Chapter 15

Terrestrial ecology

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Chapter 15 Terrestrial ecology

The Secretary's environmental assessment requirements for the Narrabri Gas Project include a requirement to assess potential impacts on biodiversity. A terrestrial ecological impact assessment is provided in Appendix J1 (Eco Logical Australia (ELA) 2016). The information provided in the terrestrial ecological impact assessment was then used to assess biodiversity in a biodiversity assessment report in accordance with the *Framework for Biodiversity Assessment* (OEH 2014d), which is provided as Appendix J2. This chapter draws on the ecological assessment and describes terrestrial flora and fauna and their habitats in the project area and the presence and likelihood of occurrence of threatened and migratory species, populations and ecological communities. The potential impacts on terrestrial ecology in the project area associated with the project are assessed. Environmental risks are identified, and mitigation measures proposed.

Field surveys were undertaken between November 2010 and September 2014. The field surveys involved a range of survey techniques to collect data on species diversity, abundance and distribution in the project area. Following the field surveys, data obtained through database searches and a literature review were consolidated. This information was then incorporated with knowledge gained from extensive mapping, with modelling and analyses undertaken to assess impacts on terrestrial flora and fauna in the project area.

The key findings of the impact assessment in relation to terrestrial ecology were:

- It is unlikely that the project would have a significant impact on the threatened flora, threatened fauna or threatened ecological communities that are considered potential, likely or known to occur in the project area.
- Construction and operation of the project would result in the removal of approximately 1.5 per cent of native vegetation dispersed throughout the project area—with about half of this vegetation being rehabilitated following construction.
- Impacts on the abundance of each threatened flora species would be less than 1.6 per cent of the total abundance estimated to occur in the project area. Threatened ecological communities present would be impacted by one per cent or less of their occurrence in the project area.
- The direct and indirect impact on fauna habitat would account for less than two per cent of the total habitat available in the project area.

A total of 807 terrestrial flora species were identified within the project area, of which 691 species were native and 116 species were introduced. Ten of the recorded plant species are listed as threatened species under State and / or Commonwealth legislation. Twenty-two plant communities occur within the project area, four of which are listed as threatened ecological communities under State and / or Commonwealth legislation. An ecological community is a naturally occurring group of native plants, animals and other organisms that are interacting in a unique habitat—as opposed to a specific species.

A total of 289 terrestrial fauna species were identified in the project area, 32 listed as threatened and / or migratory under State and / or Commonwealth legislation. An additional 25 threatened and / or migratory fauna species listed under State and / or Commonwealth legislation are considered likely or have the potential to occur in the project area based on the presence of suitable habitat.

Construction and operation of the project would result in the removal of up to 988.8 hectares of native vegetation. The indirect impacts of the project would be equivalent to the removal of an additional 181.1 hectares of native vegetation. When combined, this equates to a total impact of approximately 1,169.9 hectares of vegetation or the removal of approximately 1.5 per cent of native vegetation dispersed throughout the project area. All plant community types would be impacted by less than

three per cent of their occurrence in the project area. About half of the vegetation removed during construction of the project would be rehabilitated post construction.

Impacts on the abundance of each threatened flora species known to occur in the project area would be less than 1.6 per cent of the total abundance estimated to occur in the project area. The four threatened ecological communities present would be impacted by one per cent or less of their occurrence in the project area.

The direct and indirect impacts on vegetation would impact on fauna foraging, roosting, sheltering and breeding and dispersal habitat. For all threatened fauna species considered as potential, likely, or known to occur in the project area, the direct and indirect impact on habitat would account for less than two per cent of the total habitat available in the project area.

It is unlikely that the project would have a significant impact on the threatened flora, threatened fauna or threatened ecological communities that are considered potential, likely or known to occur in the project area. This is primarily due to:

- the small proportion of habitat being removed relative to that retained in the project area
- the removal of habitat not being at a scale likely to result in the isolation or fragmentation of populations
- it being unlikely that the project would result in invasive species or diseases becoming established
- the progressive rehabilitation of disturbed areas as part of the project.

A number of avoidance and minimisation measures would be included in the design of the project to minimise the potential impacts on terrestrial flora and fauna in the project area. These measures include:

- co-locating linear infrastructure such as gas and water gathering systems and access tracks with existing roads, access tracks and disturbance corridors, where practicable
- placing major facilities in previously cleared areas, where practicable
- implementing the Field Development Protocol to ensure the planning, design and construction phases of the project are undertaken in accordance with approval conditions
- implementing an ecological scouting framework to identify the most suitable areas for the proposed infrastructure to be positioned within a given location in order to cause the least environmental impact.

Additional mitigation and management measures would further reduce the impact of the project on flora and fauna, including threatened and migratory species, populations and ecological communities. These would include clearing vegetation in accordance with a pre-clearing and clearing procedure, and rehabilitating cleared areas in accordance with a rehabilitation strategy.

Residual impacts on threatened and migratory species and endangered ecological communities would be offset as part of a biodiversity offset strategy in accordance with the *NSW Offsetting Principals* (OEH 2014b) and the *NSW Biodiversity Offsets Policy for Major Projects* (OEH 2014c).

15.1 Methodology

The terrestrial ecological assessment included a desktop search of databases and review of relevant literature, field surveys, vegetation and habitat mapping, threatened flora population estimates and modelling, and an ecological sensitivity analysis to identify potential ecological constraints associated with the project. Impact calculations and an assessment of the significance of impacts were undertaken to determine the effect of the project on terrestrial flora and fauna.

For the purposes of this chapter, the study area is the project area. It includes areas surveyed as part of this assessment, incorporating the extent of direct and indirect impacts. The study region is defined as the area within PEL 238 which includes PAL 2 and PPL 3. This area is used to discuss the project within the context of the broader north-east Pilliga Forest.

15.1.1 Database search and literature review

A desktop assessment was undertaken to identify State and Commonwealth-listed threatened and migratory species, populations and ecological communities that may be affected by the project. Biodiversity databases pertaining to the project area were searched. They included the:

- NSW Office of Environment and Heritage BioNet database (Atlas of NSW Wildlife) for records of threatened species, populations and endangered ecological communities listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) that have been recorded within the locality (OEH 2014a).
- Commonwealth Department of the Environment and Energy Protected Matters Search Tool for matters of national environmental significance listed under the Commonwealth EPBC Act that have been recorded in the locality (DotE 2013b).

The search radius for the database review was increased from the standard 10 kilometre radius search to a 100 kilometre search from the centre point of the project area due to the lack of records and to capture all potential threatened and migratory species, populations and ecological communities that could occur in the vicinity of the project area.

The results of previous ecological assessments and scientific publications were reviewed to determine the likely presence of terrestrial flora and fauna species and their habitats within the project area. A list of the literature that was reviewed is provided in Appendix A1 of Appendix J1. The results of the literature review were compiled into databases showing all previous survey effort, plus the location of all threatened and migratory species, populations and ecological communities recorded in the project area and were used to inform this assessment, where applicable.

In addition, high resolution aerial photographs, light detection and ranging (LiDAR) data and other relevant mapping were reviewed to determine landscape features, vegetation cover and disturbance patterns in the project area.

15.1.2 Likelihood of occurrence

Following the collation of database records and results of previous ecological assessments in the project area and vicinity, a ‘likelihood of occurrence’ assessment was prepared with reference to the habitats contained within the project area. This was further refined following field surveys and the identification and assessment of the habitats present. For this assessment, the likelihood of occurrence within the project area of threatened and migratory species, populations and ecological communities is defined in Appendix J1.

15.1.3 Field surveys

The project area has been surveyed extensively for various development proposals (over 13,000 hours of survey effort has been undertaken since 2002). The survey methodology and effort for this project is presented below.

The objectives of the field surveys were to:

- determine the abundance, distribution, ecology and habitat preferences of threatened and migratory species, populations and ecological communities within the project area
- determine the conservation value of each habitat present in the project area from a local and regional perspective
- determine the importance of populations present from a local and regional perspective.

Field surveys were undertaken over a number of seasons and varying weather conditions between 2010 and 2014. Weather conditions (minimum and maximum temperatures and total rainfall) across the entire survey period were compared to historical averages (2001 to 2013 / 14) and are presented in Appendix J1.

Terrestrial flora field surveys

The terrestrial flora surveys consisted of:

- initial field reconnaissance
- vegetation validation via biometric plots and rapid vegetation validation plots; which are standard survey methods
- targeted threatened species surveys
- endangered ecological community surveys at locations stratified across the entire project area.

The timing of the field surveys is presented in Table 15-1 and a summary of the survey methods and effort is provided in Table 15-2. Survey locations are provided in Figure 5 of Appendix J1.

The surveys were designed with reference to the *BioBanking Assessment Methodology* (BBAM) (OEH 2014e) and the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)* (DEC 2004a), as appropriate.

Table 15-1 Timing of flora field surveys

Survey type	2010		2011				2012			2013												2014		
	November	January	February	April	October	February	March	September	October	March	April	May	June	July	August	September	October	November	December	January	February	March	September
Field reconnaissance																							
Detailed vegetation validation survey																							
Endangered ecological community survey																							
Rapid vegetation validation survey																							
Targeted threatened flora survey																							
Habitat survey[a]																							
Rehabilitation monitoring[b]																							

[a] Pilliga Mouse and Koala habitat validation surveys.

[b] Data collected during rehabilitation monitoring of existing exploration and appraisal activities.

Table 15-2 Flora field surveys – methods and efforts

Survey	Survey method (effort)	Approximate field person hours
Detailed vegetation validation and targeted endangered ecological community survey	Biometric plots (327)	680
Rapid vegetation and habitat validation survey	Rapid vegetation validation plots (over 1,300)	216
Targeted threatened flora survey (2011 and 2012)	Transects (523 km at 10 m wide or 523 ha)	1,300
Targeted threatened flora survey (2014)	Transects (23 at 100 m long and 10 m wide or 2.3 ha and 84 point surveys)	100

Site stratification and field reconnaissance

Vegetation mapping for the Namoi Catchment Management Authority (ELA 2009) was initially used as the basis for survey stratification as it covered the entire project area. Stratification was necessary to ensure that all vegetation types in the project area were systematically sampled. Biometric plots and rapid vegetation validation plot data, which are discussed below, were used to confirm vegetation communities within the project area. This data was used to develop fine-scale vegetation mapping in order to assess the impacts of the project on flora and fauna. The vegetation mapping is discussed further in Section 15.1.4. Field reconnaissance was undertaken in November / December 2010.

Detailed vegetation validation survey

In total, 327 biometric plot surveys were conducted in the project area using the BBAM to confirm vegetation types, assess site conditions and calculate biodiversity offsets, where required. The biometric plot locations are shown on Figure 5 in Appendix J1.

Data recorded within each biometric plot generally included all vascular plant species present, cover abundance of each species, cover of each structural layer (canopy, midstorey, groundcover), weed abundance, presence of hollows, size classification length of fallen logs and a soil classification (colour and texture). The biometric plots were located in areas of homogenous vegetation and away from the boundaries of vegetation communities. They were also located away from major tracks to reduce bias from edge effects and local disturbances.

To verify the presence of threatened ecological communities in the project area, the data collected in the biometric plots were compared against the NSW Scientific Committee Final Determination for the communities under the TSC Act and / or the listing advice for the communities under the EPBC Act.

Rapid vegetation validation survey

Over 1,300 rapid vegetation validation plots were conducted in the project area to complement the full floristic biometric plots. Data recorded at each rapid vegetation validation plot included dominant canopy, midstorey and groundcover species, structure, fire history, soil type and fauna habitat features.

Targeted threatened flora survey

Targeted threatened flora surveys were undertaken for those species considered to potentially occur within the project area based on previous records (as found in database searches) and the presence of suitable habitat. Threatened flora species targeted during the field survey are listed in Table 15-3.

Table 15-3 Threatened flora species targeted during field surveys

Scientific name	Common name	Conservation status[a]	
		TSC Act	EPBC Act
Bertya opponens	Coolabah Bertya	V	V
Cyperus conicus	-	E1	~
Diuris tricolor	Pine Donkey Orchid / Painted Diuris	V	Delisted
Homopholis belsonii	Belson's Panic	E1	V
Lepidium aschersonii	Spiny Peppercress	V	V
Lepidium monoplocoides	Winged Peppercress	E1	E
Monotaxis macrophylla	Large-leafed Monotaxis	E1	~
Myriophyllum implicatum	-	CE	
Philotheca ericifolia	-	Delisted	V
Polygala linariifolia	Native Milkwort	E1	~
Pomaderris queenslandica	Scant Pomaderris	E1	~
Pterostylis cobarensis	Greenhood Orchid	V	Delisted
Commersonia procumbens (syn. *Rulingia procumbens*) (Listed as *Androcalva procumbens* in EPBC Act)	-	V	V
Tylophora linearis	-	V	E

[a] CE = Critically endangered (TSC Act), E = Endangered (EPBC Act), E1 = Endangered (TSC Act) and V = Vulnerable, Delisted = No longer considered threatened under relevant legislation (EPBC or TSC Act).

Approximately 525 hectares distributed throughout the project area and the north-east Pilliga were surveyed via transects, quadrats and the random meander technique. The purpose of the surveys was to provide detailed information on population size, distribution and habitat requirements for threatened flora species. Details on threatened species population estimates and modelling are provided in Section 15.1.5.

Targeted endangered ecological community survey and assessment

Data collected during the biometric plot surveys were compared against the final determination and / or corresponding listing advice for each threatened ecological community considered likely to occur in the project area. This was undertaken to determine if the plant communities present were consistent with legislative descriptions for threatened ecological communities, either under the EPBC or TSC Acts.

As survey was only conducted on publicly accessible land, biometric plots were not completed for the Myall Woodlands in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW south-western slopes bioregions (TSC Act) or Weeping Myall Woodlands (EPBC Act) which occur on private land. Identification of the community was undertaken by visual observation (where possible) and through aerial photographic interpretation.

A more detailed assessment to determine the presence or absence of White Box Yellow Box Blakely's Red Gum Woodland (TSC Act) or White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (EPBC Act) within the project area was undertaken. This ecological community is listed as an endangered ecological community under the TSC Act and as a critically endangered ecological community under the EPBC Act. Sixteen biometric plots were assessed and soil sampling and analysis was undertaken within eight of the 16 biometric plots.

Terrestrial fauna field surveys

The terrestrial fauna surveys consisted of field reconnaissance, detailed fauna surveys and targeted threatened and migratory fauna surveys at locations stratified across the project area. The timing of the field surveys is presented in Table 15-4.

Table 15-4 Timing of fauna field surveys

Survey number	Survey name	2010	2011	2012	2013						2014		
		December	January	October	May	June	July	October	November	December	January	April	May
1	Field reconnaissance												
2	Detailed fauna surveys												
3	Targeted migratory bird survey – *Anthochaera phrygia* (Regent Honeyeater)												
4	Targeted threatened fauna survey – *Pseudomys pilligaensis* (Pilliga Mouse)												
5	Targeted threatened fauna survey – *Dasyurus maculatus* (Spotted-tailed Quoll)												
6	Targeted migratory bird survey – *Polytelis swainsonii* (Superb Parrot), *Lathamus discolor* (Swift Parrot)												
7	Fauna survey (southern portion of project area)												
8	Fauna survey (northern portion of project area)												
9	Targeted threatened fauna survey – *Anomalopus mackayi* (Five-clawed Worm-skink), *Crinia sloanei* (Sloane's Froglet)												
10	Regional survey – *Phascolarctos cinereus* (Koala)												

The fauna surveys were designed with reference to the guidelines administered by the Commonwealth Department of the Environment and Energy and the NSW Office of Environment and Heritage. A list of the relevant survey guidelines is provided in Appendix J1. The fauna surveys were also designed in consultation with fauna experts. For example, the Pilliga Mouse surveys were designed in consultation with Dr Hideyuki Tokushima, a recognised expert on the Pilliga Mouse. Dr Rod Kavanagh participated in the design and execution of Koala surveys (a recognised expert on the Koala in the Pilliga). In addition, the results of the field surveys were reviewed by various experts in their respective fields. For example, mammalian hair samples were identified by Hans Brunner—a renowned zoologist and animal forensic expert, and bat calls were processed by Anna Lloyd who is a bat call analysis expert.

Site stratification and field reconnaissance

The project area was categorised by habitat type initially using pre-existing vegetation mapping (ELA 2009) and later using the vegetation mapping produced specifically for the project (refer to Section 15.1.4). Survey locations were then distributed between habitat types based on this categorisation. Survey locations were refined further in the field by selecting areas with specific habitat features required by target fauna species (for example, flyways and drainage lines for trapping microbats).

Detailed fauna surveys

Detailed fauna surveys included arboreal trapping and sampling, terrestrial trapping and sampling, diurnal searches, microbat surveys, nocturnal surveys, remote recording surveys, habitat surveys and opportunistic surveys. The surveys were designed to sample both a broad range of fauna and to specifically target those threatened and migratory species known or predicted to occur in the project area. A summary of the fauna surveys is provided in Table 15-5. The locations of the survey sites are shown in Figure 6 through Figure 12 in Appendix J1. Further details on the fauna surveys are provided in Appendix J1 including methodology and release of species.

Table 15-5 Fauna field surveys – methods and effort

Survey	Survey method	Fauna groups targeted	Threatened / migratory species targeted	Survey effort (this project)	Survey effort (this project plus previous surveys in the project area)
Arboreal trapping and sampling	Elliott trapping	Arboreal mammals	*Petaurus norfolcensis* (Squirrel Glider), *Cercartetus nanus* (Eastern Pygmy Possum)	1,240 trap nights	1,768 trap nights
	Hair sampling (hair tubes and hair funnels)	Arboreal mammals	*Petaurus norfolcensis* (Squirrel Glider), *Cercartetus nanus* (Eastern Pygmy Possum)	3,080 trap nights	3,460 trap nights
Terrestrial trapping and sampling	Elliott trapping	Small terrestrial mammals	*Pseudomys pilligaensis* (Pilliga Mouse)	6,188 trap nights	11,513 trap nights
	Cage trapping	Medium terrestrial mammals	*Aepyprymnus rufescens* (Rufous Bettong), *Dasyurus maculatus* (Spotted-tailed Quoll)	536 trap nights	772 trap nights
	Pitfall trapping	Mammals and reptiles	*Pseudomys pilligaensis* (Pilliga Mouse), *Cercartetus nanus* (Eastern Pygmy Possum)	470 trap nights	981 trap nights
	Funnel trapping	Reptiles	*Hoplocephalus bitorquatus* (Pale-headed Snake)	1,054 trap nights	1,262 trap nights
	Hair sampling (hair tubes and hair funnels)	Terrestrial mammals	*Dasyurus maculatus* (Spotted-tailed Quoll), *Macropus dorsalis* (Black-striped Wallaby), *Pseudomys pilligaensis* (Pilliga Mouse)	11,628 trap nights	12,766 trap nights
	Sand plots	Mammals and reptiles	-	4 trap nights	4 trap nights
Diurnal searches	Bird census	Birds	*Anthochaera phrygia* (Regent Honeyeater), *Lathamus discolor* (Swift Parrot), *Polytelis swainsonii* (Superb Parrot), *Calyptorhynchus lathami* (Glossy Black-cockatoo), *Glossopsitta pusilla* (Little Lorikeet), *Neophema pulchella* (Turquoise Parrot), *Circus assimilis* (Spotted Harrier), *Falco subniger* (Black Falcon), *Hieraaetus morphnoides* (Little Eagle), *Lophoictinia isura* (Square-tailed Kite), *Chthonicola sagittata* (Speckled Warbler), *Daphoenositta chrysoptera* (Varied Sittella), *Melanodryas cucullata cucullata* (Hooded Robin (south-eastern form)), *Pomatostomus temporalis temporalis* (Grey-crowned Babbler (eastern subspecies)), *Stagonopleura guttata* (Diamond Firetail), *Grantiella picta* (Painted Honeyeater), *Apus pacificus* (Fork-tailed Swift), *Ardea modesta* (Great Egret), *Hirundapus caudacutus* (White-throated Needletail), *Merops ornatus* (Rainbow Bee-eater), *Myiagra cyanoleuca* (Satin Flycatcher), *Artamus cyanopterus cyanopterus* (Dusky Woodswallow)	154 person hours	182.7 person hours
	Reptile search	Reptiles	*Anomalopus mackayi* (Five-clawed Worm-skink)	57.1 person hours	66 person hours

Survey	Survey method	Fauna groups targeted	Threatened / migratory species targeted	Survey effort (this project)	Survey effort (this project plus previous surveys in the project area)
Microbat surveys	Echolocation recording – Song Meter and Anabat	Microbats	*Chalinolobus dwyeri* (Large-eared Pied Bat), *Chalinolobus picatus* (Little Pied Bat), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat), *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat), *Vespadelus troughtoni* (Eastern Cave Bat)	184 trap nights	338 trap nights
	Harp trapping	Microbats	*Nyctophilus corbeni* (South-eastern Long-eared Bat), *Chalinolobus picatus* (Little Pied Bat)	148 trap nights	249 trap nights
Nocturnal surveys	Call playback	Birds and mammals	*Ninox connivens* (Barking Owl), *Tyto novaehollandiae* (Masked Owl), *Burhinus grallarius* (Bush-stone Curlew), *Phascolarctos cinereus* (Koala), *Petaurus norfolcensis* (Squirrel Glider)	127 person hours	613 person hours
	Spotlighting	Mammals, birds, reptiles	*Hoplocephalus bitorquatus* (Pale-headed Snake), *Ninox connivens* (Barking Owl), *Tyto novaehollandiae* (Masked Owl), *Burhinus grallarius* (Bush-stone Curlew), *Phascolarctos cinereus* (Koala), *Petaurus norfolcensis* (Squirrel Glider)	34.1 person hours	66.8 person hours
	Stream search	Mammals, birds, reptiles	*Hoplocephalus bitorquatus* (Pale-headed Snake), *Ninox connivens* (Barking Owl), *Tyto novaehollandiae* (Masked Owl), *Burhinus grallarius* (Bush-stone Curlew), *Phascolarctos cinereus* (Koala), *Petaurus norfolcensis* (Squirrel Glider),	16 person hours	16 person hours
	Amphibian search	Amphibians	*Crinia Sloanei* (Sloane's Froglet)	17.5 person hours	17.5 person hours
Remote recording surveys	Remote camera	Terrestrial mammals	*Dasyurus maculatus* (Spotted-tailed Quoll), *Macropus dorsalis* (Black-striped Wallaby)	1,330 trap nights	1,505 trap nights
	Diurnal call recording - Song Meter	Birds	*Anthochaera phrygia* (Regent Honeyeater)	81 trap nights	89 trap nights
Opportunistic surveys	Scat collection	Carnivorous predator species, prey species	-	Duration of field surveys	Duration of field surveys
	Opportunistic observations	All fauna	-	Duration of field surveys	Duration of field surveys

Targeted threatened fauna and migratory bird surveys

Targeted surveys were undertaken for the following threatened species:

- *Pseudomys pilligaensis* (Pilliga Mouse)
- *Phascolarctos cinereus* (Koala)
- *Dasyurus maculatus* (Spotted-tailed Quoll)
- *Anomalopus mackayi* (Five-clawed Worm-skink)
- *Crinia sloanei* (Sloane's Froglet).

In addition, targeted migratory bird surveys were undertaken for the following species:

- *Anthochaera phrygia* (Regent Honeyeater)
- *Lathamus discolor* (Swift Parrot)
- *Polytelis swainsonii* (Superb Parrot).

The purpose of these surveys was to determine the likelihood of occurrence of these species within the project area, and to collect data about their potential distribution, abundance and habitat preferences within the project area. The surveys were required due to a lack of information regarding the species in the project area and vicinity. The targeted surveys were undertaken in addition to the detailed fauna surveys outlined above which surveyed a broad range of threatened and migratory fauna.

Survey methods used included trapping, hair sampling, remote camera surveys, call playback, spotlighting, census, call recordings and habitat assessments. A summary of the targeted threatened fauna and migratory bird surveys is provided in Table 15-6. Further details are provided in Appendix J1.

Table 15-6 Targeted threatened fauna and migratory bird surveys

Species	Survey method and effort
Pseudomys pilligaensis (Pilliga Mouse)	Undertaken in May / June and October / November 2013. Survey method included habitat assessment modelling and field surveys. A habitat model was developed that identified primary and secondary habitat within the project area. Further details regarding the habitat model are provided in Appendix F5 of Appendix J1. Survey locations were selected based on the habitat assessment modelling; they are shown on Figure 1 in Appendix F6 of Appendix J1. Survey methods included Elliott trapping (3,024 trap nights), pitfall trapping (252 trap nights), hair tubes (3,320 trap nights), fluorescent powder tracking and DNA sampling. Further details regarding the field survey are provided in Appendix F6 of Appendix J1.
Phascolarctos cinereus (Koala)	Undertaken between 2011 and 2014 across the project area. Survey locations selected based on feed and shelter tree species. Survey locations are shown on Figure 12 in Appendix J1. Survey method included call playback (27 person hours) and spotlighting (34.1 person hours). A habitat assessment was also undertaken which involved a vegetation assessment and faecal search in addition to a spot assessment technique survey (38 survey plots). Koala habitat was considered under *State Environmental Planning Policy (SEPP) 44*, the *Recovery Plan for the Koala (Phascolarctos cinereus)* (DECC 2008c) and via the Koala habitat assessment tool contained in the EPBC Act Referral Guidelines for the Vulnerable Koala (DotE 2014). Detailed habitat mapping was produced as a result of the survey.

Species	Survey method and effort
Dasyurus maculatus (Spotted-tailed Quoll)	Undertaken during breeding season (May/June 2013) when activity is considered to be high. Survey locations are shown on Figure 7 in Appendix J1. Survey methods included hair tubes (4,440 trap nights) and remote camera trapping (365 trap nights).
Anomalopus mackayi (Five-clawed Worm-skink) and *Crinia sloanei* (Sloane's Froglet).	Undertaken in April 2014 following significant rainfall event. Survey locations are shown on Figure 9 and Figure 10 in Appendix J1. Survey methods included nocturnal amphibian searches (17.5 person hours) for the Sloane's Froglet and diurnal reptile searches (57.1 person hours) for the Five-clawed Worm-skink.
Anthochaera phrygia (Regent Honeyeater), *Lathamus discolor* (Swift Parrot) and *Polytelis swainsonii* (Superb Parrot)	Undertaken in October 2012 (Regent Honeyeater) and July 2013 (Swift Parrot and Superb Parrot). Survey locations were based on targeting flowering eucalypts that could provide foraging resources. Survey locations are shown on Figure 9 in Appendix J1. Survey methods included bird census (154 person hours), diurnal call recordings (81 trap nights) and opportunistic recordings (car transects).
Phascolarctos cinereus (Koala)	Undertaken from 28 April to 8 May 2014 across the region. Survey locations were based on riparian forest locations that were expected to be among those areas most resilient to drought and high temperatures, based on recent survey results and ecological understanding of Koala habitat requirements, and thus most likely to be where relict (surviving remnant) Koala populations may occur. The selection of survey sites was based on an analysis of priority areas for Koalas in the Pilliga. Diurnal and nocturnal surveys including active searches, spotlighting, faecal pellet and scat searches were undertaken over 11 evenings. Over 1,654 hectares were searched on foot covering approximately 112 kilometres of Red Gum dominated drainage lines and water sources. Further detail on the survey methodology is provided in Appendix F7 of Appendix J1.

15.1.4 Vegetation mapping

The terrestrial vegetation validation surveys included 327 biometric plots and over 1,300 rapid vegetation validation plots to develop fine-scale vegetation mapping for the project area.

Vegetation was mapped in accordance with the plant community types defined in the *NSW Vegetation Classification and Assessment* (Benson *et al.* 2010) at a scale of 1:10,000. The vegetation mapping also included the mapping of endangered ecological communities and land use. Each plant community type was attributed to a biometric vegetation type for use in the assessment and quantification of suitable offsets for the project.

Further details on the vegetation mapping are presented in Appendix F2 of Appendix J1.

15.1.5 Population estimates and modelling

The data obtained from the targeted threatened flora survey was used to either estimate or model threatened species population sizes in the project area. Population estimates were calculated for those species with a patchy or localised distribution that were not consistently associated with the occurrence of a particular plant community type. Population estimates were calculated for *Bertya opponens* (Coolabah Bertya) and *Pomaderris queenslandica* (Scant Pomaderris), that involved:

- field counts and / or estimates of the number of individuals within mapped population / sub-populations derived from subsamples
- supplementary extrapolation to account for sub-populations assumed to be present but not yet observed. Supplementary extrapolation was based on the total number of observed individuals averaged out across all plant communities where they were known to occur.

Population modelling was used for those species with a less restrictive distribution and which occur with greater consistency in specific vegetation types. Modelled population estimates were calculated for *Diuris tricolor* (Pine Donkey Orchid / Painted Diuris), *Polygala linariifolia* (Native Milkwort), *Pterostylis cobarensis* (Greenhood Orchid) *Rulingia procumbens* and *Tylophora linearis* and included plant density and abundance estimates made by combining the field survey results and incorporating the data into a population model.

Population estimates / modelling for *Lepidium aschersonii*, *Lepidium monoplocoides*, and *Myriophyllum implicatum* was not undertaken due to insufficient records and poor seasonal conditions during the field surveys.

Further details on population estimates and modelling are provided in Appendix F4 of Appendix J1.

15.1.6 Ecological sensitivity analysis

An ecological sensitivity analysis was undertaken to identify the degree of ecological sensitivity and hence potential constraints to development in the project area. The ecological sensitivity analysis used existing spatial data, data collected from field surveys and project-specific spatial data to identify areas of sensitivity. Ecological criteria were identified and assigned rankings and weightings. The sensitivity analysis then combined scores for the data, applied weightings and modelled sensitivity indices. Five sensitivity classes were modelled:

- Low – These areas include a high degree of disturbance which impact on long-term viability. Project impacts should be directed to these areas, wherever possible.
- Low-moderate – These areas exhibit effects of disturbance or habitat values which are of lower sensitivity in the regional context. Project impacts on these areas should be minimised at the site scale.
- Moderate – These areas exhibit some effects of disturbance, or habitat values which are of moderate sensitivity in the regional context. Project impacts on these areas should be minimised at the site scale.
- Moderate-high – These areas include a range of biodiversity values, including those listed under State or Commonwealth legislation. There is a need to maximise avoidance of project impacts on these areas.
- High – These areas contain a combination of significant biodiversity values, including those listed under State or Commonwealth legislation. There is a need to maximise avoidance of project impacts on these areas.

The purpose of the ecological sensitivity analysis is to guide the selection of locations for project infrastructure (for example, well sets, access tracks and gas and water gathering systems) to maximise avoidance of areas of higher ecological sensitivity. The full methodology for the ecological sensitivity analysis is described in Appendix F8 of Appendix J1.

15.1.7 Impact calculations

Direct and indirect impacts on terrestrial flora and fauna were quantified to determine the potential impacts of the project and the requirements for biodiversity offsets. Direct impacts, being (those impacts that would directly affect habitat and individuals) considered for this assessment (plus the methodology used for calculating the impact) include:

- Vegetation removal – For the major facilities, the amount of each plant community type directly impacted was calculated in a geographic information system (GIS). For the gas field (well pads,

roads, access tracks and gathering lines), the potential impact on each plant community type was modelled and an upper disturbance limit determined. The model utilised the vegetation map for the project area and a probabilistic approach to predict the number of hectares of each plant community type to be removed. The impact assessment was then based on the upper disturbance limit value inclusive of the major facilities and gas field infrastructure vegetation removal.

- Fauna habitat removal – The area of each fauna habitat type was calculated both within the project area and the study region. This allowed for a calculation of percentage impact on the habitat used by each threatened fauna species, both in comparison to habitat available in the project area and in the study region.
- Removal of threatened flora individuals – Flora population estimates and population modelling were utilised in combination with the upper disturbance limits for each plant community type to determine the total number of threatened flora individuals that would be impacted.

Indirect impacts (those impacts that would not directly affect habitat and individuals but have the potential to interfere through indirect action) considered for this assessment include site impacts (fragmentation, noise, traffic, fencing, light, weed invasion, increased feral fauna and fire), downstream or downwind impacts (sedimentation, erosion, dust, hydrological change and accidental leaks and spills) and facilitated impacts (hunting).

Indirect impacts were quantified to provide values for the area of vegetation and habitat that would have the potential to be indirectly impacted by the project. In order to quantify the indirect impacts of the project, the level of indirect impact was correlated with an equivalent area of direct impact. As such, a proportionate amount of vegetation removal could be calculated to correspond with the direct impact calculations discussed above.

To undertake this calculation, all site, downstream and facilitated impacts were compared and quantified, where possible, first without mitigation measures, and then with the proposed mitigation measures. A buffer surrounding the infrastructure was calculated that would contain all indirect impacts pre-mitigation. Within the indirect impact buffer, the level of impact would not be linear as it would be generally greater closer to the impact source and, as such, the vegetation within the buffer would not be 100 per cent affected. To account for these factors, a formula was applied to the buffered area to account for the reduction in habitat quality within the indirect impact buffer. This formula was applied to two scenarios: without and with mitigation measures in place. Details of the calculations are presented in Table 15-7 and Table 15-8.

The indirect impact values were then applied to each plant community type, based on the ratio of direct impacts on each plant community type. This allowed for a value of indirect impact on each plant community type which could then be applied to fauna habitat types and threatened flora individuals.

Table 15-7 Indirect impact buffer rationale

Infrastructure	Indirect impact buffer (metres)	Proportion of indirect impact buffer affected without mitigation (25%) (metres)	Proportion of indirect impact buffer affected with mitigation (10%) (metres)
Leewood	As the majority of the indirect impacts would be contained within the Leewood boundary, the indirect impacts were only calculated where the modelled 45 dB(A) noise boundary crosses the Leewood boundary.		
Bibblewindi	50	12.5	5
Bibblewindi to Leewood infrastructure corridor	10	2.5	1

Infrastructure	Indirect impact buffer (metres)	Proportion of indirect impact buffer affected without mitigation (25%) (metres)	Proportion of indirect impact buffer affected with mitigation (10%) (metres)
Leewood to Wilga Park underground power line	The power line would be installed within the existing gas pipeline corridor. As no disturbance would occur outside of the corridor, no indirect impacts were calculated.		
Westport workers' accommodation	50	12.5	5
Well pads	50	12.5	5
Water and gas gathering lines / access tracks	10	2.5	1
Seismic lines	Seismic lines would be largely undertaken in previously cleared areas (e.g. roadsides) or in pasture / grassland. Seismic survey generally only requires slashing of shrub and midstorey layers and removal of canopy species, which would be minimised or avoided as far as possible. Due to the nature of the works (maximum width 3 m, slashing, short duration), no indirect impacts were calculated.		

Table 15-8 Indirect impact calculations

Infrastructure	Direct impact	Indirect impact	Direct and indirect impact
Leewood	N/A	0.36 ha	0.36 ha
Bibblewindi	283 m x 565 m (approx.) = 16 ha	0.85 ha	293 m x 575 m = 16.85 ha
Bibblewindi to Leewood infrastructure corridor	20 m width x 15.8 km length = 31.6 ha (construction footprint). The actual vegetation disturbance would be 26.7 ha due to previously cleared areas in the corridor	3.16 ha	22 m width x 15.8 km length = 34.76 ha
Westport workers' accommodation	100 m x 300 m = 3 ha	0.41 ha	110 m x 310 m = 3.41 ha
Well pads and balance tanks	1 ha x 430 = 430 ha	90.3 ha	110 m x 110 m x 430 = 520.3 ha
Water and gas gathering lines / access tracks	10 m x 430 km = 430 ha	86 ha	(10 m + (1 m x 2)) x 430 km = 516 ha
Total indirect impact		**181.1**	

To conceptualise fragmentation in the project area, an intactness analysis was performed. Intactness of a landscape is its 'naturalness' and is influenced by the proportion of native vegetation remaining and its patchiness (number of patches). An intactness input layer was developed by first dissecting all extant native vegetation patches with existing linear infrastructure (roads, corridors and other cleared areas). Then, the equation below was applied to a 10 metre gridcell layer at every point in the landscape. In each gridcell, all surrounding vegetation within a five kilometre buffer was considered. Intactness was modelled for two scenarios: before development and with all development complete.

$$Intactness = [[(Native\ vegetation)_{Area}\ ] / [(Total)_{Area}]]^{[1 + (0.01 * (no.\ patches)]}$$

Where:
$(Native\ vegetation)_{Area}$ = combined area of all native vegetation within the 5 km buffer
$(Total)_{Area}$ = area of a circle of 5 km radius
No. patches = number of patches in the 5 km radius (including those divided by existing linear infrastructure)

Further details about the impact calculations are provided in Appendix J1.

15.1.8 Assessment of significance of impacts

Section 5A of the EP&A Act lists seven factors that must be taken into account in determining the significance of potential impacts of an activity on 'threatened species, populations or ecological communities (or their habitats)' listed under the TSC Act. The '7-part test' is used to determine whether an activity is 'likely' to impose 'a significant effect' on threatened biota. For this EIS, 7 part tests were prepared for four endangered ecological communities, 10 flora species and 48 fauna species known, or considered likely to occur, in the project area.

Under the EPBC Act, an action will require approval from the Minister if the action has, will have, or is likely to have, a significant impact on matters of national environmental significance. Assessments of significance were prepared for two endangered ecological communities, five flora species, 11 fauna species and nine migratory species listed under the EPBC Act in accordance with the *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DotE 2013a).

15.2 Existing environment

This section describes the natural environment and the existing terrestrial flora, fauna and fauna habitat within the project area. This section presents:

- threatened and migratory species, populations and endangered ecological communities known or predicted to occur within the project area, along with their conservation status
- the results of the targeted threatened species and migratory bird surveys
- the results of the regional Koala survey
- the results of the ecological sensitivity analysis.

15.2.1 The natural environment

The project area is located within the Brigalow Belt South Bioregion which extends over NSW and Queensland. In NSW, the bioregion covers an area of approximately 52,409 square kilometres, which represents 18.7 per cent of the total bioregion (NPWS 2000). The majority of land within the Brigalow Belt South Bioregion in NSW is freehold land used for agricultural purposes (approximately 85 per cent) (NPWS 2000 and 2000a). Approximately 5 per cent of land within the bioregion is used for forestry. Crown lands and conservation reserves form approximately four per cent of the bioregion. Other land uses within the bioregion include mining (primarily coal) and bee-keeping (NPWS 2000).

Approximately 66 per cent of the project would be located within the Pilliga, which is an agglomeration of forested area covering more than 500,000 hectares in north-western NSW around Coonabarabran, Baradine and Narrabri. In recognition of the high ecological and landscape value of the Pilliga, about half (240,000 hectares) is allocated to conservation and is managed under the *National Parks and*

Wildlife Act 1974 (NSW). The other half is retained as State forest for commercial timber production, recreation and mineral extraction.

While the semi-arid climate and unsuitability of the soils for agriculture have combined to protect the Pilliga from widespread clearing for agriculture, the area has hosted commercial timber harvesting for more than a century. A combination of forestry and related activities, pests, drought and wildfire have impacted the ecology of the Pilliga, including habitat fragmentation by the development of more than 5,000 kilometres of existing roads, tracks and trails.

In the Pilliga, the project would be developed primarily within State forest and on privately managed agricultural land supporting pastoral (livestock) activities. The project would avoid conservation areas such as the Pilliga National Park, the Pilliga East State Conservation Area, the Pilliga Nature Reserve, the Brigalow Park Nature Reserve and the Brigalow State Conservation Area.

The project area is classified into the following categories: cleared, creek bed, dam, derived native grassland, native vegetation, cropping, improved pasture and previous evidence of pasture improvement. Native vegetation covers approximately 75 per cent of the project area whilst derived native grassland covers approximately 10 per cent of the project area. Agricultural areas of cropping, improved pasture or with evidence of previous pasture improvement together comprise approximately 14 per cent of the project area.

15.2.2 Terrestrial flora

Flora species

The field surveys identified 807 terrestrial flora species within the project area, of which 691 species were native and 116 species were introduced. A floristic species list was compiled for the project area and is presented in Appendix C of Appendix J1. A total of 10 flora species listed under the TSC Act and / or EPBC Act were recorded within the project area during the field surveys. These species are listed in Table 15-11.

Noxious weeds

Eight of the 116 introduced flora species recorded in the project area are listed as noxious weeds under the *NSW Noxious Weeds Act 1993* for the Narrabri Shire Council control area (DPI 2014a). Noxious weeds in the project area are listed in Table 15-9 along with the legal requirements for their management.

Table 15-9 Noxious weeds within the project area (terrestrial)

Scientific name	Common name	Class	Legal requirements for management
Argemone ochroleuca	Mexican Poppy	5	The requirements for a notifiable weed must be complied with.
Cestrum parqui	Green Cestrum	3	The plant must be fully and continuously suppressed and destroyed.
Heliotropium amplexicaule	Blue Heliotrope	4	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread.
Lycium ferocissimum	African Boxthorn	4	The growth of the plant must be managed in a manner that continuously inhibits the ability of

Scientific name	Common name	Class	Legal requirements for management
			the plant to spread and the plant must not be sold, propagated or knowingly distributed.
Opuntia aurantiaca	Prickly Pear	4	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed.
Opuntia stricta	Prickly Pear	4	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed.
Opuntia tomentosa	Prickly Pear	4	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed.
Phyla canescens	Lippia	4	The plant must not be sold, propagated or knowingly distributed except incidentally in hay or lucerne.

Plant communities

Plant communities within the project area were attributed in accordance with the *NSW Vegetation Classification and Assessment* (Benson *et al.* 2010). Twenty-two plant communities occur within the project area, covering a total area of approximately 80,398 hectares. These communities are listed in Table 15-10 and are shown on Figure 15-1. The corresponding biometric vegetation types (2008 and 2014) are also included in Table 15-10 and the biometric vegetation types (2008) are shown on Figure 15-2. Four of the recorded plant communities contain listed endangered ecological communities under the TSC Act and / or EPBC Act as detailed in Table 15-12.

Table 15-10 Plant communities within the project area (terrestrial)

Plant community name (identification number)[a, b]	Biometric vegetation type identification number (Oct. 2008)	Biometric vegetation type identification number (Oct. 2014)	Estimated total area in project area (hectares)	Proportion of project area (%)
Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions (27)	NA219	NA219	209.26	0.22
Brigalow – Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion (35)	NA117	NA117	6,695.19	7.04
Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions (55)	NA102	NA102	678.94	0.71
River Red Gum riparian tall woodland / open forest wetland in the Nandewar and Brigalow Belt South Bioregions (78)	NA193	NA193	10.49	0.01
Pilliga Box – White Cypress Pine – Buloke shrubby woodland in the Brigalow Belt South Bioregion (88)	NA179	NA179	5,946.61	6.25

Plant community name (identification number)[a, b]	Biometric vegetation type identification number (Oct. 2008)	Biometric vegetation type identification number (Oct. 2014)	Estimated total area in project area (hectares)	Proportion of project area (%)
Broombush – wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion (141)	NA121	NA121	1,034.76	1.09
Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South (including Pilliga) and Nandewar Bioregions (202)	NA141	NA141	589.82	0.62
Green Mallee tall Mallee woodland on rises in the Pilliga – Goonoo regions, southern BBS Bioregion (256)	NA143	NA292	20.33	0.02
Inland Scribbly Gum – White Bloodwood – Red Stringybark – Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP – Pilliga region in the BBS Bioregion (379)	NA124	NA294	103.56	0.11
Poplar Box – White Cypress Pine shrub grass tall woodland of the Pilliga – Warialda region, BBS Bioregion (397)	NA179	NA324	762.80	0.80
Narrow-leaved Ironbark – White Cypress Pine – Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north BBS Bioregion (398)	NA227	NA314	23,975.35	25.22
Red gum – Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga – Goonoo sandstone forests, BBS Bioregion (399)	NA197	NA255	1,093.46	1.15
Rough-barked Apple – red gum – cypress pine woodland on sandy flats, mainly in the Pilliga Scrub region (401)	NA197	NA338	7,580.41	7.97
Mugga Ironbark – White Cypress Pine – gum tall woodland on flats in the Pilliga forests and surrounding regions, BBS Bioregion (402)	NA160	NA307	358.20	0.38
Red Ironbark – White Bloodwood -/+ Burrows Wattle heathy woodland on sandy soil in the Pilliga forests (404)	NA124	NA326	9,982.48	10.50
White Bloodwood – Red Ironbark – cypress pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions (405)	NA124	NA390	6,650.54	6.99
White Bloodwood – Motherumbah – Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests (406)	NA124	NA389	3,232.39	3.40
Dirty Gum (Baradine Gum) – Black Cypress Pine – White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region (408)	NA124	NA279	3,188.25	3.35
White Cypress Pine – Silver-leaved Ironbark – Wilga shrub grass woodland of the Narrabri-Yetman region, BBS Bioregion (418)	NA179	NA409	131.59	0.14

Plant community name (identification number)[a, b]	Biometric vegetation type identification number (Oct. 2008)	Biometric vegetation type identification number (Oct. 2014)	Estimated total area in project area (hectares)	Proportion of project area (%)
Spur-wing Wattle heath on sandstone substrates in the Goonoo-Pilliga forests Brigalow Belt South Bioregion (425)	NA121	NA363	366.69	0.39
Carbeen – White Cypress Pine – Curracabah – White Box tall woodland on sand in the Narrabri-Warialda region of the Brigalow Belt South Bioregion (428)	NA126	NA267	15.03	0.02
White Bloodwood – Dirty Gum (Baradine Gum) – Rough Barked Apple – Black Cypress Pine heathy open woodland on deep sand in the Pilliga forests (40X)[c]	NA124	NA390	7,772.16	8.17
Cleared, creek bed, dams and improved pasture (Other)	-	-	14,678.37	15.44
TOTAL			**95,076.68**	**100.00**

[a] Plant community as per *NSW Vegetation Classification and Assessment* (Benson *et al* 2010).

[b] Communities listed under the TSC Act and/or EPBC Act are highlighted in grey.

[c] Plant community type ID40X does not correspond with the plant community types of the NSW Vegetation Classification Assessment. This community is most closely related to plant community type ID405.

Threatened flora

Twenty-seven species of threatened flora listed under the TSC Act and / or EPBC Act have been previously recorded or are predicted to occur in the study region. These species are described in Appendix I of Appendix J1. Of these, 10 species were recorded in the project area during field surveys and may be impacted by the project. These species (including their estimated or modelled population size in the project area) are listed in Table 15-11. Their distribution in the project area is shown on Figure 18 in Appendix J1. The remaining 17 species are considered unlikely to occur in the project area due to a lack of suitable habitat and, therefore, would not be impacted by the project (refer to Appendix I of Appendix J1).

Further details regarding the population size and distribution of these species is provided in Appendix J1.

Table 15-11 Threatened flora recorded in the project area (terrestrial)

Scientific name	Common name	Conservation status[a]		Population size in project area
		TSC Act	EPBC Act	(estimated or modelled)
Bertya opponens	Coolabah Bertya	V	V	956,861 (estimated)
Diuris tricolor	Pine Donkey Orchid/Painted Diuris	V	-	3,353 (modelled)
Lepidium aschersonii	Spiny Peppercress	V	V	208[b]
Lepidium monoplocoides	Winged Peppercress	E1	E	258[b]

Scientific name	Common name	Conservation status[a]		Population size in project area
		TSC Act	EPBC Act	(estimated or modelled)
Myriophyllum implicatum	-	CE	-	1[b]
Polygala linariifolia	Native Milkwort	E1	-	16,317 (modelled)
Pomaderris queenslandica	Scant Pomaderris	E1	-	45,518 (estimated)
Pterostylis cobarensis	Greenhood Orchid	V	-	431,718 (modelled)
Rulingia procumbens	-	V	V	240,274 (modelled)
Tylophora linearis	-	V	E	33,154 (modelled)

[a] CE = Critically Endangered, E = Endangered (EPBC Act), E1 = Endangered (TSC Act) and V = Vulnerable.
[b] Estimates / modelling not undertaken due to insufficient records and poor seasonal conditions during field surveys.

Endangered ecological communities

Eleven endangered ecological communities listed under the TSC Act and / or EPBC Act have been previously recorded or are predicted to occur in the study region. These communities are described in Appendix I of Appendix J1. Four of the listed communities were recorded within the project area during field surveys and have the potential to be impacted as a result of the project. These communities, including their total area within the project area, are listed in Table 15-12. Their distribution in the project area is shown on Figure 15-3. The remaining seven communities are considered unlikely to occur in the project area due to a lack of suitable habitat and, therefore, would not be impacted by the project (refer to Appendix I of Appendix J1).

White Box Yellow Box Blakely's Red Gum Woodland (TSC Act) or White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland (EPBC Act) was not found to be present in the areas sampled because the assemblage of species and soil type was not consistent with the NSW Scientific Committee Final Determination for the community under the TSC Act, nor was it consistent with the listing advice for the community under the EPBC Act.

There are slight differences between the totals for endangered ecological communities where the community is listed under both State and Commonwealth legislation due to specific listing requirements such as condition and age class. Note that the total areas stated for State and Commonwealth listed communities are not cumulative, and in all cases the higher total listed under the TSC Act is the maximum extent of the community in the project area.

Table 15-12 Endangered ecological communities recorded in the project area (terrestrial)

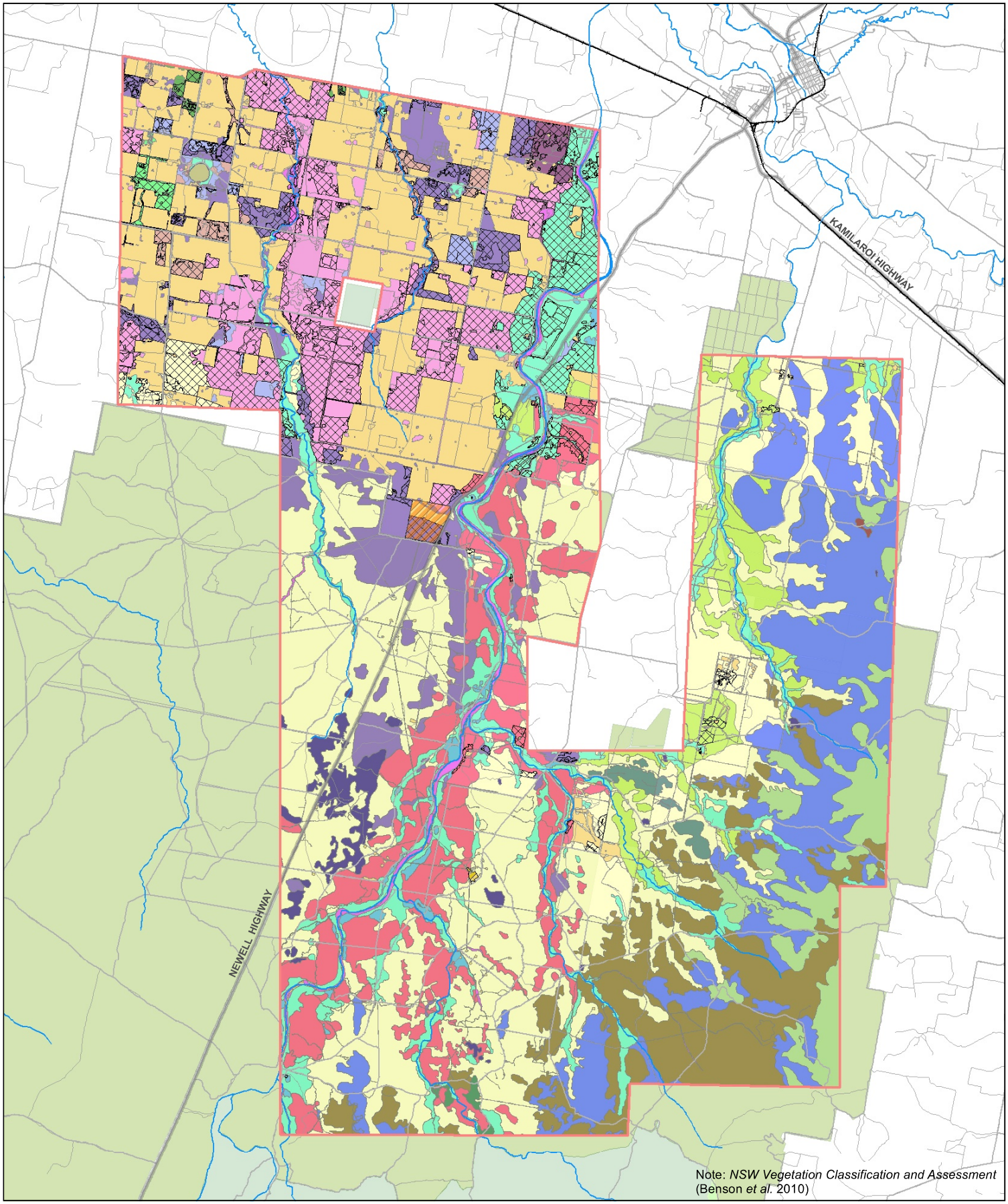
Name (plant community identification number)[a]	Conservation status[b]		Estimated total area in project area (hectares)[c]	
	TSC Act	EPBC Act	TSC Act	EPBC Act
Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (TSC Act) or Brigalow (*Acacia harpophylla* dominant and co-dominant) (EPBC Act) (35)	E	E	2,467.97	2,447.35
Carbeen Open Forest Community in the Darling Riverine Plains and Brigalow Belt South Bioregions (428)	E	-	15.03	-
Myall Woodlands in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression,	E	E	36.00	32.52

Name (plant community identification number)[a]	Conservation status[b]		Estimated total area in project area (hectares)[c]	
	TSC Act	EPBC Act	TSC Act	EPBC Act
Riverina and NSW south western slopes bioregions (TSC Act) or Weeping Myall Woodlands (EPBC Act) (27)				
Fuzzy Box Woodland on alluvial soils of the south western slopes, Darling Riverine Plains and Brigalow Belt South bioregions (202)	E	-	588.40	-
Total			**3,107.40**	**2,479.87**

[a] Plant community as per *NSW Vegetation Classification and Assessment* (Benson *et al* 2010).

[b] E = Endangered ecological community (TSC and EPBC Act).

[c] These areas are not mutually exclusive and are calculated based on the definition of the community within the TSC Act and EPBC Act.



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line

Plant community types (ELA 2014)

27	141	398	405	425	Derived native grassland	
35	202	399	406	428		
55	256	401	408	Other		
78	379	402	40X			
88	397	404	418			

0 1.75 3.5 7
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Plant communities within the project area

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Figure 15-1

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by:jrichardson

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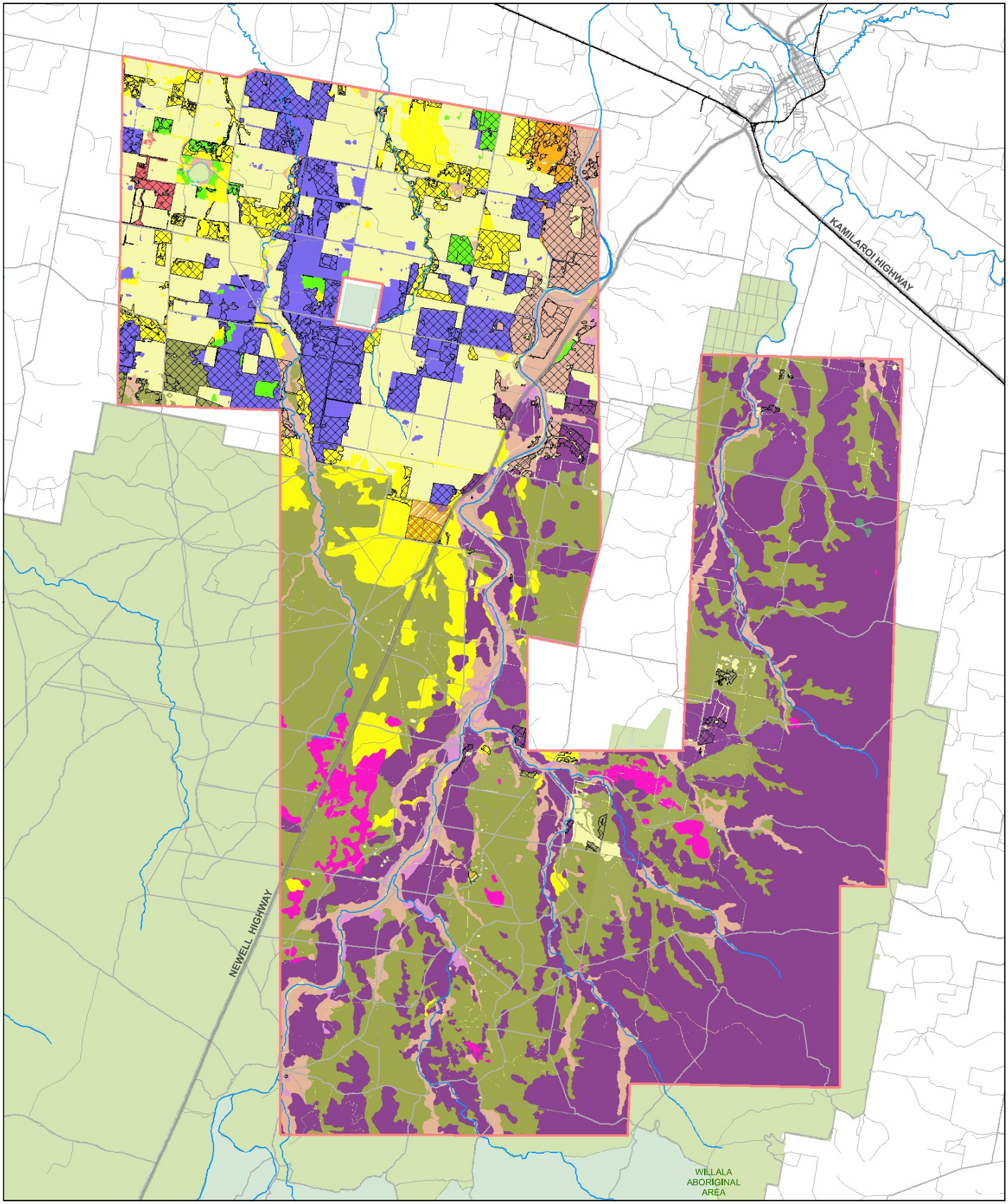

LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line

Biometric vegetation types (2008)

- NA102
- NA117
- NA121
- NA124
- NA126
- NA141
- NA143
- NA160
- NA179
- NA193
- NA197
- NA219
- NA227
- Other
- Derived native grassland

0 1.75 3.5 7
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Biometric vegetation types (2008) in the project area

Figure 15-2

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by:jrichardson

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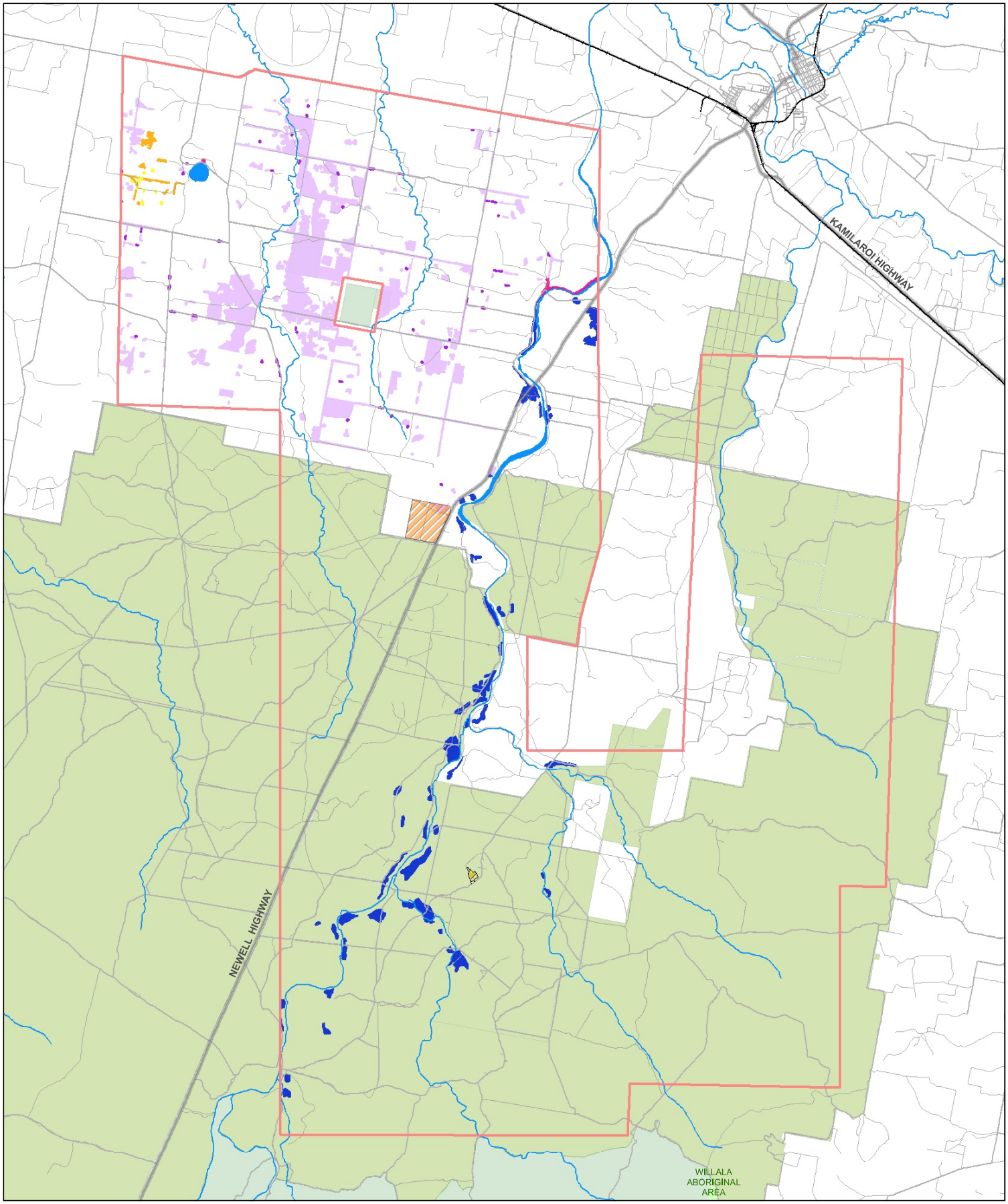

LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line

Endangered Ecological Communities

- Weeping Myall Woodlands (EPBC and TSC Act)
- Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions (TSC Act)
- Brigalow (*Acacia* harpophylla dominant and co-dominant) (EPBC and TSC Act)
- Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (TSC Act)
- Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions (TSC Act)
- Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions (TSC Act)

0 1.75 3.5 7
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Narrabri Gas Project
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Endangered ecological communities within the project area

Figure 15-3

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by:jrichardson

15.2.3 Terrestrial fauna

Fauna species

The field surveys identified 289 terrestrial fauna species in the project area (17 amphibians, 41 reptiles, 186 birds and 45 mammals). An additional three microbats were recorded to a 'possible' confidence level and one amphibian, eight reptiles, eight birds and nine mammals were recorded to genus level. A fauna species list was compiled for the project area and is presented in Appendix C of Appendix J1.

Of those species recorded to species level, 16 birds, 10 mammals and one reptile are listed as threatened under the TSC Act, three mammals and one bird are listed as threatened under the EPBC Act and five birds are listed as migratory under the EPBC Act.

Feral species

Five birds and 12 mammals recorded in the project area are listed as feral species. Predatory species recorded in the project area include *Canis lupus familiaris* (Dog), *Felis catus* (Cat) and *Vulpes vulpes* (Red Fox). These species prey on a range of native fauna species, including small and medium sized mammals, birds and reptiles.

Herbivorous species recorded in the project area were *Bos taurus* (Cow), *Capra hircus* (Goat), *Equus* sp. (Horse), *Lepus capensis* (Hare), *Sus scrofa* (Pig), *Oryctolagus cuniculus* (Rabbit) and *Ovis aries* (Sheep). These species browse on native flora, changing the composition of the groundcover and shrub layer and removing threatened flora species.

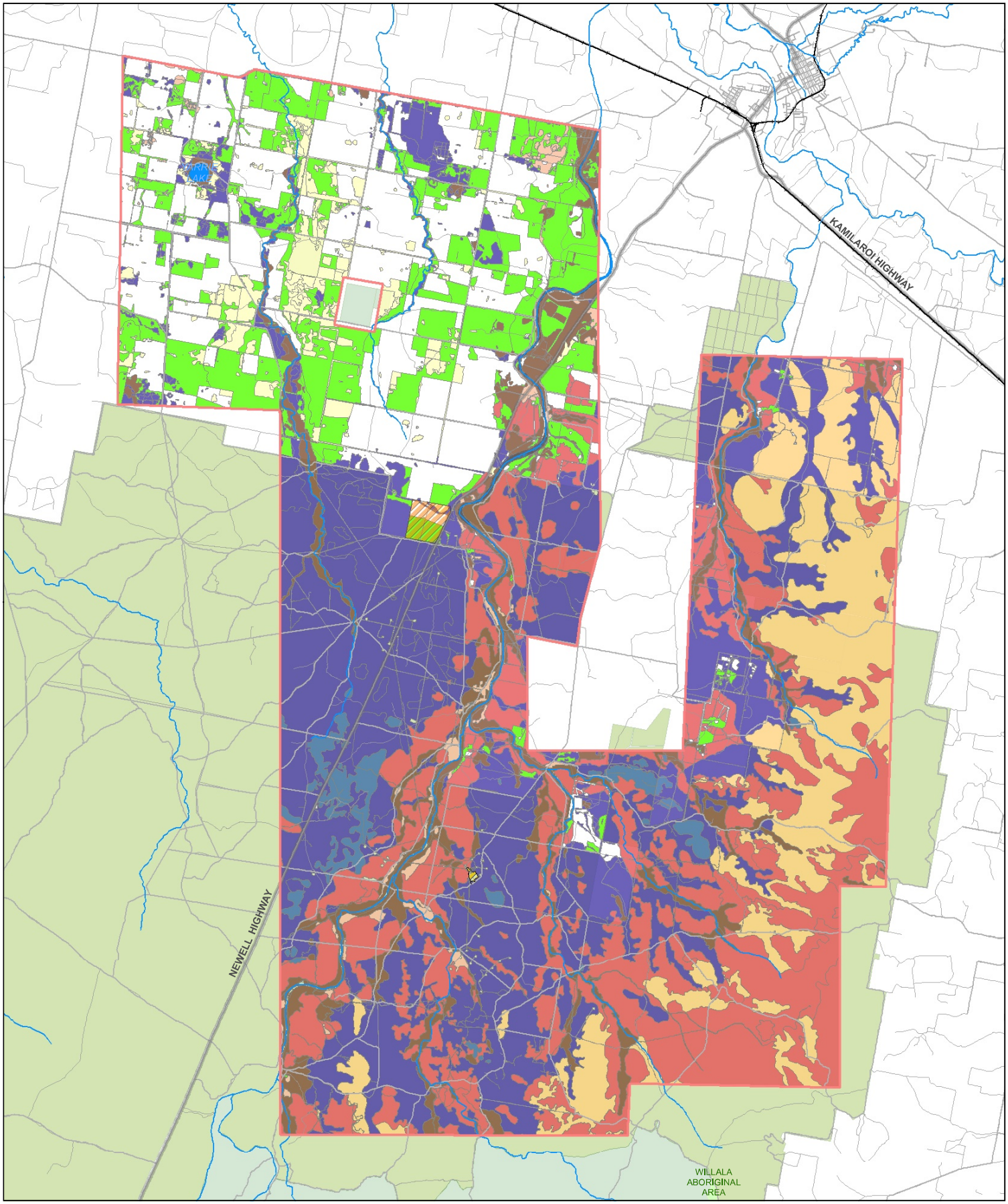
Other feral fauna species recorded in the project area were *Mus musculus* (House Mouse), *Rattus rattus* (Black Rat), *Streptopelia chinensis* (Spotted Turtle-dove), *Sturnus tristis* (Common Myna), *Sturnus vulgaris* (Common Starling), *Passer domesticus* (House Sparrow) and *Turdus merula* (Eurasian Blackbird).

Fauna habitat

Nine fauna habitat types occur within the project area. These are listed in Table 15-13 and shown on Figure 15-4. Further details on fauna habitat are provided in Appendix E of Appendix J1.

Table 15-13 Fauna habitat types within the project area (terrestrial)

Fauna habitat type	Estimated total area in project area (hectares)
Water bodies (lakes and dams)	100
Closed forest	2,827
Riparian woodland	7,011
Shrubby woodland	10,002
Heathy woodland	20,604
Shrub grass woodland	28,225
Grassy woodland	862
Heath	1,401
Grassland	9,465



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line

Fauna Habitat (ELA 2014)

- Closed Forest
- Grassland
- Grassy Woodland
- Heath
- Heathy Woodland
- Riparian Woodland
- Shrub Grass Woodland
- Shrubby Woodland
- Lakes and dams

0 1.75 3.5 7

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Fauna habitat within the project area

Figure 15-4

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by:jrichardson

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The project area does not constitute core Koala habitat as defined in SEPP 44. The project area does, however, contain habitat critical to the survival of the Koala as defined under the *EPBC Act Referral Guidelines for the Vulnerable Koala (Combined Populations of Queensland, New South Wales and the Australian Capital Territory)* (DotE 2014) and also potentially supports areas of primary and secondary habitat for the species, as defined in the *Recovery Plan for the Koala (Phascolarctos cinereus)* (DECC 2008c).

With respect to Regent Honeyeater, it is relevant to consider that the Warrumbungles, Pilliga Nature Reserve and adjoining habitat to the south of the project area has been mapped as 'other breeding areas' that support the key breeding area of Bundarra-Barraba in the National Recovery Plan (DotE, 2016). A coarse-scale map provided in the National Recovery Plan was digitised and overlayed with the project area. The 'other breeding area' mapped in the Pilliga overlays with approximately 2,755 ha (2.90%) of the project area in the south-eastern corner. The vegetation communities mapped in this area are shrubby and heathy woodlands which are not associated with drainage lines and don't support local preferred flowering Eucalypt species. At a site-scale, this habitat is not considered preferred breeding habitat for Regent Honeyeater.

There are no critical habitat declarations, nor are there draft critical habitat recommendations associated with the project area under the TSC Act or EPBC Act (OEH 2013a).

Threatened and migratory fauna

Ninety-five species of threatened and / or migratory fauna listed under the TSC Act and / or EPBC Act have been previously recorded or are predicted to occur in the study region. This includes one invertebrate, one fish, four amphibians, three reptiles, 61 birds and 25 mammals. These species are described in Appendix I of Appendix J1. Aquatic species are discussed in Chapter 16. Of these, 48 species listed as threatened under the *TSC Act* and / or EPBC Act (one reptile, 33 birds and 14 mammals) and an additional nine birds listed as migratory under the EPBC Act were recorded in the project area during field surveys or are considered potentially or likely to occur in the project area and may be impacted as a result of the project. These species are listed in Table 15-14 and their distribution in the project area is shown on Figure 15-5 and Figure 15-6. Those species recorded during the field surveys are highlighted in grey in Table 15-14. The remaining 38 species are considered unlikely to occur in the project area and, therefore, would not be impacted by the project (refer to Appendix I of Appendix J1).

Table 15-14 Threatened and migratory fauna known or predicted to occur in the project area (terrestrial)

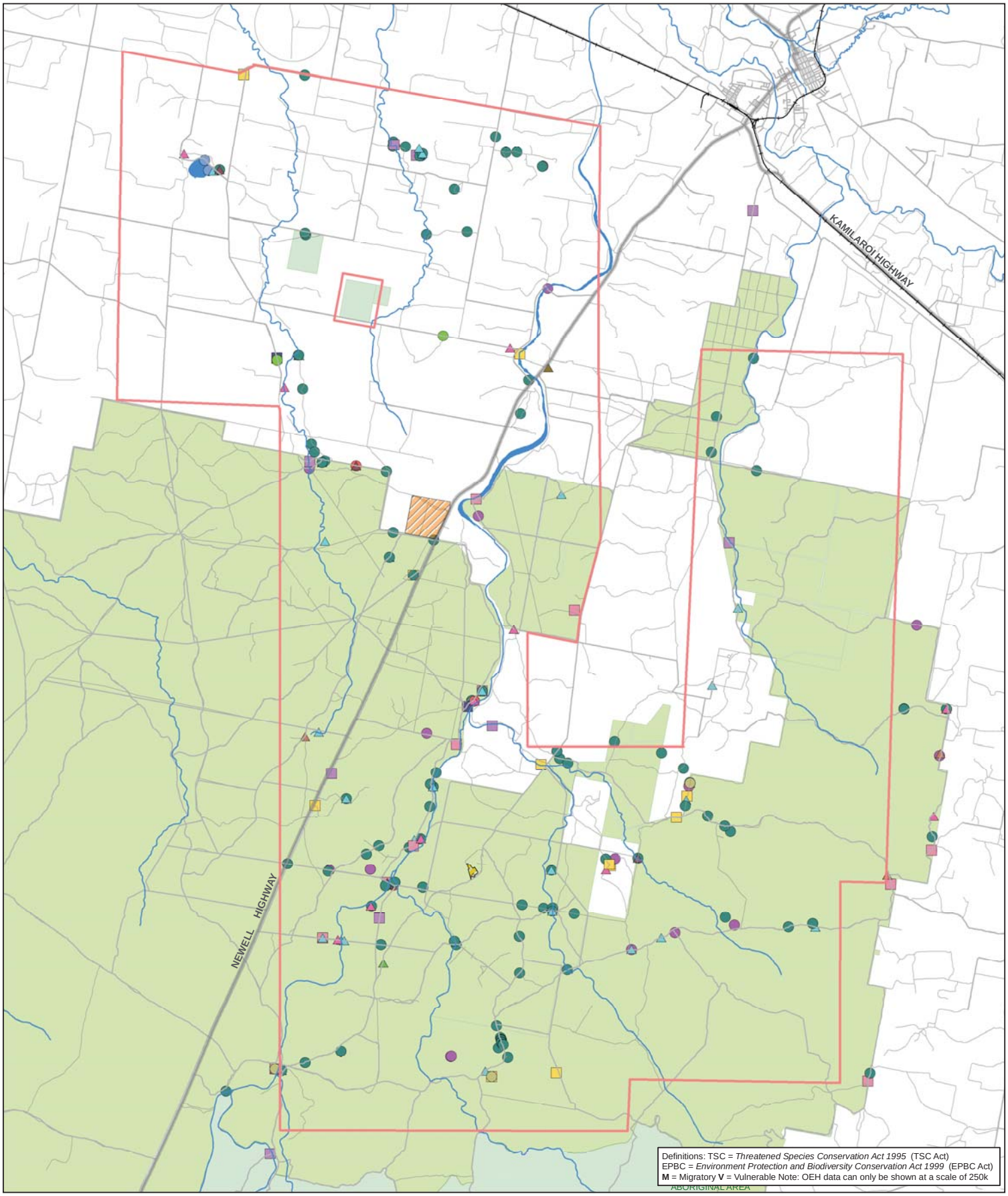
Scientific name[a]	Common name	Conservation status[b]		Comments
		TSC Act	EPBC Act	
Reptiles				
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	Known to occur
Birds				
Anseranas semipalmata	Magpie Goose	V	Mar	Potential to occur based on the presence of suitable habitat
Anthochaera phrygia	Regent Honeyeater	CE	CE, M	Potential to occur based on the presence of suitable habitat
Apus pacificus	Fork-tailed Swift	-	M, Mar	Known to occur
Ardea alba or *modesta*	Great Egret, White Egret	-	M, Mar	Known to occur
Ardea ibis	Cattle Egret	-	M, Mar	Known to occur
Ardeotis australis	Australian Bustard	E1	-	Potential to occur based on the presence of suitable habitat
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	-	Known to occur
Botaurus poiciloptilus	Australasian Bittern	E1	E	Potential to occur based on the presence of suitable habitat
Burhinus grallarius	Bush Stone-curlew	E1	-	Potential to occur based on the presence of suitable habitat
Calidris acuminata	Sharp-tailed Sandpiper	-	M, Mar	Potential to occur based on the presence of suitable habitat
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Known to occur
Chthonicola sagittata	Speckled Warbler	V	-	Known to occur
Circus assimilis	Spotted Harrier	V	-	Known to occur
Daphoenositta chrysoptera	Varied Sittella	V	-	Known to occur
Ephippiorhynchus asiaticus	Black-necked Stork	E1	-	Known to occur
Falco hypoleucos	Grey Falcon	E1	-	Potential to occur based on the presence of suitable habitat
Falco subniger	Black Falcon	V	-	Known to occur
Gallinago hardwickii	Latham's Snipe, Japanese Snipe	-	M, Mar	Potential to occur based on the presence of suitable habitat
Glossopsitta pusilla	Little Lorikeet	V	-	Known to occur
Grantiella picta	Painted Honeyeater	V	V	Known to occur
Grus rubicunda	Brolga	V	-	Potential to occur based on the presence of suitable habitat
Hamirostra melanosternon	Black-breasted Buzzard	V	-	Potential to occur based on the presence of suitable habitat
Hieraaetus morphnoides	Little Eagle	V	-	Known to occur

Scientific name[a]	Common name	Conservation status[b]		Comments
		TSC Act	EPBC Act	
Hirundapus caudacutus	White-throated Needletail	-	M, Mar	Known to occur
Lathamus discolor	Swift Parrot	E1	CE, Mar	Potential to occur based on the presence of suitable habitat
Lophoictinia isura	Square-tailed Kite	V	-	Known to occur
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	Known to occur
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	Potential to occur based on the presence of suitable habitat
Merops ornatus	Rainbow Bee-eater	-	M, Mar	Known to occur
Myiagra cyanoleuca	Satin Flycatcher	-	M, Mar	Known to occur
Neophema pulchella	Turquoise Parrot	V	-	Known to occur
Ninox connivens	Barking Owl	V	-	Known to occur
Oxyura australis	Blue-billed Duck	V	-	Potential to occur based on the presence of suitable habitat
Pachycephala inornata	Gilbert's Whistler	V	-	Potential to occur based on the presence of suitable habitat
Petroica boodang	Scarlet Robin	V	-	Potential to occur based on the presence of suitable habitat
Plegadis falcinellus	Glossy Ibis	-	M, Mar	Known to occur
Polytelis swainsonii	Superb Parrot	V	V	Potential to occur based on the presence of suitable habitat
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	Known to occur
Rostratula australis (syn. *Rostratula benghalensis australis*)	Australian Painted Snipe	E1	E, Mar	Potential to occur based on the presence of suitable habitat
Stagonopleura guttata	Diamond Firetail	V	-	Known to occur
Stictonetta naevosa	Freckled Duck	V	-	Potential to occur based on the presence of suitable habitat
Tyto novaehollandiae	Masked Owl	V	-	Known to occur
Mammals				
Aepyprymnus rufescens	Rufous Bettong	V	-	Potential to occur based on the presence of suitable habitat
Cercartetus nanus	Eastern Pygmy-possum	V	-	Known to occur
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Potential to occur based on the presence of suitable habitat
Chalinolobus picatus	Little Pied Bat	V	-	Known to occur
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Potential to occur based on the presence of suitable habitat
Macropus dorsalis	Black-striped Wallaby	E1	-	Known to occur

Scientific name[a]	Common name	Conservation status[b]		Comments
		TSC Act	EPBC Act	
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Known to occur
Nyctophilus corbeni (syn. *Nyctophilus timoriensis* (South-eastern form))	South-eastern Long eared Bat / Corben's Long-eared Bat	V	V	Known to occur
Petaurus norfolcensis	Squirrel Glider	V	-	Known to occur
Phascolarctos cinereus	Koala	V	V	Likely to occur based on the presence of suitable habitat
Pseudomys pilligaensis	Pilliga Mouse	V	V	Known to occur
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Known to occur
Sminthopsis macroura	Stripe-faced Dunnart	V	-	Potential to occur based on the presence of suitable habitat
Vespadelus troughtoni	Eastern Cave Bat	V	-	Known to occur

[a] Species recorded in the project area highlighted in grey.

[b] CE = Critically Endangered, E = Endangered (EPBC Act), E1 = Endangered (TSC Act), V = Vulnerable, M = Migratory (EPBC Act) and Mar = Marine (EPBC Act)



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line
- Barking Owl
- Black Falcon
- Diamond Firetail
- Dusky Woodswallow
- Glossy Black-cockatoo
- Grey-crowned Babbler (eastern subspecies)
- Hooded Robin (south-eastern form)
- Little Eagle
- Little Lorikeet
- Masked Owl
- Painted Honeyeater
- Rainbow Bee-eater
- Speckled Warbler
- Spotted Harrier
- Square-tailed Kite
- Turquoise Parrot
- Varied Sittella
- White-throated Needletail

0 1.75 3.5 7
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Threatened and migratory fauna within the project area (birds)

Figure 15-5

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by:afoddy

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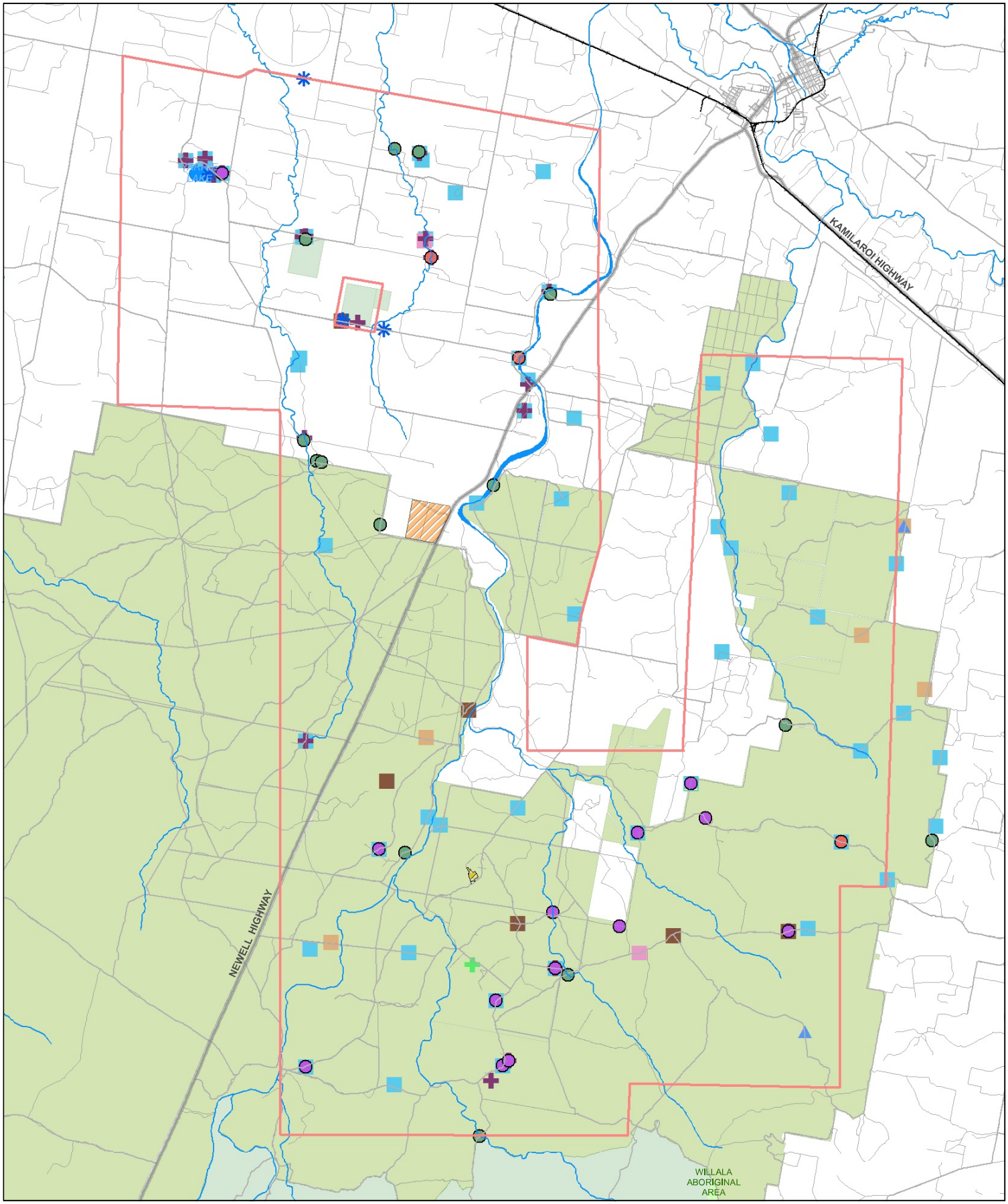

LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line

TSC & EPBC Act Listing

- Black-striped Wallaby (TSC **E**)
- Eastern Bentwing Bat (TSC **V**)
- Eastern Cave Bat (TSC **V**)
- Eastern Pygmy-possum (TSC **V**)
- Greater Broad-nosed Bat (TSC **V**)
- Koala (TSC **V**, EPBC **V**)
- Little Pied Bat (TSC **V**)
- Pilliga Mouse (TSC **V**, EPBC **V**)
- South-eastern Long-eared Bat (TSC **V**, EPBC **V**)
- Squirrel Glider (TSC **V**)
- Yellow-bellied Sheathtail-bat (TSC **V**)
- Pale-headed Snake (TSC **V**)

Definitions: TSC = *Threatened Species Conservation Act 1995* (TSC Act)
EPBC = *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
E = Endangered
V = Vulnerable
Note: OEH data can only be shown at a scale of 250k

0 1.75 3.5 7
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Date 20 Jul 2016

Threatened fauna within the project area (mammals and reptiles)

Figure 15-6

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by:jrichardson

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The results of the targeted threatened fauna and migratory bird surveys are summarised in Table 15-15. Further details are provided in Appendix J1.

Table 15-15 Targeted threatened fauna and migratory bird survey results (terrestrial)

Species	Survey results
Pseudomys pilligaensis (Pilliga Mouse)	Seven individuals were recorded during the surveys (five recorded at three sites in the project area and another two at two sites to the east of the project area). Four of the sites were within heathy woodland and one was in shrubby woodland. All sites have deep sandy soil conducive to burrowing and a diverse shrub layer less than 1 m high. The distribution of the species in the project area is likely to be confined to primary and secondary habitat in the south and east of the project area, as shown on Figure 2 of Appendix F6 in Appendix J1. The project area has the potential to carry up to 45,655 individuals in primary habitat. Populations in the project area during irruption phases are expected to be an order of magnitude higher. The species is not restricted to the project area, with a large number of existing records to the south, south-west and west of the project area. The habitats in the project area form part of a wider area of habitat for the species within the Pilliga. The habitat model is incorporated into the ecological scouting framework and the ecological sensitivity analysis to minimise impacts on the Pilliga Mouse (refer to Section 15.3.1).
Phascolarctos cinereus (Koala)	No individuals were recorded during the field surveys. However, a skull was found in shrub grass woodland adjacent to Cowallah Creek. Previous records of the species in the project area are concentrated in the north-western forested portion of the project area. The project area potentially supports areas of primary and secondary habitat for the species, as defined in the *Recovery Plan for the Koala (Phascolarctos cinereus)* (DECC 2008c). Primary and secondary habitat in the project area is shown in Figure 15-7. In particular, areas mapped as River Red Gum riparian tall woodland / open forest wetland in the Nandewar and Brigalow Belt South Bioregions (ID78) are considered to largely constitute primary Koala habitat. There are approximately 10.5 ha of this plant community type mapped in the project area, and it is distributed around Yarrie Lake in the northern portion of the project area.
Dasyurus maculatus (Spotted-tailed Quoll)	No individuals were recorded during the surveys. There are no previous records of the species in the project area (the closest record is from approximately 15 km south of the project area in the Pilliga Nature Reserve). Despite the lack of records in the project area, it is still possible that the species could move through and utilise habitat in the project area for breeding and foraging.
Anomalopus mackayi (Five-clawed Worm-skink) and *Crinia sloanei* (Sloane's Froglet).	Neither species was recorded during the surveys. Native vegetation on cracking clay soils is not present in the project area and hence it is considered unlikely that Five-clawed Worm-skink occurs in the project area. Grassland and woodland that becomes periodically inundated is present in the project area and there is potential for Sloane's Froglet to occur.

Species	Survey results
Anthochaera Phrygia (Regent Honeyeater), *Lathamus discolor* (Swift Parrot) and *Polytelis swainsonii* (Superb Parrot)	These species were not recorded during the surveys. However, other honeyeaters, lorikeets and parrots were recorded at many survey sites, which would imply that foraging resources suitable for the threatened species is present in the project area. There is potential for the project area to support foraging habitat for the species during their migration. In particular, areas with flowering *Eucalyptus sideroxylon x Eucalyptus melliodora* and *Eucalyptus sideroxylon* in the west and north-west of the project area are potential foraging resources for the Regent Honeyeater. Areas of winter-flowering eucalypts, including *Eucalyptus chloroclada, Eucalyptus blakelyi* and *Eucalyptus crebra,* could provide a foraging resource for the Superb Parrot and Swift Parrot. Due to the low number of records in the Pilliga, it is probable that the project area does not provide important habitat for these species. Instead, it may provide an alternative foraging resource when more favourable foraging habitat is not available or when flowering in the project area is more profuse.

Regional Koala survey

Regional Koala surveys were undertaken in targeted areas of the Pilliga (mainly riparian areas) but did not locate individuals within the project area. Ten individuals were observed during the surveys, occurring exclusively along Etoo Creek and Baradine Creek (located west of the project area).

In addition, 81 faecal pellet sites (trees) were recorded primarily along Etoo Creek and Baradine Creek or their immediate tributaries. Other creeks with Koala faecal pellet included Talluba Creek and Rocky Creek of Coghill Creek (also west of the project area).

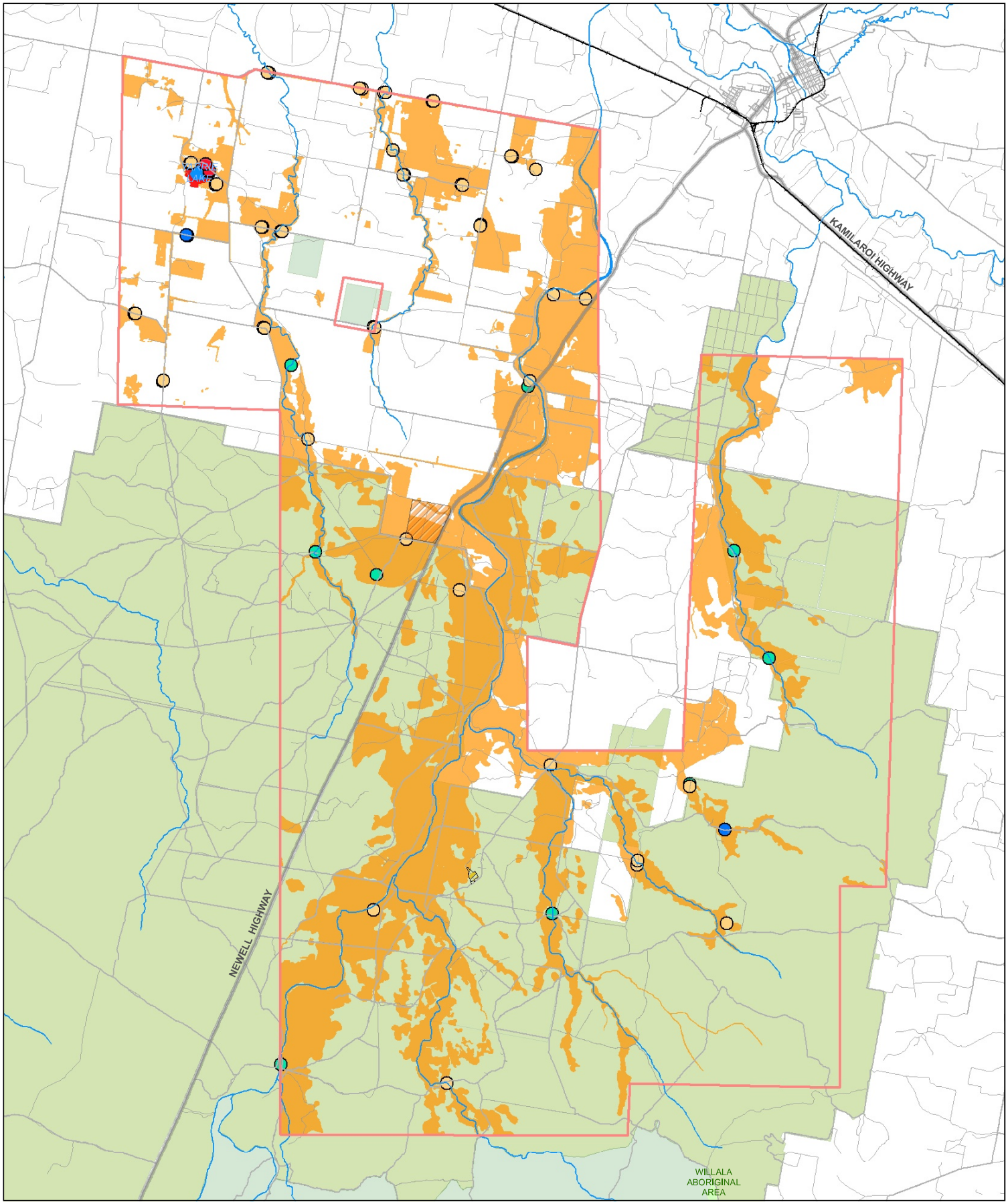
Red Gums were the main tree species group in which Koalas were observed. One Koala was recorded in a *Callitris glaucophylla* (White Cypress Pine). A similar proportion of faecal pellet records were made under Red Gums and White Cypress Pine.

Koala activity appeared low at most sites where evidence of this species was detected. Koala faecal pellets were usually recorded under few trees. In some cases, pellets were in high numbers (greater than 100) indicating a strong preference being shown for particular individual trees. Evidence of Koala-induced defoliation was uncommon but was seen at some sites.

Some sites showed strong evidence of past catastrophic wildfire, either from 1997 or 2006 / 07. These areas contained eucalypts that had been directly killed by the fire or had died post fire. The regeneration in these areas was immature, averaging only a few metres in height. These sites showed no evidence of Koala occupation.

There was no strong evidence of higher Koala concentrations near open water sources. Only two of the 10 observed Koalas were within 500 metres of a permanent water body. Of the three waterholes that were inspected along Etoo Creek, none had signs of Koala habitation within 400 metres. Rather, the pattern of Koala distribution was consistent with a low population density.

The results of the survey indicate that the most resilient areas of habitat for the Koala appear to be along Baradine Creek and Etoo Creek. The results also suggest a low population of Koalas within the Pilliga forests. Further details of the survey are provided in Appendix F7 in Appendix J1.



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line

Potential Koala habitat survey results

- Primary
- Secondary A
- Secondary B
- Secondary C

Mapped potential Koala habitat

- Primary
- Secondary

Notes: Koala habitat classification adopted from DECC 2008. This is not indicative of current Koala distrubution.

0 1.75 3.5 7
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Potential Koala habitat within the project area

Figure 15-7

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by:jrichardson

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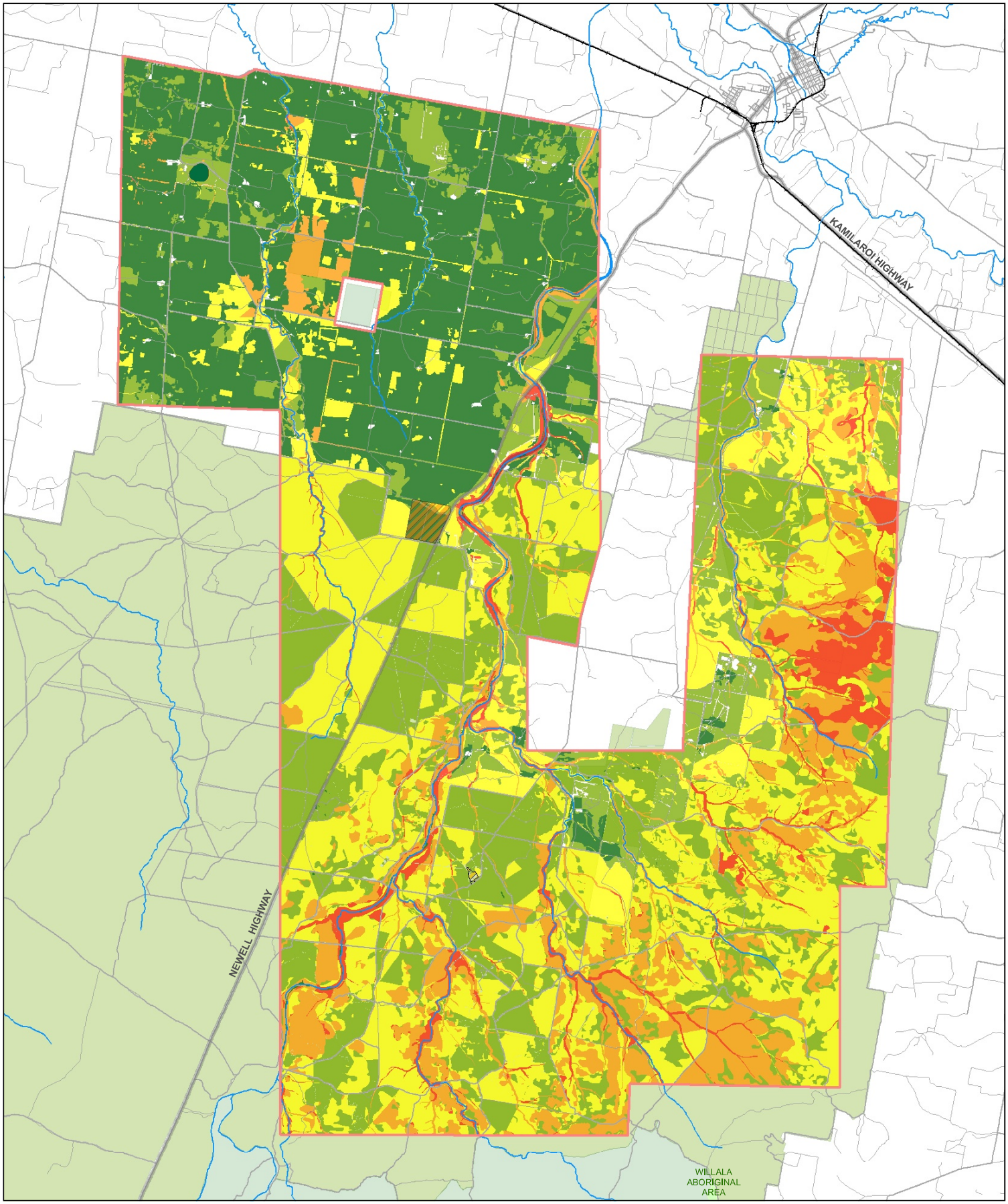
15.2.4 Ecological sensitivity analysis

The ecological sensitivity analysis categorised the project area into the five sensitivity classes. These classes are listed in Table 15-16 and shown on Figure 15-8. Definitions of each class are provided in Section 15.1.6.

Table 15-16 Ecological sensitivity classes in the project area

Ecological sensitivity	Area (hectares)	Per cent of project area
Low	23,984	25
Low-moderate	26,009	27
Moderate	28,481	30
Moderate-high	12,620	13
High	3,983	4
Total	**95,077**	**100**



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line

Ecological sensitivity classes

- Low
- Low - Moderate
- Moderate
- Moderate - High
- High

0 1.75 3.5 7

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Ecological sensitivity classes in the project area

Figure 15-8

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by:jrichardson

15.3 Potential impacts

This section presents the anticipated impacts of the project on terrestrial flora and fauna (including threatened and migratory species, populations and ecological communities) in the project area following the avoidance, minimisation and mitigation of impacts. It also outlines key threatening processes.

Construction and operation of the project would result in both direct and indirect impacts on terrestrial flora and fauna. The direct and indirect impacts on terrestrial flora and fauna associated with the project infrastructure are provided in Table 15-7.

When assessing the direct impacts, the upper disturbance limits for each plant community type, habitat type and flora species were considered. This was conservative because of the potential biases in infrastructure locations—it is unlikely that the upper disturbance limits would be reached.

When assessing the indirect impacts, the nature, extent and duration of the impacts were considered. Those impacts that were considered to be long-term (operational impacts) were weighted heavier than those impacts with an acute, short-term nature (construction impacts). The staging of the project was also considered, to account for the movement of impacts through the project area over time (that is, construction impacts were considered as localised but would spread to different locations throughout the project area as the project develops).

Table 15-17 Direct and indirect impacts of project infrastructure

Infrastructure	Direct impacts	Indirect impacts
Leewood	No direct impacts anticipated	Site impacts (noise, traffic, light, weed invasion, increased feral fauna); downstream or downwind impacts (sedimentation, erosion, dust, hydrological change, accidental leaks and spills)
Bibblewindi	Vegetation removal, habitat removal, removal of threatened flora individuals	Site impacts (fragmentation, noise, traffic, fencing, light, weed invasion, increased feral fauna, fire); downstream or downwind impacts (sedimentation, erosion, dust, hydrological change, accidental leaks and spills)
Bibblewindi to Leewood infrastructure corridor	Vegetation removal, habitat removal, removal of threatened flora individuals	Site impacts (fragmentation, noise, traffic, light, weed invasion, increased feral fauna); downstream or downwind impacts (sedimentation, erosion, dust, hydrological change, accidental leaks and spills)
Leewood to Wilga Park underground power line	No direct impacts anticipated	No indirect impacts anticipated
Westport workers' accommodation	Vegetation removal, habitat removal, removal of threatened flora individuals	Site impacts (fragmentation, noise, traffic, fencing, light, weed invasion, increased feral fauna); downstream or downwind impacts (sedimentation, erosion, dust, hydrological change)

Infrastructure	Direct impacts	Indirect impacts
Well pads	Vegetation removal, habitat removal, removal of threatened flora individuals	Site impacts (fragmentation, noise, traffic, fencing, light, weed invasion, increased feral fauna, fire) and downstream or downwind impacts (sedimentation, erosion, dust, hydrological change, accidental leaks and spills)
Water and gas gathering lines / access tracks	Vegetation removal, habitat removal, removal of threatened flora individuals	Site impacts (fragmentation, noise, traffic, light, weed invasion, increased feral fauna); downstream or downwind impacts (sedimentation, erosion, dust, hydrological change, accidental leaks and spills) and facilitated impacts (hunting)

15.3.1 Avoidance and minimisation

A number of avoidance and minimisation measures are included in the design of the project in order to minimise the potential impacts on flora and fauna in the project area (including threatened and migratory species, populations and ecological communities). These measures include:

- implementing the Field Development Protocol for siting project infrastructure
- preparing and implementing an ecological scouting framework, which considers biodiversity values such as threatened and migratory species, ecological communities and their potential habitats, and prioritises them for avoidance. This would ensure that infrastructure is appropriately located for minimal ecological impact
- minimising surface disturbance using a stacked lateral well design and multiple wells on a well pad
- using previously cleared areas for seismic survey, where practicable
- placing the central water and gas processing facilities at the Leewood site outside of the forest to minimise vegetation clearing
- co-locating linear infrastructure such as gas and water gathering systems and access tracks with existing roads, access tracks and disturbance corridors, wherever practicable. In addition, when new access tracks are required, construction of the gathering system would be aligned with the access tracks, where possible. Further micro-alignment may be undertaken to minimise impacts on known ecological constraints such as threatened species and hollow-bearing trees, if practicable
- constructing the water and gas gathering lines using a ‘plough-in’ technique, where possible, as this would reduce the width of the corridor required for construction, reduce construction duration, minimise disruption to topsoil, and minimise the need for traditional trenching and dewatering of open trenches. This would also reduce the risk of fauna falling into trenches.

Field Development Protocol

The Field Development Protocol was prepared to ensure the planning, design and construction phases of the project are undertaken in accordance with approval conditions. The Protocol addresses the avoidance and minimisation of direct and indirect impacts by implementing the following steps.

- Step 1: Desktop review. Undertake design development following procedures described in Step 1 of the ecological scouting framework. Review the cumulative disturbance figures against upper clearing limits.

- Step 2: Micro-siting. Undertake field scouting following procedures described in Step 2 of the ecological scouting framework.
- Step 3: Design (Plan of Operations to government). Complete the detailed design, implementing the results from desktop assessment and micro-siting stages following procedures in Step 3 of the ecological scouting framework.
- Step 4: Implementation (management controls and auditing). Implement the pre-clearance protocols and relocate fauna out of construction area.

The Field Development Protocol is provided as Appendix C.

Ecological scouting framework

An ecological scouting framework would be incorporated into the Field Development Protocol. It would identify the most suitable areas for the proposed infrastructure to be positioned within a given location in order to cause the least environmental impact. This process would involve the following steps.

- Step 1: Desktop assessment. Undertake a preliminary constraints analysis of a proposed well development area using spatial layers to highlight areas of ecological sensitivity.
- Step 2: In-field micro-siting. Undertake a field survey within a buffered area, collecting spatial data for biodiversity values so infrastructure can be micro-sited after fieldwork.
- Step 3: Post-field micro-siting. Position infrastructure in the areas of lowest environmental impact following a set of design principles.

Further details of the ecological scouting framework are provided in Appendix G of Appendix J1.

15.3.2 Direct impacts on terrestrial flora and fauna

Vegetation removal

Construction of the project would result in the removal of up to 988.8 hectares of native vegetation, which equates to the removal of approximately 1.3 per cent of native vegetation in the project area. Vegetation removal by plant community type is summarised in Table 15-18. Further details are provided in Appendix A6 of Appendix J1.

The largest direct impact would be on Narrow-leaved Ironbark – White Cypress Pine-Buloke tall open forest (up to 323.4 hectares). Approximately 23,492 hectares of this plant community type occurs in the project area, which constitutes a direct impact on the community of 1.4 per cent in the project area. There would also be a direct impact on two more plant community types over 100 hectares, namely White Bloodwood – Dirty Gum – Rough-barked Apple heathy open woodland (up to 138.40 hectares) and White Bloodwood – Red Ironbark – cypress pine shrubby woodland (up to 108.7 hectares).

All plant community types would be impacted by less than three per cent of their occurrence in the project area. The plant community types with the highest percentage impact in the project area would be Inland Scribbly Gum – White Bloodwood – Red Stringybark – Black Cypress Pine shrubby sandstone woodland (2.6 per cent), Spur-wing Wattle heath (2.3 per cent) and White Bloodwood – Motherumbah – Red Ironbark shrubby sandstone hill woodland / open forest (2.1 per cent).

The four endangered ecological communities present in the project area would be impacted by one per cent or less of their occurrence in the project area. The direct impact on Brigalow would be 0.8 per cent of the 2,468 hectares in the project area. The direct impact on Fuzzy Box Woodland would

be one per cent of the 588.4 hectares in the project area. Weeping Myall Woodlands would only have up to 0.1 hectares removed and Carbeen Open Forest would not be directly impacted.

Following construction, approximately 55 per cent of vegetation clearing associated with the well pads and 50 per cent of clearing associated with the gas and water gathering systems (totalling 586.6 hectares) would be rehabilitated in accordance with the rehabilitation strategy for the project (refer to Appendix V).

Table 15-18 Vegetation removal by plant community type (upper clearing limits)

Plant community type (identification number)[1]	Biometric vegetation type identification number (Oct. 2008)	Biometric vegetation type identification number (Oct. 2014)	Condition	Direct impact (hectares)	Per cent directly impacted in the project area
Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions (55)	NA102	NA102	Derived native grassland	1.70	0.53
Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions (55)	NA102	NA102	Native vegetation	3.90	1.09
Brigalow – Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion (35)	NA117	NA117	Derived native grassland	37.20	0.88
Brigalow – Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion (35)[a]	NA117	NA117	Native vegetation	19.30	0.78
Broombush – wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion (141)	NA121	NA121	Native vegetation	19.50	1.88
Spur-wing Wattle heath on sandstone substrates in the Goonoo – Pilliga forests Brigalow Belt South Bioregion (425)	NA121	NA363	Native vegetation	8.40	2.29
Inland Scribbly Gum – White Bloodwood – Red Stringybark – Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP – Pilliga region in the Brigalow Belt South Bioregion (379)	NA124	NA294	Native vegetation	2.70	2.61
Red Ironbark – White Bloodwood – /+ Burrows Wattle heathy woodland on sandy soil in the Pilliga forests (404)	NA124	NA326	Native vegetation	86.60	0.87
White Bloodwood – Red Ironbark – cypress pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions (405)	NA124	NA390	Native vegetation	108.70	1.63

Plant community type (identification number)[1]	Biometric vegetation type identification number (Oct. 2008)	Biometric vegetation type identification number (Oct. 2014)	Condition	Direct impact (hectares)	Per cent directly impacted in the project area
White Bloodwood – Motherumbah – Red Ironbark shrubby sandstone hill woodland open forest mainly in east Pilliga forests (406)	NA124	NA389	Native vegetation	69.0	2.13
Dirty Gum (Baradine Gum) –Black Cypress Pine – White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region (408)	NA124	NA279	Derived native grassland	0.40	0.39
Dirty Gum (Baradine Gum) –Black Cypress Pine – White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region (408)	NA124	NA279	Native vegetation	33.30	1.08
White Bloodwood – Dirty Gum – Rough Barked Apple heathy open woodland (40X)	NA124	NA390	Derived native grassland	1.90	0.79
White Bloodwood – Dirty Gum – Rough Barked Apple heathy open woodland (40X)	NA124	NA390	Native vegetation	138.40	1.84
Carbeen – White Cypress Pine – Curracabah – White Box tall woodland on sand in the Narrabri-Warialda region of the Brigalow Belt South Bioregion (428)[a]	NA126	NA267	Native vegetation	0	0
Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South (including Pilliga) and Nandewar Bioregions (202)[a]	NA141	NA141	Derived native grassland	0	0
Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South (including Pilliga) and Nandewar Bioregions (202)[a]	NA141	NA141	Native vegetation	5.90	1.0
Green Mallee tall Mallee woodland on rises in the Pilliga – Goonoo regions, southern Brigalow Belt South Bioregion (256)	NA143	NA292	Native vegetation	0.30	1.48
Mugga Ironbark – White Cypress Pine – gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion (402)	NA160	NA307	Native vegetation	1.6	0.91
Mugga Ironbark – White Cypress Pine – gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion (402)	NA160	NA307	Derived native grassland	1.6	0.87
Pilliga Box – White Cypress Pine – Buloke shrubby woodland in the Brigalow Belt South Bioregion (88)	NA179	NA179	Derived native grassland	8.80	0.58

Plant community type (identification number)[1]	Biometric vegetation type identification number (Oct. 2008)	Biometric vegetation type identification number (Oct. 2014)	Condition	Direct impact (hectares)	Per cent directly impacted in the project area
Pilliga Box – White Cypress Pine – Buloke shrubby woodland in the Brigalow Belt South Bioregion (88)	NA179	NA179	Native vegetation	40.80	0.92
Poplar Box – White Cypress Pine shrub grass tall woodland of the Pilliga – Warialda region, Brigalow Belt South Bioregion (397)	NA179	NA324	Derived native grassland	1.3	0.29
Poplar Box – White Cypress Pine shrub grass tall woodland of the Pilliga-Warialda region, Brigalow Belt South Bioregion (397)	NA179	NA324	Native vegetation	1.0	0.32
White Cypress Pine – Silver-leaved Ironbark – Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion (418)	NA179	NA409	Native vegetation	0.20	0.32
White Cypress Pine – Silver-leaved Ironbark – Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion (418)	NA179	NA409	Derived native grassland	0.30	0.43
River Red Gum riparian tall woodland / open forest wetland in the Nandewar and Brigalow Belt South Bioregions (78)	NA193	NA193	Native vegetation	0	0
Red gum – Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga – Goonoo sandstone forests, Brigalow Belt South Bioregion (399)	NA197	NA255	Derived native grassland	0.20	0.42
Red gum – Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga-Goonoo sandstone forests, Brigalow Belt South Bioregion (399)	NA197	NA255	Native vegetation	3.40	0.32
Rough-barked Apple – red gum – cypress pine woodland on sandy flats, mainly in the Pilliga Scrub region (401)	NA197	NA338	Derived native grassland	18.1	1.10
Rough-barked Apple – red gum – cypress pine woodland on sandy flats, mainly in the Pilliga Scrub region (401)	NA197	NA338	Native vegetation	46.40	0.78
Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions (27)[a]	NA219	NA219	Native vegetation	0.10	0.28
Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions (27)	NA219	NA219	Derived native grassland	0.50	0.29

Plant community type (identification number)[1]	Biometric vegetation type identification number (Oct. 2008)	Biometric vegetation type identification number (Oct. 2014)	Condition	Direct impact (hectares)	Per cent directly impacted in the project area
Narrow-leaved Ironbark – White Cypress Pine – Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion (398)	NA227	NA314	Derived native grassland	3.9	0.79
Narrow-leaved Ironbark – White Cypress Pine – Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion (398)	NA227	NA314	Native vegetation	323.40	1.38
Total				**988.80**	**1.23**

[a] Communities listed under the TSC Act and / or EPBC Act are highlighted in grey.

Fauna habitat removal

The removal of native vegetation in the project area would result in the removal of known or potential fauna foraging, breeding, roosting, sheltering and dispersal habitat. The impacts of vegetation removal on threatened and migratory fauna habitat are provided in Appendix A of Appendix J1. Less than two per cent of habitat would be directly impacted for all threatened and migratory fauna species in the project area.

The direct impacts on hollow-bearing trees by plant community type are provided in Appendix A8 of Appendix J1. Up to 10,143 hollow-bearing trees would be removed during construction of the project. This number was estimated based on hollow size class data collected during the field surveys averaged out across each plant community type. This estimate does not take into account the ecological scouting procedure that would be implemented prior to construction to avoid significant hollow-bearing trees, where possible. The loss of hollow-bearing trees in the project area would result in a loss of roosting and nesting habitat for birds and arboreal mammals such as possums and bats.

The Koala habitat assessment tool was applied to the project area to assess if the project area constitutes habitat critical to the survival of the Koala (DotE 2014). An impact area that scores five or more using the habitat assessment tool for the Koala contains habitat critical to its survival. The project area scored a habitat score of six. As such, a referral was made to the Department of the Environment (now Department of the Environment and Energy) in October 2014 as there is potential for the project to adversely affect habitat critical to the survival of the Koala. The referral is provided as Appendix B.

It is important to note, however, while Koala scats and a Koala skull were recorded in the project area in 2011, due to the similarity between Brushtail Possum and Koala scats, and the fact that no Koala sightings in the project area can support these records, the current evidence does not indicate presence of a current population in the project area. Additionally, the project is not considered likely to interfere substantially with the recovery of the Koala, as the project is unlikely to result in increased Koala fatalities due to dog attack or vehicle strike, is unlikely to result in the spread of disease or pathogens such as Chlamydia or *Phytophthora cinnamomi*, is unlikely to create a barrier to movement to, between or within habitat critical to the survival of the Koala, and is unlikely to change the hydrology of the project area (this is discussed further in Section 15.3.5).

Flora species removal

Direct impacts on the number of threatened flora individuals impacted by the project were calculated and are presented in Table 15-19. For those species where a population model was run, the lower and upper 95 per cent confidence intervals are presented to account for the variability in the data.

In order to reduce the likelihood of a significant impact on populations of the flora species *Lepidium aschersonii* and *Lepidium monoplocoides* in the project area, a clearing limit of 1.55 per cent of the population in the project area was assessed; this currently equates to three *Lepidium aschersonii* and four *Lepidium monoplocoides* individuals. Should further surveys increase the known abundance of these species, then the number of impacted individuals could increase but would be required to stay below 1.55 per cent of the population in the project area.

Table 15-19 Direct impacts on threatened flora individuals (upper clearing limits)

Species	Project area			Direct and indirect impact			Proportion		
	Estimated mean abundance	Lower 95% CI	Upper 95% CI	Impact (number of individuals)	Lower 95% CI	Upper 95% CI	Impact (%)	Lower 95% CI	Upper 95% CI
Bertya opponens	964,321	868,123	1,060,519	10,309	N/A	N/A	1.07	N/A	N/A
Diuris tricolor	3,357	1,746	6,453	52	27	100	1.55	1.55	1.55
Lepidium aschersonii	208	N/A	N/A	3	N/A	N/A	1.55	N/A	N/A
Lepidium monoplocoides	258	N/A	N/A	4	N/A	N/A	1.55	N/A	N/A
Myriophyllum implicatum	1	N/A	N/A	0	N/A	N/A	0	N/A	N/A
Polygala linariifolia	16,340	8,198	28,134	252	127	435	1.54	1.55	1.55
Pomaderris queenslandica	45,528	44,212	46,843	467	N/A	N/A	1.03	N/A	N/A
Pterostylis cobarensis	432,465	339,437	550,802	6,658	5,220	8,477	1.54	1.54	1.54
Rulingia procumbens	240,605	90,924	858,781	3,716	1,404	13,265	1.54	1.54	1.54
Tylophora linearis	33,200	25,775	43,772	513	398	676	1.55	1.54	1.55

The area of occupancy for *Bertya opponens* and *Pomaderris queenslandica* was calculated based on patches of the species recorded in the project area. For all modelled flora populations, potential habitat in the project area was calculated. These values are presented in Table 15-20.

As shown in Table 15-19 and Table 15-20, less than 1.6 per cent of threatened flora individuals and threatened flora habitat in the project area would be directly impacted by the project.

Table 15-20 Direct impacts on threatened flora habitat (upper clearing limits)

Species	Area of occupancy (ha)	Predicted habitat (ha)	Direct and indirect impact (ha)	Proportion (%)
Bertya opponens	456.02	N/A	6.37	1.40
Diuris tricolor	N/A	70,036.44	1,081.78	1.54
Myriophyllum implicatum	10.27	N/A	0	0
Polygala linariifolia	N/A	70,036.44	1,081.78	1.54
Pomaderris queenslandica	90.11	N/A	1.44	1.60
Pterostylis cobarensis	N/A	70,036.44	1,081.78	1.54
Rulingia procumbens	N/A	70,036.44	1,081.78	1.54
Tylophora linearis	N/A	70,036.44	1,081.78	1.54

15.3.3 Indirect impacts on terrestrial flora and fauna

Indirect impacts on flora and fauna during construction and operation of the project would include:

- Fragmentation – Construction and operation of the project would increase fragmentation in the project area. Fragmentation can impact flora and fauna species by creating barriers to movement and dispersal, which can result in genetic isolation of populations. If movement is still possible between fragments, the more an individual is forced to cross open areas between habitat fragments, the greater risk that individual faces and the more energy spent on dispersal and foraging. Fragmentation can also increase edge effects, which impact those species that are 'core sensitive' rather than 'edge' species if habitats are heavily fragmented by a series of new habitat types (for example, a network of roads compared to a single road). Fragmentation also facilitates the movement of feral animals (discussed below).
- Noise – Construction and operation of the project would result in an increase in noise levels in the project area. These increased noise levels can impact fauna species. Some fauna species would likely tolerate an increase in noise, while others may not, causing them to leave the affected area or making the area less desirable for foraging, nesting and breeding.
- Traffic – Increased traffic in the project area during construction and operation could impact flora via raised dust levels. Fauna may also be impacted by vehicle strike and habitat degradation through increased edge effects and disturbance levels (light, noise and dust).
- Fencing – Fencing (temporary and permanent) installed around well pads and other infrastructure during construction and operation of the project could present a hazard to fauna through entanglement. Some fauna is known to be impacted by fencing entanglement, especially nocturnal species such as bats, gliders and owls and also macropods. Fencing close to a wetland can also hinder water birds from landing or taking off.
- Light – Construction of the project would result in an increase in light in the project area both due to artificial light sources and by vegetation clearance opening up gaps in intact canopy cover. Artificial light from vehicles and machinery can impact nocturnal fauna, potentially disrupting movement and behaviour. This could cause changes such as increased predation, disorientation of individuals and reduced fitness. Increased sunlight reaching through the canopy would have the most impact on flora species, and could change the species composition to favour species that are more tolerant of increased light conditions.
- Weed invasion – Construction and operation of the project could result in the dispersal of weed propagules into areas of native vegetation through vegetation clearing, erosion and from the movement of workers and vehicles. An increase in weeds may impact the composition of vegetation communities and habitat for flora and fauna species in the project area. The majority of threatened

flora species recorded or considered likely to occur in the project area are threatened by habitat degradation through weed invasion.

- Feral fauna – Construction and operation of the project would require the clearing of vegetation for linear infrastructure including roads and gathering systems. Clearing vegetation can open up areas of the landscape to predators allowing easier access to these areas and their prey. This would impact all fauna species to a degree, but particularly ground foraging species that are favoured as prey by foxes, dogs and cats. Feral fauna would also introduce added competition stress on native species. For example, there would be increased competition for habitat and foraging resources between *Pseudomys pilligaensis* (Pilliga Mouse) and *Mus musculus* (House Mouse).
- Fire – Construction and operation of the project could result in the accidental lighting of fires. During operation, the extraction of natural gas, which is highly flammable, could potentially cause fire should leaks and ignition occur simultaneously. The accidental lighting of fires would alter the fire regime in the project area.
- Dust, erosion and sedimentation – Construction of the project could result in dust, erosion and sedimentation from activities such as vegetation removal and excavations. The accumulation of dust can impact on the habitat and growth of flora species and communities. Dust created during construction would be short-term and removed by wind and rain, so would not have a prolonged effect on plant physiology.
- Hydrological change – Modification to the surface layout in the project area could impact the hydrology of the project area through altering water flow and filtration. Excluding the managed release to Bohena Creek, there are no anticipated impacts on the aquatic environment.
- Accidental leaks and spills – Accidental leaks and spills (of primarily drilling fluid) during construction of the project could impact vegetation and fauna species if ingested.
- Hunting and collecting – Operation of the project could increase the accessibility of the project area to hunters and illegal collectors.

Indirect impacts were calculated to equate to the removal of an additional 181.1 hectares of vegetation in the project area. When combined with the direct impact of vegetation removal, this equates to a total impact of 1,169.9 hectares of vegetation or the removal of approximately 1.5 per cent of native vegetation in the project area (refer to Appendix A6 in Appendix J1).

The indirect impact on fauna habitat equates to less than 0.3 per cent of additional impact on foraging or breeding habitat for the threatened fauna species assessed (refer to Appendix A9 of Appendix J1). Coupled with the proposed direct impacts, there would be less than two per cent total impact on habitat for the threatened fauna assessed.

Fragmentation was calculated by an intactness analysis, as discussed in Section 15.1.7. The intactness analysis indicated that the number of patches of habitat in the project area would increase from 387 to 721, almost doubling the number of patches. This would reduce the intactness index (a measure of zero to one, with one being full intactness) from 0.446 to 0.232. The area with the lowest intactness would occur in the north of the project area, where the majority of the landscape is currently cleared. Due to the nature of the fragmentation that would be caused by the project (by narrow linear features), the removal of habitat is not considered to be at a scale likely to result in the permanent isolation or fragmentation of populations with species still able to disperse between patches.

15.3.4 Key threatening processes

Key threatening processes threaten or have the potential to threaten the survival or evolutionary development of a species, population or ecological community. They are listed under the TSC Act, the *NSW Fisheries Management Act 1994* and the EPBC Act (OEH 2013b, DPI 2014a and DotE 2009). The key threatening processes potentially relevant to the project are listed in Table 15-21. The magnitude to which these key threatening processes may be exacerbated by the project is addressed in the

assessments of significance provided in Appendix J1 and Appendix K of Appendix J1. Mitigation measures to limit the impacts of key threatening processes are discussed in Section 15.4.

Table 15-21 Key threatening processes

Key threatening process	Status
Direct impacts	
Clearing of native vegetation/Land clearance	TSC Act / EPBC Act
Loss of hollow-bearing trees	TSC Act
Removal of dead wood and dead trees	TSC Act
Removal of large woody debris from NSW rivers and streams	FM Act
The degradation of native riparian vegetation along New South Wales watercourses	FM Act
Invasive species	
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)/ Competition and land degradation by rabbits	TSC Ac / EPBC Act
Competition and habitat degradation by feral goats (*Capra hircus*) / Competition and land degradation by unmanaged goats	TSC Act / EPBC Act
Competition from feral honey bees (*Apis mellifera*)	TSC Act
Invasion of native plant communities by exotic perennial grasses	TSC Act
Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	TSC Act
Predation by the European red fox (*Vulpes vulpes*) / Predation by European red fox	TSC Act / EPBC Act
Predation by the feral cat (*Felis catus*) / Predation by feral cats	TSC Act / EPBC Act
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) / Predation, habitat degradation, competition and disease transmission by feral pigs	TSC Act / EPBC Act
Introduction of fish to fresh waters within a river catchment outside their natural range	FM Act
Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (*Manorina melanocephala*)	EPBC Act
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)	EPBC Act
Novel biota and their impact on biodiversity	EPBC Act
Environmental modification	
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	TSC Act
Anthropogenic (human caused) climate change / Human-caused climate change / Loss of climatic habitat cause by anthropogenic emissions of greenhouse gases	TSC Act / FM Act / EPBC Act
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	TSC Act
Instream structures and other mechanisms that alter natural flow	FM Act

15.3.5 Assessments of significance (EP&A Act and EPBC Act)

Assessments of significance under the EP&A Act and EPBC Act were undertaken for the species listed in Table 15-11 and Table 15-14 and the endangered ecological communities listed in Table 15-12. The assessments of significance are presented in Appendix J1 and Appendix K of Appendix J1.

It is unlikely that project would have a significant impact on threatened flora, threatened fauna or threatened ecological communities that are considered potential, likely or known to occur in the project area. This is primarily due to:

- the small proportion of habitat being removed relative to that retained in the project area
- the removal of habitat not being at a scale likely to result in the isolation or fragmentation of populations
- the unlikelihood that the project would result in invasive species or diseases becoming established
- the progressive rehabilitation of disturbed areas as part of the project.

A referral was made to the Department of the Environment (now Department of the Environment and Energy) in October 2014. The referral is provided as Appendix B. The referral identified and assessed a wide range of threatened and migratory species and ecological communities that could potentially be impacted by the project. The referral was prepared prior to the development of a detailed project design and took a precautionary approach in assessing the potential impacts of the project and, hence, in determining significance. The referral identified that the project may have a significant impact on a range of species which have been assessed in detail in this assessment and found to be unlikely to be significantly impacted by the project.

15.3.6 Further consideration

The Secretary's environmental assessment requirements for the project include a requirement from OEH to apply further consideration (as detailed in s9.2 of the Framework for Biodiversity Assessment (OEH 2014)) to three species; *Anomalopus mackayi* (Five-clawed Worm-skink), *Anthochaera phrygia* (Regent Honeyeater), and *Pomaderris queenslandica* (Scant Pomaderris). Additionally, three critically endangered entities which are specifically excluded from requiring further consideration were listed; *Lathamus discolor* (Swift Parrot), *Myriophyllum implicatum*, and White Box Yellow Box Blakely's Red Gum Woodland.

The potential impact on the three species requiring further consideration, their local populations and their habitat have been considered and detailed in Appendix D of the Biodiversity Assessment Report which is provided as Appendix J2.

The habitat in the development site that would be modified is not occupied by the Regent Honeyeater and is considered 'potential' habitat for the species. As a result, no habitat used by a local population would be impacted. The Five-clawed Work-skink is known to occur on the floodplains of the Namoi River to the north of the project area. The preferred habitat of deep cracking clay is not present in the project area and a local population of Five-clawed Worm-skink is not considered likely to occur. The area of occupancy of the *Pomaderris queenslandica* in the project area was calculated to cover 90.11 hectares, within which there is an estimated a total population size of over 45,000 individuals. With over 98 per cent of the area occupied not impacted, it is not considered that this scale of loss would decrease the viability of a local population.

15.3.7 Assessing impacts to NPWS estate

The Secretary's environmental assessment requirements for the project include a requirement from OEH to assess impacts to NPWS estate, following the guidelines for developments adjoining land and water managed by OEH (OEH 2013c). Land managed by the NPWS within, adjoining or near the project area includes the Brigalow State Conservation Area (a surface development exclusion area, there will be no direct impacts), Brigalow Nature Reserve (excluded from the project area) and Pilliga East State Conservation Area (near the project area).

The assessment concluded that no direct impacts would occur within the NPWS (OEH) estate. The potential for indirect impacts to extend to NPWS estate were then considered and assessed. Indirect impacts of feral pests, weed invasion, edge effects, noise and ecological connectivity have potential to indirectly impact NPWS estate. These potential indirect impacts would be mitigated through the implementation of avoidance, minimisation and mitigation measures proposed for the project area. They are discussed in further detail in Section 6 of the Ecological Impact Assessment provided as Appendix J1.

15.4 Environmental risk assessment

Table 15-22 summarises the environmental risk assessment undertaken for the potential impacts of the project on terrestrial ecology. For each identified potential impact, the assessment considered:

- the potential pre-mitigated impact, where only the potential impacts are uncontrolled
- the mitigation measures that would be used to manage the potential impacts on terrestrial ecology to reduce the likelihood of the potential impacts
- the residual risk of the potential impact after the implementation of mitigation measures (the residual risk takes into account the potential for impact that remains after the mitigation measures are applied).

The mitigation measures identified in Table 15-22 would be incorporated into a Biodiversity Management Plan. The Plan would include a Significant Species Management Plan and management measures to minimise impacts to terrestrial flora and fauna.

In addition to the mitigation and management measures listed in Table 15-22, the mitigation and management measures listed in Chapter 11 (Groundwater and geology), Chapter 12 (Surface water quality), Chapter 14 (Soils and land contamination), Chapter 18 (Air quality) and Chapter 25 (Hazard and risk – including bushfire management) would be implemented to minimise the impacts associated with dust, erosion and sedimentation on terrestrial flora and fauna in the project area.

15.5 Biodiversity offset strategy

Residual impacts on threatened and migratory species and endangered ecological communities as shown in Table 15-22 would be offset as part of a biodiversity offset strategy in accordance with the *NSW Offsetting Principals* (OEH 2014b) and the *NSW Biodiversity Offsets Policy for Major Projects* (OEH 2014c).

The *EPBC Act Environmental Offset Policy* (DSEWPaC 2012) requires residual significant adverse impacts to be offset. The assessment of impacts under the EPBC Act undertaken as part of this project have demonstrated that with the proposed avoidance and mitigation measures the project is unlikely to have any significant impacts on Matters of National Environmental Significance, and therefore offsets are not required in accordance with the policy.

As the *NSW Biodiversity Offset Policy for Major Projects* was developed as a whole-of-government policy, offsets determined for biodiversity impacts of the project under the NSW policy also includes all Matters of National Environmental Significance likely to be impacted by the project.

The biodiversity offset strategy is provided in Appendix L of Appendix J1. The biodiversity offset strategy would aim to compensate for all residual impacts of the project and achieve long-term conservation outcomes, by ensuring:

- vegetation, habitat and threatened species at offset sites have equal or greater conservation status to areas impacted by the project
- offsets are greater than the loss of areas impacted by the project
- land-based offset sites, supplementary measures and contributions to the biodiversity offset fund (once established) are appropriately funded, secured and managed.

The biodiversity offset strategy follows a four-step approach:

1) Quantification of the impacts of the project informed by the *Framework for Biodiversity Assessment* (OEH 2014d) to guide the development of the offset strategy including direct, indirect and cumulative impacts as well as the contribution that undertaking immediate rehabilitation post construction makes to reducing the overall offset liability.

2) Undertaking 'reasonable steps' to locate like-for-like offset, including:

    a. checking the biobanking public register and having an expression of interest for credits wanted for at least six months

    b. liaising with the OEH Northern Plains Region office and Narrabri Council to obtain a list of potential sites that meet the requirements for offsetting

    c. considering properties for sale in the area

    d. providing evidence of why offset sites are not feasible.

3) Development and contribution of funds for supplementary measures such as feral animal control, threatened species research and monitoring measures to be implemented through planning agreements.

4) For the remaining offset liability to be held for eventual transfer into the biodiversity offset fund (once established).

15.5.1 Offset requirements to achieve long-term conservation outcomes

The Framework for Biodiversity Assessment was used to inform the 'quantum' of biodiversity offsets required for the project. Four key elements were considered:

- direct impacts (988.8 hectares, split between direct impacts and areas subject to staged rehabilitation)
- indirect impacts (181.1 hectares)
- cumulative impacts from prior exploration activities (84.8 hectares, existing impacts in the project area from infrastructure that would be utilised by the project)

- staged rehabilitation (586.6 hectares, partial rehabilitation of linear and non-linear infrastructure areas).

The quantification of impacts and offset liability for both ecosystem and species credit species was undertaken, as outlined below.

Direct impacts of the project (988.8 hectares) were initially calculated to require 58,813 ecosystem credits to be offset, which is reduced to a total of 24,009 ecosystem credits when areas subject to staged rehabilitation are considered separately (586.6 hectares). Indirect impacts (181.1 hectares) were calculated to require an additional 3,366 ecosystem credits and cumulative impacts (84.8 hectares) were calculated to require an additional 5,233 ecosystem credits to be offset. Areas subject to staged rehabilitation following construction (586.6 hectares) require 23,505 ecosystem credits, which reduces the overall offset requirement for directly impacted areas by 19.2 per cent.

A total of 56,113 ecosystem credits are required to meet the outcomes of the Framework for Biodiversity Assessment. Using the OEH credit converter, which assumes an average Biobank site will generate 9.3 credits per hectare, the equivalent offset area is 6,034 hectares. This equates to a 6.1:1 offset ratio against a direct impact of 988.8 hectares or a 4.8:1 offset ratio against a combined direct, indirect and cumulative impact of 1,254.8 hectares.

Four threatened fauna species and nine threatened flora species recorded in the project area are listed as 'species credit' species under the Framework for Biodiversity Assessment. Credits required for flora species range from 43 to 147,272 credits. Credits required for fauna species range from 20,092 to 37,792 credits. *Bertya opponens* requires the largest number of flora credits to be offset, while *Hoplocephalus bitorquatus* (Pale-headed Snake) requires the greatest number of fauna credits to be offset.

Full detail on the offset quantification methodology and results are provided Appendix L of Appendix J1.

15.5.2 Biodiversity offset package

To deliver the above identified strategy, a biodiversity offset package is being proposed for the project that would contain a combination of the following:

- like-for-like offsets secured via an appropriate conservation mechanism including purchase and retirement of biodiversity credits (where available), protection under biobanking agreements, or reservation under the NSW *National Parks and Wildlife Act 1974*
- supplementary measures developed and funded through planning agreements under the NSW EP&A Act
- compensatory measures such as Koala research
- use of the NSW Biodiversity Offsets Fund for Major Projects for remaining offset liabilities (when established).

The availability and suitability of potential offset sites in the region would be investigated after submission of the EIS. This process would seek to meet the majority of the like-for-like offset liability of the project as far as practicable. The proponent is confident that suitable offsets will be available.

A range of supplementary measures were considered as part of the biodiversity offset package including a nil-tenure feral animal control strategy, weed control and prescribed burning. The proponent has committed to the development of a nil-tenure feral animal control strategy, which would be approximately equivalent to one-third of the total offset liability of the project in terms of both the native species expected to positively respond to the strategy (specifically those threatened fauna species requiring offsets) and total financial liability for offsets. The feral animal control strategy would initially focus on the forested

parts of the project area (including a five to 10 kilometre buffer) and would be implemented over a 20-year period.

The biodiversity offset package would also include compensatory measures, including a *Phascolarctos cinereus* (Koala) research proposal which would aim to determine the precise location and sizes of remnant Koala populations in the broader Pilliga region to inform conservation efforts for the population of this species.

Once land-based offsets and supplementary measures are finalised, the remaining offset liability for the project would be converted into a dollar figure and held for eventual transfer into the biodiversity offset fund (once established). The precise mechanism for holding the financial offset liability until the establishment of the biodiversity offset fund is yet to be determined, but may include preparation of a planning agreement or bond.

15.5.3 Statement of commitments

The following commitments are made with regard to the biodiversity offset strategy for the project:

- deliver biodiversity offsets which meet the offset quantum determined by the Framework for Biodiversity Assessment, including the development of an offset package which includes a combination of:
  - like-for-like offsets secured via an appropriate conservation mechanism
  - supplementary measures developed and funded through planning agreements
  - compensatory measures including Koala research
  - use of the NSW Biodiversity Offsets Fund for Major Projects for remaining offset liabilities (when established)
- prepare a Biodiversity Offset Management Plan that clearly outlines the responsible parties for the implementation of the plan, the works required to improve biodiversity values (including but not restricted to fire management, weed and feral animal control, erosion and sediment control, restrictions on access, and revegetation), performance criteria and a reporting and monitoring program in accordance with the *Biobanking Assessment Methodology* (OEH 2014e)
- prepare a nil-tenure feral animal control strategy, which would be approximately equivalent to one-third of the total offset liability of the project, which would address feral animal control at a landscape scale
- undertake reporting for land-based offsets owned and managed by the proponent in accordance with the *Biobanking Assessment Methodology* (OEH 2014e)
- undertake a periodic review of the Biodiversity Offset Management Plan every five years in accordance with the *Biobanking Assessment Methodology* (OEH 2014e).

Table 15-22 Environmental risk assessment

Potential Impact	Phase	Pre mitigated risk			Mitigation and management measure	Residual risk		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Vegetation disturbance has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Construction	Likely	Major	High	A Biodiversity Management Plan will be implemented and will include a Significant Species Management Plan. Vegetation clearance and threatened flora removal would be recorded to ensure it is within the approved limits. Vegetation will be cleared in accordance with the clearing procedure provided in Appendix H of Appendix J1 to minimise impacts to fauna during vegetation removal. The removal of hollow-bearing trees with a hollow of greater than 300 mm in diameter will be offset by a 1:1 replacement. Open trenches will be inspected each morning and where fauna is found it will be removed by a suitably qualified fauna handler. Data would be collected on the species captured, the number of individuals captured and capture locations. The disturbance limit for direct impact on native vegetation is 988.8 ha. To minimise clearing during sensitive periods, less than 50 per cent (494 ha) of the disturbance will be outside the	Likely	Moderate	Medium
	Operation	Remote	Moderate	Low		Remote	Moderate	Low
	Decommissioning	Remote	Moderate	Low		Remote	Moderate	Low
Decrease in habitat quality through fragmentation has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Construction	Likely	Major	High		Likely	Moderate	Medium
	Operation	Remote	Minor	Very Low		Remote	Minor	Very Low
	Decommissioning	Remote	Minor	Very Low		Remote	Minor	Very Low
Decrease in habitat quality through loss of habitat features has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Construction	Likely	Major	High		Likely	Moderate	Medium
	Operation	Remote	Minor	Very Low		Remote	Minor	Very Low
	Decommissioning	Remote	Minor	Very Low		Remote	Minor	Very Low
Decrease in habitat quality through weed invasion has impacts	Construction	Likely	Moderate	Medium		Possible	Minor	Low
	Operation	Likely	Moderate	Medium		Possible	Minor	Low

Potential Impact	Phase	Pre mitigated risk			Mitigation and management measure	Residual risk		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Decommissioning	Likely	Moderate	Medium	most preferred period from March to June, and less than 20 per cent (197 ha.) of this disturbance will be during the least preferred period from September to January.	Possible	Minor	Low
Decrease in habitat quality through feral fauna invasion has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Construction	Likely	Moderate	Medium	Rehabilitation of impacted areas will occur in accordance with the Rehabilitation Strategy (refer to Appendix V). Driving from dusk through to dawn will be minimised, due to high faunal activity. 'Fauna friendly' exclusion fencing (without barbed wire) will be installed around well sites during operation unless determined otherwise under a land access agreement. Lighting will be designed to meet Australian Standard AS 4282-1997 *Control of the obtrusive effects of outdoor lighting* and the Australian/New Zealand Standard AS/NZS 1158-2010 *Lighting for roads and public spaces for roadways and plant*, as applicable. The design and operation of night lighting would also consider the good lighting design principles documented in *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring* (NSW Department of Planning and Environment 2016).	Possible	Minor	Low
	Operation	Likely	Moderate	Medium		Possible	Minor	Low
	Decommissioning	Likely	Moderate	Medium		Possible	Minor	Low
Decrease in habitat quality through fire has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Construction	Remote	Major	Medium		Remote	Moderate	Low
	Operation	Remote	Major	Medium		Remote	Moderate	Low
	Decommissioning	Remote	Major	Medium		Remote	Moderate	Low
Decrease in habitat quality through erosion has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Construction	Likely	Moderate	Medium		Unlikely	Minor	Low
	Operation	Unlikely	Minor	Low		Unlikely	Minor	Low
	Decommissioning	Likely	Moderate	Medium		Unlikely	Minor	Low
	Construction	Likely	Moderate	Medium		Unlikely	Minor	Low

Potential Impact	Phase	Pre mitigated risk			Mitigation and management measure	Residual risk		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Decrease in habitat quality through dust has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Operation	Unlikely	Minor	Low	Prior to earthworks, weeds listed as noxious under the NSW *Noxious Weeds Act* 1993 that are present on the site will be removed or treated with herbicide to prevent or reduce their spread. Feral animals will be managed in accordance with a Pest Plant and Animal Control Plan. A biodiversity offset strategy will be finalised and implemented.	Unlikely	Minor	Low
	Decommissioning	Likely	Moderate	Medium		Unlikely	Minor	Low
Decrease in habitat quality through hydrological change has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Construction	Possible	Moderate	Medium		Unlikely	Minor	Low
	Operation	Unlikely	Minor	Low		Unlikely	Minor	Low
	Decommissioning	Possible	Moderate	Medium		Unlikely	Minor	Low
Decrease in habitat quality through accidental spills and leaks has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Construction	Likely	Major	High		Unlikely	Minor	Low
	Operation	Likely	Major	High		Unlikely	Minor	Low
	Decommissioning	Likely	Major	High		Unlikely	Minor	Low
Trench construction, has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Construction	Likely	Minor	Medium		Unlikely	Minor	Low
	Operation	Remote	Moderate	Low		Remote	Minor	Low
	Decommissioning	Remote	Moderate	Low		Remote	Minor	Low

Potential Impact	Phase	Pre mitigated risk			Mitigation and management measure	Residual risk		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Traffic or fence collision has impacts on native fauna (including those listed under TSC Act and / or EPBC Act)	Construction	Likely	Moderate	Medium		Possible	Minor	Low
	Operation	Likely	Moderate	Medium		Possible	Minor	Low
	Decommissioning	Likely	Moderate	Medium		Possible	Minor	Low
Chemical ingestion has impacts on native fauna (including those listed under TSC Act and / or EPBC Act)	Construction	Likely	Minor	Medium		Unlikely	Minor	Low
	Operation	Likely	Minor	Medium		Unlikely	Minor	Low
	Decommissioning	Remote	Minor	Very Low		Remote	Minor	Very Low
Hunting has impacts on native fauna (including those listed under TSC Act and / or EPBC Act)	Construction	Likely	Minor	Low		Possible	Minor	Low
	Operation	Likely	Minor	Low		Possible	Minor	Low
	Decommissioning	Likely	Minor	Low		Possible	Minor	Low

15.6 Conclusion

It is unlikely that the project would have a significant impact on threatened flora, threatened fauna or threatened ecological communities that are considered potential, likely or known to occur in the project area. This is primarily due to:

- the small proportion of habitat being removed relative to that retained in the project area
- the removal of habitat not being at a scale likely to result in the isolation or fragmentation of populations
- the unlikelihood that the project would result in invasive species or diseases becoming established
- and the progressive rehabilitation of disturbed areas as part of the project.

A number of avoidance and minimisation measures would be included in the design of the project to minimise the potential impacts on flora and fauna in the project area. These measures include:

- co-locating linear infrastructure such as gas and water gathering systems and access tracks with existing roads, access tracks and disturbance corridors
- placing infrastructure in previously cleared areas
- developing and implementing the Field Development Protocol and ecological scouting framework.

Additional mitigation and management measures (such as clearing vegetation in accordance with a pre-clearing and clearing procedure and rehabilitating cleared areas in accordance with a rehabilitation strategy) would further reduce the impact of the project on flora and fauna (including threatened and migratory species, populations and ecological communities).

The implementation of mitigation and management measures would be satisfactory to control and minimise the potential impacts of the project. The residual risk for each infrastructure component for the construction, operation and decommissioning phases of the project are summarised in Table 15-23.

Residual risks on threatened and migratory species and ecological communities would be offset as part of a biodiversity offset strategy in accordance with the *NSW Offsetting Principals* (OEH 2014f) and the *NSW Biodiversity Offsets Policy for Major Projects* (OEH 2014c).

Table 15-23 Terrestrial ecology residual risks

Potential impact	Residual risk		
	Construction	Operation	Decommissioning
Vegetation disturbance has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Medium	Low	Low
Decrease in habitat quality through fragmentation has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Medium	Very low	Very low
Decrease in habitat quality through loss of habitat features has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Medium	Very low	Very low
Decrease in habitat quality through weed invasion has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Low	Low	Low
Decrease in habitat quality through feral fauna invasion has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Low	Low	Low
Decrease in habitat quality through fire has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Low	Low	Low
Decrease in habitat quality through erosion has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Low	Low	Low
Decrease in habitat quality through dust has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Low	Low	Low
Decrease in habitat quality through hydrological change has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Low	Low	Low
Decrease in habitat quality through accidental spills and leaks has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Low	Low	Low
Trench construction, has impacts on native flora, fauna and ecological communities (including those listed under TSC Act and / or EPBC Act)	Low	Low	Low
Traffic or fence collision has impacts on native fauna (including those listed under TSC Act and / or EPBC Act)	Low	Low	Low
Chemical ingestion has impacts on native fauna (including those listed under TSC Act and / or EPBC Act)	Low	Low	Very low
Hunting has impacts on native fauna (including those listed under TSC Act and / or EPBC Act)	Low	Low	Low