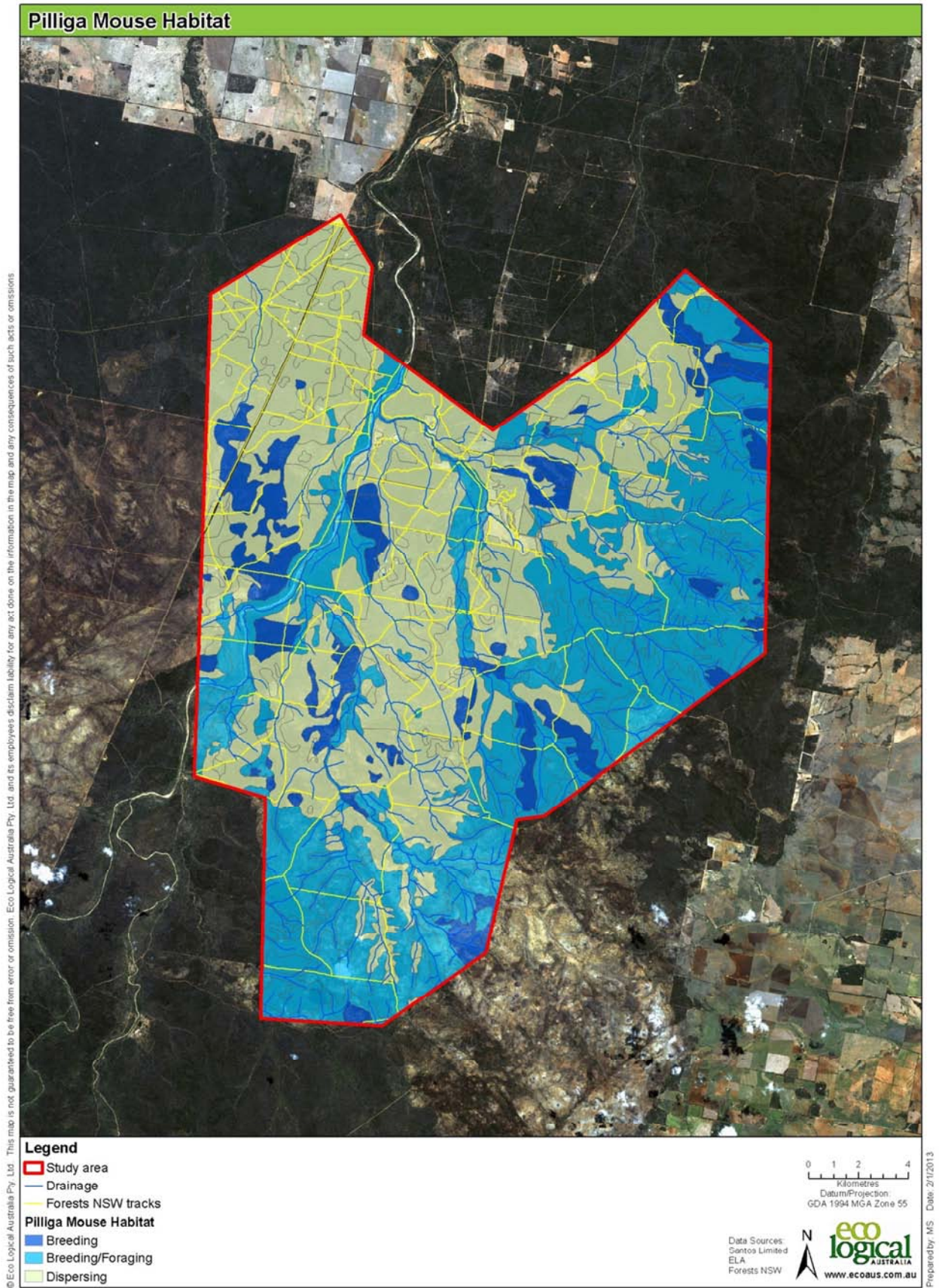


Figure 2: Pilliga Mouse breeding, foraging and dispersing habitat in the study area

Table 15: Number of existing roads, trails and drainage, and breaks caused by exploration and appraisal activities, crossing potential Pilliga Mouse movement paths

POTENTIAL MOVEMENT PATHWAY	EXISTING EXPLORATORY WORKS	PROPOSED PROGRAM	EXISTING ROADS	EXISTING TRAILS	EXISTING DRAINAGE	PROPOSED PROGRAM		EXISTING EXPLORATION AND APPRAISAL ACTIVITIES	
						SHORT-TERM IMPACTS	LONG-TERM IMPACTS	SHORT-TERM IMPACTS	LONG-TERM IMPACTS
1	No	No	3	6	1	0	0	0	0
2	No	No	1	3	0	0	0	0	0
3	No	No	3	2	0	0	0	0	0
4	Yes	No	1	1	0	0	0	0	1
5	Yes	Yes	3	0	2	1	0	1	0
6	No	No	4	13	1	0	0	0	0
7	No	No	16	4	2	0	0	0	0
8	No	Yes	3	0	2	1	0	0	0
9	No	No	3	0	0	0	0	0	0
10	No	Yes	4	2	6	1	0	0	0
11	Yes	Yes	7	2	6	0	0	2	0
12	Yes	Yes	1	2	0	0	0	1	0
13	No	Yes	1	0	2	0	0	1	0
14	No	No	1	0	0	0	0	0	0
15	No	No	0	0	0	0	0	0	0
16	No	No	1	0	1	0	0	0	0
17	No	Yes	1	4	0	1	0	0	0
18	No	No	2	0	3	0	0	0	0
19	No	Yes	2	5	0	1	0	0	0
20	No	Yes	4	4	2	1	0	0	0
21	Yes	Yes	0	3	0	0	0	1	0
22	No	Yes	1	0	0	1	0	0	0
23	No	No	1	2	3	0	0	0	0
24	No	No	3	0	2	0	0	0	0
25	No	No	1	0	0	0	0	0	0

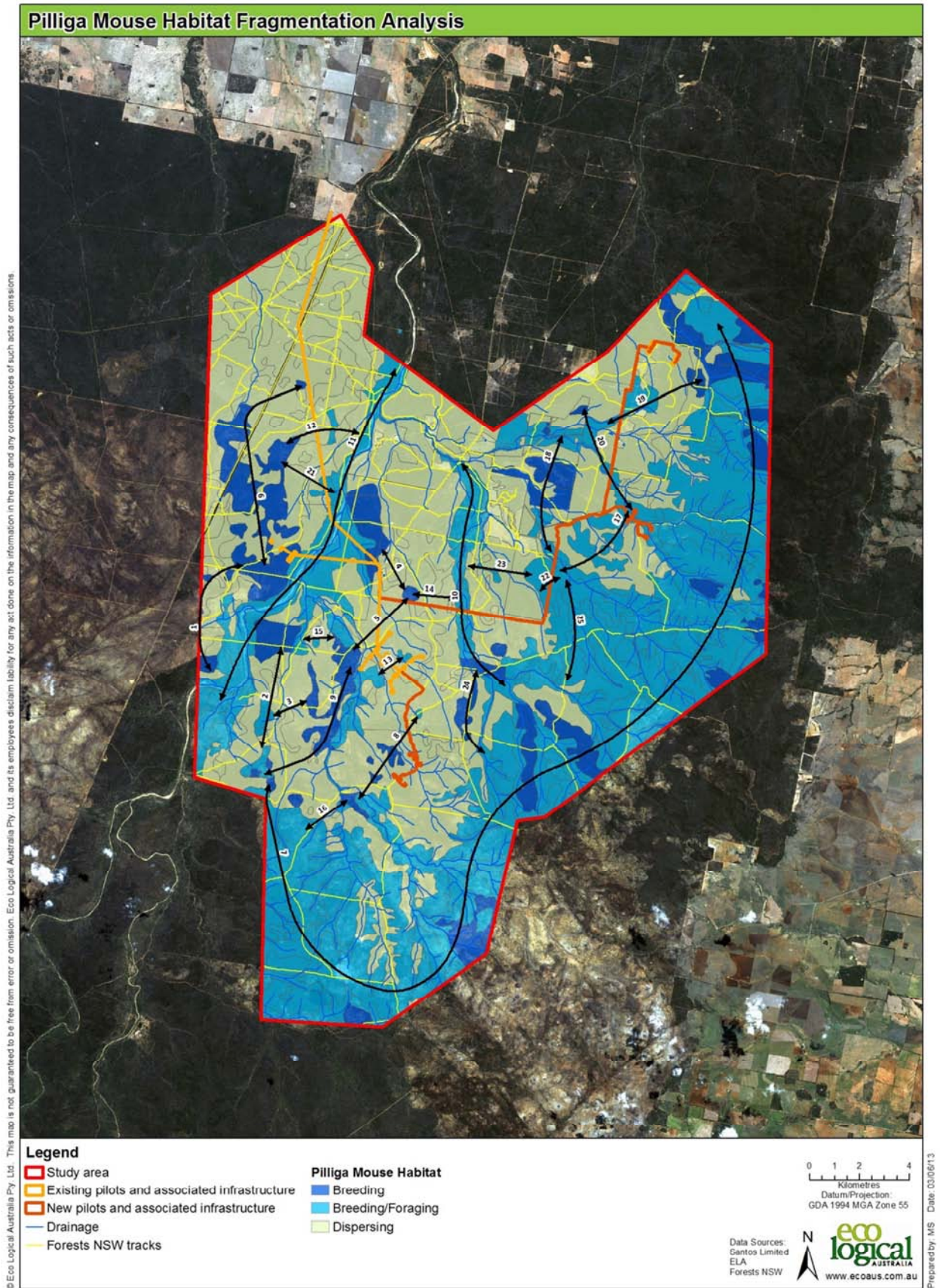


Figure 3: Pilliga Mouse fragmentation analysis

5.4.3 Discussion

The habitat fragmentation analysis identified one MNES, the Pilliga Mouse, which could potentially be affected by habitat fragmentation with other MNES identified as unlikely to be impacted. Potential movement paths for the Pilliga Mouse through the study area were identified.

The potentially impacted movement pathways were considered to be of potential significance to the Pilliga Mouse, because these potential movement paths were located between breeding and foraging habitat (**Figure 3**). Tokushima *et al.* (2008) has indicated that the Pilliga Mouse is distributed in disjunct patches of refuge habitat (considered in this report to be breeding habitat) within its range except when environmental conditions are favourable, when it then is able to irrupt and become briefly ubiquitous before suddenly declining to a lower density and sparse distribution.

For the proposed program, of the twenty-five potential movement pathways identified for the Pilliga Mouse, only seven are likely to be impacted by the proposed program, however all of these are short-term impacts (flow lines) rather than long-term (pilot wells).

Cumulatively (considering the proposed program and existing exploration and appraisal activities), eleven of the twelve paths were identified as being impacted by short-term impacts only (**Table 15**) while only 1 of the paths was identified as impacted by long-term impacts (Path 4; **Figure 2**). It should be noted that an alternative route for path 4 potentially exists heading due east to the nearest patch of potential foraging and dispersing habitat, however this pathway crosses one short-term break and the receiving patch is also fragmented in an east-west direction by the flowlines (i.e. has the same amount of impact).

The movement pathways identified are generally the shortest and most direct route between habitat types (breeding and foraging). In most cases a longer and more indirect pathway could be taken by the Pilliga Mouse, hence avoiding any potential fragmentation/disturbance. It is important to note that the fragmentation analysis has shown that the proposed program and existing exploration and appraisal activities are not likely to result in the long-term direct fragmentation of one area of breeding habitat into two smaller areas.

The extent to which habitat fragmentation may impact on Pilliga Mouse habitat is not fully understood. The specific conditions or factors that would prevent the Pilliga Mouse from crossing roads or barriers are not documented as little is known of its movement patterns and behaviour. Access roads and pipelines could represent a real or perceived barrier to movement, preventing the Pilliga Mouse from moving through the study area. Other studies of small mammals have found that many small mammal species avoid edge habitats and crossing roads (Mader 1984, Garland and Bradley 1984; Goosem 2001; Rondinini and Doncaster 2002) due to unfavourable microclimates, the amount of open space, and disturbances from traffic (the cars themselves and noise). Thus, it is possible that access roads could be a barrier to movement to Pilliga Mouse leading to an existing population being fragmented into two or more populations in the study area. It should be noted, however, that the majority of roads in the study area are existing forestry roads.

Conversely, the Pilliga Mouse inhabits open woodland and shrub areas, sometimes in areas with sparse ground cover. A much higher number of existing roads, trails and drainage lines currently fragment Pilliga Mouse habitat in the study area than those created by the proposed program and existing exploration and appraisal activities. Existing roads and trails were recorded crossing potential Pilliga Mouse movement paths 120 times (**Figure 3**) and these were intersected by drainage lines on 33 occasions. Only twelve of twenty five potential movement pathways have been intersected by existing and proposed exploratory works (**Table 15**). In addition, flow lines for the proposed program have been

largely located along existing roads to minimise the impacts of fragmentation and have been allowed to naturally regenerate following installation.

When considered in relation to the amount of habitat available for the Pilliga Mouse in the study area and the region, the small number of additional short-term breaks across potential movement pathways, the proposed program is considered unlikely to significantly increase the effects of habitat fragmentation on the Pilliga Mouse. Similarly when combined with the existing exploration and appraisal activities, the small number of additional short-term breaks across potential movement pathways are considered unlikely to significantly increase the effects of habitat fragmentation on the Pilliga Mouse.

Due to the natural rehabilitation of the flowlines, eleven of the twelve movement pathways are considered to be impacted only in the short-term.

6 Significant impact assessment under the EPBC Act

6.1 SIGNIFICANT IMPACT CRITERIA

The EPBC Act Administrative Guidelines on Significance set out 'Significant Impact Criteria' that are to be used to assist in determining whether a proposed action is likely to have a significant impact on matters of national environmental significance. Matters listed under the EPBC relevant to the exploration and appraisal activities within the Pilliga Forest are 'nationally threatened species and ecological communities' and 'listed migratory species'.

Specific 'Significant Impact Criteria' are provided for each matter of national environmental significance, except for threatened species and ecological communities, in which case separate criteria are provided for species listed as endangered and vulnerable under the EPBC Act (**Table 16**)

Table 16: Significant Impact Criteria

STATUS	SIGNIFICANT IMPACT CRITERIA
Critically endangered and endangered species	An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will: • lead to a long-term decrease in the size of a population • reduce the area of occupancy of the species • fragment an existing population into two or more populations • adversely affect habitat critical to the survival of a species • disrupt the breeding cycle of a population • modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat • introduce disease that may cause the species to decline, or • interfere with the recovery of the species.
Vulnerable species	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 • reduce the area of occupancy of an important population • fragment an existing important population into two or more populations • adversely affect habitat critical to the survival of a species • disrupt the breeding cycle of an important population • modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

STATUS	SIGNIFICANT IMPACT CRITERIA
	• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat • introduce disease that may cause the species to decline, or • interfere substantially with the recovery of the species.
Migratory species	An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will: • substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species • result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or • seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

6.2 IMPACT ASSESSMENT

This section provides an assessment of the potential significance of impacts from the proposed program on MNES. Additional context on the cumulative impact associated with the proposed program and existing exploration and appraisal activities (from 2002 to present) is provided in **Section 6.3**. MNES considered relevant to this assessment are identified in **Section 4** of this report and include:

Birds

Swift Parrot, Regent Honeyeater, Superb Parrot, Fork-tailed Swift, White-bellied Sea Eagle, White-throated Needletail and Rainbow Bee-eater

Mammals

Koala, Large-eared Pied Bat, Pilliga Mouse, South-eastern Long-eared Bat and Spotted-tailed Quoll

Plants

Pterostylis cobarensis and *Tylophora linearis*

The relevant Significant Impact Criteria have been applied to these threatened and migratory species to determine the significance of impact of the proposed program.

6.2.1 Birds

***Anthochaera phrygia* (Regent Honeyeater) – Endangered**

The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Birds are also found in drier coastal woodlands and forests in some years. There are three known key breeding regions: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands, although other potential breeding sites, close to the Study area,

include the Warrumbungles National Park and Pilliga Nature Reserve (NPWS 1999a). The species is known to make large scale nomadic movements across the landscape, which is thought to coincide with flowering times of different eucalypt species on which they feed (SEWPAC 2013).

There are no existing records for the species within the study area and they were not identified during surveys. The species has been recorded nearby with two records in the Pilliga Nature Reserve, and one in Pilliga East State Forest. Breeding behaviour has been recorded in the Pilliga Nature Reserve; however the important Bundarra-Barraba breeding area is located 150 km to the east. It is considered likely that the species would utilise habitats present in the study area for foraging.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

The proposed action could lead to a long-term decrease in the size of a population of Regent Honeyeaters if it significantly reduced or degraded foraging, roosting and breeding habitat available to the species, or contributed to the direct mortality of the species.

The proposed action will lead to the loss of approximately 36 ha of potential foraging/roosting habitat for this species, which equates to less than 0.1% of the available habitat within the study area and much less in Namoi CMA region. The loss of potential foraging/roosting habitat will occur in small areas across the landscape for the well leases and linear corridors for the flow lines which generally follow existing tracks and infrastructure. Up to 40% of clearing associated with the well pads and 60% of clearing associated with the flowlines and water and gas gathering systems will be rehabilitated.

As such, it is considered unlikely that the proposed action would lead to a long-term decrease in the size of a population of the Regent Honeyeater.

Reduce the area of occupancy of the species

The area of occupancy for Regent Honeyeaters could be reduced if significant amounts of foraging and roosting habitat were lost in the study area, or if habitats were degraded to the point that the species avoided degraded areas and could not move through the study area to undisturbed areas.

The loss of habitat through clearing is small relative to the amount of habitat retained in the study area and the wider Namoi CMA region, hence the proposed action is considered unlikely to reduce the area of occupancy of the species

Fragment an existing population into two or more populations

The proposed action could potentially fragment foraging/roosting habitat, however linear infrastructure (flow lines) has been aligned with existing roads to minimise fragmentation impacts. Regent Honeyeaters are nomadic and can make large regional movements across their range. Regent Honeyeaters would be able to traverse the length and width of the study area to access potential foraging resources despite the potential fragmentation caused by the proposed action. Habitat connectivity would be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the study area, allowing an existing population to move across the wider landscape. Thus, it is unlikely that the proposed action would fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat critical to the survival of the species includes breeding habitat, and foraging/roosting habitat. Breeding habitat is critical to the survival of the species as Regent Honeyeaters only use a small number of specific areas to breed. Any impacts to breeding habitat could threaten the survival of the species. Unlike breeding habitat, Regent Honeyeaters would likely be able to withstand minor impacts to foraging/roosting habitat, i.e. not all habitat representing foraging/roosting habitat is critical to the survival of the species. The levels tolerated would depend on the amount and quality of foraging/roosting habitat impacted, the location of the habitat in the landscape, and the amount of habitat remaining in the study area and Namoi CMA region.

There are three known key breeding regions remaining for the species: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. The species has also been recorded breeding in the Pilliga Nature Reserve and Warrumbungles National Park (NPWS 1999a), located to the south of the study area. The study area is not a known key breeding area for the species, and thus the proposed action would not directly impact on breeding habitat.

The foraging/roosting habitat proposed to be removed by the action constitutes less than 0.1% of the available habitat within the Namoi CMA region and is unlikely to be critical to the survival of the species.

Disrupt the breeding cycle of a population

The proposed action could impact on or disrupt the breeding cycle of the Regent Honeyeater if it impacted on breeding habitat directly, or reduced/degraded foraging resources used during the breeding season. The study area is not a known key breeding area for the species, and thus the proposed action would not directly impact on breeding habitat.

The vegetation types impacted by the proposed action are not considered to contain profusely flowering winter-flowering species and as such the study area is considered to only represent transient foraging/roosting habitat which is unlikely to be considered a significant foraging resource for the Regent Honeyeater during breeding.

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

The proposed action will lead to the loss of approximately 36 ha of potential foraging/roosting habitat for this species, which equates to less than 0.1% of the available habitat within the study area and much less in Namoi CMA region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing foraging/roosting habitat for the species would be retained in the study area.

Therefore it is unlikely that the proposed action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

It is unlikely that the proposed action would result in the introduction of invasive species that would impact on Regent Honeyeater in the study area. The species suffers from competition from larger

aggressive honeyeaters, particularly Noisy Miners, Noisy Friarbirds and Red Wattlebirds. However, the proposed action is unlikely to lead to an increase in the incidence of these species in the study area.

Introduce disease that may cause the species to decline, or

Disease is not listed as a threat to this species. The proposed action would be unlikely to introduce a disease that may cause this species to decline.

Interfere with the recovery of the species.

In consideration of the above factors, the proposed action is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed action is not considered likely to have a significant impact on the Regent Honeyeater for the following reasons:

- The proposed action will disturb a very small proportion (<0.1%) of available foraging/roosting habitat within the study area - the species is highly mobile and thus able to utilise areas across the landscape
- Fragmentation impacts have been minimised by aligning linear infrastructure (flow lines) with existing roads
- The proposed action will not disrupt the breeding cycle of the species as important breeding habitat will not be impacted
- The regional extent of suitable foraging habitat types is sufficient that the proposed action will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline.

***Lathamus discolor* (Swift Parrot) – Endangered**

The Swift Parrot is a wide-ranging, highly mobile species which is endemic to south-eastern Australia (SEWPAC 2013). It is known to use habitat within the Namoi CMA region (OEH 2013b). Swift Parrots breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW this species mostly occurs on the coast and south west slopes.

On the mainland birds occur in areas where eucalypts are flowering profusely or where there is abundant lerp (from sap-sucking bugs) infestations (OEH 2013b). Favoured feed trees include winter flowering species such as *Eucalyptus robusta* (Swamp Mahogany), *Corymbia maculata* (Spotted Gum), *C. gummifera* (Red Bloodwood), *E. sideroxylon* (Mugga Ironbark), and *E. albens* (White Box). Commonly used lerp infested trees include *E. microcarpa* (Inland Grey Box), *E. moluccana* (Grey Box) and *E. pilularis* (Blackbutt). Following winter they return to Tasmania where they breed from September to January.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

There are no existing records for the species within the study area. The closest records according to the Atlas of NSW Wildlife are approximately 24 km to the east in Boggabri and 55 km to the south east near

Gunnedah. The vegetation types impacted by the proposed action are not considered to contain profusely flowering winter-flowering species and as such the study area is considered to only represent transient foraging habitat.

The proposed action will lead to the loss of approximately 36 ha of potential foraging habitat for this species, which equates to less than 0.1% of the available habitat within the study area and much less in Namoi CMA region. The loss of habitat will occur in small areas across the landscape for the well pads and linear corridors for the flow lines which generally follow existing tracks and infrastructure. Up to 40% of clearing associated with the well pads and 60% of clearing associated with the flowlines and water and gas gathering systems will be rehabilitated.

As such, it is considered unlikely that the proposed action would lead to a long-term decrease in the size of a population of the Swift Parrot

Reduce the area of occupancy of the species

The area of occupancy for Swift Parrots could be reduced if significant amounts of foraging/roosting habitat were lost in the study area, or if habitats were degraded to the point that the species avoided degraded areas and could not move through the study area to undisturbed areas.

The loss of habitat through clearing is small relative to the amount of habitat retained in the study area and the wider Namoi CMA region, hence the proposed action is considered unlikely to reduce the area of occupancy of the species

Fragment an existing population into two or more populations

The proposed action could potentially fragment foraging/roosting habitat, however linear infrastructure (flow lines) has been aligned with existing roads to minimise fragmentation impacts. Swift Parrots are migratory and can make large movements across their range. Swift Parrots would be able to traverse the length and width of the study area to access potential foraging resources despite the potential fragmentation caused by the proposed action. Habitat connectivity would be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the study area, allowing an existing population to move across the wider landscape. Thus, it is unlikely that the proposed action would fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat that is necessary to the survival of the species includes breeding habitat, and foraging and roosting habitat. Breeding habitat is critical to the survival of the species as Swift Parrots only breed in Tasmania. Any impacts to breeding habitat could threaten the survival of the species. Unlike breeding habitat, Swift Parrots would likely be able to withstand some level of impact to foraging/roosting habitat, i.e. not all habitat representing foraging/roosting habitat is critical to the survival of the species.

The levels tolerated would depend on the amount and quality of foraging/roosting habitat impacted, the location of the habitat in the landscape, and the amount of habitat remaining in the study area and Namoi CMA region.

The foraging/roosting habitat proposed to be removed by the action constitutes less than 0.1% of the available habitat within the Namoi CMA region and is unlikely to be critical to the survival of the species.

Disrupt the breeding cycle of a population

The study area is not used as a breeding area for the species, and thus the proposed action would not directly impact on breeding habitat. The species would not use the study area as foraging habitat during

the breeding season as it remains in Tasmania during its breeding season (spring and summer months), only migrating to mainland Australia during its non-breeding season (autumn and winter months). Thus, the proposed action is unlikely to disrupt the breeding cycle of the species.

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

The proposed action will lead to the loss of approximately 36 ha of potential foraging/roosting habitat for this species, which equates to less than 0.1% of the available habitat within the study area and much less in Namoi CMA region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing foraging/roosting habitat for the species would be retained in the study area.

Therefore it is unlikely that the proposed action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

It is unlikely that the proposed action would result in the introduction of invasive species that would impact on Swift Parrots in the study area.

Introduce disease that may cause the species to decline, or

A disease that could potentially infect Swift Parrots is beak and feather disease. However, the proposed action would be unlikely to introduce a disease that may cause this species to decline, given the disease is transmitted by other birds of the same species.

Interfere with the recovery of the species.

In consideration of the above factors, the proposed action is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed action is not considered likely to have a significant impact on the species for the following reasons:

- The species is not known to occur in the study area
- The proposed action will disturb a very small proportion (<0.1%) of available foraging/roosting habitat within the study area - the species is highly mobile and thus able to utilise areas across the landscape
- Fragmentation impacts have been minimised by aligning linear infrastructure (flow lines) with existing roads
- The vegetation within the development footprint is not considered to represent core foraging habitat
- The species' migratory route will not be affected by the proposed action
- The proposed action will not disrupt the breeding cycle of the species as it breeds exclusively in Tasmania.

***Polytelis swainsonii* (Superb Parrot) – Vulnerable**

The Superb Parrot is found throughout eastern inland NSW and northern Victoria, with occasional vagrants recorded in southern Queensland (SEWPAC 2013). On the South-western Slopes of NSW their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. The other main breeding sites in NSW and Victoria are in the Riverina along the corridors of the Murray, Edward and Murrumbidgee Rivers where birds are present all year round.

The species inhabits Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. In the Riverina the birds nest in the hollows of large trees (dead or alive) mainly in tall riparian River Red Gum Forest or Woodland. On the South West Slopes nest trees can be in open Box-Gum Woodland or isolated paddock trees. Species known to be used are Blakely's Red Gum, Yellow Box, Apple Box and Red Box. During the breeding season, individuals may forage up to 10 km from nesting sites, primarily in grassy box woodland. The species feed in trees and understorey shrubs and on the ground and their diet consists mainly of grass seeds and herbaceous plants. Also eaten are fruits, berries, nectar, buds, flowers, insects and grain (OEH 2013b).

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

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
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

This species was not observed during field surveys and there are no existing records for the species within the study area. The closest records according to the Atlas of NSW Wildlife are approximately 20 km to the north of the study area and east of Narrabri.

The proposed action will lead to the loss of approximately 1.4 ha of potential foraging habitat for this species, which equates to less than 0.01% of the available habitat within the study area and much less in Namoi CMA region. The loss of potential habitat will occur in small areas across the landscape for the well pads and linear corridors for the flow lines which generally follow existing tracks and infrastructure. Up to 40% of clearing associated with the well pads and 60% of clearing associated with the flowlines and water and gas gathering systems will be rehabilitated.

As the species has not been recorded in the study area and the study area is not within the known breeding distribution of the species, it is considered unlikely that an 'important population' of Superb Parrots occurs within the study area. Therefore the proposed action is unlikely to lead to a long-term decrease in the size of an important population.

Reduce the area of occupancy of an important population

As an 'important population' of Superb Parrots is considered unlikely to occur within the study area, the proposed action is unlikely to reduce the area of occupancy of an important population.

Fragment an existing important population into two or more populations

As an 'important population' of Superb Parrots is considered unlikely to occur within the study area, the proposed action is unlikely to fragment an existing important population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat that is necessary to the survival of the species includes breeding habitat, and foraging/roosting habitat. Breeding habitat is critical to the survival of the Superb Parrot as they only breed in the south west slopes, bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west, and in the Murray-Riverina area (OEH 2013b). Any impacts to breeding habitat could threaten the survival of the species. Unlike breeding habitat, Superb Parrots would likely be able to withstand some level of impact to foraging and roosting habitat i.e. not all habitat representing foraging/roosting habitat is critical to the survival of the species. The levels tolerated would depend on the amount and quality of foraging and roosting habitat impacted, the location of the habitat in the landscape, and the amount of habitat remaining in the area/Namoi CMA region.

The foraging/roosting habitat proposed to be removed by the action constitutes less than 0.1% of the available habitat within the Namoi CMA region and is unlikely to be critical to the survival of the species

Disrupt the breeding cycle of an important population

As an 'important population' of Superb Parrots is considered unlikely to occur within the study area, the proposed action is unlikely to disrupt the breeding cycle of an important population.

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

The proposed action will lead to the loss of approximately 1.4 ha of potential foraging habitat for this species, which equates to less than 0.01% of the available habitat within the study area and much less in Namoi CMA region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing foraging/roosting habitat for the species would be retained in the study area.

Therefore it is unlikely that the proposed action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

The proposed action could potentially lead to the spread of weeds into the study area through the transportation of weed propagules on vehicles and equipment. This could potentially impact on Superb Parrots, which mainly feed on native grass seeds and herbaceous plants, if weeds out-competed native grasses and forbs. However, weeds are actively managed and will be controlled in the study area.

Introduce disease that may cause the species to decline, or

Disease is not listed as a threat to this species. A disease that could infect Superb Parrots is beak and feather disease. However, the proposed action would be unlikely to introduce a disease that may cause this species to decline, given the disease is transmitted by other birds of the same species.

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed action is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed action is not considered likely to have a significant impact on the species for the following reasons:

- An 'important population' of Superb Parrots is considered unlikely to occur within the study area
- The species is not currently known to occur in the study area
- The proposed action will disturb an extremely small proportion (<0.1%) of available habitat within the Namoi CMA region
- Fragmentation impacts have been minimised by aligning linear infrastructure (flow lines) with existing roads
- The species does not breed in the study area and as such the proposed action will not disrupt the breeding cycle of the species.

6.2.2 Mammals

Dasyurus maculatus (Spotted-tailed Quoll) - Endangered

The Spotted-tailed or Tiger Quoll occupies a range of environments within a disjunct distribution along the east coast of Australia, extending from south-eastern Queensland through NSW and Victoria to Tasmania. The species is found in a variety of habitats, including sclerophyll forest and woodlands, coastal heathlands and rainforests. Occasional sightings are made in open country, grazing lands, rocky outcrops and other treeless areas (SEWPAC 2013). This species feeds on a wide variety of birds, reptiles, mammals and invertebrates and uses several 'latrines' within its territory for defecation (OEH 2013b). It is essentially terrestrial, but is also an agile climber (OEH 2013b). Nesting occurs in rock shelters, hollow logs, caves or tree hollows and they use numerous dens within the home range. Estimates of home ranges vary from 800 ha to 20 km² and individuals may move several kilometres in a night (NPWS 1999b). One individual was tracked travelling 8 km in one night (Belcher *et al.* 2008).

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

The proposed action could lead to a long-term decrease in the size of a population of Spotted-tailed Quolls if it significantly reduced or degraded foraging, sheltering and breeding habitat available to the species, contributed to the direct mortality of the species, or led to an increase in introduced predators such as cats and foxes which would compete with the species for foraging resources.

The species was not observed during field surveys and there are no existing records for the species within the study area. However, this species was recorded in the Pilliga Forest in the 1990s (Paull and Date 1999). While the species occurs more frequently in coastal areas, there are scattered records for Spotted-tailed Quolls west of the study area along the Barwon River. The closest records from the Atlas of NSW Wildlife are approximately 25 km to the south east and 45 km to north east of the study area. Therefore it is considered that the species has the potential to occur in the study area.

The proposed action will lead to the loss of approximately 36 ha of potential habitat for this species, which equates to less than 0.1% of the available habitat within the study area and much less in Namoi CMA region. The loss of habitat will occur in small areas across the landscape for the well pads and linear corridors for the flow lines which generally follow existing tracks and infrastructure. Up to 40% of

clearing associated with the well pads and 60% of clearing associated with the flowlines and water and gas gathering systems will be rehabilitated.

As such, it is considered unlikely that the proposed action would lead to a long-term decrease in the size of a population of Spotted-tailed Quolls.

Reduce the area of occupancy of the species

The area of occupancy for Spotted-tailed Quolls would be reduced if significant amounts of foraging, sheltering and breeding habitat were lost in the study area, or if habitats were degraded to the point that the species avoided degraded areas and could not move through the study area to undisturbed areas.

The loss of habitat through clearing is small relative to the amount of habitat retained in the study area and the wider Namoi CMA region, hence the proposed action is considered unlikely to reduce the area of occupancy of the species.

Fragment an existing population into two or more populations

The proposed action could potentially fragment habitat for the Spotted-tailed Quoll, however linear infrastructure (flow lines) has been aligned with existing roads to minimise fragmentation impacts.

Spotted-tailed Quolls are capable of large movements, and numerous records have been made for overnight movements of several kilometres for the species (NPWS 1999b; Belcher et al. 2008). The proposed action is unlikely to create barriers to movement of this species. Habitat connectivity will be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the study area, allowing any potential populations to move across the wider landscape. Thus, it is unlikely that the proposed action would fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat that is critical to the survival of the species includes foraging, sheltering and breeding habitat. While all habitat types would be important to the species, Spotted-tailed Quolls would likely be able to withstand some level of impact to its habitat. The levels tolerated would depend on the amount and quality of foraging, sheltering and breeding habitat impacted, the time they were impacted, the location of the habitat in the landscape, and the amount of habitat remaining in the area/Namoi CMA region.

The potential habitat proposed to be removed by the action constitutes less than 0.1% of the available habitat within the Namoi CMA region and is unlikely to be critical to the survival of the species.

Disrupt the breeding cycle of a population

The proposed action could impact on or disrupt the breeding cycle of Spotted-tailed Quolls if it impacted on breeding habitat directly, disturbed the species during the breeding season, or reduced/degraded foraging resources used during the breeding season.

There is potential for the study area to be used for breeding by this species. The study area contains habitat elements necessary for breeding, including hollows and fallen logs; however this species has not been detected during field surveys.

As the species has not been detected within the study area and due to the relatively small scale of the impacts of the proposed action, it is considered unlikely that the proposed action will disrupt the breeding cycle of a population.

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

The proposed action will lead to the loss of approximately 36 ha of potential habitat for this species, which equates to less than 0.1% of the available habitat within the study area and much less in Namoi CMA region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study area.

Therefore it is unlikely that the proposed action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

Invasive species that are harmful to the Spotted-tailed Quolls such as cats and foxes are already established in the study area. The proposed action is unlikely to exacerbate the impacts of invasive species or lead to increased competition for Spotted-tailed Quolls for resources.

Introduce disease that may cause the species to decline, or

Spotted-tailed Quolls are susceptible to the spread of epidemics, such as a parasitic protozoan, by cats (NPWS 1999b). However, cat populations are already well established in the study area.

Interfere with the recovery of the species.

In consideration of the above factors, the proposed action is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed action is not considered likely to have a significant impact on the species for the following reasons:

- The species has some potential to occur within the study area, however, it is most common in coastal areas
- The proposed action will disturb a very small proportion (<0.1%) of available habitat within the study area
- Fragmentation impacts have been minimised by aligning linear infrastructure (flow lines) with existing roads
- The species is very mobile, able to utilise a variety of habitats within the landscape and is known to travel several kilometres a night
- The regional extent of suitable foraging habitat types is sufficient that the development will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline.

***Nyctophilus corbeni* (South-eastern Long-eared Bat) - Vulnerable**

Overall, the distribution of the South-eastern Long-eared Bat coincides approximately with the Murray Darling Basin (SEWPAC 2013). It is common in the Pilliga region (OEH 2013b). The species inhabits a

variety of vegetation types, including mallee, *Allocasuarina luehmannii* (Bull-oak) and box-eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland (OEH 2013b). The species roosts in tree hollows, crevices, and under loose bark. It is a slow flying agile bat, using the understorey to hunt non-flying prey, especially caterpillars and beetles, and will even hunt on the ground. Movement patterns are not well known, although roost sites have been recorded as an average of 1.89 ± 1.61 km (range 0.34–7.06 km) from the capture point of bats (Schulz and Lumsden 2010). It appears the species requires large, intact areas of habitat to persist (Turbill *et al.* 2008).

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

Nyctophilus species were recorded using anabat recorders along the Dewhurst Northern Water and Gas Flow Lines and Dewhurst Southern Water and Gas Flow Lines, although identification between species on the basis of anabat recordings is not conclusive. A number of previous surveys have also detected the species near the study area, with a large number of individuals recorded (NPWS 2000a, NPA 2002, Ecotone 2009). The Atlas of NSW Wildlife records show the species' presence throughout the study area, and NSW OEH considers the Pilliga region to be a distinct stronghold for this species.

As the South-eastern Long-eared Bat is known to occur in the study area and has its core distribution centred on the Pilliga region, it is likely that South-eastern Long-eared Bat populations within the study area would be defined as an important population under the EPBC Act.

The proposed action will lead to the loss of approximately 36 ha of habitat for this species, which equates to less than 0.1% of the available habitat within the study area and much less in Namoi CMA region. The loss of habitat will occur in small areas across the landscape for the well pads and linear corridors for the flow lines which generally follow existing tracks and infrastructure. Up to 40% of clearing associated with the well pads and 60% of clearing associated with the flowlines and water and gas gathering systems will be rehabilitated.

As the proposed action represents a small proportion of the available habitat in the study area, the proportion of hollow-bearing trees to be removed is also likely to be low. As such it is considered unlikely that the proposed action would lead to a long-term decrease in the size of a population of South-eastern Long-eared Bat.

Reduce the area of occupancy of an important population

The area of occupancy for South-eastern Long-eared Bats would be reduced if significant amounts of foraging, roosting and breeding habitat were lost in the study area, or if habitats were degraded to the point that the species avoided or could not cross degraded areas and could not move through the study area to undisturbed areas.

The loss of habitat through clearing is small relative to the amount of habitat retained in the study area and the wider Namoi CMA region, hence the proposed action is considered unlikely to reduce the area of occupancy of the species.

Fragment an existing important population into two or more populations

The nature of the proposed action being in discrete areas for the well pads and in long linear sites adjacent to existing roads for the water and gas gathering system provides a mosaic of impacted areas surrounded by intact habitat. South-eastern Long-eared Bats can travel 3 kilometres in a foraging excursion (Churchill 2008). As the species is highly mobile over the distances involved with the

proposed impacts, the proposed action will not create barriers in relation to the foraging activities of the species.

This species locates prey via echolocation and “passive listening”. The effectiveness of these prey detection mechanisms may be impacted by noise associated with the construction and/or operation of the gas facilities. However, noise impacts will be highly localised and large areas of habitat will remain undisturbed. Should the South-eastern Long-eared Bat avoid areas of habitat degraded by noise, individuals of this species would be able to traverse these areas to undisturbed patches within the study area.

Habitat connectivity will be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the study area, allowing any potential populations to move across the wider landscape. Thus, it is unlikely that the proposed action would fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat that is necessary to the survival of South-eastern Long-eared Bats includes foraging, roosting and breeding habitat. While all habitat types would be important to the species, South-eastern Long-eared Bats would likely be able to withstand some level of impact to its habitat.

The proposed action would retain the majority of foraging, roosting and breeding habitat in the study area for South-eastern Long-eared Bats, with only a small proportion of habitat impacted in the study area and Namoi CMA region. Thus, the foraging, roosting and breeding habitat lost or degraded is unlikely to be critical to the survival of the species.

Disrupt the breeding cycle of an important population

The proposed action could impact on or disrupt the breeding cycle of South-eastern Long-eared Bats if it impacted on breeding habitat directly, or reduced/degraded foraging resources used during the breeding season.

The proposed action would impact on foraging and breeding habitat, and reduce/degrade foraging resources indirectly through habitat fragmentation. However, the area directly impacted represents a small proportion available in the study area with the majority of breeding and foraging habitat retained in the study area. South-eastern Long-eared Bats would be able to use undisturbed habitat to complete their life cycles.

As such, the proposed action is unlikely to disrupt the breeding cycle of the South-eastern Long-eared Bat.

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

The proposed action will lead to the loss of approximately 36 ha of potential habitat for this species, which equates to less than 0.1% of the available habitat within the study area and much less in Namoi CMA region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study area.

Therefore it is unlikely that the proposed action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

Invasive species that are harmful to the South-eastern Long-eared Bat such as cats and foxes are already established in the study area. The proposed action is unlikely to exacerbate the impacts of invasive species or lead to increased competition for South-eastern Long-eared Bats for resources.

Introduce disease that may cause the species to decline, or

Disease is not listed as a threat to this species. The proposed action would be unlikely to introduce a disease that may cause this species to decline.

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed action is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed action is not considered likely to have a significant impact on the species for the following reasons:

- The species is highly mobile and will be able to move across disturbed areas into nearby undisturbed locations
- The regional extent of suitable habitat is sufficient that the proposed action will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline
- Fragmentation impacts have been minimised by aligning linear infrastructure (flow lines) with existing roads
- The regional extent of suitable roosting and breeding habitat is sufficient that the proposed action will not result in the substantial disruption of elements of this species' breeding cycle.

***Chalinolobus dwyeri* (Large-eared Pied Bat) - Vulnerable**

The Large-eared Pied Bat is an insectivorous bat distributed from Shoalwater Bay in Queensland through to Ulladulla in NSW. This species tends to occur in small populations of around 50 individuals, particularly around sandstone escarpments and cliff lines. Important populations for this species occur in the Hunter Valley, Sydney Basin and Southern Tablelands of NSW. There are scattered records from the New England Tablelands and North West Slopes.

The relatively short, broad wing combined with the low weight per unit area of wing suggests that the species is manoeuvrable and forages below the canopy (OEH 2013b; SEWPAC 2013). The preferred breeding habitat for the species are caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the *Hirundo ariel* (Fairy Martin). The species has been known to use hollow-bearing trees as roost sites (SEWPAC 2013). Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. They remain loyal to the same cave over many years (OEH 2013b). Breeding females have recently been recorded in sandstone caves at Coonabarabran, NSW (SEWPAC 2013).

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

The species was not observed during field surveys and there are no existing records for the species within the study area. However, previous surveys have detected the species near the study area in East Pilliga State Forest (NPWS 2000a; NPA 2002). The closest records according to the Atlas of NSW Wildlife are approximately 10 km to the south in Pilliga Nature Reserve and 25 km to the north east near Mt Kaputar National Park. Thus, the species has the potential to occur in the study area. This potential predominantly relates to foraging habitat, as preferred breeding habitat for this species (i.e. caves) is not known from within the study area.

As the species has not been recorded in the study area and preferred breeding habitat is not known to occur, it is considered unlikely that an 'important population' of Large-eared Pied Bat occurs within the study area. Therefore the proposed action is unlikely to lead to a long-term decrease in the size of an important population.

Reduce the area of occupancy of an important population

As an 'important population' of Large-eared Pied Bats is considered unlikely to occur within the study area, the proposed action is unlikely to reduce the area of occupancy of an important population.

Fragment an existing important population into two or more populations

As an 'important population' of Large-eared Pied Bats is considered unlikely to occur within the study area, the proposed action is unlikely to fragment an existing important population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat that is necessary to the survival of Large-eared Pied Bats includes foraging, roosting and breeding habitat. Breeding habitat is critical to the survival of the species as the species roosts in caves and these are limited. Any impacts to breeding habitat could potentially threaten the survival of the species.

Unlike breeding habitat, Large-eared Pied Bats would likely be able to withstand some level of impact to foraging and roosting habitat

The proposed action would retain the majority of foraging and roosting and breeding habitat in the study area for South-eastern Long-eared Bats, with only a small proportion of habitat impacted in the study area and Namoi CMA region. Thus, the foraging and roosting habitat lost or degraded is unlikely to be critical to the survival of the species.

Disrupt the breeding cycle of an important population

As an 'important population' of Large-eared Pied Bats is considered unlikely to occur within the study area, the proposed action is unlikely to disrupt the breeding cycle of an important population.

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

The proposed action will lead to the loss of approximately 36 ha of potential foraging and roosting habitat for this species, which equates to less than 0.1% of the available habitat within the study area and much less in Namoi CMA region. The loss of habitat will occur in small areas across the landscape for the well pads and linear corridors for the flow lines which generally follow existing tracks and infrastructure. Up

to 40% of clearing associated with the well pads and 60% of clearing associated with the flowlines and water and gas gathering systems will be rehabilitated.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study area.

Therefore it is unlikely that the proposed action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

Invasive species that are harmful to the Large-eared Pied Bat such as cats and foxes are already established in the study area. The proposed action is unlikely to exacerbate the impacts of invasive species or lead to increased competition for South-eastern Long-eared Bats for resources.

Introduce disease that may cause the species to decline, or

Disease is not listed as a threat to this species. The proposed action would be unlikely to introduce a disease that may cause this species to decline.

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed action is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed action is not considered likely to have a significant impact on the species for the following reasons:

- The species is highly mobile and will be able to move from disturbed areas into nearby undisturbed locations
- The regional extent of suitable foraging habitat types is sufficient that the proposed action is unlikely result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline
- Fragmentation impacts have been minimised by aligning linear infrastructure (flow lines) with existing roads
- The development will not disrupt the breeding cycle of the species as no breeding areas are known within the study area, and no caves or sandstone outcrops (breeding habitat) will be impacted by the proposed action.

***Phascolarctos cinereus* (Koala) - Vulnerable**

Koalas are associated with a wide range of temperate, tropical and sub-tropical forests as well as semi-arid communities. They feed almost exclusively on leaves of Eucalyptus species, although they have been known to forage on other genera as well (SEWPaC 2013). Koalas have large overlapping home ranges with larger home ranges present in areas of poorer quality habitat (recorded up to 135 ha in central Queensland) (SEWPaC 2013).

The species was not identified in the current surveys of the study area but has been identified in previous surveys in the vicinity. There are records of the species within 10 km of the study area on the Atlas of

NSW Wildlife. There is a well-defined Koala population in the broader Pilliga region, and as such, it is likely that Koala populations within the study area will be defined as an important population under the EPBC Act.

Actions which are likely to have a significant impact on the Koala (SEWPaC 2012a) include:

- loss, fragmentation or permanent degradation of habitat critical to the survival or recovery of the listed species
- permanent fragmentation of an important population (e.g. through proposed actions such as power lines and easements, and main road developments)
- clearing or burning of habitat where an important population (see above) is known or suspected to occur, or
- the removal of primary food trees to the extent where an important population declines.

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

The proposed action will lead to the loss of approximately 5.4 ha of potential habitat for this species, which equates to 0.02% of the available habitat within the study area and much less in Namoi CMA region.

The total area of potential habitat loss comprises the following vegetation types:

- 1.4 ha of riparian woodland (Rough-barked Apple riparian forb/grass open forest) which includes species of secondary feed trees for the Koala
- 4 ha of woodland (White Cypress Pine - Bulloak - ironbark woodland) with dense white cypress pine, of which only areas containing dense White Cypress may be used by the Koala as potential refuge habitat.

The habitat proposed to be removed is not considered to be particularly notable as there are no primary feed trees and secondary feed trees occur at low abundance. The loss of breeding habitat represents approximately 0.02% of the habitat available within the study area and much less in the Namoi CMA region. The loss of habitat will occur in small areas across the landscape for the well pads and linear corridors for the flow lines which generally follow existing tracks and infrastructure. Up to 40% of clearing associated with the well pads and 60% of clearing associated with the flowlines and water and gas gathering systems will be rehabilitated.

As the proposed action represents a small proportion of the available habitat in the study area, it is considered unlikely that the proposed action would lead to a long-term decrease in the size of a population of Koala.

Reduce the area of occupancy of an important population

The area of occupancy for Koalas would be reduced if significant amounts of foraging, refuge and breeding habitat were lost in the study area, or if habitats were degraded to the point that the species avoided or could not cross degraded areas and could not move through the study area to undisturbed areas.

The loss of habitat through clearing is small relative to the amount of habitat retained in the study area and the wider Namoi CMA region, hence the proposed action is considered unlikely to reduce the area of occupancy of the species.

Fragment an existing important population into two or more populations

The construction footprint of the proposed action will involve the temporary loss and/or modification of potential habitat. Works in these areas will increase the sizes of some existing disturbances/edges (e.g. roadsides) but will not bisect existing habitat areas into smaller fragments. Works associated with the pilot wells will occur in interior areas of habitat (i.e. not roadside edges) and may introduce edge effects into these areas, but will not bisect habitat into smaller fragments.

Patches will only be separated from other adjacent patches by road and flow line corridors, which will be approximately 10 m during construction, and up to 5 m following construction (the shrub and groundlayer vegetation will be allowed to naturally regenerate following slashing). Thus, the remaining vegetation remnants will not be completely fragmented from other remnants.

While the Koala is thought to be affected by broad-scale habitat fragmentation, the level of fragmentation as a result of proposed action is relatively minor when compared to fragmentation created by dual carriageway roads, urban or agricultural development. Regenerating flow lines are unlikely to prevent the movement of the Koala within the study area. It is also important to note that canopy species occurring on the edges of the corridors are not removed, allowing overhanging canopy over sections of the corridors, providing indirect shelter. In addition, in areas of poorer habitat quality such as in the project area, the Koala is known to occupy large home ranges and disperse large distances (Dique et al 2003).

Habitat connectivity will be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the study area, allowing any potential populations to move across the wider landscape. Thus, it is unlikely that the proposed action would fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

The interim Koala referral advice for proponents (SEWPaC 2012) identifies that 'habitat critical' to the survival of the Koala is forest or woodland where:

- Primary koala food tree species $\geq 30\%$ of the overstorey trees
- Primary koala food tree species comprise $< 30\%$ of the overstorey trees, but together with secondary food tree species comprise $\geq 50\%$ of the overstorey trees
- Primary food tree species are absent but secondary food tree species alone comprise $\geq 50\%$ of the overstorey trees
- The above qualities may be absent in a forest or woodland but other essential habitat features are present and adjacent to areas exhibiting the above qualities (e.g. dense *C. glaucophylla*)
- A relatively high density of koalas is supported, regardless of the presence of food tree species
- Any form of landscape corridor which is essential to the dispersal of koalas between forest or woodland habitats.

Primary Koala feed trees are largely absent from the study area, with commonly occurring secondary feed trees including *Eucalyptus chloroclada* (Dirty Gum), Blakely's Red Gum, *E. pilligaensis* (Pilliga Box),

E. dwyeri (Dwyer's Red Gum). These species are largely confined to drainage lines across the study area, with vegetation in the north-west of the study area supporting Pilliga Box with *E. crebra*. Areas which meet the above description of 'Habitat critical to the survival of the Koala' are therefore known to occur within the study area.

The proposed action will lead to the loss of approximately 5.4 ha of 'habitat critical' to the survival of this species, which equates to less than 0.1% of the available habitat within the study area and much less in Namoi CMA region. As the majority of habitat for this species will be retained within the study area and the region, the proposed action is considered unlikely to adversely affect habitat critical to the survival of the Koala.

Disrupt the breeding cycle of an important population

When assessing the potential for impacts to the breeding cycle of the Koala, it is also necessary to consider impacts to areas of breeding habitat and the size of the species' home range.

The home range sizes of the Koala are well documented, with populations that occur in poorer habitat (such as that present in the study area) likely to have much larger home ranges than populations in more optimal habitat. Koalas have been shown to disperse up to 10 km (Dique et al 2003) and occur over large home ranges.

The proposed action would impact on foraging, refuge and breeding habitat, and reduce/degrade foraging resources indirectly through habitat fragmentation. However, the area directly impacted represents a small proportion available in the study area with the majority of breeding, refuge and foraging habitat retained in the study area. As such, the proposed action is unlikely to disrupt the breeding cycle of the Koala.

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

The proposed action will lead to the loss of approximately 5.4 ha of habitat for this species, which equates to less than 0.1% of the available habitat within the study area and much less in Namoi CMA region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study area.

Therefore it is unlikely that the proposed action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

Invasive species that are harmful to the Koala such as cats and foxes are already established in the study area. The proposed action is unlikely to exacerbate the impacts of invasive species or lead to increased competition for the Koala for resources.

Introduce disease that may cause the species to decline, or

Koalas are susceptible to a number of common diseases; however the proposed action is unlikely to introduce disease which may cause the species to decline.

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed action is unlikely to substantially interfere with the recovery of the species.

Conclusion

It is considered unlikely that the proposed action will adversely affect habitat critical to the survival of the Koala, or result in significant impacts to the species given:

- The proposed action will disturb a very small proportion (<0.1%) of available habitat within the study area and the types of impacts and associated regeneration/rehabilitation are not expected to disrupt movement
- Fragmentation impacts have been minimised by aligning linear infrastructure (flow lines) with existing roads
- The species is mobile through the landscape and considered likely to have large home ranges due to the habitat quality within the study area
- The regional extent of suitable foraging habitat types is sufficient that the proposed action will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline.

***Pseudomys pilligaensis* (Pilliga Mouse) - Vulnerable**

It is important to note that the Pilliga Mouse is now considered a southern population of the widespread *Pseudomys delicatulus* (Delicate Mouse) based on genetic analyses, morphological studies and recent surveys which revealed a continuous distribution of the Delicate Mouse to the Pilliga region (Breed and Ford 2007; Ford 2008, as cited in SEWPaC 2012b). It is important to note that this taxonomic change has not yet been formally recognised under the EPBC Act (SEWPaC 2012b), hence this assessment considers the Pilliga Mouse as currently listed.

The Pilliga Mouse is restricted to the Pilliga region of New South Wales, where low-nutrient deep sand supports a distinctive vegetation type (Pilliga Scrub). The Pilliga Mouse is very sparsely distributed and appears to prefer areas with a light ground cover. Recent studies indicate that the Pilliga Mouse is found in greatest abundance in recently burnt moist gullies, areas dominated by broombush and areas containing an understorey of *Acacia burrowii* (Kurricabah) with a *Corymbia trachyphloia* (Brown Bloodwood) overstorey (Paull 2009). Consistent features of the latter two habitats are a relatively high plant species richness, a moderate to high low shrub cover; and a moist groundcover of plants, litter and fungi. Consistent features of gully habitat are an extensive cover by low grasses and sedges, with little shrub cover and large areas of ash-covered ground. Some evidence exists of marked population fluctuations by this species. It is nocturnal and appears to live in burrows (OEH 2013b).

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

The species was observed as part of recent surveys for the Dewhurst 22-25 pilot (RPS 2013d) and is known to occur more broadly in the study area and Pilliga East State Forest (NPWS 2000a; NPA 2002). It is likely that the study area supports part of an important population of Pilliga Mouse given that the population within the area is near the north eastern limit of the species' range, and the species is restricted to the Pilliga region of NSW.

The proposed action will lead to the loss of approximately 36 ha of habitat for this species. This area comprises:

- approximately 4.7 ha of Rough-barked Apple riparian forb/grass open forest and Brown Bloodwood - cypress - ironbark heathy woodland which represents optimal habitat in the sense that it may provide areas of potential breeding/foraging habitat for the species
- approximately 31.7 ha of White Cypress Pine - Bulloak - ironbark woodland, which is considered to be sub-optimal habitat and only likely to be used by dispersing individuals.

The proposed action will lead to the loss of 0.04% of breeding and foraging habitat within the study area and much less within the Namoi CMA region. The loss of habitat will not occur in a single large patch; rather it will occur in small areas across the landscape for the well pads and linear corridors for the flow lines which generally follow existing tracks and infrastructure. Much of the vegetation loss is linear in nature and needs to be considered within the context of the surrounding landscape, which supports a considerable amount of foraging habitat. Up to 40% of clearing associated with well pads and 60% of clearing associated with the flow lines will be rehabilitated.

As the proposed action represents a small proportion of the available habitat in the study area, it is considered unlikely that the proposed action would lead to a long-term decrease in the size of a population of Pilliga Mouse.

Reduce the area of occupancy of an important population

The area of occupancy for Pilliga Mouse would be reduced if significant amounts of dispersing, foraging and breeding habitat were lost in the study area, or if habitats were degraded to the point that the species avoided or could not cross degraded areas and could not move through the study area to undisturbed areas.

The loss of habitat through clearing is small relative to the amount of habitat retained in the study area and the wider Namoi CMA region, hence the proposed action is considered unlikely to reduce the area of occupancy of the species.

Fragment an existing important population into two or more populations

The home range sizes of the Pilliga Mouse are not well documented, although Tokushima and Jarman (2008) measured average movement distances of 40 m (range 0–181 m) for recaptured individuals. They did not discount that larger movement patterns could occur. Indeed, Paull (2002) noted that the species can experience marked population fluctuations in response to environmental changes caused by fire or rain. There are also seasonal fluctuations in Pilliga Mouse numbers, with the cooler autumn and winter months showing a time of population congregation for this species and the warmer spring and summer months a time for dispersal, indicating that the species has the ability to move some distances.

Patches will only be separated from other adjacent patches by road and flow line corridors, which will be approximately 10 m on average during construction, and up to 5 m following construction. The extent to which habitat fragmentation may impact on Pilliga Mouse habitat is not fully understood, however it is recognised that these clearings from could represent a real or perceived barrier to movement.

A fragmentation analysis was undertaken as part of this assessment (**Section 5.4**). Based on the results of this analysis, twelve out of twenty five movement pathways between modelled breeding and foraging habitat will be potentially impacted by the proposed action. However, all of these pathways are currently impacted by forestry roads. The species is known to undergo seasonal congregations and dispersals (NPA 2002) suggesting that the species has the ability to move significant distances and is currently doing so within an environment currently bisected by much higher number of existing roads, trails and drainage lines than proposed as part of this action. In this way, the proposed action is not expected to

introduce new fragmentation effects; however, they may contribute to existing impacts in some areas of habitat in the short term until natural regeneration occurs along the flow lines following installation.

Regenerating flow lines are unlikely to prevent the movement of the Pilliga Mouse within the study area. Habitat connectivity will be maintained at a local and regional level, with contiguous vegetation and habitat connectivity retained around the study area, allowing any potential populations to move across the wider landscape.

Given that the Pilliga Mouse persists in the study area that is already fragmented by roads and tracks due to a long history of forestry activities and that they are known to be able to disperse over some distances, the proposed action is considered unlikely to fragment an important population of the Pilliga Mouse.

Adversely affect habitat critical to the survival of a species

Habitat that is critical to the survival of Pilliga Mouse includes foraging and breeding habitat.

The proposed action would retain the majority of foraging and breeding habitat in the study area for Pilliga Mouse, with only a small proportion of habitat impacted in the study area and Namoi CMA region. Thus, the foraging and breeding habitat lost or degraded is unlikely to be critical to the survival of the species.

Disrupt the breeding cycle of an important population

When assessing the potential for impacts to the breeding cycle of the Pilliga Mouse, it is necessary to consider impacts to areas of breeding habitat and the size of the species' home range. Broombush was previously defined as the preferred breeding habitat for the Pilliga Mouse (Paull 2009). Recent surveys undertaken in the study area (e.g. NICE and CUCCLG 2012) indicate that breeding habitat for the Pilliga Mouse potentially occurs in a broader range of vegetation associations than previously thought. Vegetation associations within the study area where Pilliga Mouse has been recorded in breeding condition are generally characterised by a high diversity, moderate density, low (<1 m) sclerophyllous shrubby layer. These characteristics are widespread within the study area and more broadly across the eastern, southern and central Pilliga Forest.

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

The proposed action will lead to the loss of approximately 36 ha of habitat for this species which includes 4.7 ha of foraging/breeding habitat, which equates to 0.04% of the potential breeding and foraging habitat within the study area and much less in the Namoi CMA region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study area.

Therefore it is unlikely that the proposed action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

Invasive species that are harmful to the Pilliga Mouse such as house mice, cats and foxes are already established in the study area. The proposed action is unlikely to exacerbate the impacts of invasive species or lead to increased competition for Pilliga Mouse for resources.

Introduce disease that may cause the species to decline, or

Disease is not listed as a threat to this species. The proposed action would be unlikely to introduce a disease that may cause this species to decline.

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed action is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed action is not considered likely to have a significant impact on the species for the following reasons:

- The species persists in the study area which is bisected by numerous forestry access tracks and roads,
- Of the twelve movement pathways potentially impacted, all impacts will be short term and involve only a temporary widening of existing impacts
- The proposed action will lead to the loss of a very small proportion (less than 0.1%) of available optimal habitat (i.e., breeding/foraging habitat) within the study area
- Fragmentation impacts have been minimised by aligning linear infrastructure (flow lines) with existing roads
- The regional extent of suitable foraging habitat types is sufficient that the proposed action will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline.

6.2.3 Plants

***Pterostylis cobarensis* (Cobar Greenhood Orchid) - Vulnerable**

Pterostylis cobarensis is a terrestrial orchid. The species is known chiefly from the Nyngan-Cobar-Bourke district in the far western plains of NSW. Its presence has been recorded in districts including Narrabri, Nyngan, Cobar, Nymagee, Mt Gundabooka, Mt Grenfel and Mutawintji National Park. There is one outlier record for *P. cobarensis* from 1989 approximately 8 km to the north of the study area, however the remainder of the records for this species are located at least 200 km to the southwest (OEH 2013). There are also records from the Darling Downs district of Queensland (OEH 2013b).

Within the study area, *P. cobarensis* has been recorded primarily within the White Cypress Pine - Bullock - Ironbark Woodland vegetation type, but has also been recorded within other vegetation types where suitable microhabitat has been present.

The species flowers from September to November. Vegetative reproduction is not common in this group of Greenhoods, but some species may form more than one dropper annually. Plants are deciduous and die back to the large, underground tubers after seed release. New rosettes are produced following soaking autumn and winter rains. Pollination of the species is by the males of small gnats which are attracted to the flower by some pseudosexual perfume. *Pterostylis cobarensis* occurs as frequent to abundant plants in usually very localised populations (OEH 2013b).

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

As *Pterostylis cobarensis* is known to occur in the study area, has a moderately sized population and is near the edge of its known distribution, it is considered likely that the study area supports an important population of this species.

Detailed targeted surveys for *Pterostylis cobarensis* have been undertaken both within the study area and across the broader Pilliga region to model the population in this area (ELA 2012). From these studies it has been estimated that the total population of *Pterostylis cobarensis* within the Pilliga region is approximately 3,300,000 individuals and 345,000 within the study area.

The proposed action will impact on approximately 36 ha of vegetation that may include some areas that support potential habitat for this species. The loss of habitat will occur in small areas across the landscape for the well pads and linear corridors for the flow lines which generally follow existing tracks and infrastructure. Up to 40% of clearing associated with the well pads and 60% of clearing associated with the flowlines and water and gas gathering systems will be rehabilitated.

Based on the modelled data, it is estimated that proposed action could impact on approximately 185 individuals, which equates to 0.05% of the total modelled population of this species within the study area. The total amount of potential habitat likely to be impacted by the proposed program constitutes less than 0.09% of the total habitat within the study area and less than 0.01% across the Pilliga region. Given the relatively small scale of impacts to this species, it is unlikely that the proposed action would lead to a long-term decrease in the population of *P. cobarensis* in the study area.

Reduce the area of occupancy of an important population

The proposed action is likely to reduce the potential habitat for *P. cobarensis* through the clearing of approximately 36 ha of vegetation which represents potential habitat for this species.

The majority of vegetation representing potential habitat for *P. cobarensis* will be retained as part of the proposed action. The amount of habitat that would be directly impacted comprises only a small portion of potential habitat for *P. cobarensis* in the study area and an even smaller portion of potential habitat within the Namoi CMA region; hence the proposed action is unlikely to reduce the area of occupancy of this species.

Fragment an existing important population into two or more populations

P. cobarensis has the potential to be impacted on by habitat fragmentation where pollination (by small gnats) or seed dispersal (largely wind and seed fall) is interrupted. Fragmentation associated with the proposed action is considered unlikely to alter pollination or seed dispersal pathways associated with the lifecycle of *P. cobarensis* and is therefore considered unlikely to fragment an existing important population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat critical to the survival of *P. cobarensis* could include areas that are necessary for dispersal, for the long-term maintenance of the species or to maintain genetic diversity.

Potential habitat for *P. cobarensis* is extensive both within the study area and broader Pilliga region. The loss of less than 0.08% of the total habitat within the study area and less than 0.01% across the Pilliga region is considered unlikely to be critical to the survival of this species.

Disrupt the breeding cycle of an important population

The breeding cycle of *P. cobarensis* could potentially be disrupted through the loss of habitat or the displacement of pollinators through fragmentation. The loss of less than 0.01% of potential habitat across the Pilliga region and minor fragmentation affects associated with the proposed action are considered unlikely to disrupt the breeding cycle of this species.

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

The proposed action will lead to the loss of approximately 36 ha of potential habitat for this species which includes approximately 185 individuals, which equates to 0.05% of the total modelled population of this species within the study area.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study area.

Therefore it is unlikely that the proposed action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

Invasive weed species such as *Eragrostis curvula* (African Lovegrass) and *Hyparrhenia hirta* (Coolatai Grass) have the potential to invade into suitable habitat for *P. cobarensis* from disturbance associated with the proposed action. Weed and fungal invasion has the potential to degrade the habitat of this species and weed species may directly compete with the species.

Santos implements pest plant procedures to ensure the rapid and progressive rehabilitation of the study area on completion of construction works for temporary impacts (e.g. flow lines) and over the life of the proposed action for longer term impacts (e.g. wells).

Introduce disease that may cause the species to decline, or

Phytophthora cinnamomi (Cinnamon Fungus) is a microscopic soil-borne plant pathogen that can invade and destroy the root systems of susceptible native and introduced plant species. As rainfall is one of the key factors influencing the distribution of *P. cinnamomi*, the pathogen is generally restricted to coastal NSW. As such, the risk of infection of *P. cinnamomi* in the study area is considered lower than that in coastal sites.

Machinery utilised for construction and operation of the proposed action may carry the spores of *P. cinnamomi* if they have been working in coastal areas which are known to be infected by the pathogen. However, all construction machinery and vehicles would be inspected and thoroughly cleaned prior to entry to site. This would occur in Narrabri and would be undertaken initially and for those vehicles/machinery floated/hailed to the study area from outside the locality.

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed action is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed action is not considered likely to have a significant impact on the species for the following reasons:

- The modelled loss of individuals is less than 0.1% of the population from within the study area and much less in the Pilliga region
- The regional extent of suitable habitat is sufficient that the proposed action will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline
- The proposed action will not disrupt the breeding cycle of the species as vegetation patches would not be separated by distances that would interfere with the pollination of the species (by males of small gnats)
- Weed management procedures will be implemented within the study area.

***Tylophora linearis* - Endangered**

Tylophora linearis is a slender, almost hairless twiner. The species is known only from NSW and Queensland. In NSW, it is found in the Barraba, Mendooran, Temora and West Wyalong districts in the northern and central western slopes. Records include Crow Mountain near Barraba, Goonoo, Pilliga West, Cumbil, and Eura State Forests, Coolbaggie Nature Reserve, Goobang National Park, and Beni Conservation Area. The species grows in dry scrub and open forest. It has been recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa*, *E. sideroxylon*, *E. albens*, *Callitris endlicheri*, *C. glaucophylla* and *Allocasuarina luehmannii*. It also grows in association with *Acacia hakeoides*, *A. lineata*, *Melaleuca uncinata*, *Myoporum* species and *Casuarina* species. The species flowers in spring, with flowers recorded in November or May with fruiting probably 2 to 3 months later. Where the species occurs, it has been recorded in very low abundances (OEH 2013b).

Detailed targeted surveys for *T. linearis* have been undertaken both within the study area and across the broader Pilliga region to model the population in this area (ELA 2012). From these studies it has been estimated that the total population of *T. linearis* within the Pilliga region is approximately 180,000 individuals and 17,500 within the study area.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

The proposed action will impact on approximately 36 ha of known and potential habitat for this species. The loss of habitat will occur in small areas across the landscape for the well pads and linear corridors for the flow lines which generally follow existing tracks and infrastructure. Up to 40% of clearing associated with the well pads and 60% of clearing associated with the flowlines and water and gas gathering systems will be rehabilitated.

It is estimated that the proposed action will directly impact on approximately 30 individuals, which equates to 0.17% of the total modelled population of this species within the study area. The total amount of potential habitat impacted by the exploration activities constitutes less than 0.09% of the total habitat within the study area and less than 0.01% across the Pilliga region.

Given the relatively small scale of impacts to this species, it is unlikely that the proposed action would lead to a long-term decrease in the population of *T. linearis* in the study area.

Reduce the area of occupancy of the species

The proposed action is likely to reduce the potential habitat for *T. linearis* through the clearing of approximately 36 ha of vegetation which represents potential habitat for this species.

The majority of vegetation representing potential habitat for *T. linearis* will be retained as part of the proposed action. The amount of habitat that would be directly impacted comprises only a small portion of potential habitat for *T. linearis* in the study area and an even smaller portion of potential habitat within the Namoi CMA region; hence the proposed action is unlikely to reduce the area of occupancy of this species.

Fragment an existing population into two or more populations

T. linearis has the potential to be impacted on by habitat fragmentation where pollination (assumed to be insect pollinated, Forster et al. 2004) or seed dispersal (seed fall and wind) is interrupted. Fragmentation associated with the exploration activities is considered unlikely to alter pollination or seed dispersal pathways associated with the lifecycle of *T. linearis* and is therefore considered unlikely to fragment an existing population into two or more populations

Adversely affect habitat critical to the survival of a species

Habitat critical to the survival of *T. linearis* could include areas that are necessary for dispersal, for the long-term maintenance of the species or to maintain genetic diversity.

Potential habitat for *T. linearis* is extensive both within the study area and broader Pilliga region. The loss of less than 0.09% of the total habitat within the study area and less than 0.01% across the Pilliga region is considered unlikely to be critical to the survival of this species.

Disrupt the breeding cycle of a population

The breeding cycle of *T. linearis* could potentially be disrupted through the loss of habitat or the displacement of pollinators through fragmentation. The loss of less than 0.01% of potential habitat across the Pilliga region and minor fragmentation affects associated with the proposed action are considered unlikely to disrupt the breeding cycle of this species.

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

The proposed action will lead to the loss of approximately 36 ha of potential habitat for this species which includes approximately 30 individuals, which equates to less than 0.17% of the total modelled population of this species within the study area.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study area.

Therefore it is unlikely that the proposed action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

Invasive weed species such as *Eragrostis curvula* (African Lovegrass) and *Hyparrhenia hirta* (Coolatai Grass) have the potential to invade into suitable habitat for *T. linearis* from disturbance associated with the proposed action. Weed and fungal invasion has the potential to degrade the habitat of this species and weed species may directly compete with the species.

Santos implements pest plant procedures to ensure the rapid and progressive rehabilitation of the study area on completion of construction works for temporary impacts (e.g. flow lines) and over the life of the proposed action for longer term impacts (e.g. wells).

Introduce disease that may cause the species to decline, or

Phytophthora cinnamomi (Cinnamon Fungus) is a microscopic soil-borne plant pathogen that can invade and destroy the root systems of susceptible native and introduced plant species. As rainfall is one of the key factors influencing the distribution of *P. cinnamomi*, the pathogen is generally restricted to coastal NSW. As such, the risk of infection of *P. cinnamomi* in the study area is considered lower than that in coastal sites.

Machinery utilised for construction and operation of the proposed action may carry the spores of *P. cinnamomi* if they have been working in coastal areas which are known to be infected by the pathogen. However, all construction machinery and vehicles would be inspected and thoroughly cleaned prior to entry to site. This would occur in Narrabri and would be undertaken initially and for those vehicles/machinery floated/hailed to the study area from outside the locality.

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed action is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed action is not considered likely to have a significant impact on the species for the following reasons:

- The small extent of impacts from the proposed action relative to available habitat in the landscape
- The regional extent of suitable habitat types is sufficient that the proposed action will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline
- The proposed action will not disrupt the breeding cycle of the species as vegetation patches would not be separated by distances that would interfere with the pollination of the species
- Weed management procedures will be implemented within the study area.

6.2.4 Migratory species

Anthochaera phrygia (Regent Honeyeater) – Migratory

Regent Honeyeater is listed as an endangered and migratory species under the EPBC Act. A description of the species and distribution in NSW is provided in the Regent Honeyeater Impact Assessment in **Section 6.2.1** of this report.

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The proposed action would remove potential foraging and roosting habitat within the study area. No breeding habitat representing important habitat would be impacted.

The majority of vegetation representing foraging and roosting habitat for the species would be retained in the study area. The amount of habitat that would be directly impacted comprises only a small portion of

potential habitat for Regent Honeyeaters throughout the study area and an even smaller portion of potential habitat within the Namoi CMA region. This species could also access vegetation outside of the study area as it is capable of making large regional movements in the order of hundreds of kilometres.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

It is unlikely that the proposed action would result in the introduction of invasive species that would impact on Regent Honeyeater in the study area. The species suffers from competition from larger aggressive honeyeaters, particularly Noisy Miners, Noisy Friarbirds and Red Wattlebirds. However, the proposed action is unlikely to lead to an increase in the incidence of these species in the study area.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The species is not known to breed in the study area, although it has been recorded displaying breeding behaviour adjacent to the study area in Pilliga Nature Reserve. The study area could be used as a foraging resource during the species' breeding period and thus the proposed action could potentially disrupt the lifecycle of Regent Honeyeater. However, only a small proportion of the foraging habitat in the study area and in the Namoi CMA region will be removed. Regent Honeyeaters would be able to continue using these resources within and outside of the study area. Thus, the proposed action is unlikely to seriously disrupt the lifecycle of a Regent Honeyeater population.

***Apus pacificus* (Fork-tailed Swift) - Migratory**

The Fork-tailed Swift is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher. In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes (SEWPaC 2013b).

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The proposed action would remove vegetation above which Fork-tailed Swifts could potentially forage. However, the majority of vegetation in the study area would be retained. The amount of vegetation that would be directly impacted comprises only a small portion of vegetation throughout the study area and an even smaller portion of vegetation within the Namoi CMA region. The proposed action is considered unlikely to constitute important habitat for the Fork-tailed Swift and is unlikely to substantially modify, destroy or isolate areas of important habitat.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

The proposed action would not result in the establishment of an invasive species that is harmful to Fork-tailed Swifts.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

Fork-tailed Swifts do not breed in Australia. The removal of vegetation in the study area would be unlikely to affect the species, which forages aerially over a range of habitats including cleared areas. Therefore the proposed action is unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of Fork-tailed Swift.

***Haliaeetus leucogaster* (White-bellied Sea Eagle) - Migratory**

The White-bellied Sea-Eagle is found in coastal habitats (especially those close to the sea-shore) and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands. The habitats occupied by the sea-eagle are characterised by the presence of large areas of open water (larger rivers, swamps, lakes, the sea).

While the species is mostly coastal in its distribution, White-bellied Sea-Eagles may travel inland along major rivers. Birds also occasionally visit inland lakes, rivers or reservoirs that occur outside of the usual distribution of the species (SEWPaC 2013b).

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The study area could provide occasional foraging habitat for the species following heavy rainfall periods (within the riparian areas), but would be unlikely to provide permanent foraging or breeding habitat for the species as the breeding territories of White-bellied Sea Eagles are typically located close to bodies of water which are absent from the study area.

As the proposed action would avoid the main riparian area in the study area, would not construct any new major creek crossings, or install in stream devices which would impact on the natural hydrology of creek lines and the integrity of riparian vegetation, the proposed action would not substantially modify potential foraging habitat for White-bellied Sea Eagles.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

The proposed action would not result in the establishment of an invasive species that is harmful to White-bellied Sea Eagles.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The study area does not provide breeding habitat for the species. The species could potentially be present in the study area opportunistically following rain periods, however there is more optimal habitat located to the north and east of the study area along the Namoi River. The proposed action would not construct any new major creek crossings or install in stream devices which would impact on the natural hydrology of creek lines and the integrity of riparian vegetation. The proposed action is therefore unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of White-bellied Sea Eagles.

***Hirundapus caudacutus* (White-throated Needletail) - Migratory**

The White-throated Needletail is listed as a migratory species under the EPBC Act, and is included in the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA), and the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) (SEWPaC 2013b).

In Australia, the White-throated Needletail is almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground. Because they are aerial, it has been stated that conventional habitat descriptions are inapplicable, but there are, nevertheless, certain preferences exhibited by the species. Although they occur over most types of habitat, they are probably recorded most often above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy, but they are less commonly recorded flying above woodland. They also commonly occur over heathland, but less often over treeless areas, such as grassland or swamps. When flying above farmland, they are more often recorded above partly cleared pasture, plantations or remnant vegetation at the edge of paddocks. In coastal areas, they are sometimes seen flying over sandy beaches or mudflats, and often around coastal cliffs and other areas with prominent updraughts, such as ridges and sand-dunes (SEWPaC 2013b).

During the non-breeding season in Australia, the White-throated Needletail has been recorded eating a wide variety of insects, including beetles, cicadas, flying ants, bees, wasps, flies, termites, moths, locusts and grasshoppers. The White-throated Needletail almost always forage aerially, at heights up to 'cloud level' though usually much lower (SEWPaC 2013b).

The species has been recorded roosting in trees in forests and woodlands, both among dense foliage in the canopy or in hollows. It has been suggested that they also sometimes roost aerially (SEWPaC 2013b).

The species breeds in wooded lowlands and sparsely vegetated hills, as well as mountains covered with coniferous forests in Asia, from central and south-eastern Siberia and Mongolia, east to the Maritime Territories of Russia, Sakhalin and the Kuril Islands and south to northern Japan and north-eastern China (SEWPaC 2013b).

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The proposed action would remove vegetation above which White-throated Needletail could potentially forage. However, the majority of vegetation in the study area would be retained. The amount of vegetation that would be directly impacted comprises only a small portion of vegetation throughout the study area and an even smaller portion of vegetation within the Namoi CMA region. The proposed action is considered unlikely to constitute important habitat for the White-throated Needletail and is unlikely to substantially modify, destroy or isolate areas of important habitat.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

The proposed action would not result in the establishment of an invasive species that is harmful to White-throated Needletails.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

White-throated Needletails do not breed in Australia. The removal of vegetation in the study area would be unlikely to affect the species, which forages aerially over a range of habitats. Therefore the proposed action is unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of White-throated Needletail.

***Lathamus discolor* (Swift Parrot) - Migratory**

The Swift Parrot is listed as an endangered and migratory species under the EPBC Act. A description of the species and distribution in NSW is provided in the Regent Honeyeater Impact Assessment in **Section 6.2.1** of this report.

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The proposed action would remove potential foraging and roosting habitat within the study area. No breeding habitat representing important habitat would be impacted.

The majority of vegetation representing foraging and roosting habitat for the species would be retained in the study area. The amount of habitat that would be directly impacted comprises only a small portion of potential habitat for Swift Parrots throughout the study area and an even smaller portion of potential habitat within the Namoi CMA region. This species could also access vegetation outside of the study area as it is capable of making large regional movements in the order of hundreds of kilometres.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

It is unlikely that the proposed action would result in the introduction of invasive species that would impact on Swift Parrots in the study area.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW this species mostly occurs on the coast and south west slopes.

Only a small proportion of the potential foraging habitat in the study area and in the Namoi CMA region will be removed. Swift Parrots would be able to continue using these resources within and outside of the study area. Thus, the proposed action is unlikely to seriously disrupt the lifecycle of a Swift Parrot population.

***Merops omatus* (Rainbow Bee-eater) – Migratory**

The Rainbow Bee-eater is listed as a migratory species under the EPBC Act, and is included in the Japan-Australia Migratory Bird Agreement (JAMBA) (SEWPaC 2013b).

In Australia, the Rainbow Bee-eater mainly occurs in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in proximity to permanent water. It also occurs in inland and coastal sand dune systems, and in mangroves in northern Australia, and has been recorded in various other habitat types including heathland, sedgeland, vine forest and vine thicket, and on beaches (SEWPaC 2013b).

The Rainbow Bee-eater mainly feeds on insects, and will occasionally take other animal items including earthworms, spiders and tadpoles. The insect component of the diet mainly consists of bees and wasps, but also includes various other insects such as beetles, moths, butterflies, damselflies, dragonflies, flies, ants and bugs. The Rainbow Bee-eater captures most of its prey in flight, although it also takes food items from the ground and from foliage, and has occasionally been seen to snatch items from below the surface of rivers and dams (SEWPaC 2013b).

The Rainbow Bee-eater breeds in socially monogamous pairs that are sometimes assisted by a varying number of auxiliary birds or 'helpers' that are usually male. The nests are typically concentrated together in loose colonies, although in some instances pairs will nest solitarily. The nest is located in an enlarged chamber at the end of long burrow or tunnel that is excavated, by both sexes, in flat or sloping ground, in the banks of rivers, creeks or dams, in roadside cuttings, in the walls of gravel pits or quarries, in mounds of gravel, or in cliff-faces. Nesting areas are often re-used, and banding studies indicate that at least some migrant birds return to the same nesting area each year. However, pairs usually excavate a new nesting burrow for each breeding season (SEWPaC 2013b).

The movement patterns of the Rainbow Bee-eater are complex, and are not fully understood. Populations that breed in southern Australia are migratory. However, populations that breed in northern Australia are considered to be resident, and in many northern localities the Rainbow Bee-eater is present throughout the year. Regarding populations that breed in southern Australia, these move north to northern Australia, Papua New Guinea and eastern Indonesia after breeding and remain there for the duration of the Australian winter. Populations of the Rainbow Bee-eater gather together and assemble into flocks before migration. The migrating flocks, which can consist of tens to hundreds or thousands of birds, often fly high above the ground when on passage (SEWPaC 2013b).

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The proposed action would remove foraging, roosting and potential breeding habitat for the Rainbow Bee-eater. However, the majority of vegetation in the study area representing foraging, roosting and potential breeding habitat for Rainbow Bee-eater would be retained. The amount of habitat that would be directly impacted comprises only a small portion of potential habitat for Rainbow Bee-eater throughout the study area and an even smaller portion of potential habitat within the Namoi CMA region.

The proposed action is considered unlikely to substantially modify, destroy or isolate areas of important habitat.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

The proposed action would not result in the establishment of an invasive species that is harmful to Rainbow Bee-eater.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The proposed action would remove foraging, roosting and potential breeding habitat for the Rainbow Bee-eater. However, the majority of vegetation representing foraging, roosting and breeding habitat in the study area that could be used by Rainbow Bee-eater would be retained.

The amount of habitat that would be directly impacted comprises only a small portion of potential habitat for Rainbow Bee-eater throughout the study area and an even smaller portion of potential habitat within the Namoi CMA region. The species could also access vegetation outside of the study area. Thus, the proposed action is considered unlikely to seriously disrupt the lifecycle of a Rainbow Bee-eater population.

6.3 CUMULATIVE IMPACT ASSESSMENT

This report considered MNES as they relate to the proposed program, with existing exploration and appraisal activities not being referred as part the proposed program. To provide additional context on the significance of impacts, an assessment of the cumulative impact associated with the proposed program and existing exploration and appraisal activities (from 2002 to present) within the Pilliga Forest has been undertaken.

Cumulative impacts are provided in this report for vegetation (**Table 6**), threatened fauna habitat (**Table 9**) and threatened flora habitat (**Table 12**). An assessment of fragmentation impacts as a result of the proposed program and existing exploration and appraisal activities is also provided in **Section 5.4**.

The cumulative impact as a result of the proposed program and existing exploration and appraisal activities to vegetation within the Pilliga Forest equates to the loss of:

- 186.92 ha which represents a loss of approximately 0.39% of consolidated vegetation within the study area (**Table 6**)
- Between 21.6 and 145.5 ha of potential breeding habitat (depending on species) for threatened fauna species which represents a loss of between 0.21% and 0.31% of the available breeding habitat available within the study area (**Table 9**)
- Between 21.6 and 186.9 ha of potential foraging habitat (depending on species) for threatened fauna species which represents a loss of between 0.21% and 0.39% of the available foraging habitat available within the study area (**Table 9**)
- Between 0.19% and 0.33% of the total threatened flora populations modelled within the study area and 0.32% of the potential habitat available for threatened flora populations within the study area (**Table 12**).

Fragmentation of habitat as a result of the proposed program and existing exploration and appraisal activities is considered unlikely to adversely affect any MNES, with only one of the twenty-five potential movement pathways for the Pilliga Mouse affected by long-term impacts. The remaining threatened and migratory fauna are highly mobile and can traverse large distances across modified and cleared landscapes. Fragmentation is unlikely to significantly affect any threatened flora species as the proposed program and existing exploration and appraisal activities are unlikely to split contiguous habitat into two or more distinct patches with pollination and dispersal mechanisms able to continue largely unimpeded.

Given the relatively small extent of clearing as a proportion of available habitat (both within the study area and the Namoi CMA region), minimisation of fragmentation impacts by locating linear infrastructure (flow lines) along existing tracks wherever possible, and measures proposed to avoid, minimise and mitigate impacts, the proposed program and existing exploration and appraisal activities are not expected to significantly fragment or reduce the availability of habitat in a way which will adversely affect MNES within the study area.

Based on the above, the cumulative impact of the proposed program and existing exploration and appraisal activities is considered unlikely to have a significant impact on any MNES as there is unlikely to be a long term decrease in population sizes, significant fragmentation or adverse disturbance to breeding cycles or critical habitat.

7 Rehabilitation activities

Rehabilitation of existing exploration and appraisal activities is currently being undertaken. These activities provide a benchmark for understanding the potential reduction in impact as a result of rehabilitation works identified for the proposed program.

Santos has commenced a program of rehabilitation works throughout PEL 238 and PAL 2. Rehabilitation works include:

- reducing the size of existing well leases back to the minimum area required for operations
- plugging and abandoning, according to legislative requirements, wells that are no longer required for exploration and appraisal and rehabilitating associated well leases
- rehabilitating a number of water storage ponds that are no longer required for exploration and appraisal activities.

Actions undertaken during the clearing of vegetation include stockpiling 'waste' timber from felled trees not suitable for forestry activities, fallen logs and bush rock for later use in habitat restoration; low vegetation is slashed and mulched on site; and topsoil is striped and stockpiled. Rehabilitation actions include; replacing topsoil; re-installing habitat features such as fallen timber and bush rock; natural re-establishment of slashed and cleared native vegetation; and direct seeding where required.

Monitoring of rehabilitation activities has shown an overall site value close to 45% of nearby reference sites after two years. The replacement of topsoil is producing encouraging results, with sites showing a high number of native species when compared to reference sites. Rehabilitation measures undertaken have been considered using adaptive management principles with monitoring informing future modifications to works and methodology.

Rehabilitation works associated with the proposed program will follow the methods developed for the existing exploration and appraisal activities.

7.1 VEGETATION DIEBACK

Santos has identified approximately six hectares of vegetation dieback which has resulted from ESG's previous operations. The affected areas occur within the White Cypress Pine – Bulloak – Ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion vegetation type adjacent to areas cleared for infrastructure. Santos has progressed rehabilitation of these areas in consultation with the NSW Government. The vegetation dieback areas are not included in the cumulative clearing areas presented in **Table 6**.

To date, rehabilitation of approximately 28 hectares of land, including the vegetation dieback areas, has commenced.

8 Conclusion

This report has brought together information from a variety of sources to document the existing, proposed and cumulative impacts associated with exploration and appraisal activities within the Pilliga Forest.

Six ecological surveys and assessments have been completed to assess the potential impacts of the proposed program on MNES (RPS 2012a-c, 2013a-c). The advice provided from these surveys is that the proposed program is not likely to have a significant impact on any MNES, however a referral has been recommended as a precautionary measure.

An assessment of the significance of the impacts of the proposed program under the EPBC Act was completed as part of this report. The outcome of the assessment is that the proposed program is considered unlikely to result in a significant impact on any MNES. Further to this, when the impacts of the proposed program are considered in conjunction with the impacts of existing exploration and appraisal activities within the Pilliga Forest (i.e. a cumulative impact assessment), the combined impacts are also considered unlikely to result in a significant impact on any MNES.

Given the relatively small extent of clearing as a proportion of available habitat within the study area and more broadly in the Namoi CMA region, minimisation of fragmentation impacts by locating linear infrastructure (flow lines) along existing tracks wherever possible, and measures proposed to avoid, minimise and mitigate impacts, the proposed program is considered unlikely to have a significant impact on MNES.

Additional measures to further reduce impacts such as rehabilitation have been included as part of the proposed program.

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