- Disorientation and/or temporary blindness; and
- Interference with predator-prey relationships.

While the construction and operational phases of the Project will have some effect on the surrounding forest and woodland environment, the impacts from light pollution are likely to remain close to the immediate disturbance boundary of the operational pit, with only limited glare into the surrounding natural vegetation. It is likely that most fauna species would habituate to the periodic disturbance and light pollution from the mine is unlikely to have a significant or long-term impact on any fauna species.

Artificial light will diminish within areas that are progressively rehabilitated and, in the long term, light levels will return to normal following rehabilitation of the total mined area and cessation of mining.

4.3.5 Vehicle Strike

Vehicle strike can pose a significant risk to some wildlife, particularly but not exclusively ground dwelling species (Taylor and Goldingay, 2010). While some mobile species, such as birds, have the potential to move away from the path of clearing, other species that are less mobile, or those that are nocturnal and restricted to tree hollows, may have difficulty moving over relatively large distances. Pre-clearance surveys however, are likely to reduce the risk of mortality during clearing.

The Project will result in the construction of some additional roads and tracks which means an increased length of road for animals to cross and negotiate, as well as an increase in the number of vehicles operating in the Project Boundary. These changes are likely to increase the extent of vehicle strikes on native fauna, with an associated increase in mortality.

This is likely to be most significant during the construction phase, when vegetation and habitats are being cleared. This may also occur during the operation of the mine as a result of collision with vehicles entering and leaving the pit as well as during the normal daily movements of workers and vehicles throughout the site.

Although some mortality of animals as a result of vehicle strike is likely, it is not expected to be significant. The majority of the roads within the Project Boundary would not be able to be traversed at high speed due to the terrain, and animals are expected to be able to avoid vehicles. Appropriate signage and careful driving policies will increase the awareness of drivers and decrease the risk further.

The risk of vehicle strike will diminish as areas that are progressively rehabilitated will return to current levels following rehabilitation of the total mined area and cessation of mining.

4.3.6 Dust

Construction and mining activities have the ability to generate dust, which may impact on the ecology within the Project Boundary in a number of ways.

Dust that settles can accumulate on leaf surfaces and reduce essential physiological processes including photosynthesis, respiration, and transpiration. It can also permit the penetration of phytotoxic gaseous pollutants (Farmer, 1993).

Dust can also produce physical effects on plants such as blockage and damage to stomata, shading, abrasion of leaf surface or cuticle. This can result in cumulative effects e.g. drought stress on already stressed species. This can result in decreased plant health, and even death in extreme circumstances. Decreased growth and vigour of plants may mean that they are more susceptible to pathogens and other disturbance, and these plants are more likely to be subject to increased mortality. Such impacts to individual plants generally result in decreased productivity and can result in changes in vegetation and so community structure (Farmer, 1993).

The effect of dust deposition also affects animals that use plants, either as a source of food or habitat. Dust on the foliage and fruit may reduce palatability to animals and decreased health of trees and changed community structure results in a reduction in the amount of available habitat.

In common with the impacts caused by noise, dust pollution can lead to a decrease in habitat quality which has the potential to extend the area of impact beyond the area directly disturbed by the mine.

With regard to the Project Boundary, dust could impact vegetation within Box Gum Woodland and Ironbark forest, reducing health of some species along the edge of mined areas. It could also impact upon potential foraging resources for wildlife, including threatened birds and bats. Dust will diminish within areas that are progressively rehabilitated and, in the long term, dust levels should return to normal following rehabilitation of the total mined area and cessation of mining.

4.3.7 Erosion

The Project has the potential to increase the amount of erosion occurring in the Project Boundary through the construction of roads, tracks, and infrastructure. The four types of water erosion of soil are sheet, rill, gully, and tunnel (Harpstead et al., 2001). Sheet erosion is the uniform removal of soil without the development of visible water channels and is the least apparent of the four erosion types. Rill erosion is soil removal through the cutting of many small, but conspicuous, channels. Gully erosion is the consequence of water that cuts down into the soil along the line of flow and this type of erosion develops more quickly in places like tracks and animal trails. Tunnel erosion may occur in soils with sublayers that have a greater tendency to transport flowing water than does the surface layer.

The effects of erosion can already be seen within the Project Boundary, particularly in and around the Leard State Forest access roads that have been created, mostly consisting of gully erosion. During wet periods large volumes of rain wash away any disturbed earth relatively easily. This results in sedimentation and increased turbidity of streams and has particular impacts on the aquatic environment; although that is beyond the scope of this report. The Project will result in the creation of many more roads and tracks throughout the Project Boundary, with an associated likely increase in the amount of gully erosion and consequent impacts.

Sheet and rill erosion is likely to occur where large areas are cleared, particularly on hillsides. Where there is no obvious existing channel for the water to follow, it will form rills or just flow overland. This kind of erosion is likely to be exacerbated by any kind of clearance for the mine and infrastructure.

4.3.8 Weeds, Feral Animals and Overabundant Native Species

Alterations to habitat conditions often favour introduced and/or hardy native plant and animal species that can proliferate in disturbed conditions. Such species have potential to impact upon the original local native plant and animal species. Weeds such as thistles and other introduced plants have potential to outcompete regenerating native plant species. Feral animals such as foxes, rabbits and some species of birds can also breed in the more open areas following clearance of forest and woodland. They can cause problems for native fauna species by preying upon them or by competing with them for food and resources.

As mentioned previously, the presence of the feral fox is likely to be a key factor in the low numbers and diversity of ground-dwelling fauna in Leard State Forest as they have long been recognised to be a major contributor to the decline of ground-nesting birds, small to medium mammals and reptiles (SEWPaC, 2010b). Feral pigs are also known to prey on frogs, reptiles, birds and small mammals (DEC (NSW), 2005x) as well as degrade habitat by:

- Feeding selectively on plant communities;
- Creating drainage channels in swamps;
- Eroding soil and fouling watering points with their wallowing; and
- Spreading weeds and possibly disease, such as foot and mouth disease.

Some native fauna such as the Eastern Grey Kangaroo can become prolific on mine areas as access by the public, including hunters, is denied. Overabundant native animals can cause overgrazing and other related problems.

4.4 Impacts to the Namoi River

The Project will occur predominantly in areas located away from the Namoi River and its floodplain, so will have limited potential to impact the Aquatic Ecological Community within the Namoi River that is listed as an EEC. However, the Project holds the relevant licences to construct a pump station and extract up to 3000 units of High Security water from the Namoi River. The location of the pump station and associated pipeline on the Namoi River floodplain and the licensed water extraction could potentially impact upon this EEC.

4.4.1 Pipeline and Pump Construction and Management

The clearing needed for installation and maintenance of the pipeline and pump station are minimal and will not have a significant impact upon threatened flora and fauna.

The route of pipeline and the pump station that it will link to, which are proposed to be constructed along the Namoi River, are shown in **Figure 1.3**. The proposed pipeline route and the location for the pump station have been inspected by Cumberland Ecology during field surveys. The pipeline and pump station will not entail extensive tree clearance and will be located in areas covered mainly by exotic grasses and herbaceous plants on the floodplain. There will be no disturbance to fish habitats such as billabongs and no clearance of threatened species habitat.

One threatened frog species, Sloane's Froglet (*Crinia sloanei*), which is listed as Vulnerable under the TSC Act, is known to occur in the locality and has been found on heavy soils adjacent to Maules Creek, near to the Project Boundary. This froglet is typically associated with areas in grassland, woodland and disturbed habitats (NSW Scientific Committee, 2008). Although it has not been found on the highly modified areas of Namoi River floodplain in the vicinity of the pipeline, it has potential to occur there. However, as the pipeline and pump station have a small footprint and will be constructed largely on relatively dry, modified areas of the floodplain, no significant impacts upon this species are likely to occur as a result of the Project.

4.4.2 Impacts of Water Extraction

No significant ecological impacts are predicted to occur as a result of the proposed extraction of waters from the Namoi River, though the Project will be one of many licensed users of the river that collectively contribute to modified ecological conditions within the river. Such riverine impacts are monitored by various government agencies including the Department of Fisheries and OEH.

The Project intends to utlise the existing water extraction licence. Aston holds a High Security water licence and so extraction will occur as required. Therefore, the Project will potentially impact upon the Aquatic Ecological Community of the Namoi ("the aquatic EEC") by using waters that would otherwise be available for river life. This will contribute to the impacts upon the ecology of the Namoi River that result from other water extractions.

The Project will therefore contribute to cumulative aquatic impact upon fish, macroinvertebrates, water birds, water plants and riparian plants associated with downstream areas of the Namoi. This will be caused soley by removing water from the river that would otherwise be available to river life.

Water use in the Namoi is subject to the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water (DIPNR, 2004). The Project will therefore be one of a large number of legal water extractors from the river, and the collective ecological impacts will be monitored by Industry and Investment (which includes Fisheries), OEH and other government agencies.

The Water Sharing Plan commenced on 1 July 2004 and applies for a period of ten years to 30 June 2014. It is a legal document made under the Water Management Act 2000 (WM Act).

According to the Guide to the plan, "*the volume and pattern of flows in the Namoi River have been significantly altered by the extraction of water and the operation of these water storages and other water control structures. The frequency of all but the largest flood events in the Namoi catchment has been reduced. Flows at the end of the system are also lower. Average monthly flows in summer have increased and average monthly flows in winter have decreased. These changes have impacted on the environmental health of the river and its wetlands and contributed to water quality problems*."

The provisions in the Plan provide water for the environmental needs of the river and its ecological processes and direct how water available for extraction is to be shared. The Plan also establishes rules for the management of access licences, water allocation accounts, the trading of or dealings in licences and waterallocations, the extraction of water, the operation of dams and the management of water flows. The vision of the Plan is to have a sustainable, healthy river system that provides equitable water access for all users through flow management.

According to the Guide published for the plan (DIPNR, 2004) the rules of the Water Sharing Plan are put into effect via 8 key steps as follows:

> *STEP 1 – ESTABLISH THE FLOW RELATIONSHIPS OF THE RIVER AND ECOLOGICAL PROCESSES*
>
> *Based on historical flow records and known physical processes of the river, construct a hydrological model to analyse options for river management* ↓
>
> *STEP 2 – PROVIDE WATER FOR THE ENVIRONMENT*
>
> *Establish key environmental features of the river and devise flow related rules to provide water to sustain or improve those features Part 3– environmental water provisions* ↓
>
> *STEP 3 – PROVIDE WATER FOR BASIC LANDHOLDER RIGHTS*

Estimate total requirements for domestic and stock rights and native title rights.

Part 4 – basic landholder rights ↓

STEP 4 – DETERMINE ACCESS LICENCE REQUIREMENTS

Assess the total share volumes of all access licences and rules for granting of any additional access licences.

Part 6 – requirements for water under access licences, and Part 7 – rules for granting access licences ↓

STEP 5 – SET LIMITS ON WATER FOR EXTRACTION AND SHARE THAT BETWEEN DIFFERENT WATER USERS

Set a limit on the water for extraction on an average yearly basis and the rules for managing to these limits. Specify how the water that is available will be shared between all access licences Part 8 (Division 1) - long-term extraction limit, and Part 8 (Division 2) – available water determinations ↓.

STEP 6 – PROVIDE FLEXIBILITY FOR ACCESS LICENCE HOLDERS

Set rules on how water accounts are to be managed and define the trading arrangements Part 9 (Division 2) – water allocation account management, and Part 10 – access licence dealing rules ↓.

STEP 7 – PROVIDE CLEAR LICENSED RIGHTS

Translate Steps 5 and 6 into mandatory conditions on individual access licences and approvals, and specify any system operation rules, and if and how a plan rule can be amended Part 11 – mandatory conditions, Part 12 – system operation rules, and Part 14 – amendment of this plan ↓.

STEP 8 – MONITOR PLAN

Review the implementation of the Plan each year and audit performance of the Plan mid-term (year 5). Part 13 – monitoring and reporting

The impacts of water allocations within the Namoi River have already been considered by the Government and the collective impacts of the Water Sharing Plan are being monitored.

4.5 Groundwater Dependent Ecosystems

No groundwater dependant ecosystems have been identified to occur within the Project Boundary. Back Creek contains Melaleuca Riparian Forests along the fringes of this ephemeral drainage line and its tributaries (see **Section 3.2.4**). Such vegetation does not

appear to be sustained by groundwater as the groundstratum of vegetation is similar to the surrounding communities that occur on the lower slopes of nearby hillsides.

Field observations made by Cumberland Ecology suggest that it is probable that the dominant shrub *Melaleuca bracteata* draws water from perched water tables amid the alluvium of the dry creek systems. The root systems appear to be relatively shallow and concentrated in the top 1-2 m of soil/alluvium. However, the precise nature of groundwater dependence, and the interactions between surface and groundwaters in the Namoi Catchment (including Maules Creek and Back Creek) is not well understood at present (Kelly et al., 2007).

The groundwater impact assessment (AGE, 2011) predicts a zone of depressurisation that extends beyond the Project Boundary beneath the Back Creek which is located on the northern edge of the Project Boundary. No impact is predicted around Maules Creek Modelling shows that there are some areas in the vicinity of Back Creek where existing ground water levels maybe as close as 2 m below the soil surface, although the ground water study for the EA concluded that this may overestimate the proximity of the groundwater to the surface (AGE, 2011).

Although it seems unlikely based upon field observations and groundwater modelling, the Melaleuca Riparian Forest has some potential be impacted should the Projects groundwater depressurisation zone intercept groundwater from the perched water tables along Back Creek. If impacts occur, they could entail dieback of the dominant shrub, *Melaleuca bracteata* and loss of some mesic ground covers, such as the herb *Lomandra longifolia.* No threatened species are dependent upon this community and such impacts are considered likely to be highly localised to sections of Back Creek.

4.6 Impacts on Threatened Species

4.6.1 Project Impacts on Threatened Flora Species

Floristic searches for significant and threatened plant species throughout Leard State Forest and the immediate surrounds since the early 1980s have identified very few threatened species. Only two threatened species, *Pomaderris queenslandica* and *Pultenaea setulosa*, have been found within Leard State Forest (Parsons Brinckerhoff Australia Pty Ltd, 2010) and these species have not been found within the Project Boundary. A third species, *Lepidium aschersonii*, is known from the nearby Leard State Conservation Area (OEH (NSW), 2011).

Notwithstanding this, potential habitat exists for these and other threatened plant species in the Project Boundary. However, on current cumulative data dating back to the early 1980s, there are no known or sizable populations within the Project Boundary despite the availability of suitable habitat.

There is little information published on the ecology of *Pultenaea setulosa* but based on herbarium records, the species has a reported natural range that extends from the southern tablelands of NSW to the Marlborough area in Queensland (de Kok and West,

2002). However, the Conservation Advice for the species (Threatened Species Scientific Committee, 2008b) only recognises one broad area of occurrence in the species' NSW distribution and this is the Nandewar Ranges. This makes the local occurrence of *Pultenaea setulosa* in the wider study area as well as the occurrence of suitable habitat within the Project Boundary locally important. The major threat to *Pultenaea setulosa* is recognised to be the destruction of individuals and disturbance of habitat through mining activities and associated infrastructure and development. On current information, no known individuals will be removed by the Project, although ostensibly suitable habitat will be cleared by the Project.

The *Pomaderris queenslandica* specimen recorded from the Boggabri Coal study (Parsons Brinckerhoff Australia Pty Ltd, 2010) was found in sheltered, south-facing gully pockets in the central portion of Leard State Forest. Potential habitat for this species occurs within the Project Boundary in pockets of sheltered shrubby woodland and along creeks, but has not been located during targeted surveys within the Project Boundary. The *Pomaderris* group tend to occur in low numbers in localised distributions, making populations highly susceptible to natural stochastic events and clearing. Although records have not been found within the Project Boundary, suitable habitat will be cleared for these species for which records are known nearby.

Lepidium aschersonii has suffered a large contraction in its natural range since the 1950s and it now occurs as patchily distributed and isolated populations, mostly in NSW and Victoria (Carter, 2010). The species has been predominantly affected by habitat loss and continued degradation of habitat due to agricultural development but is also under major threat by weed invasion, grazing practices, altered hydrology and roadworks. Within NSW, the species appears to have a stronghold in the Narrabri LGA, with most of the known populations occurring along roadsides and in private properties (DEC (NSW), 2005f1, Carter, 2010). The number of occurrences along roadsides puts the species at particular risk from roadworks, firebreak construction and utilities installation and maintenance (Carter, 2010). Although there are no records for the species within the Project Boundary, the locality is known to support occurrences of this species. Therefore, potentially suitable habitat for this species will be cleared.

A summary of the potential impacts to these species as a result of the Project is provided in **Table 4.3** below and Formal Assessments of Significance are provided in **Appendix I**.

4.6.2 Project Impacts on Threatened Fauna Species

Recent Cumberland Ecology surveys recorded a total of 18 threatened fauna species within the Project Boundary, including sixteen bird and two mammal species. A summary of the potential impacts to these species as a result of the Project is provided in **Table 4.3** and is discussed in the following sections. Formal Assessments of Significance are provided in **Appendix I**.

i. Blossom-dependant birds

As discussed in the previous chapter, a suite of blossom-dependent migratory or nomadic birds occur or have potential to occur in the treed habitats of the Project Boundary:

- Painted Honeyeater (*Grantiella picta*) (Vulnerable under the TSC Act);
- Little Lorikeet (*Glossopsitta pusilla*) (Vulnerable under the TSC Act);
- Swift Parrot; and
- Regent Honeyeater.

The flowering resources within Leard State Forest and Leard State Conservation Area are likely to be locally significant because the vegetation in these areas represent islands of foraging habitat in a largely cleared agricultural district. Blossom feeding species rely on an abundance of blossoms year round, and migratory blossom feeders rely particularly on mass flowering events to fuel their migration to the next resource patch. Drought periods and poor flowering seasons can increase the significance of remaining patches of intact woodland and forest, and it is highly probable that the vegetation in the Leard State Conservation Area and Leard State Forest were important during the drought period of the mid 1990s for some species.

Swift Parrots and Regent Honeyeaters are migratory and have potential to occur in the area of the Project, generally anytime during the austral winter. Swift Parrots breed in Tasmania but rely on foraging resources on the mainland during winter. Swift Parrots are known from Mount Kaputar National Park (DEC (NSW), 2006b) and Regent Honeyeaters have been reliably detected in the Bundarra-Barraba area and Warrumbungle National Park from 1994 to 1997 (Oliver, 1998, 2000). Both species are predominantly nectarivorous, although psyllid lerps and invertebrates form a significant proportion of the diet of both species, especially during poor flowering seasons (Oliver, 2000, Kennedy and Tzaros, 2005). Both species are reliant on box/ironbark woodlands for foraging and birds are strongly associated with flowering and lerp bearing *Eucalyptus* spp. (Saunders and Heinsohn, 2008).

The forest, woodland and scattered paddock trees within Leard State Forest and surrounding farmlands support mature and/or old regenerating *Eucalyptus* spp. that produce nectar and support psyllid lerps. Regent Honeyeaters, in particular, forage in the canopy tops of taller trees and thus mature trees are an important component of the forest and woodland matrix (Oliver, 2000). Interestingly, the species has been observed to roost in saplings of a variety of tree species and rarely use roost trees for feed trees (Oliver, 1998). This suggests that the area of habitat required by the Regent Honeyeater could be more extensive than for some other similar species.

The loss of a large proportion of the forest and woodland in the Project Boundary is likely to represent a significant loss of locally important foraging and roosting habitat for the various blossom-dependant birds, if the clearance is not staged and if no actions are taken to replace that loss in the short term as the clearance takes place. Longer term objectives

to replace the loss of vegetation with mature woodland and forest trees should be realised as part of the Project to maintain/increase current levels of foraging resources in the area.

ii. Woodland Birds

Some of the processes that are perceived to be most responsible for the decline in populations of woodland birds in NSW are (a) increasing fragmentation, and (b) diminishing sizes of woodland patches in the fertile wheat belt of western NSW (Reid, 1999). The species that are most at risk appear to be mainly passerine species, particularly as many are ground-feeding, insectivorous, and sedentary (Reid, 1999). These characteristics likely render these woodland birds more susceptible to direct habitat loss and landscape fragmentation because they are less able to disperse to other patches of remnant woodland. As a keynote species for declining woodland birds (Doerr et al. 2011), the Brown Treecreeper demonstrates that woodland birds have limited capacity for dispersal, with a maximum gap-crossing threshold of less than 100 m (Cooper et al. 2002, Doerr et al. 2011). Similarly, Grey-crowned Babblers, for example, were recorded in a recent study moving less than 900 m (Blackmore et al. 2011).

Reduction of woodland patches below a critical size can eliminate or significantly reduce the population of some species. For example, research into the capacity of Speckled Warblers to persist in fragmented habitat suggests that small isolated populations are most at risk of extinction in the long term; in Canberra, the bird was more likely to decrease in numbers in patches below 200-400 ha (Gardner and Heinsohn 2007).

Where populations are able to disperse to nearby patches, increasing intraspecific and interspecific competition for space and resources (e.g. Maron et al., 2011) and increased exposure to predation (Ford, 2011) can become big drivers of continuing decline. Equally important to direct loss is the degredation of remaining patches of habitat from key threatening processes that facilitates further decline, including:

- Land degradation, particularly salinity, dieback and decreasing fertility (Watson, 2011);
- Collection of timber for fuelwood;
- Grazing by feral herbivores and agricultural stock;
- Weed invasions;
- Loss of and competition for hollows;
- Lack of or limited regeneration in remnants; and
- Predation by feral carnivores.

Many woodland bird species are dependent on tree hollows for nesting. Such holes take many decades to develop, with the largest hollows taking over 150 years on average to form (Mackowski, 1984). In a closely related species to the Brown Treecreeper (i.e. the

Rufous Treecreeper), the availability of nesting sites exerted a strong influence on habitat use (Luck 2002). The mature box trees within the Project Boundary both within remnants and scattered paddock trees contain tree hollows and are likely to represent a significant nesting resource for local woodland birds and scattered paddock trees are known to be a keystone resource in disturbed and fragmented landscapes (Fischer and Lindenmayer, 2002, Gibbons and Boak, 2002, Gibbons et al., 2008). The abundance of scattered paddock trees in adjacent farmlands is likely to facilitate some dispersal to nearby sites like the Leard State Conservation Area, and this is an important factor for the persistence of these woodland bird species in the long term, including reducing inbreeding depression (Sunnucks, 2011).

For all the reasons above, the forest and woodland habitat within Leard State Forest are likely to constitute important local habitat for many of the threatened woodland birds detected in the Project Boundary. Without staged clearance of the vegetation to minimise the loss at any one time, and without actions to replace that loss in the short term as the clearance takes place, the Project will result in a significant loss of foraging, shelter and breeding habitat for the woodland birds present in the Project Boundary. Maintenence or re-establishment of scattered trees in large clearings around the Project Boundary are likely to be a valuable component of any restoration/rehabilitation works to provide dispersal avenues for woodland birds into surrounding remnant vegetation, such as in the Leard State Conservation Area. Longer term objectives to replace the loss of vegetation with mature woodland and forest trees should be realised as part of the Project to maintain/increase current levels of foraging resources in the area.

iii. Raptors

Many raptor species are reliant on very large territories for foraging and nesting. Many species occupy a large home range that include both remnant forest/woodland and grassland habitats (Debus 1984) and are generally tolerant of agricultural landscapes providing there is some woodland habitat available for nesting (Marchant and Higgins 1993). Species such as the Little Eagle hunt primarily rabbits in disturbed areas but in undisturbed habitat the prey species also includes marsupials and birds (Olsen et al. 2010). The Masked Owl is also tolerant of disturbed areas and has a close association with drier, unlogged, or selectively logged forests (Kavanagh, 2002). Thus, the vegetation within the Project Boundary is likely to support both potential breeding sites (tall remnant trees) and foraging resources (abundant mammal and bird prey) for these species.

The main risk to birds of prey in general, particularly owl species, is that they often have a requirement for nesting in large hollows, which are typically a very limiting resource in fragmented and disturbed landscapes. Considering that there is a relatively low proportion of large hollows in the Project Boundary (see **Section 3.4.1iv**), the loss of remaining hollows and future hollows may be important for the raptor species recorded in the Project Boundary. It is possible that these species, particularly Masked Owl, could lose actual or potential nest sites within the Project Boundary, although no nest sites have been identified in this area to date. Furthermore, the loss of wooded habitat represents the potential loss of a varied diet if prey species decline or disperse to other areas.

The Project has potential to put local populations of species like the Little Eagle or the Masked Owl at risk in the short term. However, local occurrences of the species may be at risk from loss of hollow trees and feeding areas. Measures should be taken to replace hollow-bearing trees with future-hollow bearing trees in the vicinity of the Project. Rehabilitation within proximity of the Project Boundary should take place to ensure that these species do not lose substantial foraging resources or future nesting. If the landscape is rehabilitated and replanted to forest and woodland species, such bird species are likely to maintain their presence in the locality in the long term.

iv. Migratory birds

The Project Boundary provides suitable forage habitat for the Rainbow Bee-eater and for the Regent Honeyeater. No records exist to show that the latter species occurs in the Leard State Forest. Given the Australia-wide range of the Rainbow Bee-eater, the abundance of suitable foraging habitat in the locality and the absence of suitable breeding habitat within the Project Boundary; it is unlikely that the Project will result in any significant impacts on this species.

v. Microbats

On a local scale, without mitigation, the Project is likely to remove substantial habitat for microbats, including tree hollows used for shelter, potentially rock overhangs in some limited areas, and extensive areas of forest and woodland used for foraging. The Project is likely to have a significant impact upon tree roosting species of microbats and possibly, to a lesser extent, cave roosting species including the Little Bentwing-bat or the Eastern Bentwing-bat. Habitats for species of microbats are likely to remain extensive in the subregion and region.

vi. Koala Habitat

No Koala were detected during the site surveys and the data collected from the SAT surveys indicates that this species makes, at most, very limited use of the Project Boundary. No evidence of a permanent resident population of Koala were found. The Project will clear low quality habitats with little or no use by Koala except for periodic use as a corridor to move to other habitats.

The dominant trees across a high proportion of the woodland and open forest within the Project Boundary include species that are regarded as important secondary feed species such as White Box (*Eucalyptus albens*). Primary Browse trees include River Red Gum (*Eucalyptus camaldulensis*) which does not occur in significant numbers within the Project Boundary.

4.6.3 Summary of Impacts on Threatened Species

The following table presents a summary of the potential impacts on threatened species based on the potential direct and indirect impacts to species habitat. It compares the area of direct and indirect impact for each threatened species that is known or is likely to occur within Leard State Forest against the area of habitat in the Project Boundary, locality and

sub-bioregion (Liverpool Plains sub-bioregion). Areas of indirect impact have been calculated on the residual vegetation that will not be cleared by the Project. For a definition of locality, please refer to the terms and abbreviations in **Section 1.4**.

Table 4.3 uses the following keys:

Status			*Preferred Habitat*		
V	=	Vulnerable	**F**	=	forest
E	=	Endangered	**W**	=	woodland
M	=	Migratory	**G**	=	grassland
CE	=	Critically Endangered	**Wtld**	=	Wetland

The estimates of potential habitat within the locality assume that approximately 40% is comprised of forest and woodland, 59% is grassland and less than 1% is wetland habitat. It also estimates that less than half of the extant forest and woodland within the locality represents various forms of CEEC Box Gum Woodland.

The Project Boundary is located within the Liverpool Plains sub-bioregion, which lies within the Namoi River Catchment. The total area of the sub-bioregion is approximately 1.2 million ha, of which 1.06 million ha is being managed for agricultural purposes (Scott *et al*., 2004). According to URS Australia Pty Ltd. (2001), 36% of agricultural land is under dry land cropping, 4.5% under irrigation, 7.5% under improved pasture, 35% is under native pasture and 17% is under timbered native vegetation. It is assumed that the remaining areas of the sub-bioregion not under agricultural land use include another 10% of extant timbered native vegetation to account for State Forests; travelling stock reserves; and national parks and reserves managed for conservation.

Based on the above proportions, estimates of potential habitat within the sub-bioregion region have relied on the following proportions: 30% woodland and forest, approximately 43% grassland (improved pasture and native pasture) and 1% wetland. However, to better reflect the proportion of CEEC Box Gum Woodland in the sub-bioregion, the estimates assume that it represents approximately 10% of the extant vegetation. The areas of cropping and irrigation have been considered to be in too altered a state to provide habitat for most flora and fauna and have been conservatively excluded from the habitat estimates, although this is acknowledged to be a crude assumption. In the same way, the residual non-timbered areas of the sub-bioregion (i.e. cleared areas in the sub-bioregion that are not under agricultural use) have been conservatively excluded from the calculations to reach an under-estimate of the likely areas of habitat available in the sub-bioregion.

Note that it is assumed that 10% of the extant forest and woodland constitutes habitat for the Koala.

The summary shows that whilst the Project will result in the loss of habitat for threatened species relevant to the Project Boundary, there will be a sizable proportion remaining in the locality and in the region. If offsetting and mitigation measures are implemented, then the Project is unlikely to significantly impact the occurrence of these species and communities in the locality or region in the medium to long term.

Table 4.3 Summary of Project Impacts on Threatened Species and Ecological Communities

Scientific Name	*Status		LGA Count	Detected in Project Boundary and immediate surrounds	Preferred Habitat	Area of direct Impact on Habitat (ha)	Total Area in Project Boundary (ha)	#Area Indirectly Impacted (ha)	Est. Abundance of habitat locally (ha)	Est. Abundance of habitat regionally (ha)
	TSC	EPBC								
AVES										
Pyrrholaemus saggitatus	V		136	Yes	F, W	1665	2728	1063	>50000	~318000
Circus assimilis	V		4	Yes	F, W, G	2079	3373	1294	125600	~784400
Hieraaetus morphnoides	V		19	Yes	F, W, G	2079	3373	1294	125600	~784400
Lophoictinia isura	V		14	Yes	F, W, G	2079	3373	1294	125600	~784400
Apus pacificus		M	1	Yes	F, W, G	2079	3373	1294	125600	~784400
Hirundapus caudacutus		M	30	Yes	F, W, G	2079	3373	1294	125600	~784400
Artamus superciliosus	V		23	Yes	F, W	1665	2728	1063	>50000	~318000
Ephippiorhynchus asiaticus	E		7	Yes	Wtld	<0.5	<0.5	<0.5	<1256	~10600
Climacteris picumnus	V		92	Yes	F, W	1665	2728	1063	>50000	~318000
Stagonopleura guttata	V		17	Yes	F, W	1665	2728	1063	>50000	~318000
Grantiella picta	V		21	Yes	F, W	1665	2728	1063	>50000	~318000
Melithreptus gularis gularis	V		4	Yes	F, W	1665	2728	1063	>50000	~318000
Xanthomyza phrygia	E	E,M	7	No	F, W	1665	2728	1063	>50000	~318000
Merops ornatus		M	75	Yes	F, W	1665	2728	1063	>50000	~318000
Myiagra cyanoleuca		M	9	Yes	F, W	1665	2728	1063	>50000	~318000

Table 4.3 Summary of Project Impacts on Threatened Species and Ecological Communities

Scientific Name	*Status		LGA Count	Detected in Project Boundary and immediate surrounds	Preferred Habitat	Area of direct Impact on Habitat (ha)	Total Area in Project Boundary (ha)	#Area Indirectly Impacted (ha)	Est. Abundance of habitat locally (ha)	Est. Abundance of habitat regionally (ha)
	TSC	EPBC								
Daphoenositta chrysoptera	V		35	Yes	F, W	1665	2728	1063	>50000	~318000
Melanodryas cucullata	V		22	Yes	F, W	1665	2728	1063	>50000	~318000
Pomatostomus temporalis temporalis	V		130	Yes	F, W, G	2079	3373	1294	>50000	~784400
Glossopsitta pusilla	V		38	Yes	F, W	1665	2728	1063	>50000	~318000
Lathamus discolor	E	E	0	No	F, W	1665	2728	1063	>50000	~318000
Neophema pulchella	V		114	Yes	F, W	1665	2728	1063	>50000	~318000
Ninox connivens	V		129	Yes	F, W	1665	2728	1063	>50000	~318000
Tyto novaehollandiae	V		8	Yes	F, W	1665	2728	1063	>50000	~318000
MAMMALIA										
Saccolaimus flaviventris	V		46	Yes	F, W	1665	2728	1063	>50000	~318000
Phascolarctos cinereus	V		344	Yes	F, W	1665	2728	1063	>10000	~100000
Chalinolobus picatus	V		6	Yes	F, W	1665	2728	1063	>50000	~318000
Falsistrellus tasmaniensis	V		1	Yes	F, W	1665	2728	1063	>50000	~318000
Miniopterus schreibersii oceanensis	V		7	Yes	F, W	1665	2728	1063	>50000	~318000
Nyctophilus timoriensis	V	V	52	Yes	F, W	1665	2728	1063	>50000	~318000
Vespadelus troughtoni	V		2	Yes	F, W	1665	2728	1063	>50000	~318000

Table 4.3 Summary of Project Impacts on Threatened Species and Ecological Communities

Scientific Name	*Status		LGA Count	Detected in Project Boundary and immediate surrounds	Preferred Habitat	Area of direct Impact on Habitat (ha)	Total Area in Project Boundary (ha)	#Area Indirectly Impacted (ha)	Est. Abundance of habitat locally (ha)	Est. Abundance of habitat regionally (ha)
	TSC	EPBC								
						1665	2728	1063	>50000	~318000
PLANTS						1665	2728	1063	>50000	~318000
Pultenaea setulosa		V		Yes	F, W	1665	2728	1063	>50000	~318000
Pomaderris queenslandica	E			Yes	F, W	1665	2728	1063	>50000	~318000
ECOLOGICAL COMMUNITIES										
Box Gum Woodland and Derived Native Grassland	CE	CE		Yes		544	944	400	<25000	<100000
Plains Grassland	E	CE		Yes		0	1	1	no data - rare	no data - rare

**V = Vulnerable; E = Endangered; CE = Critically Endangered; M = Migratory*

#Residual vegetation (i.e. Total vegetation in Project Boundary – direct impacts on habitat)

4.7 Project Impacts on Other Fauna Species

4.7.1 Amphibians

A total of 13 amphibian species were recorded from within the Project Boundary during the current and previous surveys. None of these amphibians is listed as threatened under Commonwealth or State legislation.

All amphibian habitats described as occurring within the Project Boundary are also commonly represented in the wider locality, including nearby protected areas. Numerous surveys have been conducted within the Project Boundary since 1979. None of these surveys have recorded any of the threatened amphibians known to occur in the locality, despite targeted efforts. Although the Project will result in the removal of foraging and breeding habitat for common amphibians it is unlikely that this will result in any significant impacts on these species in the wider locality.

4.7.2 Reptiles

A total of 49 reptile species have been recorded within the Project Boundary during surveys conducted since 1979. No reptiles listed as threatened under Commonwealth or NSW legislation were recorded, and none are likely to occur in the locality.

All reptile habitats described as occurring within the Project Boundary are also commonly represented in the wider locality, including nearby protected areas. As with amphibians, the Project will result in the removal of foraging and breeding habitat for common reptiles. However, it is unlikely that this will result in any significant impacts on these species in the subregion.

4.7.3 Birds

A total of 170 bird species have been recorded within the Project Boundary during surveys conducted since 1979. This included a number of birds that are listed as threatened under both the EPBC Act and TSC Act.

The Project will result in the removal of approximately 1664.8 ha of treed foraging and/or breeding habitat for common birds. Given the extent of woodland habitat to be removed, it is likely that this will result in some impacts on common woodland-dependant birds that currently occupy the Project Boundary. However, a significant portion of woodland habitat will still remain to the west of the Project Boundary. Some areas of woodland habitat also remain in the wider locality. Therefore, due to the areas of adjacent habitat as well as the staged clearing of the mine combined with further mitigatory actions, outlined in **Chapter 5**, to be under taken the overall impacts on common birds in the wider locality is not expected to be significant.

4.7.4 Mammals

A total of 37 mammal species have been recorded from within the Project Boundary during current and previous surveys conducted between 1979 and present (James B. Croft & Associates, 1979, Dames & Moore, 1983a, Parsons Brinckerhoff Australia Pty Ltd, 2010). The Project will result in the removal of up to 1664.8 ha of treed foraging, breeding and shelter habitat for common mammals. As few of the common mammals occurring within the Project Boundary are woodland-dependant species, it is unlikely that the removal of habitat under the Project will result in any significant impacts on common mammal species in the wider locality.

4.8 Cumulative Impacts

4.8.1 Local Scale

Cumulative impacts result when many small-scale alterations to the environment combine to cause an overall greater level of impact. Cumulative impacts can arise from either persistent losses of one resource, or the compounding effects of two or more impacts (Lindenmayer, 2006). Impacts that may be insignificant on their own may be significant when considered together with other actions being undertaken as part of the same Project.

Extensive vegetation clearing has already occurred in the locality as a result of agriculture, forestry, and other mining projects. These processes are still occurring and impacting the area, and the broad scale vegetation clearance that will occur as a result of the Project will exacerbate these existing ecological impacts. If no mitigation or compensatory measures are provided, this will result in cumulative impacts on flora and fauna as habitats are further reduced and fragmented.

Coal mining is currently taking place in other portions of Leard State Forest and nearby country. When preparing this flora and fauna assessment, information has become available about other nearby projects including:

- Continuation of Boggabri Coal Mine;
- Tarrawonga Modification;
- Tarrawonga Expansion; and
- Goonbri Project.

Cumberand Ecology has utlised the publicly available information about the first three mine projects to examine the potential impacts to Leard State Forest. Additionally, although Goonbri is currently not formally proposed for mining, Cumberland Ecology has assumed that mining could occur and that it may impact upon forest and woodland to the east of Leard State Forest.

Collectively, when considered with the current proposal, a high proportion of the existing Leard State Forest will be subject to mining within the next two to three decades (see **Table 4.3**). Based upon current proposals within Leard State Forest, the combined impacts of mining could remove 3081.8 ha of forest and woodland, which is 60% of the extant forest and woodland. Such mining would also be likely to remove 1217.1 of 2153.1 ha of Box Gum Woodland and Derived Native Grassland, equating to 57% of the CEEC within Leard State Forest.

Notwithstanding this, all of the mines propose to rehabilitate mined areas and return them to forest and woodland. The mined landscaped will be progressively returned as flora and fauna habitat in the medium to long term. Additionally, all of the mines have provisions for offsetting ecological impacts. All of the mines will or have purchased additional surrounding lands that contain forest, woodland and derived native grasslands. These will collectively and significantly increase the total areas of native vegetation that exist in the locality in the future and will significantly increase the total area of native vegetation within conservation reserves in the locality and the region. Further details about the collective benefits of offsetting by mines in the locality are provided in **Chapter 6**.

Cumulative impacts are also likely to occur from a combination of all the pressures caused by the development. This includes the direct impacts of habitat removal, and the subsequent impacts of dust, noise and erosion. These cumulative impacts are likely to be most strongly felt in the patches remaining after clearing, and are likely to extend the footprint of the mine beyond the areas actually cleared.

Despite these collective impacts, the Project is unlikely to directly threaten the occurrence of these vegetation communities within the Project Boundary or the region. Large areas of such vegetation will remain both within the Project Boundary and outside of it, including areas within the Nandewar Ranges and surrounding rural areas. Some vegetation communities to be impacted, particularly the CEEC Box Gum Woodland and Derived Grasslands, are not well represented within secure tenures, particularly within conservation reserves. However, this situation is likely to change within the locality (20 km radius of the Project Boundary) and subregion (the Nandewar Subregion) in the near future because a number of mining projects are proposing to establish permanent biodiversity offsets containing Box Gum Woodland and other closely related vegetation. The offsetting arrangements will both protect existing forest and woodland communities and restore vegetation on farmland, with the net result being an increase in total woodland vegetation and an increase in such vegetation under conservation tenures. The offset strategy is described in further detail in **Chapter 6**.

4.8.2 Regional Scale

There are no regional statistics available to provide quantitative commentary on the cumulative impacts of mining on a regional scale. As with the locality around Boggabri and Leard State Forest, it is obvious that the wider region has also experienced large-scale vegetation clearing resulting from decades of agriculture, forestry and mining.

Although severely cleared in the past, many contemporary mining projects are capable of positively addressing current and future threatened species and ecological community impacts via offsetting, particularly when considered collectively.

Current assessments and offsetting projects now place a high focus on replacing and supplementing ecological communities, which can be considered as surrogates or "flagship items" for a suite of threatened species that rely on them for habitat.

It is also important to recognise that whilst CEECs like Box Gum Woodland and Derived Native Grassland are worthy of consideration in their own right, the emphasis on making secure provisions for CEECs also makes significant contributions to the conservation of a suite of threatened species such as the Regent Honeyeater and Swift Parrot.

The EPBC listed species and communities that would benefit from the cumulation of offsetting efforts in the region include the following:

- Box Gum Woodland and Derived Native Grassland;
- Plains Grassland;
- *Apus pacificus;*
- *Hirundapus caudacutus;*
- *Xanthomyza phrygia;*
- *Merops ornatus;*
- *Myiagra cyanoleuca;*
- *Lathamus discolour;*
- *Nyctophilus timoriensis*; and
- *Pultenaea setulosa*.

Table 4.4 Hypothetical Cumulative Impacts on Native Vegetation of Leard State Forest from Combined Coal Projects and Without Rehabilitation or Offsets

Associations	Vegetation Communities	Area within Combined Project Boundaries (ha)	Area to be cleared (ha)			Total Cumulative Impact (ha)	Proportion to be cleared (%)
			Maules Creek Coal Project	Boggabri Coal Project	Tarrawonga Project		
Red Gum/Ironbark forests	Dwyer's Red Gum - Ironbark woodland	191.40	123.61	0.30	0.00	123.91	64.74
	Narrow-leaved Ironbark - White Cypress Pine shrubby open forest	1977.00	594.83	528.80	36.80	1160.43	58.70
	Silver-leaved Ironbark heathy woodland	454.00	334.52	3.70	0.00	338.22	74.50
	Narrow-leaved Ironbark - Brown Bloodwood - White Cypress Pine shrubby open forest	20.80	0.00	14.80	0.00	14.80	71.15
Riparian forests	Melaleuca riparian forest	11.44	0.00	0.00	0.00	0.00	0.00
	River Red Gum riparian woodlands and forests	11.96	1.57	0.60	0.00	2.17	18.14
	White Box - Blakely's Red Gum - Melaleuca riparian forest	17.20	10.12	0.60	0.00	10.72	62.33
White Box, Yellow Box, Blakely's Red Gum woodlands	White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest	1424.80	406.97	474.40	0.00	881.37	61.86
	White Box - Narrow-leaved Ironbark - White Cypress Pine shrubby open forest	496.10	136.43	175.10	0.00	311.53	62.80
	White Box - White Cypress Pine grassy woodland	238.50	0.80	147.20	22.30	170.30	71.40

Table 4.4 Hypothetical Cumulative Impacts on Native Vegetation of Leard State Forest from Combined Coal Projects and Without Rehabilitation or Offsets

Associations	Vegetation Communities	Area within Combined Project Boundaries (ha)	Area to be cleared (ha)			Total Cumulative Impact (ha)	Proportion to be cleared (%)
			Maules Creek Coal Project	Boggabri Coal Project	Tarrawonga Project		
	Yellow Box - Blakely's Red Gum grassy woodland	38.60	8.64	2.00	0.00	10.64	27.56
Belah associations	Belah woodland	4.21	4.21	0.00	0.00	4.21	100.00
	Pilliga Box - Poplar Box - White Cypress Pine grassy open woodland	131.70	11.69	10.30	0.00	21.99	16.70
	White Box - Wilga - Belah woodland	34.11	31.46	0.00	0.00	31.46	92.23
Dry Rainforest	Native Olive dry gully forest	0.80	0.00	0.00	0.00	0.00	0.00
	Cliff and scree Thickets (Rainforest Species)	0.13	0.00	0.00	0.00	0.00	0.00
Subtotal Forest and Woodland		**5052.75**	**1664.85**	**1357.80**	**59.10**	**3081.75**	**60.99**
Grasslands	Plains Grassland	0.99	0.00	0.00	0.00	0.00	0.00
	Derived Native Grassland	399.90	86.48	26.10	0.00	112.58	28.15
	Exotic grassland	63.57	24.51	40.60	0.00	65.11	102.42
Subtotal Grassland		**464.46**	**110.99**	**66.70**	**0.00**	**177.69**	**38.26**

Table 4.4 Hypothetical Cumulative Impacts on Native Vegetation of Leard State Forest from Combined Coal Projects and Without Rehabilitation or Offsets

Associations	Vegetation Communities	Area within Combined Project Boundaries (ha)	Area to be cleared (ha)			Total Cumulative Impact (ha)	Proportion to be cleared (%)
			Maules Creek Coal Project	Boggabri Coal Project	Tarrawonga Project		
TOTAL AREA/PROPORTION		**5517.21**	**1775.84**	**1424.50**	**59.10**	**3259.44**	**59.08**
Threatened Ecological Community							
Box Gum Woodland and Derived Native Grassland		2153.11	544.47	650.30	22.30	1217.07	56.53

4.9 Duration and Timing of Impacts

The duration and timing of the impacts of the Project has important effects on the magnitude of the overall impacts on the ecology of the Project Boundary at any given time.

Leard State Forest is 7,500 ha in size and of this, 1664.8 ha of forest and woodland will be progressively cleared by the Project. However, land within the Project Boundary will also be progressively rehabilitated with the primary aim of returning it to forest and woodland. Thus the *net loss* of vegetation at a given stage of the Project time will be minimised through the progressive clearance and concurrent rehabilitation of the land within the Project Boundary.

This means that for much of the life of the mine, 21 years, the majority of the Project Boundary will be vegetated, although mined areas will have young, rehabilitated vegetation. These young rehabilitated areas will still represent habitat for some fauna species, including woodland birds, and play an important role in maintaining habitat areas as the Project progresses. **Table 4.5** provides a breakdown of the progressive rehabilitation projected for Years 1, 5, 10, 15 and 21 of the Project.

In addition to this, not all areas will be permanently cleared and disturbed. Areas to be used for buildings and other mine infrastructure will be returned to forest and woodland in the long term once mining has ceased. Moreover, all of the mined areas other than the final void will be revegetated to forest and woodland in accordance with a Biodiversity Management Plan (BMP; see **Chapter 5**) and added to the Biodiversity Offset Strategy (see **Chapter 6**). Boggabri Coal will also clear land within the south eastern part of the Leard State Forest but this will also be rehabilitated to forest and woodland.

In the long term the offset proposal by Aston (and that of Boggabri Coal) would maintain the size of the Leard State Forest by rehabilitating mined areas, and build upon its size by strategic acquisition of lands in surrounding areas.

Table 4.5 Progressive Completion of Rehabilitation

	Year 1 (06904E)	Year 5 (06905E)	Year 10 (06906E)	Year 15 (06907E)	Year 21 (06908E)
Northern Rehabilitation	0.0	242.3	319.7	466.4	466.3
Northern Overburden	142.6	315.0	262.4	115.8	585.4
Southern Overburden	0.0	141.4	447.6	535.7	
Southern Active Mining	76.7	191.2	160.9	184.3	158.9
Southern Rehabilitation	0.0	0.0	0.0	85.2	381.7

Table 4.5 Progressive Completion of Rehabilitation					
	Year 1 (06904E)	Year 5 (06905E)	Year 10 (06906E)	Year 15 (06907E)	Year 21 (06908E)
TOTAL	**219.3**	**889.9**	**1190.6**	**1387.4**	**1592.3**

4.10 Permanence and Reversibility of Impacts

Although extensive impacts will occur on a local scale, not all of these are irreversible, and with appropriate management and mitigation measures being applied, the impact of these can be considerably reduced.

Apart from the large components of the mine that will alter the topography of the site, other aspects of the development are likely to have reversible impacts, and flora and fauna are likely to recover well with appropriate rehabilitation measures.

If appropriate effort is put into the subsequent rehabilitation of these areas, it is likely to be possible to recreate the communities that previously existed in these areas. Rehabilitation and regeneration of forest and woodland is possible on degraded areas and has the potential to reduce the impacts of habitat removal on threatened species. The planting of threatened plant species in rehabilitation efforts, which are known to occur in the mine disturbance boundary would reduce impacts on these species and enable recovery of populations in the Project Boundary.

4.11 Summary of Impacts

The major impact of the Project will be from the clearance of broad areas of forest and woodland, directly removing biodiverse habitats for many species and important habitat resources such as tree hollows. Without substantial mitigation and compensation measures, the Project would add significantly to ecological impacts within the locality – denuding it of native vegetation and habitat for many native species. For this reason, substantial ameliorative measures, including avoidance, mitigation and compensation, are an integral part of the Project. These are discussed in detail in **Chapter 5** and **Chapter 6**.

Chapter 5

Impact Mitigation

The purpose of this chapter is to outline the mitigation measures proposed to ameliorate the impacts of the Project on flora and fauna. As demonstrated in previous chapters, the Project Boundary is biodiverse and provides habitat for a wide range of flora and fauna, including species listed under State and Commonwealth threatened species legislation. The Project has been designed with substantial mitigation measures.

The considerations for reducing the ecological impacts followed the Part 3A Draft Guidelines for Threatened Species Assessment which include a hierarchy of principles:

- Avoid – to the extent possible, developments should be designed to avoid or minimize ecological impacts;
- Mitigate – where certain impacts are unavoidable through design changes, mitigation measures should be introduced to ameliorate the ecological impacts of the Project; and
- Compensate – the residual impacts of the Project, following the implementation of mitigation measures, should be compensated to offset what would otherwise be a net loss of habitat.

Further to these considerations, it is essential to monitor the ongoing status and health of flora and fauna communities that will be retained within the Project Boundary in order to assess the success of the mitigation and compensation measures. This will be achieved through the establishment of an ecological monitoring program. Two management plans should be prepared to guide the implementation of the mitigation strategy:

1. A Biodiversity Management Plan (BMP): This should be prepared prior to the commencement of construction and would provide detailed specifications for the implementation of all the impact mitigation measures described below. The BMP is the key document that will ensure that the conservation objectives of the Project are met and that impacts to biodiversity are adequately managed for the life of the Project. This is explained further in **Section 5.2**.
2. Biodiversity Offset Management Plan (BOMP): The BOMP should provide specifications for the restoration and management of biodiversity offset areas. It should be finalised prior to the commencement of mining operations. This is explained further in **Chapter 6**.

The structure of this chapter is as follows:

- Measures to Avoid Impacts (**Section 5.1**);
- Measures to Mitigate Impacts (**Section 5.2**);
- Ecological Monitoring (**Section 5.3**); and
- Measures to Provide Compensation for Impacts (see **Chapter 6**).

5.1 Measures to Avoid Impacts

Open cut mining projects cannot readily avoid impacts where mineral resources are beneath flora and fauna habitats. However, avoidance can be achieved to varying degrees by modification of the design and location of mine associated infrastructure away from natural habitats where feasible. Wherever possible, risks of environmental impacts have been avoided through the overall Project design itself. At the local scale some of the avoidance measures are discussed below.

Avoiding environmental impacts has been considered where possible throughout the Project planning and design phases. In the first instance, significant modification to the design of the Project was undertaken to improve Biodiversity outcomes. The Project mine plan has been devised through the consideration of a number of alternatives which were developed to reduce the potential for adverse impacts to the environment, including specific impacts on threatened ecological communities and species. In particular, the northern overburden emplacement area has been aligned to avoid the disturbance of a sizable proportion of Box Gum Woodland and Derived Grassland that would have otherwise been disturbed by the Project.

Project related infrastructure such as the MIA, CHPP, and water storages are illustrated in indicative locations within the Project Disturbance Boundary. Further avoidance of threatened communities and species should be achieved by locating infrastructure on cleared land and locating the Namoi River pump station and pipeline in areas with exotic grassland understorey. Aston proposes for the final alignment and location of these facilities will be designed and constructed in order to avoid the disturbance of areas of CEEC, where engineering practicality and efficiency provides.

Aston currently has in place a Land Disturbance Protocol that will be revised for the Project. This Land Disturbance Protocol requires the Environmental Manager (or delegate) to carry out an inspection of the proposed disturbance areas prior to any disturbance activities occurring. This Protocol provides a process to ensure that compliance with the relevant licences and approvals is met, that sensitive ecological features are not impacted upon directly and that appropriate mitigation is put in place.

Further avoidance should be a key aim during detailed design.

Substantive mitigation and compensation measures are proposed to offset the impacts of the Project on flora and fauna as described below.

5.2 Measures to Mitigate Impacts

Where the design of the Project is determined, measures can be considered to mitigate some of the direct and indirect impacts of the construction and operation of the mine Project. This section summarises the recommended mitigation measures.

5.2.1 General Mitigation Measures

A suite of general environmental control measures should be implemented for the Project which will have indirect benefits that will help to protect the ecology of the site. Such general measures are outlined within **Table 5.1**.

Table 5.1 Summary of Proposed General Mitigation Measures at Maules Creek

Mitigation Measures	General Ecological Benefits
Dust minimisation	Control of dust reduces the indirect impacts on vegetation condition and the habitat quality for all native species.
Noise minimisation	Minimisation of noise benefits fauna by reducing the potential for disturbance of animals in habitat patches around the mine.
Management of surface water, erosion and sedimentation	Protects the integrity of the landscape.
Due diligence inspections for proposed disturbance areas	Provides data for ongoing adaptive management and protection of adjacent landscape areas if required.
Visual and lighting management	

5.2.2 Biodiversity Management Plan

In addition to the general measures, a suite of specific ecological impact mitigation measures should be implemented. These should be developed and presented in the BMP covering both the construction and operation of the mine. The BMP should include, where appropriate, measures for:

- Protocols for fauna preclearance, rescue and translocation (if relevant);
- Prescriptions for vegetation clearance;
- Detailed design of mitigation measures such as fauna underpasses and fencing (if required);

- Inductions for staff, contractors and visitors to the site to address the location of sensitive flora and fauna and their role and responsibilities to the protection and/or minimisation of impacts to all native biodiversity;
- Rehabilitation of adjoining habitat where needed;
- Management of noxious and environmental weeds;
- Management of feral animals;
- Rehabilitation methods; and
- An ecological monitoring program to provide feedback about impacts and to furnish information for adaptive management and rehabilitation actions for native flora and fauna.

The BMP should include a summary of values to be protected, objectives and management actions including, where appropriate:

- Reducing human disturbance to native plants and animals;
- Strictly limiting vegetation disturbance or clearing;
- Protecting and minimising impacts to threatened species and communities;
- Protecting and minimising impacts to aquatic habitats and species; and
- Ongoing monitoring and adaptive management of flora and fauna.

Table 5.2 provides a summary of the specific ecological mitigation measures to be implemented within the BMP.

Table 5.2 Summary of Specific Ecological Mitigation Measures at Maules Creek

Impact	Mitigation
Vegetation clearance and habitat loss	Mine associated infrastructure should be located in existing cleared areas where possible to minimise the loss of habitat.
	Disturbance of vegetation should be limited to the minimum necessary for each stage of the pre strip clearing. Limits of clearing should be marked and fencing installed where appropriate around the construction footprint area prior to construction activities commencing to avoid unnecessary vegetation and habitat removal.
	A pre-clearing protocol should be implemented for all tree clearing to minimise impacts to resident fauna.
	Clearing of vegetation should be scheduled where possible to optimise seed collection.

Table 5.2 Summary of Specific Ecological Mitigation Measures at Maules Creek

Impact	Mitigation
	Transportable habitat features such as large logs and boulders should be placed in rehabilitation areas where feasible to allow their continuation as potential fauna refuge sites.
	Native seed should be collected and propagated for use in rehabilitation areas and other disturbed areas.
	Appropriate regeneration methodologies and strategies should be developed, and appropriate sites for regeneration and conservation should be identified. As part of these methodologies there should be a focus on optimising revegetation efforts and offsetting areas for threatened species.
	Mined areas should be progressively revegetated.
	Retained vegetation and revegetated/regenerated vegetation should be managed for conservation including access restrictions, weed control, and feral animal management.
	A substantial external offset strategy should be developed and implemented.
	A terrestrial ecology monitoring program for the Project should be developed to better understand impacts and guide rehabilitation actions for flora and fauna throughout the Project Boundary.
	Threatened species monitoring should be undertaken.
	Monitoring should be undertaken for exotic weeds and feral animals to determine management actions required.
	Reference sites should be established and monitored for the life of the mine.
Habitat fragmentation	Linkages and or crossing zones between isolated vegetation remnant patches should be maintained where feasible.
	Vegetation should be rehabilitated to link existing patches of habitat and create corridors where feasible.
Weed and feral animal invasion	Detailed management strategies should be contained in the BMP.
Vehicle strike and direct mortality	Vehicle driving policies should be implemented with speed restrictions to minimise the risk to fauna.
	Signs should be erected to remind drivers to be alert at known fauna crossings; and
General	Contributions should be made to environmental education and research where feasible.

5.2.3 Rehabilitation

All areas disturbed by mining activities will be progressively rehabilitated over the life of the mine. The principle objective of the site rehabilitation strategy will be to establish native forest woodlands with a focus on the establishment of the threatened CEEC Box Gum Woodland. Local native plant species will be utilised where possible which will be supplemented by additional native species represented in the area to ensure the rehabilitation objectives are achieved. Where practical, topsoil will be translocated from proposed mining areas to conserve the native seed bank of local ecological communities. This will:

- Maintain or establish corridor connectivity as mining progresses;
- Improve the quality and diversity of native growth in rehabilitation areas;
- Maximise the establishment of a diversity of native species, particularly the understorey species that maintain the ecological function of native vegetation communities; and
- Provide additional habitat for native flora and fauna.

A Rehabilitation Management Plan should be developed that prescribes the staged rehabilitation of all mine disturbed areas. The key objectives of this plan should be to restore, where possible, the pre-mining biodiversity within a safe and stable landform including 544 ha of the Box-Gum Woodland and supplementary habitat features, including translocated hollow logs.

A Closure Plan should also be developed at the relevant time to specify how the Project Boundary will be finally closed to mining and returned to other land uses.

5.3 Monitoring

It is essential to monitor the ongoing status and health of flora and fauna that is to be retained on the Project Boundary. This will provide feedback data to determine the level of success of the mitigation and compensation measures. Such monitoring is often undertaken using appropriate reference sites that are located away from mining activities to use as a baseline against which to compare the status of habitats in close proximity to mining.

This section discusses these strategies and their applicability to the Project. More detailed prescriptions for reference sites and monitoring strategies will be incorporated into the BMP, including a framework for reporting on the results of the monitoring.

5.3.1 Reference Sites

The establishment of reference sites is recommended by the *ICMM Good Practice for Mining and Biodiversity guidelines* to enable impacts resulting from mining to be better understood and quantified (International Council on Mining and Metals, 2006). Reference areas serve

as a benchmark against which changes in biodiversity over time can be compared (for example, through the use of the BACI before-after/control-impact, approach). This approach collects and compares data from sites before and after the impact has occurred, and also from control (un-impacted) and impacted sites. Reference sites help to determine which changes are directly attributable to the mining operations and which are the results of unrelated outside factors. They can also be very useful in rehabilitation, as they allow a desired endpoint to be set for rehabilitation efforts, and progress towards this endpoint through time can be quantified.

Reference sites should be selected before construction activities and mining commences. These sites should be established in areas that will not be subject to impacts from mining but as close as possible to the Project Boundary. Locations suitable as reference sites should ideally contain the same ecological community that is being impacted, should be in a similar position in the landscape, should have similar topography and disturbance history, and should not be subject to impacts from the mine (International Council on Mining and Metals, 2006). At each reference site, a range of data will be collected in order to allow comparisons to be made between impacted and non impacted sites. This would provide an indication of the potential impacts occurring as a result of the Project. The full range of data to be collected at each reference site will be developed during the preparation of the BMP.

Appropriate locations for reference sites should be determined in consultation with relevant government agencies as part of the finalisation of the BMP. Off-site reference sites should be sourced to provide additional baseline ecological data. Suitable sites may be found within the Project Boundary that would not be expected to be impacted by mining activities.

5.3.2 Monitoring

This section considers the broad principles to be considered for ecological monitoring programs; more detailed specifications for ecological monitoring should be contained in the BMP.

i. Vegetation Monitoring

It is recommended that a monitoring strategy be established to determine the magnitude of the ecological impacts from mining activities on species and habitats. The monitoring program would provide information to quantify the change in biodiversity over time within the Project Boundary. It is proposed that monitoring sites be established in areas of vegetation both inside and outside of the disturbance area and in designated reference sites. Regenerated areas are also proposed to be monitored in the long term to allow changes in species composition and structure over time to be quantified. Information will be used in adaptive management, in order to continually improve the outcomes of the rehabilitation and land management strategy. Appropriate data management procedures should be implemented to ensure that all data is collected using appropriate techniques and suitably analysed to allow meaningful spatial and temporal comparisons to be made. More specific details of the vegetation monitoring strategy should be contained in the BMP (see below).

ii. Threatened Species Monitoring

Monitoring will also be undertaken on selected threatened species of flora and fauna, in order to determine whether populations are being adversely affected by the Project.

Threatened species monitoring will:

- Enable the identification of the impacts of the Project on threatened species;
- Identify changes in population numbers over time;
- Determine the success of impact mitigation and conservation measures; and
- Highlight areas for improvement if these measures are found to be inadequate.

Threatened species monitoring will involve conducting targeted threatened species surveys annually in areas of known habitat in order to record the abundance of selected species. This should include both flora and fauna species. The level of monitoring effort would be determined according to risk level and biology of the particular species in question (e.g. coordinating with breeding or movement times).

Chapter 6

Biodiversity Offsetting

In regional context, it is recognised that the Project will take place on land classified as Zone 4 under the BNC Agreement, which permits the development of the timber, gas, minerals and apiary sectors. Notwithstanding this, Aston Resources have developed a Biodiversity Offset Strategy with the objective of offsetting the residual impacts on biodiversity, particularly on threatened ecological communities and habitat for threatened species. The Offset Strategy has been devised to comply with the current principles for offsetting set out by SEWPAC (DEWR, 2007) and by OEH (DECC (NSW), 2008a).

6.1 Project Approach to Biodiversity Offsetting

The Biodiversity Offset Strategy entails acquisition of offset properties for permanent conservation of native flora and fauna, including threatened flora and fauna predicted to be impacted by the Project, supported by ongoing land management to improve the biodiversity values of the offsets. In addition to the principles set out by SEWPAC and OEH, the development of the Biodiversity Offset Strategy has been guided by the following key design concepts (adapted from Business and Biodiversity Offsets Programme (BBOP), 2009):

- Secure land for permanent conservation;
- Increase the area of forest and woodland under conservation above what will be lost through the Project;
- Improve the biodiversity values of the offset properties through changing land use (i.e. deliver conservation gains to offset properties that would otherwise not have taken place under current use);
- Improve the biodiversity values of the offset properties through the implementation of positive management interventions to actively stop degradation and to increase the area of native vegetation and habitat for native flora and fauna; and
- Time the offsets to minimise the lags between the Project's impacts and the offset achieving its objectives.

Consideration of the local and regional context of the Project and the offsets can help to enhance the land in the vicinity of the Project and to provide longer term community benefits. The surrounding land, including other mining projects (e.g. Boggabri Coal, Tarrawonga Mine); conservation areas (e.g. Mt Kaputar National Park, Leard State Conservation Area);

and existing corridors (e.g. creeks, rivers, travelling stock reserves) have played a significant role in shaping the Biodiversity Offset Strategy. Thus, the development of the offsets was also influenced by the following design concepts:

- Locate offsets in the locality of the Project;
- Enhance existing conservation reserves by:
  - Adding to the patch size of a reserve by locating offsets nearby or adjacent to the reserve;
  - Adding additional land to the reserve system;
  - Connecting an existing reserve to other areas of habitat by building corridors; and
  - Buffering the reserve from surrounding land use;
- Build upon natural corridors like creeks and rivers to mitigate broadscale habitat fragmentation; and
- Build onto other nearby biodiversity offsets, which will add value by effectively increasing the net area of established offset areas in the locality.

The establishment of an offset package that is capable of connecting to other areas of conservation is a major feature of the Biodiversity Offset Strategy for this Project. The Biodiversity Offset Strategy will add value to the existing reserve system in the area and to local offset efforts to be established by other mines in the locality. The key concept underpinning this is to provide connectivity between these remnant and rehabilitation areas and to increase the patch size to enhance the contributions of each offset or reserve land.

Research has highlighted the importance of maintaining treed habitats in the intervening disturbed landscape, as these patches or corridors are important for fauna movement and seed dispersal (Cooper *et al.*, 2002; Fischer and Lindenmayer, 2002; DSE (VIC), 2008; Goldingay and Taylor, 2009). Remnant patches also serve as stepping stone corridors that facilitate the movement of fauna in the landscape (DSE (VIC), 2008). Stepping stones have been shown to be important in maintaining landscape connectivity and maintaining gene flow between separate populations because of the movement of pollen and seed vectors such as animals and insects (Lindenmayer, 2006).

6.2 Offset Strategy Concept Plan

Figure 6.1 presents the overview concept for the Biodiversity Offset Strategy. As mentioned above, a key design in the Biodiversity Offset Strategy for the Project is to build onto existing and future conservation lands and natural corridors to enhance the overall package of conservation lands in the locality of the Project. With this in mind, offset properties have been and are continuing to be sought from the following broad areas:

- **Western Offset Area**: properties west of the Project Boundary and in the vicinity of the Leard State Conservation Area, and the Namoi River riparian corridor on the western margins of the Project Boundary that have been, or will be acquired for conservation and farming purposes. Key design considerations are to form links or "stepping stones" of habitat between rehabilitated lands that will be formed in the Project Boundary with Leard State Conservation Area and with the River Red Gum corridors along the Namoi River and to increase the overall patch size of the forest and woodland adjacent to the Leard State Conservation Area;

- **Eastern Offset Area**: properties on the eastern and north eastern side of the Project Boundary that have been, or will be acquired for conservation and farming purposes. A primary objective of the management of forest within the Eastern Offsets will be to complement land already acquired by Boggabri Coal by adding to a "steppng stone" wildlife corridor from the remaining areas of the Leard State Forest to the east towards the Nandewar Ranges.

- **Northern Offset Area**: properties to the north of the Project Boundary that have been acquired for use as compensatory habitat. These two properties, "Mt Lindesay" and "Wirradale", are extensively vegetated and link to each other and to adjacent forest lands, including Mount Kaputar National Park; and

- **Shared Properties**: Aston also possesses property in shared ownership with Boggabri Coal to the south west of the Project Boundary (**Figure 6.1**). Aston intends to incorporate this shared property into the Biodiversity Offset Strategy as it links well to the Western Offset Area and Boggabri Coal's other offset lands.

6.3 The Offset Properties

This section describes some of the properties within the Western, Eastern, Northern and Shared Offset Areas that have been considered for conservation.

6.3.1 Western and Eastern Offset Areas

Aston Resources has committed to providing 1000 ha of remnant woodland and forest from the Western and Eastern Offset Areas for inclusion within the Biodiversity Offset Strategy. Based upon preliminary surveys, half of this is expected to comprise Box Gum Woodland and Derived Grassland community types.

The Project is predicted to affect a few properties within and surrounding the Project Boundary by elevated noise and air quality emissions. Aston Resources has identified portions of these properties that could be incorporated into the Biodiversity Offset Strategy. Some of these properties are either owned by Aston Resources or subject to a private agreement with Aston Resources for purchase. Further discussions will continue to take place with the remaining landholders in relation to the possible purchase of their property for inclusion as part of the Biodiversity Offset Strategy for the Project.

For the purposes of this report, it is acknowledged that only the properties that have already been purchased, or have agreements in place to purchase, can be included in the Biodiversity Offset Strategy. Nevertheless, further land acquisition is likely to take place to add to the Biodiversity Offset Strategy. For further information regarding the property acquisition, please refer to the main volumes of the EA.

The Western Offsets will be comprised of four properties that include parts of Velyama, Teston and Olivedeen, which are already owned by Aston Resources; and Longueville, which is adjacent to the Leard State Conservation Area. Olivedeen also has frontage to the Namoi River (**Figure 6.2**). Other properties may potentially be acquired in future.

The Eastern Offsets will potentially be comprised of eight landholdings along the northern boundary of the Leard State Forest (**Figure 6.3**). Three of these properties, Warriahdool, Property B and Property C, have purchase agreements in place. Other properties may potentially be acquired in future. Some of these properties lie partly within the Maules Creek exploration lease (A346). It is acknowledged that where these areas fall on land that has been identified to comprise coal resources (the Maules Creek JORC Coal Reserves Pit Shell) they may potentially be considered for mining in the future. These areas have been excluded from the Biodiversity Offset Strategy.

6.3.2 Northern Offset Area

The Northern Offsets have been acquired or are subject to an acquisition agreement and are located approximately 40 km west of the township of Barraba and are approximately 10 km north east of the Project Boundary (**Figure 6.4**). The properties, comprising Wirradale and Mt Lindesay, are adjacent to one another and are nestled in a valley within the northern reaches of the Nandewar Ranges. Wirradale is immediatey adjacent to the Mount Kaputar National Park.

6.3.3 Shared Offset Properties

Aston Resources owns property under a joint venture ownership with Boggabri Coal. The shared property is located on the western side of the Kamilaroi Highway to the south-west of the Project Boundary (see **Figure 6.1** and **6.5**). A small proportion of this land will be utilised by Aston and Boggabri Coal for the proposed rail spur, of which the southern-most section will extend into this shared property.

Aston Resources intends to dedicate its 50% of the property to the Biodiversity Offset Strategy. As Boggabri Coal also intend to incorporate the remainder of their half of the shared property to the Boggabri Coal Offset Strategy (Parsons Brinckerhoff Australia Pty Ltd,

2010), this would contribute to a regional East-West Corridor strategy comprising various offsetting efforts and conservation/forestry reserves in the locality (**Figure 6.1**). An agreement will be required between Aston Resources and Boggabri Coal regarding the management responsibilities of both parties for the conservation of the shared property.

6.3.4 Strategic Values of Offset Properties

The above properties were subject to site inspection, entailing habitat description, notes made about dominant flora species and preparation of preliminary vegetation mapping. The preliminary information was used to determine the suitability of the properties as offsets for the Project. During the offset selection process, a large emphasis was placed on sourcing potential offset properties with realistic prospects for long term security. The offset properties (and portions of properties) were chosen for inclusion in the Biodiversity Offset Strategy with due consideration for their location outside existing mining/exploration tenements and their placement outside prime agricultural land. Other values for which the offset properties were chosen include the following:

- They are proximate to the Project or within the wider locality of the Project;
- They contain comparable, or "like for like" vegetation community types to the vegetation within the Project Boundary. These vegetation communities are currently in reasonably good condition but are currently not managed for conservation and could be improved (generally State 2 - 4 woodlands, native pastures, and fertilised pastures; see Rawlings et al., 2010);
- They contain reasonably large areas forest and woodland areas that:
  - Constitute valuable habitat for native flora and fauna, particularly those that will be impacted by the Project;
  - Increase the natural regeneration of nearby derived native grasslands and pastures by providing a seed source for recruitment (Rawlings et al., 2010);
  - Can secure valuable "stepping stone" patches of remnant forest in a largely cleared, agricultural landscape;
- They contain derived native grasslands of varying conditions that have potential to be improved and planted with trees and shrubs to provide habitat for native fauna;
- They will build onto existing conservation areas (Leard State Conservation Area, Mount Kaputar and Horton Falls National Parks) and thus will effectively increase the patch size of these areas and buffer them from surrounding agricultural or mining use;
- The Northern Offsets will provide better linkage between Mount Kaputar National Park, Horton Falls National Park, forested crown land and vegetation on the two properties themselves;

- They will build onto other offset lands owned by Boggabri Coal to create larger corridors and larger habitat areas; and
- Some properties include permanent streams, including the upper reaches of Maules Creek, and some are proximate to, or have frontage to the Namoi River.

Based on this information, some of these properties were purchased and others have an option to purchase. Comprehensive surveys will be completed for these offset properties in the near future and this detailed information will be used to guide appropriate land management and restoration activities for conservation.

6.4 Security of the Offset Properties for Conservation in Perpetuity

At the time of writing, Aston Resources are considering a number of mechanisms to permanently secure the offset properties for conservation. There are a number of options to permanently protect land for conservation and these include:

- Voluntary conservation agreements, which are a joint agreement between landowners and the Minister for the Environment under the National Parks and Wildlife Act 1974;
- Conservation covenants under Section 88 of the Conveyancing Act 1919; this is a joint agreement between the landowner and an authorised body;
- Application to change zoning regulation that dictates land use;
- Dedication of land to the National Parks reserve estates; and
- Land acquisition and management of the land under private ownership with conditions commitments.

Some of the options that Aston Resources are considering include:

- Dedication of the entirety of offsets properties to the National Parks reserve system;
- Partial dedication of offsets to the National Parks reserve system with remaining areas in private ownership; and
- Full or partial private ownership with protection conditions on title or development consent conditions.

Aston Resources has already approached the NSW National Parks and Wildlife Service. A site meeting on the Northern Offset properties with representatives of the NSW National Parks and Wildlife Service took place on the 30 June 2011. The final outcome will depend on negotiations with the NSW National Parks and Wildlife Service.

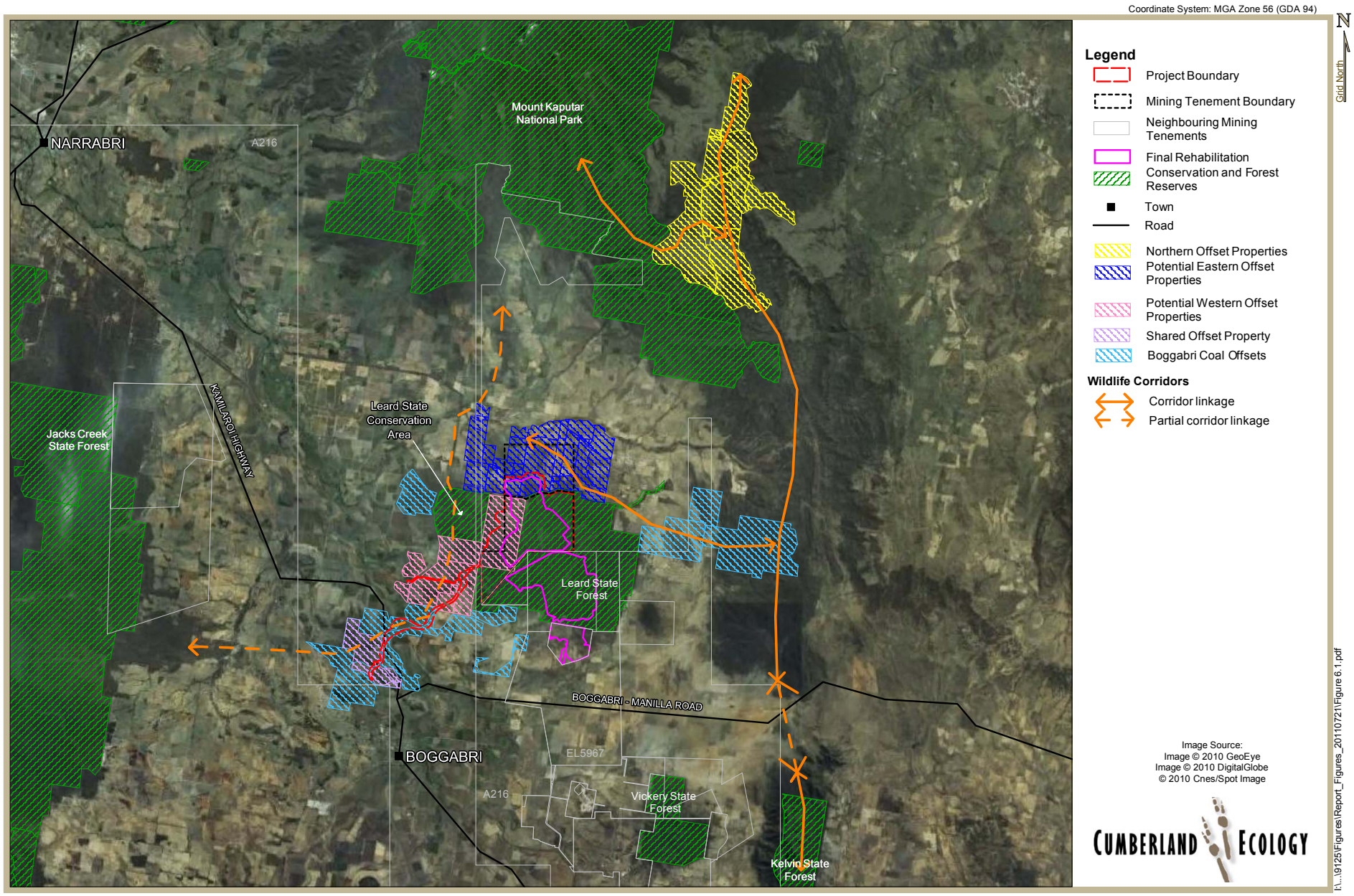

Figure 6.1 THE BIODIVERSITY OFFSET STRATEGY: CONCEPT OVERVIEW

6.5 Vegetation of the Offset Properties

The vegetation communities over the offset properties have been subject to site inspections and preliminary mapping. Further baseline surveys will be required in the near future to refine the vegetation maps, particularly with reference to delineating the various forms of Box Gum Woodland and Derived Grasslands (e.g. see **Photographs 6.1-6.5**) and to accurately differentiate between areas of high, moderate and low condition grasslands. Nevertheless, the preliminary vegetation mapping provides a broad indication of the types and proportions of various community types across the potential offset properties. The vegetation maps for the offset areas are presented in **Figures 6.2-6.5**.

Table 6.1 presents a summary of the areas of vegetation communities that occur in the Western, Eastern, Northern and Shared Offset Properties. The most extensive areas of vegetation occur in the Northern Offset Properties, which have been acquired for conservation. The vegetation on the Western Offset Properties also provides substantial areas of native vegetation that connect to the Leard State Conservation Area. As mentioned previously, Aston Resources intend to dedicate approximately 1000 ha of forest and woodland to the Offset Strategy from the Western and Eastern Offset Properties. Of this, approximately 500 ha is expected to comprise Box Gum Woodalnd and Derived Grassland community types.

Table 6.2 presents a summary of the areas of Box Gum Woodland and Derived Grasslands within the offset properties. The remaining woodland and forest types are representative of the vegetation in the Project Boundary and include Ironbark forests, Dwyers Red Gum Woodland and Poplar Box Woodland types. The cleared areas have been classified as native pastures (i.e. derived native grasslands of varying conditions), cropping fields, exotic pastures or improved pastures. A further 972 ha of grassland is currently unclassified and will require further survey.

Additional information on the offset properties is provided in **Appendix J**. This additional information relates to EPBC protected matters, namely the condition and area of Box Gum Woodland and Derived Grasslands, and the extent of suitable habitat for the Regent Honeyeater, Swift Parrot and Greater Long-eared Bat.

Table 6.1 Vegetation Areas Within the Western, Eastern, Northern and Shared Offset Properties

Vegetation Community	Eastern Offsets									Northern Offsets			Western Offsets						*#Shared Property	TOTAL
	Property A	Property B	Property C	Property D	Property E	Property F	Property G	Warriahdool	Subtotal	Mt Lindesay	Wirradale	Subtotal	Property H	Longueville	Olivedeen	Teston	Velyama	Subtotal		
Cliff and scree Thickets (Rainforest Species)														0.53				0.53		**0.53**
Ironbark Forests and Woodlands											852.53	852.53								**852.53**
Melaleuca riparian forest	28.47	5.42	7.02	2.68	12.25	12.32	32.00	24.43	124.59					0.76				0.76		**125.35**
Narrow-leaved Ironbark - White Cypress Pine shrubby open forest													270.42	33.70		54.27	59.46	417.85		**417.85**
White Box - Blakely's Red Gum - Melaleuca riparian forest	0.34	8.93	0.23						9.50					0.29				0.29		**9.79**
White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest			0.01				13.18		13.20				16.49	151.16		10.65	23.23	201.53		**214.72**
White Box - Narrow-leaved Ironbark - White Cypress Pine shrubby open forest														0.28		30.52		30.80	188.38	**219.17**
River Red Gum riparian woodlands and forests													11.89		8.30			20.19		**20.19**
Dwyer's Red Gum - Ironbark woodland														3.09		81.46		84.56		**84.56**
Dwyer's Red Gum woodland																			89.05	**89.05**
Belah woodland																	6.94	6.94		**6.94**
Box Gum Grassy Woodland										1241.66	1022.88	2264.54								**2264.54**
Box Gum Shrubby Woodland											257.29	257.29								**257.29**
Pilliga Box - Poplar Box - White Cypress Pine grassy open woodland			1.63		2.27	11.15	98.83	0.30	114.18				43.80		4.95		4.91	53.65		**167.83**
Regrowth - White Cypress Pine																			5.35	**5.35**
Silver-leaved Ironbark heathy woodland																			35.27	**35.27**
Weeping Myall grassy open woodland																	0.15	0.15		**0.15**
White Box - White Cypress Pine grassy woodland	2.26	51.58	25.58	35.98	15.82	55.79	16.14	65.47	268.61											**268.61**
White Box - White Cypress Pine grassy woodland (low condition)																			37.30	**37.30**
White Box - Wilga - Belah woodland																52.85	17.05	69.90		**69.90**
Yellow Box - Blakely's Red Gum grassy woodland							0.02		0.02											**0.02**

Vegetation Community	Eastern Offsets									Northern Offsets			Western Offsets						*#Shared Property	TOTAL
	Property A	Property B	Property C	Property D	Property E	Property F	Property G	Warriahdool	Subtotal	Mt Lindesay	Wirradale	Subtotal	Property H	Longueville	Olivedeen	Teston	Velyama	Subtotal		
Subtotal forests and woodlands	**31.07**	**65.93**	**34.46**	**38.66**	**30.34**	**79.26**	**160.17**	**90.20**	**530.09**	**1241.66**	**2132.70**	**3374.36**	**342.60**	**189.81**	**13.24**	**229.76**	**111.74**	**887.14**	**355.34**	**5146.94**
Derived Native Grassland										880.70	1022.86	1903.56				55.18	10.87	66.04		**1969.60**
Derived Native Grassland (Low Diversity - Ironbark Woodland)													56.57				65.27	121.83		**121.83**
Derived Native Grassland (Low Diversity - White Box Woodland)		51.56	48.07	103.09			0.43	17.01	220.17		129.41	129.41	22.12	0.13			143.21	165.46		**515.04**
Derived Native Grassland (Low Diversity - with scattered Poplar Box trees)			112.13	0.19			0.08	14.35	126.75				77.73	1.87			94.10	173.70		**300.46**
Subtotal derived native grasslands	**0.00**	**51.56**	**160.21**	**103.28**	**0.00**	**0.00**	**0.52**	**31.36**	**346.93**	**880.70**	**1152.28**	**2032.97**	**156.42**	**2.00**	**0.00**	**55.18**	**313.44**	**527.04**	**0.00**	**2906.94**
Crop land on basalt soil (with scattered Poplar Box trees)				0.49				59.29	59.78											**59.78**
Crop land on basalt soil (with scattered Poplar Box)								1.36	1.36											**1.36**
Crop land on basalt soil (with scattered White Box)	356.20	22.04		139.47				350.22	867.93							19.61		19.61		**887.53**
Cultivation	335.86	146.86			188.87	188.46	7.70		867.76											**867.76**
Exotic grassland (with scattered Poplar Box trees)																	62.38	62.38		**62.38**
Improved Pastures										136.85	808.79	945.64								**945.64**
Wheat Field (with scattered Ironbark trees)																	32.03	32.03		**32.03**
Wheat Field (with scattered Poplar Box trees)													0.01				118.36	118.37		**118.37**
Wheat Field (with scattered White Box trees)														270.19			140.58	410.77		**410.77**
Unclassified grassland					181.02	311.29	296.07	89.19	877.56						94.89			94.89		**972.45**
Subtotal other vegetation	**692.06**	**168.90**	**0.00**	**139.96**	**369.89**	**499.75**	**303.77**	**500.06**	**2674.39**	**136.85**	**808.79**	**945.64**	**0.01**	**270.19**	**94.89**	**19.61**	**353.35**	**738.05**	**0.00**	**4358.08**
TOTAL	**723.13**	**286.39**	**194.67**	**281.90**	**400.23**	**579.01**	**464.46**	**621.62**	**3551.40**	**2259.21**	**4093.76**	**6352.97**	**499.03**	**462.00**	**108.13**	**304.54**	**778.54**	**2152.24**	**355.34**	**12411.95**

**Based on values from the Boggabri Coal Offset Strategy (Parsons Brinckerhoff Australia Pty Ltd, 2010)*

#Areas calculated on 50% ownership.

Table 6.2 Box Gum Woodland and Derived Grassland Areas Within the Western, Eastern, Northern and Shared Offset Properties

Vegetation Community	Eastern Offsets									Northern Offsets			Western Offsets						*#Shared Property	TOTAL
	Property A	Property B	Property C	Property D	Property E	Property F	Property G	Warriahdool	Subtotal	Mt Lindesay	Wirradale	Subtotal	Property H	Longueville	Olivedeen	Teston	Velyama	Subtotal		
White Box - Blakely's Red Gum - Melaleuca riparian forest	0.34	8.93	0.23						9.50					0.29				0.29		**9.79**
White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest			0.01				13.18		13.20				16.49	151.16		10.65	23.23	201.53		**214.72**
Box Gum Grassy Woodland										1241.66	1022.88	2264.54								**2264.54**
White Box - White Cypress Pine grassy woodland	2.26	51.58	25.58	35.98	15.82	55.79	16.14	65.47	268.61											**268.61**
White Box - Wilga - Belah woodland																52.85	17.05	69.90		**69.90**
Yellow Box - Blakely's Red Gum grassy woodland							0.02		0.02											**0.02**
Subtotal forests and woodlands	**2.60**	**60.51**	**25.81**	**35.98**	**15.82**	**55.79**	**29.34**	**65.47**	**291.32**	**1241.66**	**1022.88**	**2264.54**	**16.49**	**151.45**	**0.00**	**63.51**	**40.28**	**271.72**	**0.00**	**2827.59**
Derived Native Grassland										880.70	1022.86	1903.56				55.18	10.87	66.04		**1969.60**
Subtotal derived native grasslands										880.70	1022.86	1903.56				55.18	10.87	66.04		**1969.60**
TOTAL	**2.60**	**60.51**	**25.81**	**35.98**	**15.82**	**55.79**	**29.34**	**65.47**	**291.32**	**2122.36**	**2045.74**	**4168.10**	**16.49**	**151.45**	**0.00**	**118.68**	**51.15**	**337.77**	**0.00**	**4797.19**

**Based on values from the Boggabri Coal Offset Strategy (Parsons Brinckerhoff Australia Pty Ltd, 2010)*

#Areas calculated on 50% ownership.

Photograph 6.1 **Box Gum Woodland in a grazing paddock on Wirradale**

Photograph 6.2 **Box Gum Woodland in a grazing paddock on Mt Lindesay**

Photograph 6.3 **Box Gum Woodland on Mt Lindesay (dominated by Blakely's Red Gum and Rough-barked Apple)**

Photograph 6.4 **Box Gum Woodland on Mt Lindesay (dominated by Blakely's Red Gum and Red Stringybark)**

Photograph 6.5 Derived Native Grassland on Wirradale

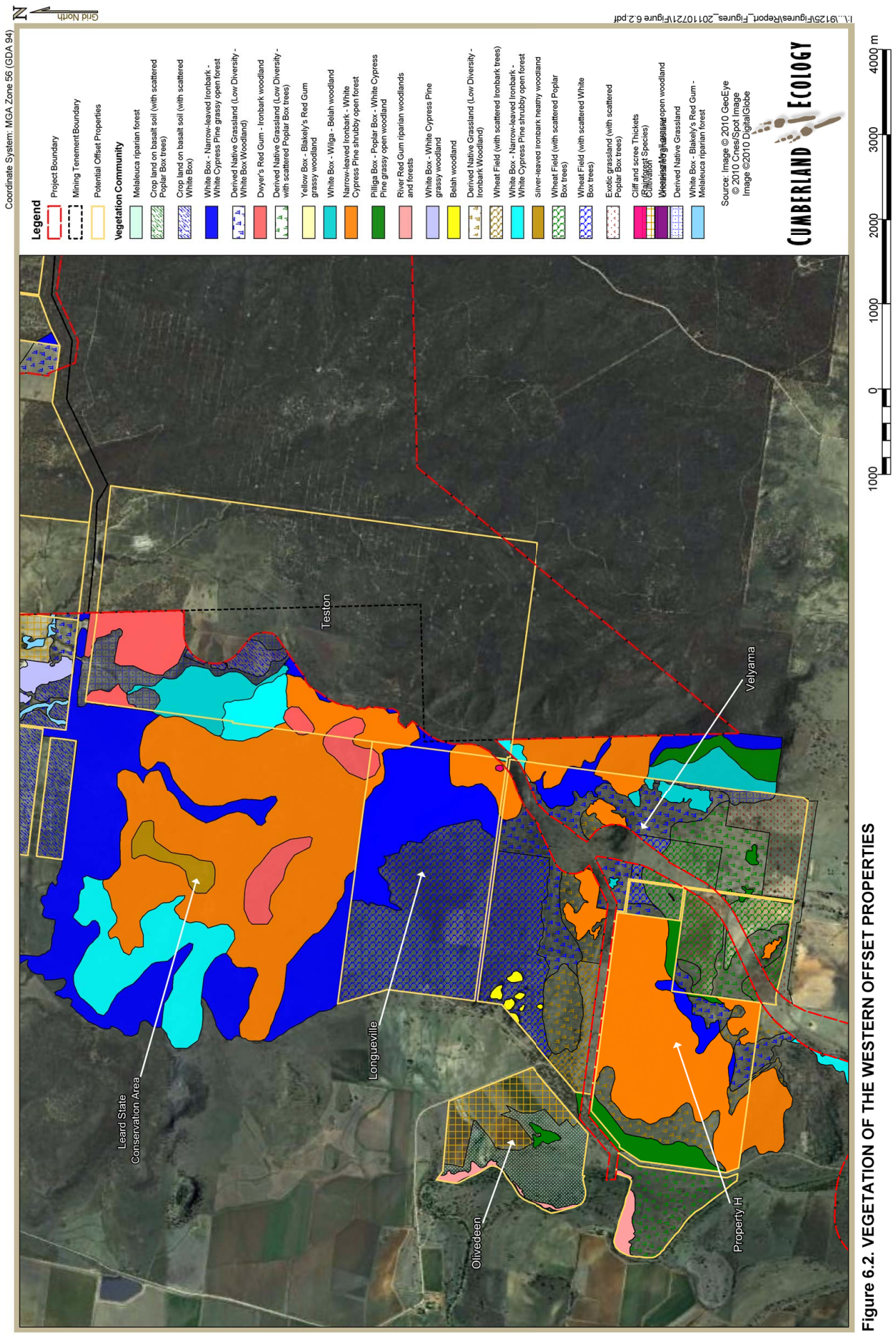

Figure 6.2. VEGETATION OF THE WESTERN OFFSET PROPERTIES

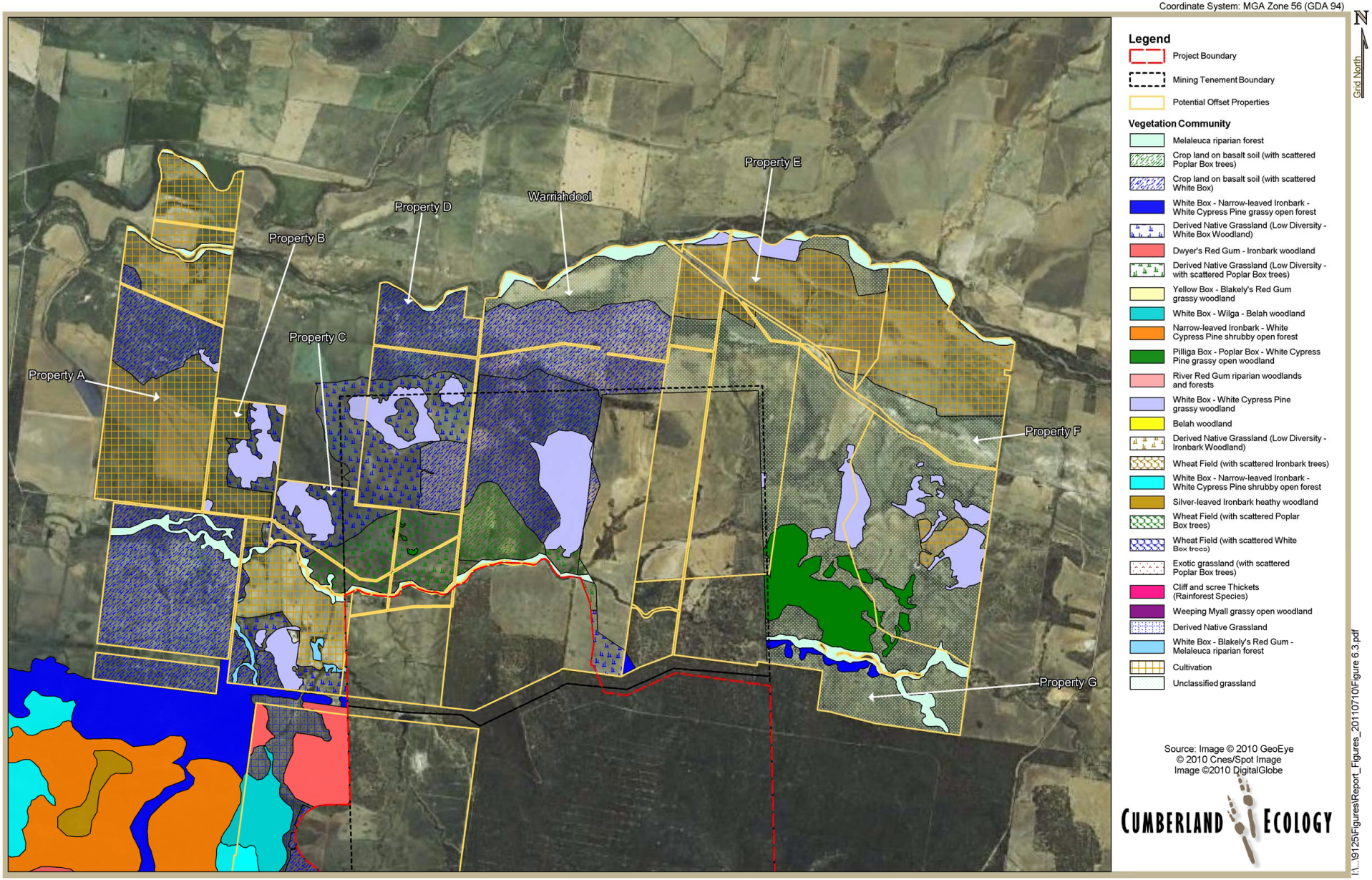

Figure 6.3. VEGETATION OF THE EASTERN OFFSET PROPERTIES

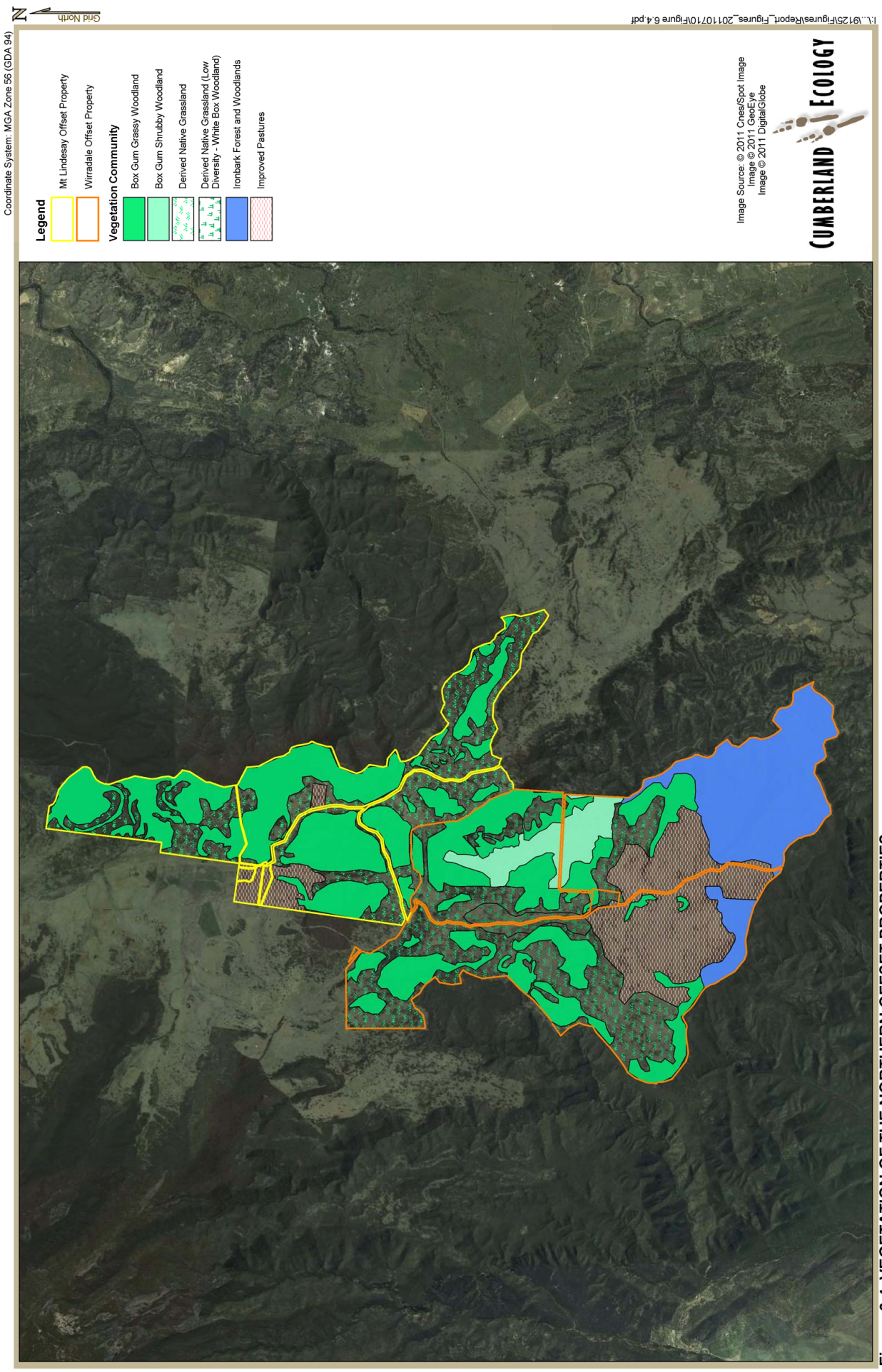

Figure 6.4. VEGETATION OF THE NORTHERN OFFSET PROPERTIES

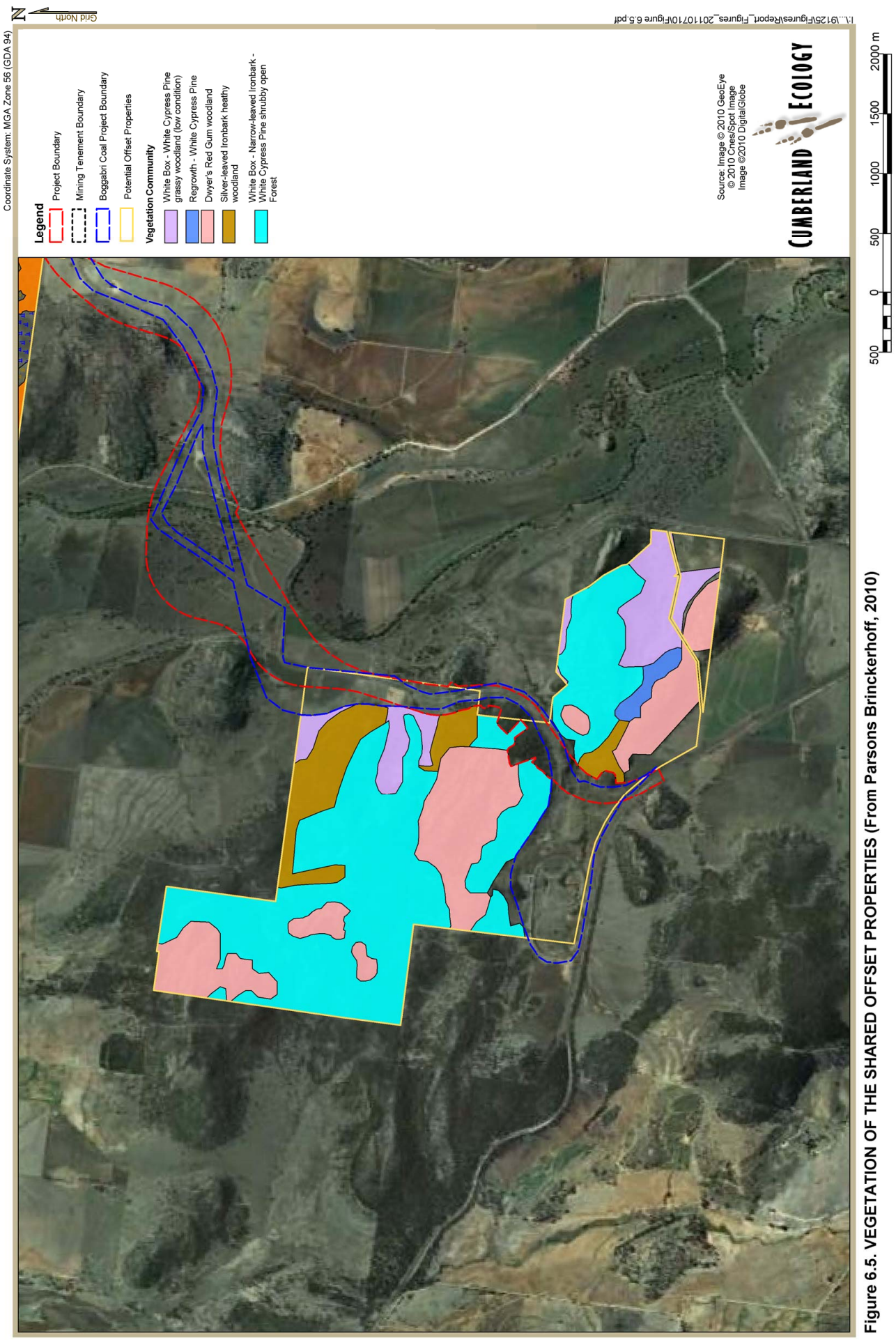

Figure 6.5. VEGETATION OF THE SHARED OFFSET PROPERTIES (From Parsons Brinckerhoff, 2010)

6.6 Habitat for Threatened Species

The native vegetation within the offset properties provides forest, woodland and grassland habitat for many of the threatened and migratory fauna that are predicted to be impacted by the Project, as indicated in **Table 6.3**. The habitat areas of the Eastern and Western Offset Areas are within proximity, or connected to the habitat in the Leard State Conservation Area and the Leard State Forest. These properties would presumably provide habitat for the fauna assemblages present in the Leard State Forest and Leard State Conservation Area. Further surveys are imminent for these properties.

Within the Northern Offsets, there are extensive areas of well connected forest and woodland that provide good quality habitat for a wide variety of species, potentially including species that are not found in Leard State Forest, such as the nationally endangered Spotted Tailed Quoll, Swift Parrot and Regent Honeyeater (**Table 6.4**). The Northern Offset Properties also contain four permanent streams, including the Horton River and the upper reaches of Maules Creek (**Photograph 6.6**), which are valuable resources for many faunal species. The Northern Offset properties are also located in the Barraba area, a known habitat area for Regent Honeyeater and have habitat that appears highly suitable for this species. The offset properties also contain habitat for other native species of interest, such as the Tiger Orchid shown in **Photograph 6.7** below.

Table 6.3 Habitats for Threatened Species that are Within Offset Properties (Western, Eastern and Northern Offsets)

Family	Scientific Name	Common Name	Status		Habitat Present in Offsets (Eastern, Western & Northern)
			TSC	EPBC	
Aves					
Acanthizidae	*Pyrrholaemus saggitatus*	Speckled Warbler	V		E, W, N
Accipitridae	*Circus assimilis*	Spotted Harrier	V		E, W, N
Accipitridae	*Hieraaetus morphnoides*	Little Eagle	V		E, W, N
Accipitridae	*Lophoictinia isura*	Square-tailed Kite	V		E, W, N
Apodidae	*Apus pacificus*	Fork-tailed Swift		M	E, W, N
Apodidae	*Hirundapus caudacutus*	White-throated Needletail		M	E, W, N
Artamidae	*Artamus superciliosus*	White-browed Woodswallow	V		E, W, N
Climacteridae	*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subspecies)	V		E, W, N

Table 6.3 Habitats for Threatened Species that are Within Offset Properties (Western, Eastern and Northern Offsets)

Family	Scientific Name	Common Name	Status		Habitat Present in Offsets (Eastern, Western & Northern)
			TSC	EPBC	
Estrildidae	*Stagonopleura guttata*	Diamond Firetail	V		E, W, N
Meliphagidae	*Grantiella picta*	Painted Honeyeater	V		E, W, N
Meliphagidae	*Melithreptus gularis gularis*	Black-chinned Honeyeater (eastern subspecies)	V		E, W, N
Meropidae	*Merops ornatus*	Rainbow Bee-eater		M	E, W, N
Monarchidae	*Myiagra cyanoleuca*	Satin Flycatcher		M	E, W, N
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V		E, W, N
Petroicidae	*Melanodryas cucullata*	Hooded Robin	V		E, W, N
Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	V		E, W, N
Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V		E, W, N
Psittacidae	*Neophema pulchella*	Turquoise Parrot	V		E, W, N
Strigidae	*Ninox connivens*	Barking Owl	V		E, W, N
Tytonidae	*Tyto novaehollandiae*	Masked Owl	V		E, W, N
Mammalia					
Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail Bat	V		E, W, N
Phascolarctidae	*Phascolarctos cinereus*	Koala	V		E, W, N
Vespertilionidae	*Chalinolobus picatus*	Little Pied Bat	V		E, W, N
Vespertilionidae	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V		E, W, N
Vespertilionidae	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V		E, W, N
Vespertilionidae	*Nyctophilus timoriensis*	Greater Long-eared Bat	V	V	E, W, N
Vespertilionidae	*Vespadelus*	Eastern Cave Bat	V		E, W, N

Table 6.3 Habitats for Threatened Species that are Within Offset Properties (Western, Eastern and Northern Offsets)

Family	Scientific Name	Common Name	Status		Habitat Present in Offsets (Eastern, Western & Northern)
			TSC	EPBC	
	troughtoni				
Plants					
Fabaceae (Faboideae)	*Pultenaea setulosa*			V	Unknown

Photograph 6.6 **Creek habitat on Wirradale (Maules Creek)**

Photograph 6.7 **Tiger Orchid in White Box tree at Warriahdool**

Table 6.4 Habitat Provided By Northern Offsets for Relevant Matters of National Environmental Significance

Scientific Name	Common Name	Status		Preferred Habitat	Project Impacts-direct habitat removal (ha)	Habitat within Northern Offset lands (ha) [A]		Habitat to be restored / enhanced within Offset lands (ha) [B]	Total Habitat including restoration [C]=[A]+[B]
		TSC	EPBC			Forest / Woodland	Grassland		
Aves									
Apus pacificus	Fork-tailed Swift		M	F, W, G	2079	3314	2975^	2029	5343
Hirundapus caudacutus	White-throated Needletail		M	F, W, G	2079	3314	2975^	2029	5343
Xanthomyza phrygia	Regent Honeyeater	E	E,M	F, W	1665	3314	0	2029	5343
Merops ornatus	Rainbow Bee-eater		M	F, W	1665	3314	0	2029	5343
Myiagra cyanoleuca	Satin Flycatcher		M	F, W	1665	3314	0	2029	5343
Lathamus discolor	Swift Parrot	E	E	F, W	1665	3314	0	2029	5343
Mammalia									
Nyctophilus timoriensis	Greater Long-eared Bat	V	V	F, W	1665	3314	0	2029	5343
Plants									
Pultenaea setulosa			V	F, W	1665	3314	0	2029	5343
Ecological Communities									
Box Gum Woodland and Derived Native Grassland		CE	CE		545	2261	2029*	2029	4290

^includes exotic pastures **Derived Native Grassland and Low Diversity Derived Native Grassland*

6.7 Biodiversity Offset Management Plan

A key component of the Biodiversity Offset Strategy is the establishment and future ongoing management of the vegetation and habitats on the offset properties. Biodiversity management of the properties will ensure that there is an improvement in the biodiversity values of the offset properties. On this basis, Aston Resources intends to implement a Biodiversity Offset Management Plan (BOMP) to achieve a maintain and improve outcome for the Project.

The Biodiversity Offset Handbook (Business and Biodiversity Offsets Programme (BBOP), 2009) is guide that provides suggestions on designing offsets. It was developed by the the Business and Biodiversity Offsets Programme (BBOP), which is a partnership between companies, governments, conservation experts and financial institutions. Their aim is to explore whether biodiversity offsets can help achieve better and more cost effective conservation outcomes. According to the Biodiversity Offset Handbook:

> *An offset should deliver conservation gains over and above planned or predicted conservation actions being taken by other parties (otherwise the offset is making no difference). In practice, biodiversity gains can be achieved in a number of ways, such as undertaking positive management interventions to restore an area or stop degradation: improving the conservation status of an area of land by restoring habitats or ecosystems and reintroducing native species. Where proven methods exist or there are no other options, reconstructing or creating ecosystems. Also, reducing or removing current threats or pressures by, for instance, introducing sustainable livelihoods or substitute materials.*

The aforementioned BOMP will be prepared for the Project that provides for the management of each offset property. Detailed surveys of the offset properties are imminent and will provide comprehensive baseline information. Different properties and different areas within a single property will inevitably require varying levels and methods of management. The baseline survey information will be used to identify site specific issues; formulate scope of works and indicator performance criteria; prepare a series of site specific management actions; and prepare a set of implementation timeframes and key milestones.

The BOMP is intended to be adaptive and regular monitoring will be an important aspect of the BOMP to guide the progressive rehabilitation of the offset properties. The preparation of the BOMP will be guided by a number of relevant texts, including the draft National Recovery Plan for Box Gum Woodland and Derived Native Grasslands (NSW DECCW, 2010) and Rawlings et al. (2010). Other references that will guide the development of the BOMP and the rehabilitation of the offset properties also relate to the restoration of grassy temperate woodlands and will include McIntyre *et al.* (2002), Spooner *et al.* (2002), Gibson Roy (2008), and Lindenmayer *et al*. (2010).

6.7.1 Implementation Objectives

The BOMP will provide clear implementation objectives that will be consistent with the desired outcomes of the draft National Recovery Plan for Box Gum Woodland and Derived Native Grassland.

The objectives for regeneration of vegetation within the offsets will include but not be limited to the following:

- Maintenance and improvement of the condition of existing forest and woodland within all offset areas, specifically to improve conditions for threatened flora and fauna;
- Maintenance and improvement of derived native grassland to promote, through management of grazing pressure, natural succession towards woodland and or open forest;
- Rehabilitation of selected areas of low diversity native grassland by replanting trees and shrubs to promote a more rapid regeneration towards forest or woodland;
- Improvement of habitat connectivity across offset lands, and from offset lands to adjacent native vegetation and mine rehabilitation in order to improve wildlife movement in the long term.

The land within the offsets contains extensive areas of existing woodland and open forest that will form nuclei for ongoing regeneration of trees and shrubs into grassland areas. Such habitats will provide immediate and ongoing habitats for native plants and animals. Existing forest and woodland areas are currently mature, functioning examples of natural ecosystems, but their condition is expected to improve with time as trees mature, tree hollows are generated and as regeneration of understorey takes place when livestock are progressively removed (McIntyre et al., 2002).

Derived Native Grassland within the offsets has significant floral diversity, including scattered trees and shrubs. It is intended that grazing management, combined with the management of weeds and feral animals will be able to accelerate regeneration of Derived Native Grassland to forest and woodland areas. Such habitats are semi-natural and cannot currently be considered fully functional as they generally lack trees and shrubs. However, in the medium to long term, trees and shrubs are expected to regenerate into such areas if the condition of the land is improved through grazing and weed management (Lindenmayer et al., 2010). It is expected that substantial regeneration will occur within the life of the mine and a mature, functional ecosystem will be established across much of thes grassland areas within 50 years.

Low diversity native grasslands have low diversity of native ground covers and essentially no trees and shrubs. However, to overcome this, trees and shrubs will be planted into such areas to form nuclei of regenerating woody habitats that will then be able to progressively grow back into woodland or open forest. Replanting of such areas will take place early in the

life of the Project (within the first five years) and it is expected that substantial regeneration of woody plants will occur within the life of the mine. It is expected that substantial regeneration will occur witin the life of the mine and a mature, functional ecosystem will be established across much of thes grassland areas within 50 years.

6.7.2 Monitoring

The BOMP will establish key performance objectives for various areas and vegetation types within the offsets, consistent with the objectives listed above, and with the objectives of the draft National Recovery Plan for Box Gum Woodland and Derived Native Grassland.

The BOMP will include a monitoring program that tracks the progress of regeneration of open forest, woodland and grassland areas on site, and which identifies problems that require active management, such as infestatations of weeds and feral animals, or failure of some areas of plant species to regenerate.

Monitoring of the offset sites will be done in a manner that is consistent with the recommendations of **Section 5.3** in the previous chapter, which specifies Reference Sites and Monitoring for the land within the Project Boundary.

6.7.3 Ongoing Management

The BOMP will include:

- Management of land that contains and/or can be regenerated to provide Box Gum Woodland at a ratio of approximately 8 ha of conserved land for each ha to be cleared (ie a ratio of 8:1);
- Provision of land that contains or could be regenerated to provide Ironbark Forest, Dwyer's Red Gum Woodland and other non-EEC vegetation at a ratio of 3:1;
- Provision of land that includes habitat for all relevant threatened flora and fauna species that could be impacted by the Project;
- Provision of land that contributes to an existing regional biodiversity conservation strategy; and
- Re-establishment of habitat linkages to existing areas of habitat in the locality including existing native vegetation within and closely adjacent to the Project Boundary and the southern portion of the Nandewar Ranges.

The BOMP will also include specifications for weed and feral animal management, for management of tracks and trails, for active replanting of vegetation within selected areas and for monitoring.

The implementation of the plan will be funded by the proponent, Aston Resources, for the life of the Project.

The offset lands will be permanently protected by an appropriate mechanism such as a planning agreement, rezoning or transferral to National Parks estate, if accepted by OEH.

6.7.4 Sponsoring Applied Research

Aston has recognised the potential value of research aimed at improving the management of Box Gum Woodland and threatened species habitats within the offset properties. For this reason the company will commit to providing support for ecological research initiatives that cover such issues as regeneration of understorey of Box Gum Woodland, recolonisation of regenerating woodland by threatened species (eg birds and bats) and the relative importance of various habitats for maintenance of threatened species populations.

6.8 Likely Success of Rehabilitation Efforts

The proposed package of offsets and the actions proposed to be implemented in the BOMP has been designed to produce measurable biodiversity outcomes and are based on recognised principles of rehabilitation and land management (McIntyre *et al*., 2002). Agricultural land, (particularly grazing properties), often demonstrates a level of natural resilience and is usually colonised by native vegetation without any active management when the land use changes, or when areas are abandoned (Geddes *et al*., 2011; Bowen *et al*., 2007). Natural regrowth of woody vegetation on disused agricultural land has shown to correlate positively with species abundance, richness and diversity of different faunal groups (Bowen *et al*., 2007).

The degree of unassisted regeneration that occurs once agriculture is abandoned is dependent on the land use history, time since abandonment and the presence of nearby vegetation from which regeneration may occur. Appropriate management of regeneration areas has the potential to produce results in less time than unassisted regeneration alone. Assisted regeneration can overcome the shortfalls of unmanaged regrowth areas, such as lack of structural and floristic complexity, spatial population dynamics, appropriate patch scale characteristics, soil conditions, and open canopy and understory cover (Bowen *et* al., 2007; Kanowski *et al*., 2003; Prober *et al*., 2002).

It is difficult to predict how long it will take a given rehabilitation area to regenerate into a fully functioning ecosystem, as this is dependent on many factors including disturbance history, proximity of nearby remnant vegetation, condition of the soil and the management regime implemented. There are few areas of mature rehabilitation in Australia, which means that there is little information currently available on the long-term ecological development of rehabilitated communities (Nichols, 2005). Due to the inherent variability of ecological systems, the ability to predict long-term successional trends in rehabilitation is low, and it is difficult to accurately predict the composition and structure of vegetation beyond 10 years (Nichols, 2005). Nevertheless, it is clear that ceasing agricultural activities and the implementation of appropriate management techniques have the potential to substantially increase biodiversity in offset sites. The BOMP will contain details of the proposed management measures that will be implemented in the offset properties, including phased reduction of livestock management and the management of weeds to assist natural

regeneration of native pastures and derived native grasslands, as well as shrub and tree planting and direct seeding of groundcover species in more modified areas.

Three case studies illustrating how an appropriate management regime can lead to direct measurable increases in biodiversity are presented below.

6.8.1 Case Study: Mt Owen Coal Mine

The Mt Owen Coal Mine disturbed approximately 240 ha of the Ravensworth State Forest (RSF), which was subject to logging, cattle grazing and recreational activities in the past (Charnock, 2005). To offset these mining activities approximately 430 ha of woodland (New Forest), located adjacent to the RSF, was conserved and rehabilitated with native vegetation (Charnock, 2005). An extensive management programme was put in place for continuous research into best practises and monitoring of fauna and flora in conjunction with the University of Newcastle's Centre for Sustainable Ecosystem Restoration (Department of Industry, Tourism and Resources, 2006).

Mt Owen sought approval for an increase to the mining footprint, resulting in an additional impact of 94 ha of woodland. A Biodiversity Offset Strategy was developed to compensate for these impacts. The development of the strategy followed a specific methodology, with the outcome being the identification of additional offset (376 ha) and rehabilitation (968 ha) areas, specific principles, objectives and a set of exhaustive assessment criteria (Charnock, 2005).

Surveys of the RSF, New Forest and offset area have shown a doubling of plant species previously recorded in the RSF remnants (with 70% being native), structural changes occurring in the understorey and herb layers, and development of ecological models for long term sustainability of ecosystem development (Cole, 2009). The New Forest was planted between 1995 and 1997 and is in an advanced stage of vegetation development with over 80 ha containing 50000-60000 trees and upper middle storey plants surviving from an initial planting of approximately 80000, as well as vegetation arising from natural regeneration. Some areas are growing well and producing viable seed, other areas will require further restoration efforts to balance nutrient availability and to manage weed competition. Some of the restoration planting areas that were more recently planted are also responding very well, with over 90% survival, and more than 2 m growth in less than 2 years (Cole, 2009). Some of these plants are already lowering and setting seed, which is a very promising sign for their long-term sustainability.

6.8.2 Case Study: Boggabri Coal Mine

The Boggabri Coal mining activities are located within the Leard State Forest and share a common boundary with the Project. Boggabri Coal Mine commenced mining in 2006 and has implemented a progressive rehabilitation strategy. Early monitoring results of its rehabilitation area have identified 31 native vegetation species, 0 % over-storey, 35 % shrub and 20 % ground cover after 12 months increasing to 35 species, 10 % over-storey, 40 % shrub and 60 % ground cover after 36 months, with a reduction in exotic species from 9 after 12 months to 6 after 36 months survey (Parsons Brinckerhoff Pty Ltd, 2011).

Mining activities are planned in stages with corresponding rehabilitation efforts producing a continuous corridor link of over 3 km between various ages of rehabilitated land (Parsons Brinckerhoff Pty Ltd, 2011), ensuring the spread of genetic diversity. After 10 years of cumulative disturbances a conservative estimate of 20-30% of woody vegetation cover, including ground and shrub layers, has been predicted for the local rehabilitated mine and revegetated offset sites (Parsons Brinckerhoff Pty Ltd, 2011). Predicted growth parameters are reproduced from Parsons Brinckerhoff Pty Ltd (2011) and shown in **Table 6.5** below. Monitoring of the offset areas and management strategies will remain for the life the Project.

Table 6.5 Predicted Growth Parameters for Boggabri Coal Rehabilitation

Habitat Feature	Rehabilitation Age (years)				
	5	10	15	20	30+
Canopy height (m)	4.5	9	13.5	18	>20
Canopy cover (%)	10	20	30	30	30
Understorey cover (%)	22	30	30	30	30

Source: Parsons Brinckerhoff (2011)

6.8.3 Case Study: Alcoa

Alcoa World Alumina Australia commenced mining in Jarrah forests in 1963, near Perth, Western Australia. It is a large scale operation that has disturbed over 13500 ha of forest to date, and has an expected life span of over 100 years. To compensate for these impacts Alcoa has developed a comprehensive rehabilitation program in collaboration with scientists within the company's environmental research group and in local universities, Kings Park and Botanic Gardens, and the Department of Conservation and Land Management (DCLM).

Alcoa restores approximately 450 ha of forest per year (Baker et al. 1995) and to date over 11100 ha have been rehabilitated to forests by the company. During the last ten years, a key objective has been to return the plant species richness of the jarrah forest to the mined areas. A number of innovative techniques for soil handling, soil cultivation, seed collection and treatment and plant propagation have resulted in plant species richness, measured at 15-months age, increasing from an average of 65% of forest control sites in 1991 to 100% in 2001 rehabilitated areas.

The offset properties proposed for the Project are largely agricultural-grazing properties that contain remnant woodland and forest, as well as native pastures, areas of derived native grassland and in some circumstances, dry cropping land. In many of the areas, particularly the northern offset properties, it is anticipated that the phased reduction of livestock management and the management of weeds will be some of the more effective methods to assist the natural regeneration of native pastures and derived native grasslands in the first

instance. Assisted regeneration using a number of appropriate methods, including shrub and tree planting and direct seeding of groundcover species in the more modified areas of the offsets, are necessary to achieve similar results to the above examples in comparable timeframes.

6.9 Compliance with State and Commonwealth Offset Principles

The offset package has been designed to comply with State and Commonwealth principles for offsetting (DEWR, 2007, DECC (NSW), 2008a). The Northern, Western and Eastern Offsets will all provide targeted, permanent conservation lands that will be progressively regenerated over time to increasethe quality of flora and fauna habitats within them. **Tables 6.7** and **6.8** explain how the offset package is compliant with current State and Commonwealth offsetting principles.

Table 6.6 Compliance with NSW Offset Principles

NSW Biodiversity Offset Principles		Justification
1	Impacts must be avoided first by using prevention and mitigation measures.	Avoidance and mitigation measures have been incorporated into the Project prior to offsetting. The Project has been designed to avoid flora and fauna habitats as much as practicable. In particular, the Project infrastructure and mine emplacements have been located in areas cleared of Box Gum Woodland.
2	All regulatory requirements must be met.	All regulatory requirments, both State and Commonwealth, will be met by the Project.
3	Offsets must never reward ongoing poor performance.	The Project is a new mining project and as such there is no operational data to demonstrate ongoing poor performance. The offsets will be managed according to a Biodiversity Management Plan that will have Key Performance Indicators that will require to be met in order to ensure that the Project attains a high environmental standard.
4	Offsets will complement other government programs	The proposed offsets do complement other government Projects - particularly the draft Recovery Plan for Box Gum Woodland and other similar threatened species Recovery Plans (eg for Spotted-tailed Quoll). The proposed offsetting will increase the area of Box Gum Woodland and other native forests under conservation tenure in the Region and will provide increased quality of habitat in the long term.
5	Offsets must be underpinned by sound ecological principles.	The proposed offsets are underpinned by sound ecological principles. Firstly, they are designed to be "like for like" and will provide increased areas of Box Gum Woodland and other forest types in conservation tenure. Secondly, the offsets are

Table 6.6 Compliance with NSW Offset Principles

NSW Biodiversity Offset Principles		Justification
		located between a National Park and other areas of forest on Crown land. They will therefore be available for regenerating forest and woodland that can form a link between existing high quality forest and woodland areas, adding to the size and viability of the Mt Kaputar National Park. Thirdly, the offsets provide habitat for a wide variety of plants and animals, including the threatened species of animals known to occur in the area of impact – particularly threatened birds and bats (see Table **5.4**). All of the threatened species that are known to occur in the Leard State Forest also occur within the proposed offset areas. However, in addition, the proposed offsets have potential to suppport other species not previously recorded in Leard State Forest such as the Regent Honeyeater and Spotted-tailed Quoll. Finally, the offsets will be managed sustainably and weeds and feral animals will be conrolled, as will grazing by livestock. Hence the landscape will be managed to facilitate an incease in forest and woodland as these vegetation types are regenerated.
6	Offsets should aim to result in a net improvement in biodiversity over time.	The offsets contain broad areas of derived native grassland with high potential for regeneration. They will be managed sustainably and weeds and feral animals will be controlled, as will grazing by livestock. Hence the landscape will be managed to facilitate an incease in forest and woodland as these vegetation types are regenerated.
7	Offsets must be enduring and they must offset the impact of the development for the period that the impact occurs.	The offsets will be conserved in the long term and protected by an appropriate legal mechanism to ensure that the conservation measures are permanent.
8	Offsets should be agreed prior to the impact occurring.	The offsets are proposed "up front" and are available prior to the impact occurring. Rehabilitation and management of the native flora and fauna within the offsets will commence at the beginning of the Project, prior to any mining.
9	Offsets must be quantifiable and the impacts and benefits must be reliably estimated.	The offsets are quantified within the EA and the impacts and benefits have been spelled out in tables within Chapter 5. The total offset package will result in a net gain in woodland and open forest under conservation tenure and will likewise result in an increase in threatened species habitat. The areas of existing derived native grassland will be regenerated to woodland and this will provide a measureable increase in woodland and open forest habitat for threatened species.

Table 6.6 Compliance with NSW Offset Principles

NSW Biodiversity Offset Principles		Justification
10	Offsets must be targeted.	Offsets have been specifically targeted to provide Box Gum Woodland and Derived Native Grassland, and other habitats such as Ironbark Forest. The offsets have also been targeted to provide habitat for all threatened species – particularly birds and bats - that are known to occur in Leard State Forest.
11	Offsets must be located appropriately.	The offsets proposed are located appropriately beside such Leard State Conservation Area and Mt Kaputar National Park and adjacent to forested Crown Land. They will form a continuous forest and woodland habitat between the National Park and the Crown Land.
12	Offsets must be supplementary.	Offsets are supplementary to the avoidance and mitigation measures that have or will be deployed at the mine site. The mine site will be rehabilitated to forest and woodland in the long term and so the original area of forest and woodland will be recreated for flora and fauna. The offsets will be supplementary to these measures and will add sizeable areas of forest and woodland to conservation tenure in the longer term.
13	Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.	The proposed offsets are readily enforceable through development consent conditions.

Table 6.7 Compliance with Commonwealth Offset Principles

Draft Environmental Offset Policy Principles		Justification
1	Environmental offsets should be targeted to the matter protected by the EPBC Act that is being impacted.	Offsets have been specifically targeted to provide Box Gum Woodland and Derived Native Grassland, and other habitats such as Ironbark Forest. The offsets have also been targeted to provide habitat for all threatened species that are known to occur in Leard State Forest. They provide habitat for the

Table 6.7 Compliance with Commonwealth Offset Principles

	Draft Environmental Offset Policy Principles	Justification
		threatened Greater Long-eared Bat, *Nyctophilus timoriensis*, and for threatened birds including Regent Honeyeater and Swift Parrot. Although not found within the Leard State Forest, the northern offstets are also likely to provide habitat for Spotted-tailed Quoll.
2	A flexible approach should be taken to the design and use of environmental offsets to achieve long-term and certain conservation outcomes which are cost effective for proponents.	The proposed offsets will be managed in a cost effective way, with farming (livestock grazing), gradually phased out to provide for effective conservation. Offsets will be managed in a flexible, adaptive way to ensure that conservation outcomes are achieved in a cost effective and practical manner. The progress of regeneration of offsets will be monitored and monitoring data will be provided to fine tune offset management.
3	Environmental offsets should deliver a real conservation outcome.	The proposed offsets will be managed to provide a real conservation outcome, increasing the quantity and quality of Box Gum Woodland and other forest and woodland types in the region. The existing areas of derived native grassland will be regenerated progressively to woodland and this will provide a net increase in woodland habitat for threatened species.
4	Environmental offsets should be developed as a package of actions, which may include both direct and indirect offsets.	The offsets are part of a package that includes rehabilitation of the mine site area back to forest and woodland and the immediate conservation and regeneration of offset land.
5	As a minimum, environmental offsets should be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like for like'.	The proposed offsets, when fully regenerated, will greatly exceed the total area that will be impacted by mining. This - when combined with rehabilitation of the mine site - will result in a net increase in forest and woodland habitat in the Region in the long term.
6	Environmental offsets should be located within the same general area as the development activity.	All offsets are located within the same subregion and are within 50 km of the proposed Project. This means that the vegetation of the proposed offsets will be essentially the same or very similar to the impacted vegetation.
7	Environmental offsets should be delivered in a timely manner and be long lasting.	The proposed offsets will be available at the commencement of mining and will be permanent. The quality of offsets and the quantity of woodland and open forest will increase over time.
8	Environmental offsets should be enforceable, monitored and	The proposed offsets are readily enforceable through development of a BOMP. They will be monitored annually and

Table 6.7 Compliance with Commonwealth Offset Principles		
Draft Environmental Offset Policy Principles		**Justification**
	audited.	subjected to independent audit.

6.10 Potential Cumulative Benefits from Adjacent Projects

The biodiversity offset package has been designed to provide a net benefit to flora and fauna in the locality and region. This is to be achieved principally by:

- Adding to the vegetation that is permanently protected so that there is a substantial increase in conserved woodland and open forest in the long term;
- Linking large blocks of forest and woodland to the rehabilitation areas and to substantial blocks of habitat in the locality, including the Nandewar Ranges and the riparian forests around the Namoi River; and
- Providing for the conservation management of vegetation and threatened species for the life of the Project.

Collectively, when considered with the current proposal, a high proportion of the existing Leard State Forest will be subject to mining within the next two to three decades. All of the mines propose to rehabilitate mined areas and return them to forest and woodland. The mined landscaped will be progressively returned as flora and fauna habitat in the medium to long term. Additionally, all of the mines have provisions for offsetting ecological impacts. All of the mines will or have purchased additional surrounding lands that contain forest, woodland and derived native grasslands. These will collectively and significantly increase the total areas of native vegetation that exist in the locality in the future and will significantly increase the total area of native vegetation within conservation reserves in the locality and the region.

Table 6.9 provides a summary of offsetting data from publicly available material for Boggabri Coal Mine (Parsons Brinckerhoff Australia Pty Ltd, 2010) and Tarrawonga Coal Mine (ELA, 2010), combined with the current proposal for offsetting for the Maules Creek Coal Project. The available data indicates that in the medium to long term the mining activities will result in a net increase in forest and woodland in and around Leard State Forest, and in the wider locality. Excluding mine rehabilitation, this is likely to include offsets in the order of 17320 ha, providing an offset to impact ratio of approximately 3.9:1. However, offsetting for CEEC will be at a higher ratio, estimated to be at least 5.3:1. Therefore it is estimated that the combined offsetting will provide 8013 ha of Box Gum Woodland and Derived Native Grassland at a ratio of approximately 5.3:1.

Such long term increases in forest and woodland cover are likely to have significant benefits to native flora and fauna including all threatened species covered within this assessment.

Table 6.8 Potential Cumulative Offsets Within and Around Leard State Forest

Projects/Potential Projects	[A] IMPACTS: forest, woodland, derived native grassland (ha)	[B] IMPACTS: Box Gum Woodland and Derived Native Grasslands (ha)	[C] OFFSETS: forest, woodland and derived native grassland (ha)	[D] OFFSETS: Box Gum Woodland and Derived Native Grasslands (ha	Offset Ratio - [C]:[A] (ha)	Offset Ratio - [D]:[B] (ha)
Maules Creek Coal Project	2078.6	544.5	6407.3	4668.1	3.1	8.6
Boggabri Coal Continuation Project	1357.8	650.3	7571.0	1724.1	5.6	2.7
Tarrawonga Project	59.1	22.3	242.0	121.0	4.1	5.4
Goonbri (hypothetical - no data)	1000.0	300.0	3100.0	1500.0	3.1	5.0
Total	**4495.5**	**1517.1**	**17320.3**	**8013.2**	**3.9**	**5.3**

Chapter 7

Conclusion

The Project is largely located within Leard State Forest, which comprises a very large remnant patch of vegetation surrounded by a landscape that has been significantly affected by past land uses. Nevertheless, the Project is expected to have a substantial impact on the ecology of the local area as it would remove 1665 ha of native forest and woodland, and 544 ha of Box Gum Woodland and Derived Native Grassland. This vegetation also provides habitat for a range of threatened species, including at least 30 fauna species as listed under the TSC Act and/or EPBC Act, and two threatened plant species as listed under the TSC Act and/or EPBC Act, which were recorded in the vicinity of the Project Boundary within the Leard State Forest.

Assessment under the EPBC Act has also been required for impacts to Box Gum Woodland and Derived Grasslands, and for impacts to threatened species including the Vulnerable Greater Long-eared Bat and the Migratory and Critically Endangered Regent Honeyeater. Given the scale of the Project's potential impacts on the flora and fauna listed by the EPBC Act, the Project was deemed to be a controlled action under the EPBC Act.

At the sub-bioregional level, these impacts would not be significant as there are broad areas of similar landscape that are well conserved, and there are also broad areas to be set aside as compensatory offsets by other mining projects. Despite this, it is acknowledged that the Project will remove broad areas of vegetation and associated habitat from the Project Boundary, which would result in a substantial ecological impact at the local level in the absence of appropriate impact amelioration measures.

In recognition of the potential ecological impacts of the Project, the Project has been designed with substantial amelioration measures. The considerations for reducing the ecological impacts followed a hierarchy of principles:

- Avoid – to the extent possible, developments should be designed to avoid or minimize ecological impacts;
- Mitigate – where certain impacts are unavoidable through design changes, mitigation measures should be introduced to ameliorate the ecological impacts of the Project; and
- Compensate – the residual impacts of the Project, following the implementation of mitigation measures, should be compensated to offset what would otherwise be a net loss of habitat.

The Project would impact habitats for locally occurring threatened biodiversity in the short term. This however, is only considered to be a temporary disturbance. The Project would incorporate an extensive rehabilitation program as part of the mine closure procedures. This rehabilitation plan includes restoration of the Leard State Forest to the existing forest where practical. A Rehabilitation Management Plan should be developed that prescribes the progressive rehabilitation of all mine disturbed areas. The key objectives of this plan will be to restore, where possible, the pre-mining biodiversity within a safe and stable landform including 544 ha of the Box-Gum Woodland and supplementary habitat features, including translocated hollow logs. All forest and woodland areas to be cleared by mining should be rehabilitated as forest and woodland in the long term using local native species, maintaining treed habitat in the locality. The restoration of the Leard State Forest would be a staged process and has been designed with the intention of providing a self sustaining native forestry operation as well as maintaining pre-mine biodiversity values.

Further to this, a carefully designed Biodiversity Offset Strategy is proposed and should be implemented. The Biodiversity Offset Strategy identifies large patches of remnant vegetation in the locality of the Project Boundary. Over 8000 ha of forest, woodland and grassland habitat for native flora and fauna is proposed for permanent conservation, including 4797 ha of Box Gum Woodland and Derived Grasslands. In the long term, 1969 ha of Derived Native Grassland within the offset land is proposed to be regenerated to woodland. Importantly, these areas would provide upfront mitigation of the Project's impacts on locally occurring biodiversity. A critical component of the strategy would be the restoration and establishment of a regional corridor linking the Leard State Forest with the Namoi River and large vegetation remnants to the west. The inclusion of these lands as biodiversity offsets would provide additional conservation areas in the region for threatened flora and fauna, which has previously been highly fragmented.

Aside from the Project, other coal mining is currently taking place in the southern part of Leard State Forest. Boggabri Coal is currently mining in the southern half of the State Forest. It is also proposing to continue mining the southern half of the State Forest and will eventually mine a high proportion of the southern lease. Tarrawonga Mine is further to the southeast and will mine additional areas of forest. Collectively, when considered with the Project, a high proportion of the existing Leard State Forest will be subject to mining within the next two to three decades.

Notwithstanding this, all of the mines propose to rehabilitate mined areas and return them to forest and woodland. The mined landscaped will be progressively returned as flora and fauna habitat in the medium to long term. Additionally, all of the mines have provisions for offsetting ecological impacts. All of the mines will or have purchased additional surrounding lands that contain forest, woodland and derived native grasslands. These will collectively and significantly increase the total areas of native vegetation that exist in the locality in the future and will significantly increase the total area of native vegetation within conservation reserves in the locality and the region.

The available data indicates that in the medium to long term the mining activities will result in a net increase in forest and woodland in and around Leard State Forest, and in the wider locality. Excluding mine rehabilitation, this is likely to include offsets in the order of 18967

ha, providing an offset to impact ratio of approximately 4.2:1. However, offsetting for CEEC in the locality will be at a higher ratio, estimated to be at least 5.4:1. Therefore it is estimated that the combined offsetting will provide 8013.2 ha of Box Gum Woodland and Derived Native Grassland.

The Leard State Forest is Zone 4 under the Brigalow Nandewar Community Conservation Area Agreement, meaning that it is zoned for forestry and mining. It has been logged for its valuable timber resources on a regular basis up until the late 1970s early 1980s and continues to be assessed for its commercial timber values. These activities have affected the quality and diversity of habitats for locally occurring threatened species and it is likely that in the absence of the Project, these activities would continue throughout the Forest as productive timber develops.

The combined mitigation measures and Biodiversity Offset Strategy to be implemented over the life of the Project are likely to sufficiently ameliorate these impacts to the extent that no threatened species are likely to become extinct as a result of the Project. Moreover, the long term objective of the Biodiversity Offset Strategy is to provide for a net benefit to flora and fauna within the locality and region, substantially increasing the proportion of native forest and woodland in conservation tenure. The ratio of Box Gum Woodland to be conserved to that cleared for the Project will exceed 8:1, excluding areas to be rehabilitated within the Project Boundary. When the mitigation and offsetting package is considered, the Project will have a major ecological benefit in the medium to long term.

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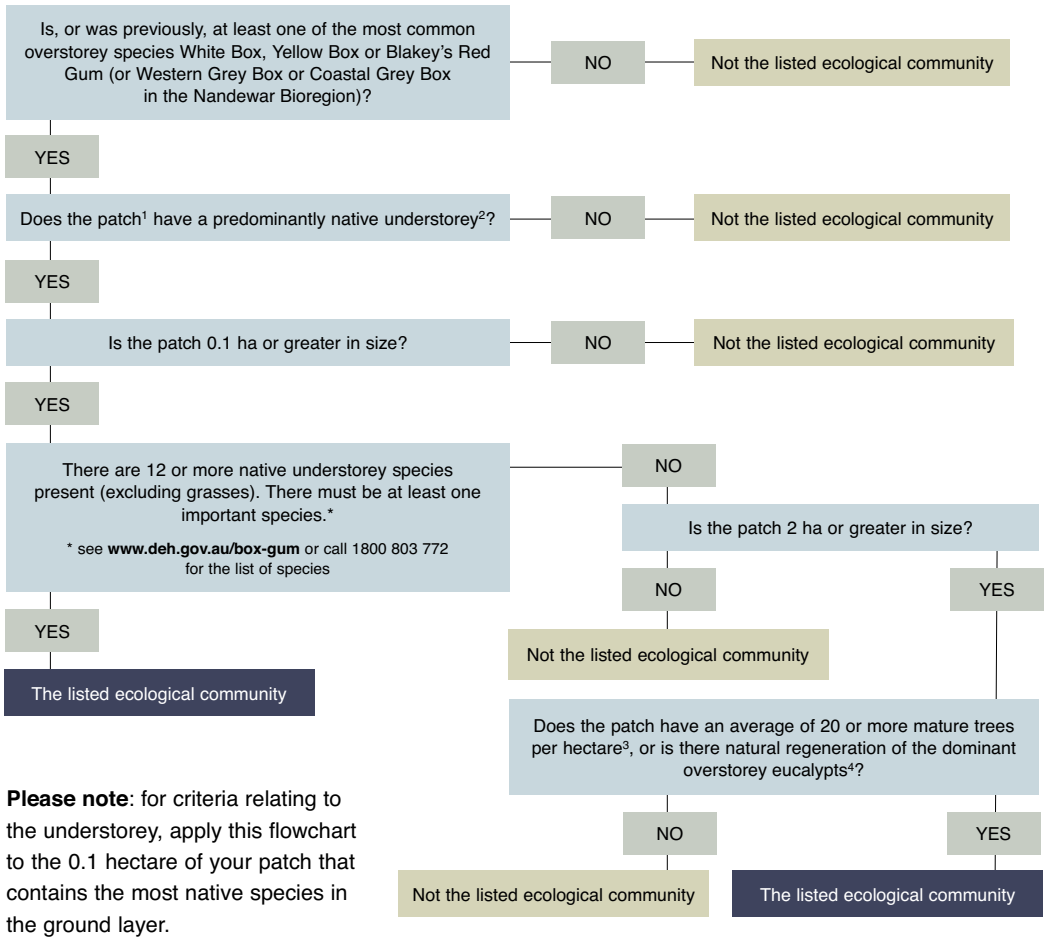
Appendix A
A.

Identification Guidelines from the EPBC Act Policy Statement for Box Gum Woodland

The flowchart below represents the lowest condition at which patches are included in the listed ecological community. This is not the ideal state of the ecological community. Large patches, those that link remnants in the landscape, those that occur in highly cleared areas, those that contain rare, declining or threatened species, and those that represent the entire range of the ecological community, are important for the long-term future of the ecological community.

Determining if your land has an area of the listed ecological community



Please note: for criteria relating to the understorey, apply this flowchart to the 0.1 hectare of your patch that contains the most native species in the ground layer.

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[1] Patch – a patch is a continuous area containing the ecological community (areas of other ecological communities such as woodlands dominated by other species are not included in a patch). In determining patch size it is important to know what is, and is not, included within any individual patch. The patch is the larger of:

- an area that contains five or more trees in which no tree is greater than 75 m from another tree, or
- the area over which the understorey is predominantly native.

Patches must be assessed at a scale of 0.1 ha (1000m^2) or greater.

[2] A predominantly native ground layer is one where at least 50 per cent of the perennial vegetation cover in the ground layer is made up of native species. The best time of the year to determine this is late autumn when the annual species have died back and have not yet started to regrow. (At other times of the year, you can determine whether something is perennial or not is if it is difficult to pull out of the soil. Annual species pull out very easily.)

[3] Mature trees are trees with a circumference of at least 125 cm at 130 cm above the ground.

[4] Natural regeneration of the dominant overstorey eucalypts when there are mature trees plus regenerating trees of at least 15 cm circumference at 130 cm above the ground.

Appendix B

B.

Flora Species List

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
Trees										
Apocynaceae		*Alstonia constricta*	Quinine Tree					X		X
Casuarinaceae		*Allocasuarina gymnanthera*						X		
		Allocasuarina luehmannii	Bulloak					X		X
		Allocasuarina stricta						X		
		Casuarina cristata	Belah			X	X	X		X
		Casuarina cunninghamiana	River Oak							X
		Casuarina pauper	Black Oak				X			
Cupressaceae		*Callitris endlicheri*	Black Cypress Pine			X	X	X	X	
		Callitris glaucophylla	White Cypress Pine			X	X	X	X	X
		Callitris sp.							X	
Fabaceae (Mimosoideae)		*Acacia dealbata*	Silver Wattle				X	X		
		Acacia implexa	Hickory Wattle				X			
		Vachellia farnesiana	Mimosa Bush				X	X		
Loranthaceae		*Amyema cambagei*						X		
		Amyema lucasii						X		
		Amyema maidenii	a mistletoe				X			

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Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Amyema miquelii	a mistletoe				X	X		X
		Amyema miraculosum						X		
		Amyema pendulum							X	
Loranthaceae		*Amyema quandang*							X	
		Amyema quandang var. bancroftii						X		
		Amyema quandang var. quandang						X		
		Amyema sp.	a mistletoe			X				
Meliaceae		*Melia azedarach*	White Cedar					X		
Moraceae		*Ficus ?virens*	White Fig				X			
		Ficus rubiginosa	Port Jackson Fig				X	X		
Myrtaceae		*Angophora floribunda*	Rough-barked Apple			X	X	X		
		Corymbia trachyphloia	White Bloodwood					X		
		Eucalyptus albens	White Box			X	X	X	X	X
		Eucalyptus bancroftii	Orange Gum			X				
		Eucalyptus blakelyi	Blakely's Red Gum			X	X	X		X
		Eucalyptus camaldulensis	River Red Gum					X		
		Eucalyptus chloroclada	Dirty Gum					X		
		Eucalyptus crebra	Narrow-leaved Ironbark			X	X	X	X	X
		Eucalyptus dealbata	Tumbledown Red Gum				X	X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Eucalyptus dwyeri	Dwyer's Red Gum				X	X		X
		Eucalyptus fibrosa subsp. nubila				X		X		
		Eucalyptus goniocalyx	Long-leaved Box			X				
		Eucalyptus melanophloia	Silver-leaved Ironbark			X	X	X		X
		Eucalyptus melliodora	Yellow Box			X		X		X
		Eucalyptus microcarpa	Western Grey Box				X	X		
		Eucalyptus nandewarica						X		
		Eucalyptus pilligaensis	Narrow-leaved Grey Box			X		X	X	X
		Eucalyptus populnea	Poplar Box			X	X	X		X
		Eucalyptus sp.	a Red Gum							X
		Melaleuca bracteata	Black Tea-tree					X		
Pittosporaceae		*Bursaria spinosa*	Native Blackthorn					X		
Rhamnaceae		*Alphitonia excelsa*	Red Ash			X	X	X		X
		Pomaderris graniticola								X
		Ventilago viminalis	Supple Jack							X
Santalaceae		*Exocarpos cupressiformis*	Native Cherry			X	X	X		X
Sapindaceae		*Alectryon subcinereus*	Wild Quince				X			
		Atalaya hemiglauca	Whitewood			X	X	X		
		Dodonaea sinuolata subsp. sinuolata	Hop-bush					X		X

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Heterodendrum oleifolium						X		
Sterculiaceae		*Brachychiton populneus*	Kurrajong			X	X	X		X
Shrubs										
Agavaceae	*	*Agave americana*	Century Plant					X		
Apocynaceae		*Carissa ovata*	Kunkerberry						X	
Asteraceae		*Cassinia arcuata*	Sifton Bush				X			X
Boraginaceae		*Ehretia membranifolia*	Peach Bush					X		
Capparaceae		*Capparis mitchellii*	Wild Orange					X		X
Celastraceae		*Maytenus cunninghamii*	Yellow-berry Bush					X		
		Maytenus silvestris	Narrow-leaved Orangebark				X			
Chenopodiaceae		*Atriplex muelleri*						X		
		Atriplex semibaccata	Creeping Saltbush				X			X
		Atriplex sp.							X	
		Maireana microphylla	Small-leaf Bluebush					X	X	
		Rhagodia parabolica	Mealy Saltbush				X			
Chloanthaceae		*Spartothamnella juncea*	Bead Bush					X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
Cupressaceae		*Callitris glaucophylla (regeneration)*	White Cypress Pine			X	X			X
Ericaceae (Styphelioideae)		*Epacris impressa*	Common Heath			X				
		Leucopogon sp.					X			X
		Melichrus urceolatus	Urn-heath					X		X
Euphorbiaceae		*Beyeria viscosa*	Pinkwood			X	X	X	X	X
		Petalostigma quadriloculare					X			
Fabaceae (Caesalpinioideae)		*Cassia barclayana*	Smooth Senna					X		
		Cassia eremophila var. eremophila								
		Senna aciphylla	Sprawling Cassia					X		
		Senna artemisioides	Silver Cassia			X		X		
		Senna artemisioides subsp. coriacea					X			
		Senna artemisioides subsp. zygophylla					X			
		Senna sp.								X
Fabaceae (Faboideae)		*Bossiaea sp.*								X
		Daviesia leptophylla					X			
		Daviesia nova-anglica						X		
		Daviesia pubigera						X		
		Dillwynia sieberi						X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Dillwynia sp.				X				
		Goodia lotifolia					X			
		Hovea lanceolata						X		
		Indigofera adesmiifolia	Tick Indigo			X	X	X		X
		Indigofera australis var. australis	Australian Indigo				X	X	X	X
		Indigofera sp.								X
		Pultenaea cuneata						X		X
		Pultenaea daphnoides	Large-leaf Bush-pea							X
		Pultenaea microphylla				X				
		Pultenaea retusa	Notched Bush-pea				X	X		
		Pultenaea setulosa			V			X		
		Swainsona galegifolia	Smooth Darling-pea			X		X		X
		Swainsona swainsonioides						X		
		Templetonia stenophylla	Leafy Templetonia					X		
Fabaceae (Mimosoideae)		*Acacia aneura*	Mulga							
		Acacia buxifolia	Box-leaved Wattle							X
		Acacia cheelii	Motherumbah			X		X		X
		Acacia deanei	Deane's Wattle					X		X
		Acacia decora	Western Golden Wattle			X	X	X	X	X

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Acacia doratoxylon	Currawang					X		
		Acacia excelsa	Ironwood					X		
		Acacia gladiiformis	Sword-leaved Wattle					X		
		Acacia hakeoides	Hakea Wattle			X		X		X
		Acacia harpophylla	Brigalow					X		
		Acacia homalophylla	Yarran					X		
		Acacia leiocalyx						X		
		Acacia oswaldii	Miljee					X		
		Acacia pendula	Weeping Myall			X		X		X
		Acacia sp.								X
		Acacia spectabilis	Mudgee Wattle			X		X		
		Acacia triptera	Spurwing Wattle					X	X	
Goodeniaceae		*Goodenia ovata*	Hop Goodenia				X			X
Lamiaceae	*	*Marrubium vulgare*	Horehound				X	X		
		Prostanthera cruciflora						X		
		Prostanthera rhombea	Sparkling Mint-bush					X		
		Prostanthera sp.	A Mint Bush							X
		Spartothamnella puberula					X			
		Westringia rigida	Stiff Westringia					X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
Loranthaceae		*Lysiana sp.*					X			
		Lysiana subfalcata						X		
Malvaceae		*Abutilon leucopetalum*						X		
		Abutilon oxycarpum	Lantern Bush					X	X	
		Hibiscus sturtii				X		X		
	*	*Malva parviflora*	Small-flowered Mallow					X		
		Malva preissiana	Native Hollyhock				X			
		Malva sp.							X	
	*	*Malvastrum americanum*	Spiked Malvastrum					X		
Myoporaceae		*Eremophila mitchellii*	Budda			X		X	X	X
		Myoporum deserti						X		
		Myoporum montanum	Western Boobialla					X	X	
Myrtaceae		*Melaleuca lanceolata*	Moonah							X
Olacaceae		*Olax stricta*						X		
Oleaceae		*Jasminum lineare*	Desert Jasmine					X	X	
		Notelaea linearis						X		X
		Notelaea microcarpa	Native Olive			X			X	X
		Notelaea microcarpa var. microcarpa	Native Olive					X	X	X
		Notelaea sp.								X

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
Phyllanthaceae		*Breynia oblongifolia*	Coffee Bush			X	X	X		X
Pittosporaceae		*Pittosporum angustifolium*	Weeping Pittosporum				X	X		X
Proteaceae		*Grevillea sp.*								X
Rhamnaceae		*Pomaderris andromedifolia*						X		
		Pomaderris queenslandica	Scant Pomaderris	E				X		
Rosaceae	*	*Rubus ulmifolius*	Blackberry					X		
Rubiaceae		*Canthium odoratum*	Shiny-leaved Canthium					X		
		Canthium sp.					X			X
		Psydrax odorata	Shiny-leaved Canthium			X				
		Psydrax oleifolia				X				
Rutaceae		*Geijera parviflora*	Wilga			X	X	X	X	X
		Geijera salicifolia							X	
Sapindaceae		*Alectryon diversifolius*	Scrub Boonaree					X		
		Alectryon oleifolius				X		X	X	
		Alectryon oleifolius subsp. elongatus								X
		Dodonaea boroniifolia	Fern-leaf Hop-bush			X		X		
		Dodonaea heteromorpha	Maple-fruited Hop-bush				X	X		X
		Dodonaea multijuga					X			
		Dodonaea tenuifolia						X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Dodonaea truncatiales	Angular Hop-bush					X		
		Dodonaea viscosa	Sticky Hop-bush					X	X	
		Dodonaea viscosa ssp angustifolia	Sticky Hop-bush			X	X	X		X
		Dodonaea viscosa ssp. cuneata	Wedge-leaf Hop-bush					X		
Solanaceae	*	*Lycium ferocissimum*	African Boxthorn						X	
		Solanum cinereum	Narrawa Burr				X			X
		Solanum ellipticum	Velvet Potato Bush					X		
		Solanum esuriale	Quena						X	
		Solanum ferocissimum	Spiny Potato-bush					X		
		Solanum linearifolium	Mountain Kangaroo Apple					X		
Sterculiaceae		*Gilesia biniflora*	Western Tarvine					X		
Thymelaeaceae		*Pimelea curviflora*						X		
		Pimelea linifolia ssp. linifolia	Riceflower							X
		Pimelea neo-anglica	Poison Pimelea					X	X	
		Pimelea sp.								X
		Pimelea stricta						X		
Dicots										
Acanthaceae		*Brunoniella australis*	Blue Trumpet					X	X	X
		Brunoniella pumilio	Dwarf Brunoniella							

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Pseuderanthemum variabile	Pastel Flower					X		
		Rostellularia adscendens							X	
		Rostellularia adscendens var. adscendens						X		X
Aizoaceae		*Carpobrotus glaucescens*	Pigface						X	
	*	*Galenia pubescens*	Galenia / Carpet Weed					X		
		Zaleya galericulata	Hogweed						X	
Amaranthaceae		*Alternanthera denticulata*	Lesser Joyweed							X
		Alternanthera nana	Hairy Joyweed					X		
	*	*Alternanthera pungens*	Khaki Weed					X		
		Alternanthera sp.							X	
	*	*Amaranthus viridis*	Green Amaranth					X		
Apiaceae		*Actinotus helianthi*	Flannel Flower					X		
	*	*Conium maculatum*	Hemlock					X		
		Daucus glochidiatus	Native Carrot					X		X
		Trachymene sp.					X			
Apocynaceae		*Marsdenia australis*	Doubah					X		
		Marsdenia sp.					X			X
		Marsdenia viridiflora	Native Pear					X		X

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
Asteraceae		*Ammobium alatum*						X		
	*	*Arctotheca calendula*	Capeweed					X		
	*	*Bidens Pilosa*	Cobbler's Pegs					X		
		Brachyscome ciliaris	Variable Daisy			X		X		
		Brachyscome multifida	Cut-leaved Daisy					X		
		Calotis cuneata	Mountain Burr-daisy					X		
		Calotis cuneifolia	Purple Burr-daisy			X		X		X
		Calotis erinacea	Tangled Burr-daisy					X		
		Calotis hispidula	Bogan Flea				X	X		
		Calotis lappulacea	Yellow Burr-daisy					X	X	X
		Calotis sp.	Burr-daisy							X
	*	*Carthamus lanatus*	Saffron Thistle					X	X	
		Cassinia aculeata	Dolly Bush				X	X		
		Cassinia laevis	Cough Bush					X		
	*	*Centaurea melitensis*	Maltese Cockspur				X			
	*	*Chondrilla juncea*	Skeleton Weed					X	X	X
		Chrysocephalum apiculatum	Common Everlasting			X		X	X	X
		Chrysocephalum semipapposum	Clustered Everlasting			X	X	X	X	X
	*	*Cirsium vulgare*	Spear Thistle				X	X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
	*	*Conyza albida*	Tall Fleabane					X		
	*	*Conyza bonariensis*	Flaxleaf Fleabane					X		
	*	*Conyza sp.*	Fleabane							X
		Cymbonotus lawsonianus	Bears-ear							X
		Euchiton sphaericus						X		X
		Glossogyne tannensis	Cobblers Tack						X	X
		Glossogyne tenuifolia	Native Cobbler's Peg					X		
	*	*Gnaphalium japonicum*	Japanese Cudweed			X				
	*	*Gnaphalium sp.*	a cudweed							X
		Gnaphalium sphaericum						X		
		Helichrysum sp.								X
	*	*Hypochaeris glabra*	Smooth Catsear					X		
	*	*Lactuca saligna*	Willow-leaved Lettuce						X	
		Leptorhynchos panaetioides	Woolly Buttons					X	X	
		Leptorhynchos tetrachaetus	Beauty Buttons					X		
		Minuria integerrima	Smooth Minuria					X		
		Minuria leptophylla						X		
		Olearia elliptica	Sticky Daisy-bush			X		X	X	X
		Olearia nernstii						X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Olearia ramulosa	Twiggy Daisy-bush					X		
		Olearia rosmarinifolia					X			
		Ozothamnus diosmifolius	White Dogwood			X	X			
		Pseudognaphalium luteoalbum	Jersey Cudweed					X		
	*	*Schkuhria pinnata*						X		
		Senecio hispidulus	Hill Fireweed				X			X
		Senecio lautus	Variable Groundsel							X
	*	*Senecio madagascariensis*	Fireweed					X		
		Senecio quadridentatus	Cotton Fireweed					X		X
		Senecio sp.						X		X
		Sigesbeckia australiensis						X		
		Sigesbeckia sp.								X
	*	*Silybum marianum*	Variegated Thistle					X		
		Solenogyne bellioides						X		X
	*	*Sonchus asper*	Prickly Sowthistle				X			X
	*	*Sonchus oleraceus*	Common Sowthistle					X		X
		Vernonia cinerea						X		
		Vittadinia cervicularis var. cervicularis					X	X		
		Vittadinia cuneata	Fuzzweed					X	X	X

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Vittadinia cuneata var. hirsuta	Fuzzweed							X
		Vittadinia dissecta						X		
		Vittadinia muelleri						X	X	
		Vittadinia pterochaeta	Rough Fuzzweed					X		
		Vittadinia sulcata						X		X
	*	*Xanthium spinosum*	Bathurst Burr					X		
		Xanthium strumarium						X		
		Xerochrysum bracteatum	Golden Everlasting			X	X	X	X	
		Xerochrysum palustre	Swamp Everlasting					X		
		Xerochrysum viscosum	Sticky Everlasting					X	X	X
Boraginaceae		*Cynoglossum australe*							X	
	*	*Echium plantagineum*	Patterson's Curse				X		X	
	*	*Heliotropium amplexicaule*	Blue Heliotrope					X		
Brassicaceae	*	*Brassica napus*	Coleseed					X		
	*	*Brassica rapa*	Field Mustard					X		
	*	*Brassica* sp.						X	X	
	*	*Capsella bursa-pastoralis*	Shepard's Purse				X	X		
	*	*Lepidium africanum*						X		
	*	*Lepidium bonariense*					X		X	

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Lepidium papillosum	Warty Papercress					X		
		Lepidium pseudohyssopifolium	Peppercress							X
		Lepidium sagittulatum						X		
		Lepidium sp.							X	
Cactaceae	*	*Cylindropuntia imbricata*	Devil's Rope Pear				X			
	*	*Cylindropuntia* sp.							X	
	*	*Opuntia aurantiaca*	Tiger Pear					X		
	*	*Opuntia* sp.							X	
	*	*Opuntia stricta*	Prickly Pear			X	X	X		X
	*	*Opuntia tomentosa*	Velvet Tree Pear					X		
Campanulaceae		*Wahlenbergia communis*	Tufted Bluebell			X		X		X
		Wahlenbergia fluminalis	River Bluebell							X
		Wahlenbergia gracilis	Australian Bluebell				X	X		
		Wahlenbergia planiflora ssp.longipila						X		
		Wahlenbergia sp.	Bluebell			X		X		X
		Wahlenbergia sp. 1							X	
		Wahlenbergia sp. 2							X	
		Wahlenbergia stricta	Tall Bluebell					X		X
Caryophyllaceae	*	*Petrorhagia nanteuilii*							X	

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
	*	*Petrorhagia velutina*	Velvet Pink							X
		Polycarpaea corymbosa						X		
	*	*Polycarpon tetraphyllum*	Four-leaved Allseed					X		
Chenopodiaceae		*Chenopodium pumilio*	Small Crumbweed			X				
		Einadia hastata	Berry Saltbush			X		X	X	X
		Einadia nutans	Climbing Saltbush				X	X	X	X
		Einadia nutans ssp. Linifolia						X		
		Einadia polygonoides						X		X
		Einadia sp.							X	
		Einadia trigonos	Fishweed					X		
		Enchylaena tomentosa	Ruby Saltbush					X		X
		Maireana pentagona	Hairy Bluebush					X		
		Maireana sp.						X	X	
		Salsola kali						X		
		Sclerolaena birchii (syn. Bassia birchii)	Galvinized Burr				X	X	X	X
		Sclerolaena muricata	Black Rolypoly					X		
		Sclerolaena sp.								X
Clusiaceae		*Hypericum gramineum*	Small St. John's Wort			X		X	X	
Colchicaceae		*Wurmbea dioica*	Early Nancy							X

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
Convolvulaceae		*Convolvulus erubescens*	Blushing Bindweed					X	X	
		Dichondra repens	Kidney Weed				X	X	X	X
		Dichondra sp. A						X		
		Evolvulus alsinoides						X		
Crassulaceae		*Crassula sp.*								X
Dilleniaceae		*Hibbertia obtusifolia*	Hoary Guniea Flower			X	X	X	X	X
		Hibbertia riparia	Erect Guinea-flower						X	
Droseraceae		*Drosera* sp.	A Sundew							X
Euphorbiaceae		*Chamaesyce drummondii*	Caustic Weed					X	X	X
		Chamaesyce drummondii/Chamaesyce dallachyana					X			
		Euphorbia drummondii	Caustic Weed					X		
		Euphorbia eremophila	Desert Spurge					X		
		Phyllanthus gunii						X		X
		Phyllanthus sp.								
		Phyllanthus virgatus						X		X
		Poranthera microphylla						X		
		Sauropus ramosissimus						X		
Fabaceae (Faboideae)		*Desmodium brachypodum*	Large tick-trefoil			X		X	X	X

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Desmodium sp.							X	
		Desmodium varians	Tick-trefoil					X		X
	*	*Medicago polymorpha*	Burr-Medic					X		
		Medicago sativa	Lucerne					X		
	*	*Medicago sp.*	Burr-Medic						X	X
		Pultenaea foliolosa	Small-leaf Bush-pea							X
	*	*Trifolium arvense*	Haresfoot Clover					X	X	X
	*	*Trifolium repens*	White Clover					X		
		Zornia dyctiocarpa	Zornia					X		
Fabaceae (Mimosoideae)		*Neptunia gracilis*	Sensitive Plant					X		
Gentianaceae	*	*Centaurium erythraea*	Common Centaury						X	X
Geraniaceae	*	*Geranium molle*	Cranesbill Geranium					X		
		Geranium solanderi	Native Geranium					X		X
Goodeniaceae		*Goodenia bellidifolia*						X		
		Goodenia cycloptera								X
		Goodenia fascicularis						X		
		Goodenia glabra				X		X		
		Goodenia hederacea	Ivy Goodenia					X	X	X
		Goodenia rotundifolia						X		

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Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Goodenia sp.				X		X		
		Scaevola spinescens						X		
Haloragaceae		*Gonocarpus elatus*						X		
		Gonocarpus sp.	a Raspwort							X
		Gonocarpus teucrioides						X		
		Haloragis ?aspera	Rough Raspwort				X			
Lamiaceae		*Ajuga australis*	Austral Bugle			X		X		X
		Mentha satureioides	Native Pennyroyal					X		
		Oncinocalyx betchei							X	
		Prostanthera granitica					X			X
		Salvia plebeia						X		
	*	*Salvia verbenaca*	Wild Sage					X		
		Scutellaria humilis	Dwarf Skullcap					X		
	*	*Stachys arvensis*	Stagger Weed					X		
		Teucrium racemosum	Grey Germander					X		
Linaceae		*Linum marginale*	Native Flax					X		
Lobeliaceae		*Isotoma axillaris*	Showy Isotome				X	X		
		Pratia purpurascens								X
Lythraceae		*Lythrum hyssopifolia*	Hyssop Loosestrife					X		

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Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
Malvaceae		*Hibiscus trionum*	Flower-of-an-hour					X		
		Sida corrugata	Corrugated Sida				X	X	X	X
		Sida cunninghamii	Ridged Sida			X		X	X	X
		Sida filiformis	Fine Sida					X		
	*	*Sida rhombifolia*	Paddy's Lucerne					X	X	X
		Sida sp.							X	
		Sida sp.A							X	
		Sida sp.B							X	
		Sida spinosa							X	
		Sida subspicata	Spiked Sida					X		
Marsileaceae		*Marsilea drummondii*	Common Nardoo					X		
Myoporaceae		*Eremophila debilis*	Winter Apple			X		X	X	X
		Eremophila longifolia	Emubush					X	X	
Myrsinaceae	*	*Anagallis arvensis*	Scarlet/Blue Pimpernel					X		X
Nyctaginaceae		*Boerhavia dominii*	Tarvine					X	X	
Orchidaceae		*Glossodia* sp.	Waxlip Orchid							X
Oxalidaceae		*Oxalis chnoodes*								X
	*	*Oxalis corniculata*	Creeping Oxalis				X	X		
		Oxalis exilis								X

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Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Oxalis perennans						X	X	X
		Oxalis radicosa						X		
		Oxalis sp.								X
Phyllanthaceae		*Phyllanthus virgatus*							X	
Plantaginaceae		*Plantago cunninghamii*						X		
		Plantago debilis						X		X
Polygonaceae		*Persicaria decipiens*	Slender Knotweed					X		
	*	*Polygonum aviculare*	Wireweed					X		
		Polygonum plebeium	Small Knotweed					X		
		Polygonum sp.	Wireweed							X
		Rumex brownii	Dockweed					X	X	X
	*	*Rumex crispus*	Curled Dock					X		
Portulacaceae		*Portulaca oleracea*	Pigweed					X	X	
Rubiaceae		*Asperula conferta*	Common Woodruff					X		X
		Asperula sp.								X
		Galium gaudichaudii	Rough Bedstraw				X	X		X
		Galium migrans						X		
	*	*Galium murale*	Small Bedstraw				X			
		Galium sp.							X	

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Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Opercularia aspera	Coarse Stinkweed						X	
		Opercularia hispida	Hairy Stinkweed					X		
		Opercularia sp.								X
		Pomax umbellata						X		X
Santalaceae		*Santalum lanceolatum*	Northern Sandalwood					X		
Santalaceae		*Santalum sp.*								X
Scrophulariaceae		*Mimulus gracilis*	Slender Monkey-flower			X				
		Verbascum sp.								X
		Veronica plebeia	Trailing Speedwell					X		
Solanaceae		*Solanum aviculare*	Kangaroo Apple				X			
	*	*Solanum linnaeanum*	Apple of Sodom			X				
	*	*Solanum nigrum*	Black-berry Nightshade					X		
		Solanum opacum	Green-berry Nightshade					X		
		Solanum parvifolium				X		X		X
		Solanum sp.							X	X
		Solanum stelligerum	Devil's Needles				X	X		
		Solanum tetrathecum						X		
Stackhousiaceae		*Stackhousia viminea*	Slender Stackhousia					X	X	X
Thymelaeaceae		*Pimelea microcephala*	Shrubby Rice-flower				X	X		

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Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Pimelea pauciflora				X	X			
Urticaceae	*	*Urtica dioica*	Stinging Nettle							X
		Urtica incisa	Stinging Nettle					X		
Verbenaceae	*	*Glandularia aristigera*	Mayne's Pest							
		Oncinocalyx betchei						X		
	*	*Verbena bonariensis*	Purpletop					X		
		Verbena gaudichaudii						X		
	*	*Verbena officinalis*	Common Verbena					X		
Violaceae		*Viola betonicifolia*	Native Violet							X
		Viola hederacea	Ivy-leaved Violet			X				
Zygophyllaceae	*	*Tribulus terrestris*	Catshead					X		
Monocots										
Amaryllidaceae		*Crinum pedunculatum*	Swamp Lily				X			
		Crinum sp.								X
Anthericaceae		*Arthropodium milleflorum*	Pale Vanilla-lily			X		X		X
		Arthropodium minus	Small Vanilla Lily				X			
		Caesia parviflora	Pale Grass-lily					X		
		Dichopogon fimbriatus	Nodding Chocolate Lily							X
		Dichopogon strictus	Chocolate Lily			X		X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Laxmannia gracilis	Slender Wire-lily					X	X	
Asphodelaceae		*Bulbine bulbosa*	Native Leek			X				X
Cyperaceae		*Carex appressa*	Tussock Sedge					X		
		Carex inversa						X	X	X
		Carex sp.						X		
		Cyperus exaltatus					X			
		Cyperus fulvus	Sticky Sedge					X		
		Cyperus gracilis	Slender Flat-sedge					X	X	X
		Cyperus sp.								X
	*	*Cyperus tenellus*								X
		Eleocharis sp.						X		
		Fimbristylis dichotoma						X		
		Isolepis hookeriana						X		
		Lepidosperma laterale						X		
		Lepidosperma sp.	a sedge							X
		Lipocarpha microcephala					X			
		Scirpus sp.					X			
Juncaceae		*Juncus continuus*						X		
		Juncus kraussii	Sea Rush				X			

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Juncus sp.						X		
		Juncus sp.D1							X	
		Juncus subsecundus				X				X
		Juncus usitatus						X	X	
Juncaginaceae		*Triglochin procera*	Watter Ribbons					X		
Lomandraceae		*Lomandra bracteata*						X		
		Lomandra confertifolia	Mat-rush					X		
		Lomandra filiformis	Wattle Mat-rush					X	X	X
		Lomandra glauca	Pale Mat-rush					X		
		Lomandra longifolia	Spiny-headed Mat-rush			X	X	X		X
		Lomandra multiflora	Many-flowered Mat-rush				X	X	X	X
		Lomandra sp.				X			X	X
Orchidaceae		*Cymbidium canaliculatum*	Tiger Orchid			X		X	X	X
		Pterostylis boormanii						X		
		Pterostylis hamata	Hooked Greenhood					X		
		Pterostylis mutica	Midget Greenhood					X		
		Pterostylis revoluta						X		
		Pterostylis sp.	Greenhood							X
Phormiaceae		*Dianella longifolia*						X		X

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Dianella revoluta	Blue Flax-lily			X	X	X		
		Dianella sp.							X	
Xanthorrhoeaceae		*Xanthorrhoea glauca*						X		
		Xanthorrhoea sp.				X				X
Ferns										
Adiantaceae		*Adiantum aethiopicum*	Common Maidenhair				X			
		Adiantum formosum	Giant Maidenhair					X		
		Cheilanthes austrotenuifolia	Rock Fern					X		
		Cheilanthes distans	Bristly Cloak Fern					X		X
		Cheilanthes lasiophylla	Annual Fern				X			
		Cheilanthes sieberi	Poison Rock Fern				X	X	X	X
Aspleniaceae		*Pleurosorus rutifolius*	Bristly Cloak Fern					X		
Ophioglossaceae		*Ophioglossum lusitanicum*	Adders Tongue			X				
Vines										
Apiaceae		*Hydrocotyle geraniifolia*	Forest Pennywort				X	X		
Apocynaceae		*Parsonsia eucalyptophylla*	Gargaloo			X		X	X	X
		Rhyncharrhena linearis	Purple Pentatrope					X		
Bignoniaceae		*Pandorea pandorana*	Wonga Wonga Vine					X		
Fabaceae (Faboideae)		*Glycine canescens*	Silky Glycine					X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Glycine clandestina				X		X		X
		Glycine microphylla	Small-leaf Glycine							X
		Glycine sp.								X
		Glycine tabacina						X	X	X
		Glycine tomentella	Woolly Glycine						X	
		Hardenbergia violacea	False Sarsaparilla					X		
	*	*Vicia sativa ssp .nigra*	Narrow-leaved Vetch					X		
Lauraceae		*Cassytha pubescens*						X		
Ranunculaceae		*Clematis glycinoides*	Headache Vine				X			X
		Clematis microphylla	Small-leaved Clematis						X	
		Clematis microphylla var. leptophylla	Small-leaved Clematis			X	X			X
		Clematis sp. (seedling)								X
Grasses										
Poaceae		*Aristida behriana*	Bunch Wiregrass				X			
		Aristida benthamii	Three-awned Speargrass				X			
		Aristida jerichoensis var.jerichoensis	Jericho Wiregrass					X		
		Aristida leptopoda	White Speargrass					X		
		Aristida personata (Syn Aristida ramosa var. speciosa)	Purple Wiregrass					X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Aristida ramosa	Purple Wiregrass					X	X	X
		Aristida sp.	Wire Grass				X	X		X
		Aristida vagans	Threeawn Speargrass			X		X	X	X
		Austipa aristiglumis	Plains Grass				X			
		Austrodanthonia auriculata	Lobed Wallaby Grass					X		
		Austrodanthonia bipartita	Wallaby Grass					X		X
		Austrodanthonia caespitosa	Ringed Wallaby Grass					X	X	
		Austrodanthonia eriantha	Wallaby Grass				X			
		Austrodanthonia induta	Wallaby Grass							X
		Austrodanthonia monticola						X		
		Austrodanthonia racemosa	Wallaby Grass					X		X
		Austrodanthonia richardsonii	Straw Wallaby-grass							X
		Austrodanthonia setacea	Smallflower Wallaby Grass					X	X	
		Austrodanthonia sp.	Wallaby Grass			X		X	X	X
		Austrostipa aristiglumis	Plains Grass					X		
		Austrostipa bigeniculata						X	X	
		Austrostipa densiflora					X			
		Austrostipa ramosissima	Stout Bamboo Grass				X	X		
		Austrostipa scabra	Speargrass					X	X	X

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Austrostipa setacea	Corkscrew Grass					X		
		Austrostipa sp.					X			X
		Austrostipa variabilis					X			
		Austrostipa verticillata	Slender Bamboo Grass					X	X	X
	*	*Avena fatua*	Wild Oats					X	X	
	*	*Avena sp.*	Oats							X
		Bothriochloa decipiens	Red Grass					X		X
		Bothriochloa macra	Red-leg Grass					X	X	X
		Bothriochloa sp.				X				X
		Brachiaria milliformis						X		
	*	*Bromus catharticus*	Prairie Grass						X	X
		Capillipedium parviflorum	Scented-top Grass			X				
		Chloris divaricata	Slender Chloris					X		
	*	*Chloris gayana*	Rhodes Grass					X		
		Chloris truncata	Windmill Grass			X		X	X	X
		Chloris ventricosa	Plump Windmill Grass					X	X	X
		Cymbopogon refractus	Barbed Wire Grass			X		X	X	X
		Cynodon dactylon	Common Couch					X	X	
		Dichanthium sericeum	Silky Blue-grass					X	X	X

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Dichelachne crinita	Longhair Plumegrass							X
		Dichelachne micrantha	Shorthair Plumegrass					X		
		Dichelachne sp.	Plume Grass			X				X
		Digitaria brownii	Cotton Panic Grass					X		
		Digitaria diffusa	Open Summer-grass					X		
		Digitaria divaricatissima	Umbrella Grass					X		
		Digitaria sp.						X		X
		Digitaria sp.1							X	
		Digitaria sp.2							X	
		Echinopogon sp.	Hedgehog Grass					X		
	*	*Eleusine indica*	Crowsfoot Grass					X		
		Elymus scaber	Common Wheatgrass					X	X	X
		Elymus scaber var. scaber	Common Wheatgrass					X		
		Enneapogon avenaceus	Bottle Washers					X		X
		Enneapogon gracilis	Slender Bottle-washers					X		
		Enneapogon intermedius						X		
		Enneapogon nigricans	Niggerheads					X	X	
		Enteropogon acicularis						X		
		Entolasia sp.	Panic					X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Eragrostis brownii	Lovegrass					X	X	X
	*	*Eragrostis cilianensis*	Stinkgrass					X		
	*	*Eragrostis curvula*	African Lovegrass						X	
		Eragrostis lacunaria	Purple Lovegrass					X		
		Eragrostis laniflora	Woollybutt					X		
		Eragrostis leptostachya						X		X
		Eragrostis megalosperma						X		
		Eragrostis molybdea						X		
		Eragrostis sp.	Lovegrass			X	X	X		X
		Eragrostis sp.1							X	
		Eragrostis sp.2							X	
		Eragrostis tenellula	Delicate Lovegrass					X		
		Eriochloa pseudoacrotricha	Early Spring Grass					X		
		Eriochloa sp.						X		
	*	*Hordeum leporinum*	Barley Grass							
		Joycea pallida	Silvertop Wallaby Grass					X		
		Lachnagrostis filiformis (syn. Agrostis avenacea)								X
	*	*Lolium perenne*	Perennial Ryegrass			X		X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
	*	*Lolium* sp.							X	
		Microlaena stipoides	Weeping Meadow Grass					X		X
		Notodanthonia longifolia	Long-leaved Wallaby Grass					X		
		Oplismensus aemulus var. aemulus						X		
		Panicum decompositum	Native Millet					X		
		Panicum effusum	Hairy Panic			X		X		
		Panicum simile	Two-colour Panic					X		
		Panicum sp.							X	
		Paspalidium caespitosum	Brigalow Grass					X		
		Paspalidium constrictum	Knottybutt Grass					X	X	
		Paspalidium distans								X
		Paspalidium gracile	Slender Panic					X		
		Paspalidium sp.							X	X
	*	*Paspalum dilatatum*	Paspalum					X	X	
	*	*Paspalum urvillei*	Vasey Grass					X		
	*	*Pennisetum clandestinum*	Kikuyu Grass					X		
		Pentapogon quadrifidus	Fiveawn Speargrass			X				
	*	*Phalaris aquatica*	Phalaris					X		
		Phragmites australis	Common Reed					X		

Table B.1 Flora Species Recorded in Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	C&A	D&M	PB	ELA	CE
		Poa labillardierei	Tussock Grass			X				
		Poa sieberiana	Snowgrass					X		X
		Poa sp.					X			X
		Setaria sp.						X		
		Sorghum sp.	Columbus Grass			X				
		Sporobolus caroli	Fairy Grass					X		
		Sporobolus creber	Western Rat-tail Grass					X		
		Sporobolus elongatus	Slender Rat's Tail Grass						X	
		Sporobolus sp.							X	X
		Themeda australis	Kangaroo Grass			X	X	X		X
		Tragus australianus	Small Burrgrass					X	X	
	*	*Urochloa advena*						X		
	*	*Vulpia bromoides*	Squirrel Tail Fesque			X	X	X		X
	*	*Vulpia muralis*							X	
	*	*Vulpia myuros*	Rat's Tail Fescue					X		
	*	*Vulpia* sp.							X	

Table Keys:

LGA Count: Narrabri LGA Count from the NPWS Wildlife Atlas

C&A: Croft and Associates survey results (1979)

D&M: Dames and Moore survey results (1983-1984)

CE: Cumberland Ecology survey results (2008 & 2010)

PB: Parsons Brinckerhoff survey results (2010)

ELA: Eco Logical survey results (2010). Results are not the full species list; fauna results are from an opportunistic fauna species list from 2 days of sampling in 2009

** = exotic species*

Appendix C

C.

Fauna Species List

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
AMPHIBIA												
Hylidae		*Cyclorana verrucosa*	Rough Frog			6					X	P
		Litoria caerulea	Green Tree Frog			48	X	X	X			
		Litoria latopalmata	Broad-palmed Rocket-frog			62		X	X		X	Ca
		Litoria peronii	Peron's Tree Frog			53	X		X		X	Ca
		Litoria rubella	Desert Tree-frog			67		X	X		X	Ca
Myobatrachidae		*Crinia parinsignifera*	Eastern Sign-bearing Froglet			9	X	X			X	Ca
		Crinia signifera	Eastern Common Froglet			26		X			X	Ca
		Limnodynastes dumerilii	Eastern Banjo Frog			18		X				
		Limnodynastes fletcheri	Long- thumbed Frog			28			X			
		Limnodynastes ornatus	Ornate Burrowing Frog			69		X				
		Limnodynastes tasmaniensis	Spotted Grass Frog			105	X	X	X		X	Ca
		Limnodynastes terraereginae	Northern Banjo Frog			16		X				
		Neobatrachus sudelli	Sudell's Frog			71		X			X	P
AVES												
Acanthizidae		*Acanthiza apicalis*	Inland Thornbill			96	X	X	X		X	Ob
		Acanthiza chrysorrhoa	Yellow-rumped Thornbill			94	X		X		X	Ob

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
		Acanthiza nana	Yellow Thornbill			136	X	X	X		X	Ob
		Acanthiza pusilla	Brown Thornbill			9			X			
		Acanthiza reguloides	Buff-rumped Thornbill			73	X	X	X	X	X	Ob
		Acanthiza uropygialis	Chestnut-rumped Thornbill			36	X	X	X		X	Ob
		Aphelocephala leucopsis	Southern Whiteface			4	X		X			
		Calamanthus pyrrhopygius	Chestnut-rumped Heathwren			19	X					
		Gerygone fusca	Western Gerygone			45	X	X	X		X	Ob
		Gerygone olivacea	White-throated Gerygone			46	X	X	X		X	Ob
		Pyrrholaemus saggitatus	Speckled Warbler	V		136	X	X	X	X	X	Ob, CP
		Smicrornis brevirostris	Weebill			154	X	X	X		X	Ob
Accipitridae		*Accipiter cirrocephalus*	Collared Sparrowhawk			8	X					
		Accipiter fasciatus	Brown Goshawk			13	X		X		X	Ob
		Aquila audax	Wedge-tailed Eagle			38	X	X	X	X	X	Ob
		Circus assimilis	Spotted Harrier	V		4			X		X	Ob
		Elanus axillaris	Black-shouldered Kite			13		X	X		X	Ob
		Haliastur sphenurus	Whistling Kite			6		X	X		X	Ob
		Hieraaetus morphnoides	Little Eagle	V		19	X		X			
		Lophoictinia isura	Square-tailed Kite	V		14					X	Ob

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
Aegothelidae		*Aegotheles cristatus*	Australian Owlet-nightjar			157		X	X		X	Ca
Alcedinidae		*Ceyx azureus*	Azure Kingfisher			12			X			
		Dacelo novaeguineae	Laughing Kookaburra			107	X	X	X		X	Ob
		Todiramphus sanctus	Sacred Kingfisher			79	X	X	X	X	X	Ob
Anatidae		*Anas castanea*	Chestnut Teal							X		
		Anas gracilis	Grey Teal			82			X		X	Ob
		Anas superciliosa	Pacific Black Duck			92					X	Ob
		Chenonetta jubata	Australian Wood Duck			102		X	X		X	Ob
Apodidae		*Apus pacificus*	Fork-tailed Swift		M	1	X				X	Ob
		Hirundapus caudacutus	White-throated Needletail		M	30	X		X			
Ardeidae		*Ardea pacifica*	White-necked Heron			39			X			
		Egretta novaehollandiae	White-faced Heron			40			X		X	Ob
Artamidae		*Artamus cyanopterus*	Dusky Woodswallow			45	X	X	X	X	X	Ob
		Artamus personatus	Masked Woodswallow			8	X				X	Ob
		Artamus superciliosus	White-browed Woodswallow	V		23	X		X		X	Ob
		Cracticus nigrogularis	Pied Butcherbird			77		X	X		X	Ob
		Cracticus torquatus	Grey Butcherbird			119	X	X	X		X	Ob
		Gymnorhina tibicen	Australian Magpie			107	X	X	X	X	X	Ob

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
		Strepera graculina	Pied Currawong			160	X	X	X	X	X	Ob
Cacatuidae		*Cacatua galerita*	Sulphur-crested Cockatoo			87	X	X	X		X	Ob
		Cacatua roseicapilla	Galah			135	X	X	X	X	X	Ob
		Cacatua sanguinea	Little Corella			9			X		X	Ob
		Nymphicus hollandicus	Cockatiel			44	X	X	X		X	Ob
Campephagidae		*Coracina novaehollandiae*	Black-faced Cuckoo-shrike			80	X	X	X	X	X	Ob
		Coracina papuensis	White-bellied Cuckoo-shrike			16	X		X		X	Ob
		Coracina tenuirostris	Cicadabird			34	X				X	Ob
		Lalage tricolor	White-winged Triller			36	X	X			X	Ob
Caprimulgidae		*Eurostopodus mystacalis*	White-throated Nightjar			17	X					
Charadriidae		*Charadrius hiaticula*	Ringed Plover							X		
		Elseyornis melanops	Black-fronted Dotterel			11			X			
		Vanellus miles	Masked Lapwing			23					X	Ob
Ciconiidae		*Ephippiorhynchus asiaticus*	Black-necked Stork	E1		7			X			
Climacteridae		*Climacteris picumnus*	Brown Treecreeper	V		91	X	X	X		X	Ob
		Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V		1				X	X	Ob
		Cormobates leucophaea	White-throated Treecreeper			195	X	X	X		X	Ob

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
Columbidae		*Geopelia humeralis*	Bar-shouldered Dove			55	X	X	X		X	Ob
		Geopelia striata	Peaceful Dove			111	X	X	X	X	X	Ob
		Ocyphaps lophotes	Crested Pigeon			77	X	X	X	X	X	Ob
		Phaps chalcoptera	Common Bronzewing			101	X	X	X	X	X	Ob
Coraciidae		*Eurystomus orientalis*	Dollarbird			12			X		X	Ob
		Corcorax melanorhamphos	White-winged Chough			59	X	X	X		X	Ob
		Struthidea cinerea	Apostlebird			48	X	X	X	X	X	Ob
Corvidae		*Corvus coronoides*	Australian Raven			106	X	X	X		X	Ob
		Corvus mellori	Little Raven			1			X		X	Ob
		Corvus orru	Torresian Crow							X		
Cuculidae		*Cacomantis flabelliformis*	Fan-tailed Cuckoo			43	X		X		X	Ob
		Cacomantis variolosus	Brush Cuckoo			3	X				X	Ob
		Chalcites basalis	Horsfield's Bronze-Cuckoo			19	X					
		Chalcites lucidus	Shining Bronze-Cuckoo			12	X				X	Ob
		Chalcites osculans	Black-eared Cuckoo			10			X			
		Cuculus pallidus	Pallid Cuckoo			15	X	X	X		X	Ob
		Eudynamys orientalis	Pacific Koel			17					X	Ob
		Scythrops novaehollandiae	Channel-billed Cuckoo			27	X				X	Ob

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
Dicaeidae		*Dicaeum hirundinaceum*	Mistletoebird			134	X	X	X		X	Ob
Dicruridae		*Grallina cyanoleuca*	Magpie-lark			107	X	X	X	X	X	Ob
		Myiagra inquieta	Restless Flycatcher			46	X		X		X	Ob
		Myiagra rubecula	Leaden Flycatcher			52	X	X	X	X	X	Ob
		Rhipidura albiscapa	Grey Fantail			185	X	X	X	X	X	Ob
		Rhipidura leucophrys	Willie Wagtail			179	X	X	X	X	X	Ob
Estrildidae		*Neochmia modesta*	Plum-headed Finch			106	X	X	X			
		Neochmia temporalis	Red-browed Finch			69	X		X			
		Stagonopleura guttata	Diamond Firetail	V		17	X	X	X		X	Ob
		Taeniopygia bichenovii	Double-barred Finch			149	X	X	X	X	X	Ob
		Taeniopygia guttata	Zebra Finch			236					X	Ob
Falconidae		*Falco berigora*	Brown Falcon			23	X		X		X	Ob
		Falco cenchroides	Nankeen Kestrel			27	X		X		X	Ob
		Falco longipennis	Australian Hobby			8	X		X		X	Ob
		Falco peregrinus	Peregrine Falcon			13	X		X		X	Ob
		Falco subniger	Black Falcon			4		X				
Hirundinidae		*Cheramoeca leucosterna*	White-backed Swallow			7	X					
		Hirundo neoxena	Welcome Swallow			125	X		X		X	Ob

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
		Petrochelidon ariel	Fairy Martin			22			X			
		Petrochelidon nigricans	Tree Martin			19	X	X	X		X	Ob
Maluridae		*Malurus cyaneus*	Superb Fairy-wren			228	X	X	X	X	X	Ob
		Malurus lamberti	Variegated Fairy-wren			58	X	X	X			
Meliphagidae		*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater			159	X	X	X		X	Ob
		Entomyzon cyanotis	Blue-faced Honeyeater			26	X				X	Ob
		Grantiella picta	Painted Honeyeater	V		21					X	Ob, CP
		Lichenostomus chrysops	Yellow-faced Honeyeater			152	X	X	X		X	Ob
		Lichenostomus fuscus	Fuscous Honeyeater			42	X	X	X		X	Ob
		Lichenostomus leucotis	White-eared Honeyeater			120	X	X	X		X	Ob
		Lichenostomus melanops	Yellow-tufted Honeyeater			51	X				X	Ob
		Lichenostomus penicillatus	White-plumed Honeyeater			360	X	X	X	X	X	Ob
		Lichenostomus plumulus	Grey-fronted Honeyeater			-			X			
		Lichenostomus virescens	Singing Honeyeater			44	X				X	Ob
		Lichmera indistincta	Brown Honeyeater			44	X				X	Ob
		Manorina flavigula	Yellow-throated Miner			37			X		X	Ob
		Manorina melanochepala	Noisy Miner			89	X	X	X	X	X	Ob
		Melithreptus albogularis	White-throated Honeyeater			-					X	Ob

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
		Melithreptus brevirostris	Brown-headed Honeyeater			56	X	X	X		X	Ob
		Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V		4			X			
		Melithreptus lunatus	White-naped Honeyeater			16		X	X			
		Myzomela sanguinolenta	Scarlet Honeyeater			-					X	Ob
		Philemon citreogularis	Little Friarbird			83	X	X	X		X	Ob
		Philemon corniculatus	Noisy Friarbird			112	X	X	X		X	Ob
		Plectorhyncha lanceolata	Striped Honeyeater			106	X	X	X		X	Ob
Meropidae		*Merops ornatus*	Rainbow Bee-eater		M	75	X	X	X		X	Ob
Monarchidae		*Myiagra cyanoleuca*	Satin Flycatcher		M	9			X			
Motacillidae		*Anthus australis*	Australian Pipit			22		X		X	X	Ob
		Anthus novaeseelandiae	Australian Pipit			23			X			
Neosittidae		*Daphoenositta chrysoptera*	Varied Sittella	V		35	X	X	X		X	Ob
Oriolidae		*Oriolus sagittatus*	Olive-backed Oriole			54	X	X	X	X	X	Ob
Pachycephalidae		*Colluricincla harmonica*	Grey Shrike-thrush			181	X	X	X		X	Ob
		Falcunculus frontatus	Crested Shrike-tit			19	X	X	X		X	Ob
		Oreoica gutturalis	Crested Bellbird			8	X	X				
		Pachycephala pectoralis	Golden Whistler			50	X		X			

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
		Pachycephala rufiventris	Rufous Whistler			216	X	X	X	X	X	Ob
Pardalotidae		*Pardalotus punctatus*	Spotted Pardalote			124	X	X	X		X	Ob
		Pardalotus striatus	Striated Pardalote			102	X	X	X		X	Ob
		Sericornis frontalis	White-browed Scrubwren			82			X		X	Ob
Pelecanidae		*Pelecanus conspicillatus*	Australian Pelican			56					X	Ob
Petroicidae		*Eopsaltria australis*	Eastern Yellow Robin			246	X	X	X		X	Ob
		Melanodryas cucullata	Hooded Robin	V		22	X		X		X	Ob
		Microeca fascinans	Jacky Winter			73	X	X	X		X	Ob
		Petroica goodenovii	Red-capped Robin			55	X	X	X			
Phasianidae		*Coturnix pectoralis*	Stubble Quail			9	X	X	X			
		Coturnix ypsilophora	Brown Quail			7			X		X	Ob
Podargidae		*Podargus strigoides*	Tawny Frogmouth			87	X	X	X		X	Ob
Podicipedidae		*Tachybaptus novaehollandiae*	Australasian Grebe			12			X		X	Ob
Pomatostomidae		*Pomatostomus superciliosus*	White-browed Babbler			29	X	X	X		X	Ob
		Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V		130	X	X	X		X	Ob
Psittacidae		*Alisterus scapularis*	Australian King Parrot			64	X	X	X	X	X	Ob
		Aprosmictus erythropterus	Red-winged Parrot			23	X		X		X	Ob

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
		Barnardius zonarius	Australian Ringneck							X		
		Barnardius zonarius barnardi	Malle Ringneck			48	X	X	X		X	Ob
		Glossopsitta concinna	Musk Lorikeet			20			X		X	Ob
		Glossopsitta pusilla	Little Lorikeet	V		38	X		X		X	Ob
		Melopsittacus undulatus	Budgerigar			3					X	Ob
		Neophema pulchella	Turquoise Parrot	V		114	X	X	X	X	X	Ob
		Northiella haematogaster	Blue Bonnet			25	X	X	X		X	Ob
		Platycercus adscitus eximius	Eastern Rosella			66	X	X			X	Ob
		Platycercus elegans	Crimson Rosella			38		X			X	Ob
		Platycercus eximius	Eastern Rosella			74			X	X	X	Ob
		Psephotus haematonotus	Red-rumped Parrot			45	X	X	X	X	X	Ob
		Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet								X	Ob
		Trichoglossus haematodus	Rainbow Lorikeet			4					X	Ob
Ptilonorhynchidae		*Ptilonorhynchus maculatus*	Spotted Bowerbird			40					X	Ob
Strigidae		*Ninox connivens*	Barking Owl	V		129	X		X		X	Ob, CP
		Ninox novaeseelandiae	Southern Boobook			69	X	X	X		X	Ob
Sturnidae	*	*Sturnus vulgaris*	Common Starling			44			X			

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
Sylviidae		*Cincloramphus cruralis*	Brown Songlark			5					X	Ob
		Cincloramphus mathewsi	Rufous Songlark			27	X	X			X	Ob
Threskiornithidae		*Platalea flavipes*	Yellow-billed Spoonbill			57			X			
		Platalea regia	Royal Spoonbill			4			X			
		Threskiornis spinicollis	Straw-necked Ibis			37			X			
Turnicidae		*Turnix pyrrhothorax*	Red-chested Button-quail			4	X		X			
		Turnix varia	Painted Button-quail			12		X	X		X	Ob
Tytonidae		*Tyto alba*	Barn Owl						X			
		Tyto novaehollandiae	Masked Owl	V		8			X		X	Ob, CP
Zosteropidae		*Zosterops lateralis*	Silvereye			161	X	X	X		X	Ob
MAMMALIA												
Bovidae	*	*Bos taurus*	European cattle			10	X				X	Ob
Canidae	*	*Canis lupus*	Dingo			11	X					
	*	*Vulpes vulpes*	Fox			144	X		X	X	X	IR, Sp
Dasyuridae		*Antechinus flavipes*	Yellow-footed Antechinus			193		X	X		X	Tr
		Sminthopsis murina	Common Dunnart			41		X	X		X	P
Emballonuridae		*Saccolaimus flaviventris*	Yellow-bellied Sheathtail Bat	V		46			X		X	An
Felidae	*	*Felis catus*	Cat			28	X					

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
Leporidae	*	*Lepus capensis*	Brown Hare			34	X		X	X	X	Sp, Ob
	*	*Oryctolagus cuniculus*	Rabbit			40	X		X		X	Sp, Ob
Macropodidae		*Macropus giganteus*	Eastern Grey Kangaroo			176	X	X	X	X	X	Ob
		Macropus robustus	Common Wallaroo			47	X	X	X		X	Ob
		Macropus rufogriseus	Red-necked Wallaby			43	X	X			X	Ob
		Wallabia bicolor	Swamp Wallaby			84	X	X	X	X	X	Ob
Molossidae		*Mormopterus "Species 3" (little)*							X			
		Mormopterus "Species 4" (big)	Southern Free-tail Bat			29			X		X	Tp
		Tadarida australis	White-striped Freetail-bat			29	X		X		X	Ca
Muridae	*	*Mus musculus*	House Mouse			73			X		X	Tr
	*	*Rattus rattus*	Black Rat			25			X			
Petauridae		*Petaurus breviceps*	Sugar Glider			46	X		X		X	Sp, Ca
Phalangeridae		*Trichosurus vulpecula*	Common Brushtail Possum			100	X		X		X	Tr, Sp
Phascolarctidae		*Phascolarctos cinereus*	Koala	V		344	X		X			
Suidae	*	*Sus scrofa*	Pig			44			X		X	IR
Tachyglossidae		*Tachyglossus aculeatus*	Short-beaked Echidna			98	X	X	X		X	IR
Vespertilionidae		*Chalinolobus gouldii*	Gould's Wattled Bat			224		X	X		X	HT
		Chalinolobus morio	Chocolate Wattled Bat			61			X		X	HT

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
		Chalinolobus picatus	Little Pied Bat	V		6			X			
		Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		-			X			
		Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V		7			X			
		Nyctophilus geoffroyi	Lesser Long-eared Bat			125		X	X		X	HT
		Nyctophilus gouldi	Gould's Long-eared Bat			106		X	X		X	HT
		Nyctophilus timoriensis	Greater Long-eared Bat	V	V	52	X				X	HT
		Scotorepens balstoni	Inland Broad-nosed Bat			111		X	X			
		Scotorepens greyii	Little Broad-nosed Bat			121			X			
		Scotorepens sp.	Unidentified broad-nosed bat								X	Tp, HT
		Vespadelus regulus	Southern Forest Bat			-			X			
		Vespadelus troughtoni	Eastern Cave Bat	V		2			X			
		Vespadelus vulturnus	Little Forest Bat			596		X	X		X	HT
REPTILIA												
Agamidae		*Amphibolurus nobbi*	Nobbi			48	X	X	X			
		Lophognathus burnsi	Burns' Dragon			23			X		X	P, Ob
		Pogona barbata	Bearded Dragon			24	X		X	X	X	Sp, Ob
Boidae		*Morelia spilota*	Carpet Python			3	X					

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
Chelidae		*Chelodina longicollis*	Eastern Long-necked Tortoise			13			X			
Elapidae		*Brachyurophis australis*	Coral Snake			11		X				
		Demansia psammophis	Yellow-faced Whip Snake			6			X		X	AS
		Furina diadema	Red-naped Snake			12	X				X	P
		Notechis scutatus	Eastern Tiger Snake			-			X			
		Pseudechis guttatus	Spotted Black Snake			8					X	Ob
		Pseudechis porphyriacus	Red-bellied Black Snake			8			X			
		Pseudonaja nuchalis	Western Brown Snake			1			X			
		Pseudonaja textilis	Eastern Brown Snake			6	X				X	Ob
		Vermicella annulata	Bandy-bandy			7					X	AS
Gekkonidae		*Diplodactylus vittatus*	Eastern Stone Gecko			23	X	X	X		X	P, Sp
		Gehyra australis	Northern Dtella					X				
		Gehyra dubia	Dubious Dtella			28			X			
		Gehyra variegata	Tree Dtella			20			X		X	P, Sp
		Heteronotia binoei	Bynoe's Gecko			75		X	X		X	AS, P, Sp
		Oedura robusta	Robust Velvet Gecko			10			X		X	Sp
		Strophurus intermedius	Southern Spiny-tailed Gecko							X		
		Strophurus williamsi	Eastern Spiny-tailed Gecko			47			X		X	Sp

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
		Underwoodisaurus milii	Thick-tailed Gecko			20	X	X	X		X	P
Pygopodidae		*Delma inornata*	Patternless Delma			7		X				
		Delma plebeia	Leaden Delma			6			X		X	AS, P
		Lialis burtonis	Burton's Snake-lizard			15	X		X			
		Pygopus lepidopodus	Common Scaly-foot			2					X	Ob
Scincidae		*Acritoscincus platynota*	Red-throated Skink			12	X					
		Carlia burnetti	Rainbow-Skink					X				
		Carlia foliorum	Tree-base Litter-skink			19					X	AS, P
		Cryptoblepharus carnabyi	Spiny-palmed Snake-eyed Skink								X	Ob
		Cryptoblepharus virgatus	Cream-striped Shinning-skink			10		X			X	AS, P
		Ctenotus allotropis	Brown-blazed Wedgesnout Ctenotus			7			X		X	P
		Ctenotus robustus	Robust Ctenotus			29		X	X			
		Ctenotus taeniolatus	Copper-tailed Skink			19			X		X	Ob
		Egernia striolata	Tree Skink			152	X	X	X		X	AS, Tr, P
		Lampropholis delicata	Dark-flecked Garden Sunskink			4			X			
		Lampropholis guichenoti	Pale-flecked Garden Sunskink			4	X					
		Lerista bougainvillii	Bougainville's skink			17			X		X	AS, P

Table C.1 Fauna Species Recorded from Leard State Forest and Surrounds By Past Studies

Family		Scientific Name	Common Name	TSC Act	EPBC Act	LGA Count	C&A	D&M	PB	ELA	CE	CE Detection Method
		Lerista muelleri	Wood Mulch-slider			8		X				
		Lerista punctatovittata	Eastern Robust Slider			11		X			X	Ob
		Liopholis modesta	Eastern Ranges Rock-skink			4			X			
		Morethia boulengeri	South-eastern Morethia Skink			72		X	X		X	P
		Scincidae sp.					X					
		Tiliqua scincoides	Eastern Blue-tongue			5			X	X		
Typhlopidae		*Ramphotyphlops sp.*						X				
		Ramphotyphlops wiedii	Brown-snouted Blind Snake			6					X	AS
Varanidae		*Varanus gouldii*	Gould's Goanna			20					X	Ob, Sp
		Varanus varius	Lace Monitor			44	X	X	X		X	Ob, Tr

Table Keys: *- LGA Count: Narrabri LGA Count from the NPWS Wildlife Atlas*

- C&A: Croft and Associates survey results (1979)

- D&M: Dames and Moore survey results (1983-1984)

- CE: Cumberland Ecology survey results (2008 & 2010)

- PB: Parsons Brinckerhoff survey results (2010)

- ELA: Eco Logical survey results (2010). Results are not the full species list; fauna results are from an opportunistic fauna species list from 2 days of sampling in 2009

- Detection Methods: An = Anabat; AS = Active Search; Ca = Call; CP = Call playback; Ha = Hair tubes; HT = Harp trap; IR = IR camera; Ob = Incidental observation; P = Pitfall; Sc = Scats/tracks; Sp = Spotlighting; Tp = Triplining.

** = exotic species*

Appendix D

D.

Flora Likelihood of Occurrence

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
Brassicaceae	*Lepidium aschersonii*	Spiny Pepper-cress	V	V	Found on ridges of gilgai clays dominated by Brigalow (*Acacia harpophylla*), with *Austrodanthonia* and/or *Austrostipa* species in the understorey. The species grows as a component of the ground flora, in grey loamy clays. Vegetation structure varies from open to dense Brigalow, with sparse grassy understorey and occasional heavy litter (DEC (NSW), 2005f1). Flowering Time: Spring - Autumn	**High.** There is preferred habitat for this species available within the Project Boundary. However this species was not recorded despite targeted surveys during the flowering period. Known from Leard State Conservation Area nearby.
Brassicaceae	*Lepidium monoplocoides*	Winged Peppercress	E	E	Widespread in semi-arid regions. Occurs on seasonally moist to waterlogged sites, on heavy fertile soils. Predominant vegetation is usually an open woodland dominated by *Allocasuarina luehmannii* (Bulloak) and/or eucalypts, particularly *Eucalyptus largiflorens* (Black Box) or *Eucalyptus populnea* (Poplar Box). The field layer of the surrounding woodland is dominated by tussock grasses (DEC (NSW), 2005i1).	**Low.** Little habitat present in Project Boundary and not detected during surveys.
Brassicaceae	*Lepidium hyssopifolium*	Aromatic Peppercress	E	E	Occurs in a variety of habitats including woodland with a grassy understorey and	**Low.** There are only a few populations known in NSW

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
					grassland (DEC (NSW), 2005a).	(incl. Bathurst, Bungendore, and Crookwell). There are no records within the locality of the Project Boundary.
Cyperaceae	*Cyperus conicus*	-	E	-	Occurs rarely in the Pilliga area of NSW and is also found in Victoria, Qld, the NT and WA. It grows in open woodland on sandy soil. In central Australia, the species grows near waterholes and on the banks of streams in sandy soils. In Qld the species usually found on heavy soils. Recorded from Callitris forest in the Pilliga area, growing in sandy soil with *Cyperus gracilis, C. squarrosus* and *C. fulvus*. Often associated with other sedge species including *C. victoriensis*, *C. difformis*, *C. iria, C. compressus, C. nervulosus, C. dactylotes, Fimbristylis* and *Eleocharis* species. *Cyperus conicus* has been recorded as very rare and occasional, to common and abundant in populations. Interstate habitats include floodplains, creek beds and banks, swamps, run-on areas and various watercourses, near or in dams and bores, and in vegetation communities such as Melaleuca swamps, open Box woodland	**Low.** There is low to moderate habitat for this species within the riparian habitats and dam areas in the Project Boundary.

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
					and sedgelands. Soils are usually sandy or silty and damp to wet (DEC (NSW), 2005j).	
Euphorbiaceae	*Bertya opponens*	Coolabah Bertya	V	V	Coolabah Bertya occurs in a range of habitats ranging from stony mallee ridges and cypress pine forest on red soils in the west, to coastal cliff edges in open eucalypt forest in the east (DEC (NSW), 2005h).	**Moderate.** Known or predicted to occur in the Pilliga sub-regions of the Namoi Catchment Management Region. However habitat does not seem to be suitable, and this species was not recorded during surveys
Euphorbiaceae	*Monotaxis macrophylla*	Large-leafed Monotaxis	E		Large-leaf Monotaxis is recorded from several highly disjunct populations in NSW: eastern edge of Deua NP (west of Moruya), Bemboka portion of South East Forests National Park, Cobar area (Hermitage Plains), the Tenterfield area, and Woodenbong (near the Queensland border). It is also in Queensland. A record was found from the eastern spur of the Nandewar Range is in the Namoi catchment. Rare; isolated on rocky ridges and hillsides (DEC (NSW), 2005s).	**Low.** Little habitat present in Project Boundary and not detected during surveys.
Fabaceae - Faboideae	*Desmodium campylocaulon*	Creeping Tick-trefoil	E		Grows in grassland on brown soil plains, chiefly in the Collarenebri district. NSW subdivisions:	**Low.** Little habitat present in Project Boundary and not

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
					CC, NWP (DEC (NSW), 2005i).	detected during surveys.
Fabaceae - Faboideae	*Pultenaea pedunculata*	Matted Bush-pea	E1	-	Restricted to Wianamatta Shales of the Cumberland Plain from Bankstown to Liverpool and on the South Coast in the Southeast Corner Bioregion at Bournda. If grows on a variety of soils in dry sclerophyll forest and disturbed sites (NPWS NSW, 2002). It is largely confined to loamy soils in dry gullies in populations in the Windellama area (DEC (NSW), 2005u).	**Low.** There is no preferred habitat for this species available within the study area.
Fabaceae - Faboideae	*Swainsona murrayana*	Slender Darling Pea	V	V	Often grows with Maireana species on heavy soils, especially in depression (Thompson and James, 2011). Found throughout NSW, it has been recorded in the Jerilderie and Deniliquin areas of the southern riverine plain, the Hay plain as far north as Willandra National Park, near Broken Hill and in various localities between Dubbo and Moree. It grows in a variety of vegetation types including bladder saltbush, black box and grassland communities on level plains, floodplains and depressions and is often found with Maireana species. Plants have been found in remnant native grasslands or grassy woodlands that have been intermittently grazed	**Low.** There is low to moderate potential habitat for this species available within the study area. However this species was not recorded despite targeted searches within the study area. Furthermore, the closest records are 50km to the west at Narrabri and 60km to the south.

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
					or cultivated. The species has been collected from clay-based soils, ranging from grey, red and brown cracking clays to red-brown earths and loams. The species may require some disturbance and has been known to occur in paddocks that have been moderately grazed or occasionally cultivated (DEC (NSW), 2005e1).	
Fabaceae - Faboideae	*Swainsona recta*	Mountain Swainson-pea			Occurs in grassland and open woodland, often on stony hillsides. ST, CWS, SWS, ?NWP	**Moderate.** Ostensibly suitable habitat present in Project Boundary but not detected during surveys.
Fabaceae - Faboideae	*Pultenaea setulosa*		-	V	Occurs in central coast, central and northern tablelands and western slopes bioregions west to Gilgandra district. It grows in dry sclerophyll forest. The species is known from Broad Sound to the Marlborough area in Queensland and also from the Nandewar Range in northern New South Wales. In Queensland the species grows on serpentinite substrates in *Eucalyptus fibrosa* and/or *Corymbia xanthope* woodlands or open forests. In NSW, the species grows in wet sclerophyll forest on volcanic substrates. This species occurs within the Fitzroy (Queensland)	**High:** This species was recorded within close proximity of the Project Boundary (Parsons Brinckerhoff Australia Pty Ltd, 2010).

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
					and Border Rivers–Gwydir (NSW) Natural Resource Management Regions (Threatened Species Scientific Committee, 2008b).	
Grammitaceae	*Grammitis stenophylla*		E	-	Moist places, usually near streams, on rocks or in trees, in rainforest and moist eucalypt forest (NSW Scientific Committee, 2004e).	**Low.** Little habitat present in Project Boundary and not detected during surveys.
Haloragaceae	*Haloragis exalata exalata*	Square Raspwort	V	-	Square Raspwort appears to require protected and shaded damp situations in riparian habitats (NSW Scientific Committee, 2004f).	**Low.** Little habitat present in Project Boundary and not detected during surveys.
Lamiaceae	*Prostanthera cryptandroides*		V	V	Grows in dry sclerophyll forest, often in rocky sites. NSW subdivisions: CC, CT, NWS, CWS, NWP (DEC (NSW), 2005j1).	**Low.** Little habitat present in Project Boundary and not detected during surveys.
Myrtaceae	*Eucalyptus rubida subsp. barbigerorum*	Blackbutt Candlebark	V	V	Occurs on woodland on medium or high fertility soils (DEC (NSW), 2005g).	**Low.** Little habitat present in Project Boundary and not detected during surveys.
Orchidaceae	*Diuris aequalis*	Double-tail Orchid	E	V	Grows among grass in sclerophyll forest, mainly in the ranges and tablelands. Buttercup Doubletail favours montane eucalypt forest and low open woodland with a grassy heathy understory, and secondary grassland, growing in gravelly clay-loam, often on gentle slopes (Bishop, 2000, DEC (NSW), 2005h1). Only	**Low.** No known populations locally and not detected in repeated surveys.

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
					about 200 plants of Buttercup Doubletail are known, and are scattered across 20 small and fragmented populations (NSW Scientific Committee, 2011). Most populations are restricted to remnant vegetation along roadsides and within agricultural lands (NSW Scientific Committee, 2011).	
Orchidaceae	*Diuris tricolor* (syn. *Diuris sheaffiana*)	Painted Diuris/ Donkey Orchid	V		Grows in sclerophyll forest among grass, often with Callitris, or in grassy Callitris woodland It is found in sandy soils, either on flats or small rises. Also recorded from a red earth soil in a Bimble Box community in western NSW. Soils include gritty orange-brown loam on granite, shallow red loamy sand on stony porphyry, skeletal lateritic soil and alluvial grey silty loam. Disturbance regimes are not known, although the species is usually recorded from disturbed habitats. Within the Upper Hunter it is known to occur in *Eucalyptus albens/Eucalyptus crebra/Eucalyptus blakelyi/Corymbia maculata* woodland complexes and grasslands (NSW Scientific Committee, 2006b, DEC (NSW), 2005z).	**Low.** There is preferred habitat for this species available within the study area. However this species was not recorded despite targeted surveys during the flowering period.
Orchidaceae	*Pterostylis cobarensis*	Greenhood	V	V	Grows among rocks on low hills and on slopes	**Low.** There is low to

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
		Orchid / Cobar Rustyhood			above streams; chiefly from Nyngan to Bourke district. Western plains of NSW, chiefly in Nyngan - Cobar – Bourke region; favours stony ridges, often growing under *Eucalyptus morrisii* (Grey Mallee) (Bishop, 2000). Habitats are eucalypt woodlands, open mallee or Callitris shrublands on low stony ridges and slopes in skeletal sandy-loam soils. It has been recorded from ridge tops as well as steep exposed slopes and sheltered east slopes. Soils include shallow red clay-loam, skeletal red loam on metaquartzite, shallow sandy-loam on conglomerate and sandstone, and skeletal gritty organic loam on microgranite. Associated species include *Eucalyptus morrisii, E. viridis, E. intertexta, E. vicina, Callitris glaucophylla, Geijera parviflora, Casuarina cristata, Acacia doratoxylon, Senna* sp. and *Eremophila* sp. (DEC (NSW), 2005q).	moderate habitat for this species available within the study area. Targeted searches were undertaken during the flowering period for this species. Other *Pterostylis* sp. species were recorded and careful checking for this species was undertaken.
Poaceae	*Bothriochloa biloba*		V	V	Commonly found on clay soils. Woodlands and grasslands. NSW subdivisions: NC, ?CC, NT, NWS, CWS, NWP, SWP (Threatened Species Scientific Committee, 2008c).	**Low.** Not detected in repeated surveys. Most soils in Leard State Forest have somewhat sandy topsoil.

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
Poaceae	*Dichanthium setosum*		V	V	Grows in woodland. NSW subdivisions: NT, NWS, CWS, NWP (NSW Scientific Committee, 2004d).	**Moderate**, as what appears to be suitable habitat is present. However, not detected in repeated surveys.
Poaceae	*Digitaria porrecta*	Finger Panic Grass	E	E	In NSW it occurs in north western slopes and north western plains subdivisions where it grows in native grassland, woodlands or open forest with a grassy understorey, on richer soils. It is often found along roadsides and travelling stock routes where there is light grazing and occasional fire (DEC (NSW), 2005k, Threatened Species Scientific Committee, 2008d).	**Moderate.** Potentially recorded within the wider study area. There is marginal preferred habitat for this species available within the study area.
Poaceae	*Homopholis belsonii*	Belson's Panic	-	V	Occurs north from the Warialda district. It grows in dry woodland on poor soils such as Belah woodlands (Threatened Species Scientific Committee, 2008a).	**Low.** There is no preferred habitat for this species available within the study area.
Polygalaceae	*Polygala linariifolia*		E	-	Grows in dry sclerophyll communities from Warialda area to Weebah gate on the Qld border (DEC (NSW), 2005v).	**Low.** Little habitat present in Project Boundary and not detected during surveys.
Polygonaceae	*Muehlenbeckia costata*		V	-	Grows in coarse sandy soils and peat in heath, mallee and open eucalypt woodland on granite or acid volcanic outcrops at higher altitudes.	**Low.** Little habitat present in Project Boundary and not detected during surveys.

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
					Occurs mostly in rocky, higher-altitude sites following disturbance such as fire or clearing for powerlines (DEC (NSW), 2005d1).	
Proteaceae	*Hakea pulvinifera*	Lake Keepit Hakea	E	E	Recorded from a single population on a hard rocky hillside below a dam. The site is also recorded as being hot and dry and well drained (Department of Sustainability, 2011b).	**Low.** Lake Keepit Hakea is confined to a single population near Lake Keepit, north-east of Gunnedah
Rhamnaceae	*Pomaderris queenslandica*	Scant Pomaderris	E	-	Found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks. Found in the Namoi Catchment Area (NSW Scientific Committee, 2004h).	**High.** This species was recorded within the wider study area (Parsons Brinckerhoff Australia Pty Ltd, 2010). This species was recorded in the Narrow-leaved Ironbark – White Cypress Pine shrubby open forest. This species was only recorded in the Leard State Forest in the offset areas. It was not recorded within the proposed mining areas.
Rutaceae	*Boronia ruppii*	Rupp's Boronia	E	-	Rupp's Boronia grows in dry eucalypt woodland on soils derived from serpentinite rock (DEC (NSW), 2005c1). .	**Low.** No soils derived from serpentinite rock present in Project Boundary and not

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
						detected during surveys.
Rutaceae	*Philotheca ericifolia*		-	V	Known only from the upper Hunter Valley and Pilliga to Peak Hill districts of NSW. The records are scattered over a range of over 400 km between West Wyalong and the Pilliga Scrub. Grows chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies. It has been collected from a variety of habitats including heath, open woodland, dry sandy creek beds, and rocky ridge and cliff tops. Associated species include *Melaleuca uncinata, Eucalyptus crebra, E. rossii, E. punctata, Corymbia trachyphloia, Acacia triptera, A. burrowii, Beyeria viscosa, Philotheca australis, Leucopogon muticus* and *Calytrix tetragona* (DEH, 2004, NSW Scientific Committee, 2004g).	**Low.** There is low to moderate potential habitat for this species available within the study area. However targeted searches failed to locate any of these species. The closest record for this species is within the Pilliga to the west of the study area.
Santalaceae	*Thesium australe*	Austral Toadflax	V	V	Grows in grassland or woodland often in damp sites. It is a semi-parasitic herb and hosts are likely to be *Themeda australis* and *Poa* spp.. On the tablelands it occurs with *Eucalyptus pauciflora, E. dalrympleana* or *E. viminalis* **Error! Bookmark not defined.**	**Low.** There is low to moderate habitat for this species available within the study area. This species was not recorded despite surveys undertaken during the flowering period for this

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
						species.
Scrophulariaceae	*Euphrasia orthocheila orthocheila*	Yellow-flowered Euphrasia	E	-	Grows in moist open situations north from Walcha districts and west to Mt Kaputar N.P (Barker, 2011).	**Low to moderate** but not detected in repeated surveys.
Sterculiaceae	*Rulingia procumbens*		V	V	Found in sandy sites often along roadsides. Mainly confined to the Dubbo - Mendooran - Gilgandra region, though occasionally found in the Pilliga and Nymagee areas. The species is often found as a pioneer species of disturbed habitats. It has been recorded colonising disturbed areas such as roadsides, the edges of quarries and gravel stockpiles and a recently cleared easement under power lines (NSW Scientific Committee, 2004j). .	**Low.** Occurs in typically sandy communities.
Surianaceae	*Cadellia pentastylis*	Ooline	V	V	Occurs west from near Tenterfield and north from Terry Hie Hie (Harden, 2011)Grows mainly in vine thickets or dry rainforest, and more rarely occurs in woodlands. It is a relict rainforest species and tends to favour upper and mid slope positions, often with a northerly aspect. It commonly occurs on sandy-loam to clay soils of low to medium fertility. It can occur in pure stands or in a mixed community on the slopes of	**Low.** There is marginal preferred habitat for this species available within the study area.

Table D.1 Likelihood of Occurrence of Threatened Plant Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Habitat	Likelihood of Occurrence
					residual sandstone ranges and scarps (DEC (NSW), 2005w).	

Appendix E

E.

Fauna Likelihood of Occurrence

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
Amphibians							
Hylidae	*Litoria booroolongensis*	Booroolong Frog	E1	E	Yes - 2 records	Confined to mountain streams of the Great Dividing Range (Cogger, 2000). Usually found on or under boulders and debris in and beside the rocky beds of mountain streams; breeds in summer (Anstis, 2002).	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded during field surveys.
Myobatrichidae	*Crinia sloanei*	Sloane's Froglet	V	-	Yes - 1 recent record on heavy soils to the north west of the Project Boundary	Sloane's Froglet is a small (25mm), cryptic ground dwelling frog which is found in woodland, grassland and open or disturbed areas, usually associated with inundated areas (Robinson, 2000). In appearance this species superficially resembles other frogs of the genus *Crinia*, but it can be readily identified by its call and specific physical characteristics. It can usually only be found after rain events when it calls from grasses within and fringing temporarily inundated areas (Cogger, 2000).	**High** within heavy soils of the Namoi and Maules Creek floodplains. Suitable habitats are available for this species. This species was not recorded during field surveys.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						Sloane's Froglet has been recorded from widely scattered sites in the floodplains of the Murray- Darling Basin, with the majority of records in the Darling Riverine Plains, NSW South Western Slopes and Riverina bioregions in New South Wales. Since 1958 Sloane's Froglet has been recorded only 45 times in NSW. The low number of sites, low number of recorded individuals per site, and the low proportion of records of this species in regional surveys all indicate that a moderately low number of mature individuals exist. The apparent loss from previous recorded sites and decline of recording rates indicates at least a moderate reduction in population size of the species. Threats to survival of the species include infection from Chytrid fungus, habitat clearing, overgrazing and changes in flooding regimes, predation and climate change (NSW Scientific Committee, 2008).	

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
Fish							
Ambassidae	*Ambassis agassizii*	Olive Perchlet / Agassiz's glassperch	E2	-	No	Inhabits rivers, creeks, ponds and swamps in both eastern (coastal) and western (Murray-Darling) drainage lines. This species is usually found in slow flowing or still water, often in proximity to overhanging vegetation, snags and boulders during the day. At night they disperse to feed on microcrustaceans and insects (NSW DPI, 2005)	**Low.** There is no preferred habitat available for this species in the study area.
Eleotridae	*Mogurnda adspersa*	Purple Spotted Gudgeon	E1	-	No	A Murray-Darling fish, now reduced to a patchy distribution in Northern New South Wales and Southern Queensland. Slow flowing waters among weed where suitable hard objects are available for spawning. Primarily a bottom dweller, rarely swims continuously. Longer distances accomplished by a series of jerky darts. Migrate from deeper water and spend winter in sheltered situations. An ambush predator, lying motionless on bottom until suitable prey approaches	**Low.** There is no preferred habitat available for this species in the study area.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						(Fisheries Scientific Committee, 2008a).	
Percichthyidae	*Maccullochella peelii peelii*	Murray Cod	-	V	Yes	The Murray Cod occurs in lower reaches of the Murray-Darling Basin, where the water temperature is warm. The diverse range of habitats frequented by the Murray Cod includes slow moving rivers, murky billabongs and clear, rocky rivers (National Murray Cod Recovery Team, 2010).	**Present** in the Namoi River. There is no preferred habitat available for this species in the majority of the Project Boundary.
Plotosidae	*Tandanus tandanus*	Eel-tailed Catfish	E2	-	Yes	Occupies a wide range of habitats including rivers, creeks, lakes, billabongs and lagoons. It inhabits flowing streams but preferes slow and still waters and can be found in clear or turbid water over substrates including mud, gravel and rock (Fisheries Scientific Committee, 2008b).	**Present** in the Namoi River**.** There is no preferred habitat available for this species in the study area.
Terapontidae	*Bidyanus bidyanus*	Silver Perch	V	-	Yes	Schools in large numbers sometimes seen near the surface. In summer, often congregates below rapids and weirs. Prefers warmer sluggish waters with debris cover. Once very common	**Present** in the Namoi River. There is no preferred habitat available for this species in the majority of the

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						throughout the warmer waters of the Murray-Darling, silver perch river numbers have dropped alarmingly in recent years (NSW DPI,).	Project Boundary.
Aquatic Invertebrates							
Viviparidae	*Notopala sublineata*	River Snail	E	-	No	River snails are endemic to the Murray-Darling Basin and were once common and widely distributed. Although now virtually extinct throughout its natural range, they are restricted to a few populations near Mildura. River Snails were found along river banks attached to logs and rocks or crawling in the mud (NSW DPI,).	**Low.** There is no preferred habitat available for this species in the study area.
Native Birds							
Acanthizidae	*Pyrrholaemus saggitatus*	Speckled Warbler	V	-	Yes - 159 records	Occurs in a wide range of eucalypt dominated vegetation with a grassy understorey and is often found on rocky ridges or in gullies. It feeds on seeds and	**Present.** This species was observed and recorded using call playback during field

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						insects and builds domed nests on the ground (Garnett and Crowley, 2000).	surveys. Consistently recorded in the area since the 1980s.
Accipitridae	*Circus assimilis*	Spotted Harrier	V	-	Yes - 5 records	The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast and ranges. Individuals disperse widely in NSW and occur in grassy open woodland including acacia and mallee remnants, inland riparian woodland and grassland. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands (NSW Scientific Committee, 2010b).	**Present.** This species was observed during field surveys.
Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	-	M	Yes - 3 records	Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey and Knight, 2003).	**High** chance of occurrence, but infrequent occurrence. There is no preferred habitat available for this species in the study area

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
							other than along the Namoi River. This species was not recorded during field surveys –but has been recorded overflying nearby properties.
Accipitridae	*Hamirostra melanosternon*	Black-breasted Buzzard	V	-	Yes - 3 records	Distributed throughout most of inland Australia and prefers arid scrubland, and open woodlands. Feeds on small mammals and birds (Garnett and Crowley, 2000).	**Moderate** chance of occurring infrequently. Habitat exists across the locality. This species was not recorded during field surveys.
Accipitridae	*Hieraaetus morphnoides*	Little Eagle	V	-	Yes - 19 records	The Little Eagle is distributed throughout the Australian mainland except in the most densely forested parts of the Dividing Range. Occupies habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree	**Present.** This species was recorded during field surveys for past studies

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						within a remnant patch. It feeds on birds, reptiles and mammals (NSW Scientific Committee, 2010a).	
Accipitridae	*Lophoictinia isura*	Square-tailed Kite	V	-	Yes- 14 records	This species hunts primarily over open forest, woodland and mallee communities as well as over adjacent heaths and other low scrubby habitats in wooded towns. It feeds on small birds, their eggs and nestlings as well as insects. Seems to prefer structurally diverse landscapes (Garnett and Crowley, 2000).	**Present.** This species has previously been recorded in Leard State Forest. Individuals were observed during field surveys.
Anatidae	*Stictonetta naevosa*	Freckled Duck	V	-	Yes - 2 records	In most years this species appear to be nomadic between ephemeral inland wetlands. In dry years they congregate on permanent wetlands while in wet years they breed prolifically and disperse widely, generally towards the coast. In inland eastern Australia, they generally occur in brackish to hyposaline wetlands that are densely vegetated with Lignum (*Muehlenbeckia cunninghamii*) within which they build their nests (Garnett and	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded during field surveys.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						Crowley, 2000).	
Anatidae	Oxyura australis	Blue-billed Duck	V		Yes - 2 records	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed, but prefers to dive if approached. Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and overwintering lakes with some long-distance dispersal to breed during spring and early summer. Found in the Namoi Catchment Area (DEC (NSW), 2006a).	**Low** within most of the Project Boundary, but potential to occur in association with the Namoi River.
Anseranatidae	*Anseranas semipalmata*	Magpie Goose	V	-	Yes - 5 records	Occurs in shallow wetlands such as large swamps and dams, especially with dense growth of rushes or sedges, and with permanent lagoons and grassland nearby. Feeds on seeds, tubers and green grass. Form large nesting colonies during the wet season. During the dry	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded during field surveys.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						season this species migrates hundreds of kilometres to perennial swamps (Garnett and Crowley, 2000, DEC (NSW), 2006a).	
Apodidae	*Apus pacificus*	Fork-tailed Swift	-	M	Yes - 1 record	Breeds from central Siberia eastwards through Asia, and is migratory, wintering south to Australia. Individuals never settle voluntarily on the ground and spend most of their lives in the air, living on the insects they catch in their beaks (Higgins, 1999).	**Present.** This species was recorded overflying the Project Boundary.
Apodidae	*Hirundapus caudacutus*	White-throated Needletail	-	M	Yes - 30 records	Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey and Knight, 2003).	**Present.** This species was recorded during field surveys for past studies.
Ardeidae	*Ardea alba*	Great Egret	-	M	-	Great Egrets occur throughout most of the world. They are common throughout Australia, with the exception of the most arid areas. Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. Great Egrets can be	**High.** Suitable habitats are available for this species. This species was not recorded during field surveys.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						seen alone or in small flocks, often with other egret species, and roost at night in groups. In Australia, the breeding season of the Great Egret is normally October to December in the south and March to May in the north. This species breeds in colonies, and often in association with cormorants, ibises and other egrets (SEWPAC, 2010a).	
Ardeidae	*Ardea ibis*	Cattle Egret	-	M	-	Subspecies *A. i. coromanda* is found across the Indian subcontinent and Asia as far north as Korea and Japan, and in South-east Asia, Papua New Guinea and Australia (Department of Sustainability, 2011a).	**High.** Suitable habitats are available for this species. This species was not recorded during field surveys.
Ardeidae	*Botaurus poiciloptilus*	Australasian Bittern	V		Yes - 1 record	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (Typha spp.) and spikerushes (Eleoacharis spp.). Found in the Namoi Catchment Area (DEC (NSW), 2005c)	**Low** across most of the Project Boundary. However, some preferred habitat present along the margins of the Namoi River and some billabongs.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
Artamidae	*Artamus superciliosus*	White-browed Woodswallow	V	-	Yes - 26 records	The White-browed Woodswallow occurs in eastern, northern and central Australia. In NSW it typically breeds in open forests and woodlands from the inland slopes to the far western plains but during dry years its distribution extends east to open habitats of the tablelands and coast (NSW Scientific Committee, 2009b).	**Present.** This species was observed during field surveys.
Burhinidae	*Burhinus grallarius*	Bush Stonecurlew	E1	-	Yes - 2 records	Require sparsely grassed, lightly timbered, open forest of woodland. In southern Australia they often occur where there is a well structured litter layer and fallen timber debris. Feed on a range of invertebrates and small vertebrates, as well as seeds and shoots (DEC (NSW), 2006c).	**Low to moderate.** There is ostensibly suitable habitat available for this species in the study area, which is at least likely to have occurred historically. This species was not recorded during field surveys.
Cacatuidae	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V	-	Yes - 114 records	Occurs in eucalypt woodland and forest with *Casuarina*/ Allocasuarina spp. Characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key *Allocasuarina* species.	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						The drier forest types with intact and less rugged landscapes are preferred by the species. Nests in tree hollows (Garnett and Crowley, 2000, DEC(NSW), 2005p)	during field surveys. Locality records are likely to occur further to the east of the LGA.
Cacatuidae	*Calyptorhynchus banksii*	Red-tailed Black-Cockatoo	V		Yes - 1 record	Red-tailed Black-Cockatoos are found in a wide variety of habitats. Prefer Eucalyptus forest and woodlands, particularly river red gum and coolabah lined water courses. In the arid zone usually occur mainly near eucalypts along larger watercourses and associated acacia and casuarina woodlands nearby. Also utilise grasslands, scrublands, wetlands and vegetation on floodplains. Species is found in the Namoi Catchment Area (Joseph et al., 1991).	**Moderate to high** – but infrequent as this species is more a bird of the inland. May occur along the Namoi River red gum forests.
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	E1	-	Yes - 7 records	Feed in shallow water up to 0.5 m deep on fish, reptiles and frogs. Build nests in trees close to feeding sites (Garnett and Crowley, 2000).	**Present** on floodplain areas of the Namoi River. This species was recorded during field surveys by past studies

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
Climacteridae	Climacteris picumnus	Brown Treecreeper	V		Yes - 104 records	Occurs in eucalypt woodland and adjoining vegetation. Feeds on ants, beetles and larvae on trees and from fallen timber and leaf litter. Usually nests in (Garnett and Crowley, 2000). The Brown Treecreeper is a resident species that stays in the same area all year round.	**Present.** This species was recorded during field surveys and has been consistently recorded since the 1980s
Dicruridae	*Myiagra cyanoleuca*	Satin Flycatcher	-	M	Yes - 9 records	Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens (Pizzey and Knight, 2003).	**Present.** This species was recorded during field surveys by past studies
Estrildidae	*Stagonopleura guttata*	Diamond Firetail	V	-	Yes - 20 records	Occurs in a range of eucalypt dominated communities with a grassy understorey including woodland, forest and mallee. Most populations occur on the inland slopes of the dividing range. Feed on seeds, mostly of grasses (Garnett and Crowley, 2000).	**Present.** This species was recorded during field surveys and has been consistently recorded since the 1980s
Falconidae	*Falco hypoleucos*	Grey Falcon	V	-	No	Generally centred on inland drainage	**Low** due to lack of

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						systems where the average rainfall is less than 500 millimetres. It is found in timbered lowland plains that are crossed by tree-lined water courses. Nests in the old nests of other birds, particularly (Garnett and Crowley, 2000).	records in spite of detailed bird surveys in the area. However, what appears to be suitable habitat is present. This species was not recorded during field surveys
Gruidae	*Grus rubicunda*	Brolga	V	-	Yes - 1 record	Occurs in well vegetated shallow freshwater wetlands, small isolated swamps in eucalypt forests, floodplains, grasslands, paddocks, ploughed fields, irrigated pastures, stubbles, crops, desert claypans, bore drains, tidal areas, mangroves, beach wastes. Roosts in shallow, bare swamps and nests on small islands in wetland or standing in shallow water, eggs are occasionally laid on bare ground (Pizzey and Knight, 2003).	**Low** throughout most of the Project Boundary, as there is no preferred habitat available for this species in the mining and infrastructure areas. However, there is some habitat in the locality along the Namoi River floodplain. This species was not recorded during field surveys.
Megapodiidae	*Leipoa ocellata*	Malleefowl	E1	V,M	Yes - 7 records	Ground-dwelling bird found in mallee woodland and other dry scrub in the semi-arid zone of inland Australia.	**Low.** There is no preferred habitat available for this species

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						Restricted to semi-arid rangelands and small habitat remnants in the dryland cropping zone of the southwest and centre of NSW. Prefers well drained, light sandy or loamy soils. Habitat usually contains dense but discontinuous canopy which provides abundant leaf litter and dense, varied shrub and herb layers containing food plants, particularly acacia, cassia, bassiaea, beyeria and some open ground for ease of movement (Benshemesh, 2007).	in the study area. This species was not recorded during field surveys.
Megapodiidae	*Alectura lathami*	Australian Brush-turkey population in the Nandewar and Brigalow Belt South Bioregions	E2	-	Yes - 36 records	Brush-turkeys live in rainforests near the coast and in scrubs further inland. Recent records for the species show the population to range from north east of Warialda, to Narrabri, approximately 115 km to the south-west, and occur within the local government areas of Yallaroi, Bingara, Narrabri, Barraba and Moree Plains. The majority of records are from Mount Kaputar National Park and nearby	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded during field surveys.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						Deriah State Forest (DEC (NSW), 2005d).	
Meliphagidae	*Certhionyx variegatus*	Pied Honeyeater	V	-	Yes - 1 record	Inhabits wattle shrub (primarily Mulga, *Acacia aneura*), mallee, spinifex and eucalypt woodlands, usually when shrubs are flowering; feeds on nectar, predominantly from various species of emu-bushes (*Eremophila* spp.); also from mistletoes and various other shrubs (e.g. Brachysema spp. and Grevillea spp.); also eats saltbush fruit, berries, seed, flowers and insects. Highly nomadic, following the erratic flowering of shrubs; can be locally common at times. Constructs a relatively large cup-shaped nest, constructed of grasses and fine twigs, in the fork of a shrub or tree (Higgins et al., 2001).	**Low** due to lack of records in spite of detailed bird surveys in the area. Ostensibly suitable habitats are available for this species.
Meliphagidae	*Grantiella picta*	Painted Honeyeater	V	-	Yes - 22 records	Lives in dry forests and woodlands. Primary food is the mistletoes in the genus Amyema, though it will take some nectar and insects. Its breeding	**Present.** This species was observed during surveys and detected using call playback.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						distribution is dictated by presence of mistletoes which are largely restricted to older trees. Less likely to be found in strips of remnant box-ironbark woodlands, such as occur along roadsides and in windbreaks, than in wider blocks (Garnett and Crowley, 2000).	Suitable habitats are available for this species.
Meliphagidae	*Melithreptus gularis gularis*	Black-chinned Honeyeater	V	-	Yes - 4 records	Found in dry eucalypt woodland particularly those containing ironbark and box. Occurs within areas of annual rainfall between 400-700 mm. Feed on insects, nectar and lerps (Garnett and Crowley, 2000).	**Present.** This species was recorded during field surveys for past studies.
Meliphagidae	*Xanthomyza phrygia*	Regent Honeyeater	E1	EM	Yes - 7 records	Occurs mostly in box-ironbark forests and woodland and prefers the wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with *Casuarina cunninghamiana* and *Amyema cambagei* are important for feeding and breeding. Important food trees include *Eucalyptus sideroxylon*	**Moderate.** Suitable habitats are available for this species. This species was not recorded during field surveys.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						(Mugga Ironbark), *E. albens* (White Box) , *E. melliodora* (Yellow Box) and *E. leucoxylon* (Yellow Gum) (Garnett and Crowley, 2000).	
Meliphagidae	Epthianura albifrons	White-fronted Chat	V	-	Yes - 1 record	Found mostly in temperate to arid climates and very rarely seen in sub-tropical areas, the White-fronted Chat occupies foothills and lowlands below 1000 m above sea level (Higgins et al., 2001, Barrett et al., 2003). In New South Wales the White-fronted Chat occurs mostly in the southern half of the state, occurring in damp open habitats along the coast, and near waterways in the western part of the state (Higgins et al., 2001).	**Low** due to lack of records in spite of detailed bird surveys in the area. The species is not prevalent in northern NSW.
Meropidae	*Merops ornatus*	Rainbow Bee-eater	-	M	Yes - 79 records	Usually occur in open or lightly timbered areas, often near water. Breed in open areas with friable, often sandy soil, good visibility, convenient perches and often near wetlands. Nests in embankments including creeks, rivers and sand dunes.	**Present.** This species was recorded during field surveys and has been consistently recorded since the 1980s

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						Insectivorous, most foraging is aerial, in clearings (Higgins, 1999).	
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V	-	Yes - 41 records	The Varied Sittella is sedentary and inhabits most of mainland Australia with a nearly continuous distribution in NSW from the coast to the far west. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches and twigs in the tree canopy (DECCW, 2010c, NSW Scientific Committee, 2010c)	**Present.** This species was recorded during field surveys and has been consistently recorded since the 1980s
Otididae	*Ardeotis australis*	Australian Bustard	E1	-	Yes - 2 records	The ground-dwelling bird mainly inhabits tussock and hummock grasslands, though prefers tussock grasses to hummock grasses; also occurs in low shrublands and low open grassy woodlands; occasionally seen in pastoral and cropping country, golf courses and	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded during field surveys.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						near dams. Breeds on bare ground on low sandy ridges or stony rises in ecotones between grassland and protective shrubland cover; roosts on ground among shrubs and long grasses or under trees. Forages on insects, young birds, lizards, mice, leaves, seeds and fruit. Dispersive, with irregular widespread movements over long distances; movements are thought to be in response to habitat and climatic conditions (Marchant and Higgins, 1993).	
Petroicidae	*Melanodryas cucullata*	Hooded Robin	V	-	Yes - 25 records	Found in south-eastern Australia, generally east of the Great Dividing Range. Found in eucalypt woodland and mallee and acacia shrubland. This is one of a suite of species that has declined in woodland areas in south-eastern Australia (Garnett and Crowley, 2000).	**Present.** This species was observed during field surveys.
Petroicidae	Petroica phoenicea	Flame Robin	V	-	Yes - 1 record	The Flame Robin is found in south-eastern Australia (Queensland border to Tasmania, western Victoria and south-	**Moderate.** Suitable habitat exists within the Project Boundary.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						east South Australia). In NSW it breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats such as grassland with scattered trees and open woodland on the inland slopes and plains (Higgins and Peter, 2002). There may be two disjunct breeding populations in NSW on the Northern Tablelands and the Central–Southern Tablelands, as inferred from distributional data (Barrett et al., 2003, DECCW, 2011).	
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler	V	-	Yes - 153 records	Found throughout western slopes and plains, southern and central tablelands and occurring in Northern Rivers area, mid-north coast and the Hunter Valley of NSW. Lives in open forest and woodland, acacia shrubland and adjoining farmland. Large stick dome nest with spout-like entrance (Pizzey and Knight, 2003).	**Present.** This species was recorded during field surveys and has been consistently recorded since the 1980s

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V	-	Yes - 38 records	Found in forests, woodland, treed areas along watercourses and roads. Forages mainly on flowers, nectar and fruit. Found along coastal east Australia from Cape York in Queensland down east coast and round to South Australia. Uncommon in southern Victoria (Higgins, 1999).	**Present.** This species was recorded during field surveys
Psittacidae	*Lathamus discolor*	Swift Parrot	E1	E	No	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important. In mainland	**Moderate.** Suitable habitats are available for this species. This species was not recorded during field surveys.

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Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						Australia is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants. Sites used vary from year to year (Swift Parrot Recovery Team, 2001, Garnett and Crowley, 2000).	
Psittacidae	*Neophema pulchella*	Turquoise Parrot	V	-	Yes- 134 records	Occurs in the foothills of the great dividing range in eucalypt woodlands and forests with a grassy or sparsely shrubby understorey. Nests in hollows in trees, stumps or even fence posts. It feeds on seeds of both native and introduced grass and herb species (Garnett and Crowley, 2000).	**Present.** This species was recorded during field surveys and has been consistently recorded since the 1980s
Psittacidae	*Polytelis swainsonii*	Superb Parrot	V	V	Yes - 17 records	Mainly found in the Riverina where they nest in loose colonies in riparian woodland on River Red Gum. On the	**Low to moderate.** These birds have declined in numbers such

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						inland slopes, Superb Parrots both forage and feed within box woodland, especially box eucalypts such as *E. melliodora* (Yellow Box) or *E. microcarpa* (Grey Box) and also seasonally occurs in box-pine and *Acacia pendula* (Boree) woodlands. Mostly nests in dead trees (DEWHA, 2009b, Garnett and Crowley, 2000).	that many historic parts of their range with suitable habitats are no longer occupied by this species. This species was not recorded during field surveys.
Rostratulidae	*Rostratula benghalensis*	Painted Snipe	E1	VM	Yes - 3 records	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as *Eucalyptus camaldulensis* (River Red Gum), *E. populnea* (Poplar Box) or shrubs such as *Muehlenbeckia florulenta* (Lignum) or *Sarcocornia quinqueflora* (Samphire). Feeds at the water's edge and on mudlflats on seeds and invertebrates, including insects, worms, mollusks and crustaceans. Males incubate eggs in a shallow scrape nest (Garnett and Crowley, 2000).	**Low.** There is no preferred habitat available for this species in the study area other than in limited areas on the Namoi floodplain. This species was not recorded during field surveys.

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Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
Scolopacidae	*Gallinago hardwickii*	Latham's Snipe		M	Yes - 1 record	Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere to breed (Garnett and Crowley, 2000).	**Low.** There is no preferred habitat available for this species in the study area other than in limited areas on the Namoi floodplain. This species was not recorded during field surveys
Strigidae	*Ninox connivens*	Barking Owl	V	-	Yes - 154 records	Occurs in dry sclerophyll woodland. In the south west it is often associated with riparian vegetation while in the south east it generally occurs on forest edges. It nests in large hollows in live eucalypts, often near open country. It feeds on insects in the non-breeding season and on birds and mammals in the breeding season (Garnett and Crowley, 2000).	**Present.** This species was observed and detected using call playback during field surveys.
Tytonidae	*Tyto novaehollandiae*	Masked Owl	V	-	Yes - 9 records	Occurs within a diverse range of wooded habitats including forests, remnants and almost treeless inland plains. This species requires large-hollow bearing	**Present.** This species was observed and detected using call playback during field

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Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						trees for roosting and nesting and nearby open areas for foraging. They typically prey on terrestrial mammals including rodents and marsupials but will also take other species opportunistically. Also known to occasionally roost and nest in caves (Garnett and Crowley, 2000).	surveys.
Tytonidae	Tyto capensis	Grass Owl	V	-	Yes - 3 records	Grass Owls are found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains.	**Low.** Not detected during surveys – little or no habitat present.
Mammals							
Burramyidae	*Cercartetus nanus*	Eastern Pygmy possum	V	-	Yes - 6 records	Found in a range of habitats from rainforest through sclerophyll forest to tree heath. It feeds largely on the nectar and pollen of banksias, eucalypts and bottlebrushes and sometimes soft fruits. It nests in very small tree holes, between the wood and bark of a tree, abandoned birds nests and shredded bark in the fork	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded during field surveys.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						of trees (DEC (NSW), 2005m).	
Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail Bat	V	-	Yes - 50 records	Occurs in eucalypt forest where it feeds above the canopy and in mallee or open country where it feeds closer to the ground. Generally a solitary species but sometimes found in colonies of up to 10. It roosts in tree hollows. Thought to be a migratory species (Churchill, 2008).	**Present.** This species was recorded during field surveys using anabats.
Dasyuridae	*Dasyurus maculatus*	Spotted-tailed Quoll	V	E	Yes -9 records	Occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold (NSW NPWS, 1999)Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland. Nests in rock	**Moderate.** Suitable habitats are available for this species. This species was not recorded during field surveys and few records exist for the locality.

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Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						caves and hollow logs or trees. Feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods (Long and Nelson, 2010).	
Dasyuridae	*Sminthopsis macroura*	Stripe-faced Dunnart	V	-	Yes - 1 record	The species are found in many habitats in the arid and semi-arid parts of Australia; they occur in low shrublands of saltbush and bluebush, in tussock grasslands on clay, sandy or stony soils, among sparse shrublands and on low, shrubby, rocky ridges. Dense populations occur in tussock grasslands. The species shelters in cracks in the soil or under rocks and logs, probably in nests (Strahan, 1995).	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded during field surveys.
Petauridae	*Petaurus norfolcensis*	Squirrel Glider	V	-	Yes - 14 records	Found in dry sclerophyll forest and woodland but not found in dense coastal ranges. Nests in hollows and feeds on gum of acacias, eucalypt sap and invertebrates (DEC (NSW), 2005g1, Smith and Murray, 2003).	**Moderate.** Suitable habitats are available for this species. This species was not recorded during field surveys.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
Macropodidae	*Macropus dorsalis*	Black-striped Wallaby	E1	-	Yes - 444 records	The preferred habitats for the species is forested country with a dense shrub layer including rainforest margins; brigalow scrub, particularly in a phase of regrowth; open forest with a thick acacia or other shrub understorey; and lantana thickets (Strahan, 1995).	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded during field surveys.
Macropodidae	*Petrogale penicillata*	Brush-tailed Rock-wallaby	E1	V	Yes - 13 records	Occurs in inland and sub-coastal south eastern Australia where it inhabits rock slopes. It has a preference for rocks which receive sunlight for a considerable part of the day. Windblown caves, rock cracks or tumbled boulders are used for shelter. Occur in small groups or "colonies" each usually separated by hundreds of metres (NSW NPWS, 2003).	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded during field surveys.
Macropodidae	Lagorchestes leporides	Eastern Hare-wallaby	E4		Yes - 1 record	Presumed extinct.	**Very low.**
Phascolarctidae	*Phascolarctos cinereus*	Koala	V	-	Yes - 396 records	Found in sclerophyll forest. Throughout New South Wales, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and	**High** likelihood, but at very low densities due to lack of preferred feed trees. This species was

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include Forest Red Gum *Eucalyptus tereticornis*, Grey Gum *E. punctata*, Monkey Gum *E. cypellocarpa* and Ribbon Gum *E. viminalis*. In coastal areas, Tallowwood *E. microcorys* and Swamp Mahogany *E. robusta* are important food species, while in inland areas White Box *E. albens*, Bimble Box *E. populnea* and River Red Gum *E. camaldulensis* are favoured (DECC (NSW), 2008b)	not recorded during field surveys, though it is known from the locality and was detected in the Southern part of Leard State Forest.
Molossidae	*Mormopterus norfolkensis*	East Coast Freetail-bat	V	-	No	Thought to live in sclerophyll forest and woodland. Small colonies have been found in tree hollows or under loose bark. It feeds on insects above the forest canopy or in clearings at the forest edge	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded

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Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						(Churchill, 2008).	during field surveys.
Muridae	*Pseudomys pilligaensis*	Pilliga Mouse	V	V	Yes - 93 records	Restricted to unique habitat known as Pilliga scrub, which occurs on deep, low nutrient sand in the Pilliga region of NSW (south of Narrabri). Specifically, Pilliga mouse has been found in areas dominated by broombush, or with *Acacia burrowii* shrub layer and *Corymbia trachyphloia* overstory. Both of these habitats had relatively high species richness with moist groundcover and medium to high shrub cover. An additional habitat for the Pilliga Mouse is recently burnt moist gullies with high cover of low grasses and sedges, yet low cover of shrubs (DEC (NSW), 2005y).	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded during field surveys.
Muridae	*Leporillus conditor*	Greater Stick-nest Rat	E4	V	Yes - 1 record	Presumed extinct; currently only found in WA and SA	**Very low.**
Potoroidae	*Aepyprymnus rufescens*	Rufous Bettong	V	-	Yes - 1 record	Distribution: From Cooktown in north Queensland, to north-east NSW, where it occurs east of the Dividing Range. In Queensland, it still occurs on both sides	**Low.** There is no preferred habitat available for this species in the study area. This

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						of the Great Divide. Macrohabitat: Found in a variety of forest types from wet sclerophyll to dry open woodland, where grass tussocks or fallen timber are present. Also known to occupy a mosaic of open forest and grasslands. Microhabitat: It appears to prefer a more open forest structure, with an sparse shrub layer and a diverse ground cover. Builds nests in grass tussocks and under logs. Strongly associated with dry sclerophyll forest particularly those dominated by Spotted Gum (DEC (NSW), 2005b1).	species was not recorded during field surveys.
Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V	Yes - 1 record	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps (DEC (NSW), 2005r).	**Low.** Suboptimal foraging habitat and only one record in the Narrabri LGA since 1980. No known camps in the locality.
Vespertilionidae	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	V	Yes - 39 records	Occurs in moderately wooded habitats and roosts in caves, mine tunnels and	**Moderate.** Suitable foraging habitats are

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						the abandoned, bottleshaped mud nests of Fairy Martins. Thought to forage below the forest canopy for small flying insects (Churchill, 2008).	available for this species. This species was not recorded during field surveys.
Vespertilionidae	*Chalinolobus picatus*	Little Pied Bat	V	-	Yes - 6 records	The species roosts in trees, caves, and abandoned mines and houses. Roost sites in caves are usually warm and dry but they can tolerate roost temperatures of more than 40 degrees celsius. The Little Pied Bat has been recorded in dry open forest, open woodland, Mulga woodlands, chenopod shrublands, Callitris forest and mallee (Churchill, 2008).	**Present.** This species was recorded in Leard State Forest in past surveys
Vespertilionidae	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V	-	No	Usually roosts in tree hollows in higher rainfall forests. Sometimes found in caves (Jenolan area) and abandoned buildings. Forages within the canopy of dry sclerophyll forest. It prefers wet habitats where trees are more than 20 metres high (Churchill, 2008).	**Present.** This species was recorded in Leard State Forest in past surveys
Vespertilionidae	*Miniopterus*	Eastern Bent-	V	-	Yes - 7	Usually found in well timbered valleys	**Present.** This species

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Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
	schreibersii oceanensis	wing Bat			records	where it forages on small insects above the canopy. Roosts in caves, old mines, stormwater channels and sometimes buildings and often return to a particular nursery cave each year (Churchill, 2008).	was recorded in Leard State Forest in past surveys
Vespertilionidae	*Nyctophilus timoriensis*	Greater Long-eared Bat (Southeastern form)	V	V	Yes - 58 records	Roosts in tree hollows and under loose bark in arid and semi-arid Australia (Strahan, 1995) and forages in the understorey of woodlands and open savanna and swamps (Churchill, 2008).	**Present.** This species was recorded during field surveys using Harp traps.
Vespertilionidae	*Vespadelus troughtoni*	Eastern Cave Bat	V	-	Yes - 2 records	A cave-dwelling species found in eastern Australia from Cape York to NSW. They inhabit tropical mixed woodland and wet sclerophyll forests on the coast and the dividing range, but extend into drier forests on the western slopes (Churchill, 2008).	**Present.** This species was not recorded during field surveys, but was detected in other past surveys of the State Forest.
Vespertilionidae	*Miniopterus australis*	Little Bentwing-bat	V		Yes - 1 record	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, *Melaleuca* swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Little	**Low** due to lack of records despite extensive bat surveys using ultrasonic call recording. .

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters (DEC (NSW), 2005t).	
Reptiles							
Chelidae	*Elseya belli*	Bell's Turtle	V	V	No	Found in upper reaches of rivers overlying granite, on the western slopes of the Northern NSW Tablelands, specifically in the Namoi, Gwydir and MacDonald Rivers and major tributaries. Often occurs in shallow or deep pools or in narrow (30 - 40 m wide) river stretches along grazing land (DEC (NSW), 2005e).	**Low.** There is no preferred habitat available for this species in the study area. This species was not recorded during field surveys.
Elapidae	*Hoplocephalus bitorquatus*	Pale-headed Snake	V	-	Yes - 8 records	A partly arboreal, nocturnal species found in a range of habitats from	**Low.** There is no preferred habitat

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						rainforest and wet sclerophyll forest to the drier eucalypt forests of the western slopes. Feeds largely on frogs and lizards (Cogger, 2000).	available for this species in the study area. This species was not recorded during field surveys.
Gekkonidae	*Underwoodisaurus sphyrurus*	Border Thicktailed Gecko	V	V	Yes - 1 record	Found only on the tablelands and slopes of northern NSW and southern Queensland, reaching south to Tamworth and west to Moree. Most common in the granite country of the New England Tablelands. It is found on rocky hills with dry open eucalypt forest or woodland. It favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter (DEC (NSW), 2005f).	**Moderate.** Suitable habitats are available for this species.
Scincidae	*Anomalopus mackayi*	Five-clawed Worm-skink	E1	V	Yes - 3 records	The Five-clawed Worm-skink's preferred habitat is open woodland. It often occurs on the lower slopes of slight rises in grassy White Box Woodland. It is also known to occur in River Red Gum and Coolibah-Bimble Box woodland. Both types of woodland occur on red-black to black clay-loam soils. The species lives	**Moderate.** Suitable habitats are available for this species.

Table E.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Locality

Family	Scientific Name	Common Name	TSC Act	EPBC Act	Recorded in Narrabri LGA	Preferred Habitat	Likelihood of Occurrence
						in permanent tunnel-like burrows and deep cracks within the soil. On the surface the species utilises fallen logs and timber for shelter (DEC (NSW), 2005o).	

Appendix F

F.

Survey Effort from Previous Studies of Leard State Forest and Surrounds

Table F.1 Survey Effort from Previous Studies of Leard State Forest and Surrounds

	C&A	D&M	D&M	PB	CES	Eco Logical	CE
Survey Dates	**4 seasons, 1977-1978**	**14-25 September 1983**	**19-25 February 1984**	**December 2008-September 2009**	**2005**	**7-9 December 2009 (targeted threatened fauna surveys)**	**2008 & 2010**
Location	**Leard State Forest**	**K.C.C Maules Creek; Leard State Forest & private property west of the Forest**	**K.C.C Maules Creek; Leard State Forest & private property west of the Forest**	**Boggabri Coal Mine; Leard State Forest and adjacent land**	**Tarrawonga Coal Mine; Southern boundary of Leard State Forest and adjacent agricultural lands**	**Tarrawonga Coal Mine; Southern boundary of Leard State Forest and adjacent agricultural lands**	**Maules Creek; Leard State Forest and farming land north of the Forest**
Amphibians							
Systematic day habitat search		Yes	Yes	14 hours			4 hours
Night habitat search of damp and watery sites							2 hours
Nocturnal call playback							4 nights
Night watercourse search							2 hours
Tracing calls and spotlighting		Yes	Yes				

Table F.1 Survey Effort from Previous Studies of Leard State Forest and Surrounds

	C&A	D&M	D&M	PB	CES	Eco Logical	CE
Reptiles							
Active searching		2.5 hours/ day	2.5 hours/ day				
Habitat search	Yes	Yes	Yes	23.5 hours	8 hours	8 hours	10 x 30 minutes (2 x 30 mins on 5 separate days)
Pitfall traps					4 pitfall trap lines		270 trap nights (54 traps for 4 nights, 18 traps for 3 nights) (with drift nets)
Spotlighting	Yes				8km spotlighting	8 hours	10 hours (1 hour on 10 separate days)
Diurnal Birds							
Census						Yes.	Systematic grid basedcensue- 13.5 hours (10 min x 81 sites)

Table F.1 Survey Effort from Previous Studies of Leard State Forest and Surrounds

	C&A	D&M	D&M	PB	CES	Eco Logical	CE
Call playback	Stop-call-count' method used between 0700-1800 in August 1977, October 1977, December 1977 and April 1978. Hours varied with seasons.					Yes.	
Area search				22.5 hours		8 hours	6 days
Water source census							30 minutes
Transect		45min per transect (unknown no of transects)			Morning bird surveys along 4 trap lines		
Nocturnal Birds							
Call playback				25 hours	6 call playback stations over 4 nights		12 nights (30 minutes each night, 1 site per night)
Day habitat search						Yes.	Throughout survey period

Table F.1 Survey Effort from Previous Studies of Leard State Forest and Surrounds

	C&A	D&M	D&M	PB	CES	Eco Logical	CE
Spotlighting		Yes, in conjunction with mammal spotlighting	Yes, in conjunction with mammal spotlighting				
Non-flying Mammals							
Small Elliott traps	(and Longworth Traps) 8 trap nights	1400 trap nights	900 trap nights	1900 trap nights	Yes		1125 trap nights
Large Elliott traps				800 trap nights			450 trap nights
Arboreal Elliott traps				552 trap nights			320 trap nights
Wire cage traps		1400 trap nights		480 trap nights			270 trap nights
Pitfall traps				336 trap nights	Yes. 4 pitfall trap lines	Yes	270 trap nights (with drift nets)
Pit traps		Open for 4 nights, closed for 3, reopened for 4	Open for 4 nights, closed for 3, reopened for 4				
Hair tubes					Yes. 20 hair trap sites	Yes	2000 trap nights
Arboreal hair tubes							2000 trap nights

Table F.1 Survey Effort from Previous Studies of Leard State Forest and Surrounds

	C&A	D&M	D&M	PB	CES	Eco Logical	CE
Spotlighting on foot	1900 - 2400, varying with season	3 hours per night of spotlighting on foot and from a vehicle, targeting all nocturnal animals		27.5 hours	Yes. 8km	8 hours	16 hours (8 x 2 hours per night)
Spotlighting from vehicle			45 minute transects				16 hours (8 x 2 hours per night)
Call playback						Yes.	12 nights
Search for scats and signs				Koala scats- 117.5 hours	Yes	Yes- Koala scat search	6 hours
IR cameras							34 survey nights
Collection of predator scats					Yes		Throughout survey period
Habitat Search				109.5 hours hollow-bearing trees search		8 hours	HBT at 81 sites (50 x 20m plots)
Koala grid based SAT (spot assessment technique)							81 sites
Traplines (trapping method not specified)					800 trap nights	Yes.	
Bats							
Harp trapping				34 trap nights	3 trap nights	Yes.	22 trap nights

Table F.1 Survey Effort from Previous Studies of Leard State Forest and Surrounds

	C&A	D&M	D&M	PB	CES	Eco Logical	CE
Mist- nets	4 hours, 1 night in April		5 nights at base dam and 1 night at the gauging station				26 nights
Triplining							1 night
Anabat recorders				151 hours	Yes. Used while spotlighting (8km and 1 fixed location)	Yes.	
Modified bat-trap			2 nights at the gauging station downstream of bore dam				
Aquatic macroinvertebrates							
Dip net sweeps				Yes			
Fish							
Electrofisher				3 minutes each for 3 replicates at each site			

Appendix G

G.

Floristic Quadrat Data

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Trees																						
Apocynaceae		*Alstonia constricta*																				
Casuarinaceae		*Casuarina cristata*																				2
Cupressaceae		*Callitris glaucophylla*	2	2	1	1	1	2	3	2	2	2		2	1	3	1	4	2			
Loranthaceae		*Amyema miquelii*																				
Loranthaceae		*Amyema sp.*																				
Moraceae		*Ficus rubiginosa*																				
Myrtaceae		*Eucalyptus albens*	5		5		2	4	5	5	4	5	5				1				3	
		Eucalyptus blakelyi																				
		Eucalyptus crebra	1	5		4	4	2			2	2	2	2	4			3	3	3		
		Eucalyptus dwyeri																+	3			
		Eucalyptus melanophloia														2						
		Eucalyptus melliodora												3								
		Eucalyptus pilligaensis																				
		Eucalyptus populnea																				
		Eucalyptus sp.												1								
		Melaleuca bracteata																				
Santalaceae		*Exocarpos cupressiformis*												2					+			
Sapindaceae		*Dodonaea sinuolata subsp. sinuolata*							4		1	1	2				+					

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Sterculiaceae		*Brachychiton populneus*				2																
Shrubs																						
Asteraceae		*Cassinia arcuata*		2		1	1	1	2		1											
		Cassinia quinquefaria	3											+	2	+		+	1			
		Cassinia sp.																		+		
		Xanthium spinosum																				
Capparaceae		*Capparis mitchellii*	1	1								1										
Chenopodiaceae		*Atriplex semibaccata*			1						1						+					
		Atriplex sp.																				
		Maireana microphylla																				
Cupressaceae		*Callitris glaucophylla (regeneration)*												3	1							
Ericaceae (Styphelioideae)		*Leucopogon sp.*	1	1	1	1		1														
		Melichrus urceolatus														+			+			
Euphorbiaceae		*Beyeria viscosa*												+	+		2	+	+	+		
Fabaceae (Caesalpinioideae)		*Senna sp.*																		+		
Fabaceae (Faboideae)		*Bossiaea sp.*	1																			
		Hovea sp. (bush)																				

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
		Indigofera adesmiifolia	1				1	1	1	1	1											
		Indigofera australis var. australis															+					
		Indigofera sp.												+	+							
		Pultenaea daphnoides																				
		Swainsona galegifolia												+			+				+	
		Templetonia stenophylla																				
Fabaceae (Mimosoideae)		*Acacia buxifolia*	3	3	2				1	2												
		Acacia cheelii		1		1																
		Acacia deanei															+	+				
		Acacia decora												+	+	+					+	
		Acacia hakeoides			2																	
		Acacia salicina																				2
		Acacia sp.			2	1	1	1			1	1		+	+	+		+	+			
Goodeniaceae		*Goodenia ovata*																+				
Lamiaceae	*	*Marrubium vulgare*																				
Myoporaceae		*Eremophila mitchellii*																				
Myrtaceae		*Melaleuca lanceolata*																				
Oleaceae		*Notelaea linearis*			2		1	1		1		1										

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
		Notelaea microcarpa			2												+		+	+	+	
		Notelaea microcarpa var. microcarpa																				
		Notelaea sp.																				
Phyllanthaceae		*Breynia oblongifolia*		1		2							1							+		
Pittosporaceae		*Pittosporum phillyreoides*	1																			
Proteaceae		*Grevillea sp.*																	+			
Rubiaceae		*Canthium sp.*																	+			
Rutaceae		*Geijera parviflora*						1	1	2	1	1	1							+	+	2
Sapindaceae		*Dodonaea august? (entire leaf margin)*																				
		Dodonaea viscosa ssp angustifolia	1	1			1										1	+		2		
		Dodonaea viscosa ssp. cuneata																				
Solanaceae	*	*Lycium ferocissimum*																				
		Solanum cinereum												+								
		Solanum ellipticum																				
		Solanum esuriale																				
		Solanum ferocissimum																				
		Solanum linearifolium																				
Sterculiaceae		*Gilesia biniflora*																				
Thymelaeaceae		*Pimelea curviflora*																				

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
		Pimelea linifolia ssp. linifolia				1		1	1			1	1	+			+	+		+	+	
		Pimelea neo-anglica																				
		Pimelea sp.	1		1		1															
		Pimelea stricta																				
Dicots																						
Acanthaceae		*Brunoniella australis*	3	2	1	1	1	1	1	1	1	1	1	+	+	+	+					
		Rostellularia adscendens																				
		Rostellularia adscendens var. adscendens												+	+	+	+					
Aizoaceae	*	*Galenia pubescens*																				
Amaranthaceae		*Alternanthera denticulata*															+					
Apiaceae		*Daucus glochidiatus*			1							1	1				+					
Apocynaceae		*Marsdenia sp.*		1							1				+					+		
		Marsdenia viridiflora									1							+				
Asteraceae	*	*Aster subulatus*																				
		Calotis cuneifolia												+								
		Calotis lappulacea												+		+	+			+		
		Calotis sp.	3		1	1	1	1		1	1	1			2	1			+			

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
	*	*Carthamus lanatus*																				
	*	*Chondrilla juncea*																			+	+
		Chrysocephalum apiculatum												+								
		Chrysocephalum semipapposum		2							1		1	+		+		+				
	*	*Conyza sp. (bonariensis?)*																				
	*	*Conyza sp.*												+								
		Cymbonotus lawsonianus																		+		
		Euchiton sphaericus																				
		Euchiton sp. (big)																				
		Euchiton sp.																				
	*	*Facelis sp.*																				
		Glossocardia bidens																				
		Glossogyne tannensis	2			1	1	1	1	1	1			+	+	+				+		
	*	*Gnaphalium sp.*															+					
		Helichrysum sp.														+						
	*	*Lactuca sp.*																				
		Olearia elliptica	1			1												+		+		
	*	*Schkuhria pinnata*																				
		Senecio hispidulus															+			+		

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
		Senecio lautus																			+	
		Senecio quadridentatus																			+	
		Senecio sp.																				
		Sigesbeckia sp.												+								
		Solenogyne bellioides															+					
	*	*Sonchus asper*															+					
	*	*Sonchus oleraceus*																			+	+
	*	*Tagetes minuta*																				
		Vittadinia cuneata																				
		Vittadinia cuneata var. hirsuta	2		1		1	2		1	1	1	1	+	1		+					
		Vittadinia sulcata																				
		Xerochrysum viscosum																				
Boraginaceae	*	*Echium plantagineum*																				
Brassicaceae	*	*Lepidium bonariense*																				
		Lepidium pseudohyssopifolium								1						+					+	
	*	*Rapistrum rugosum*																				
Cactaceae	*	*Opuntia stricta*	1	1	1	1	1	1	1			1	1	+	+		+	+				+
	*	*Opuntia tomentosa*																				
Campanulaceae		*Wahlenbergia communis*									1			+			+			+	+	

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
		Wahlenbergia fluminalis		1																		
		Wahlenbergia gracilis																		+	+	
		Wahlenbergia sp.						1		1			1									
		Wahlenbergia stricta													+	+						
Caryophyllaceae	*	*Petrorhagia dubia*																				
Chenopodiaceae		*Einadia hastata*			1	1		1	2			1	1	+				1		+		+
		Einadia nutans									1											
		Einadia polygonoides																			+	
		Einadia trigonos																				
		Enchylaena tomentosa																				
		Sclerolaena birchii (syn. Bassia birchii)																				+
Convolvulaceae		*Convolvulus erubescens*																				
		Dichondra repens	3	2	2	2	2	2	1	1	1		1	+	+	+	2			+	+	
Crassulaceae		*Crassula sp.*																				
Dilleniaceae		*Hibbertia obtusifolia*		1		1		1						+				+	1			
Euphorbiaceae		*Chamaesyce drummondii*												+	+	+	+	+		+		
Fabaceae (Faboideae)		*Desmodium brachypodum*	2	3	2	3	1	1	1	2	1	1	1	2	1	3	+	+		+		
		Desmodium varians												+								
	*	*Medicago sp.*																				+

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
		Pultenaea foliolosa		1																		
	*	*Trifolium arvense*																				
Fabaceae (Mimosoideae)	*	*Mimosa sp.*																				
Gentianaceae	*	*Centaurium erythraea*																				
Geraniaceae		*Erodium crinitum*																				
		Geranium solanderi					1				1		1				+					
Goodeniaceae		*Goodenia cycloptera*									1											
		Goodenia hederacea																				
Haloragaceae		*Gonocarpus sp.*																	+	+		
Lamiaceae		*Ajuga australis*				1	1	1		1				+			+					
		Oncinocalyx betchei																				
Linaceae		*Linum marginale*																				
Lobeliaceae		*Pratia purpurascens*																			+	
Malvaceae	*	*Modiola caroliniana*																				
		Sida corrugata	2	1	1		1		1	1	1	1	1		+		+			+		
		Sida cunninghamii													+	+		+			+	
	*	*Sida rhombifolia*																			+	
Myoporaceae		*Eremophila debilis*																				

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Myrsinaceae	*	*Anagallis arvensis*															+					
Nyctaginaceae		*Boerhavia dominii*																				
Orchidaceae		*Glossodia* sp.																				
Oxalidaceae		*Oxalis chnoodes*		1	1	1	1		1	1	1	1										
		Oxalis exilis														+					+	
		Oxalis perennans														+	+	+				+
Phyllanthaceae		*Phyllanthus sp.*																				
		Phyllanthus virgatus			1	1																
Phytolaccaceae	*	*Phytolacca octandra*																				
Plantaginaceae		*Plantago debilis*		1		1		1		2			1								+	
Polygonaceae		*Polygonum sp.*																				
		Rumex brownii															+				+	
Rubiaceae		*Asperula conferta*																				
		Asperula sp.		1													+					
		Galium gaudichaudii																				
		Galium sp.																				
		Opercularia sp.													+							
		Pomax umbellata																+	2	+		
Santalaceae		*Santalum sp.*	1																			

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Scrophulariaceae		*Verbascum sp.*															+					
Solanaceae		*Solanum sp.*																		+		
Stackhousiaceae		*Stackhousia viminea*												+		+	+					
Urticaceae	*	*Urtica dioica*																				
Monocots																						
Amaryllidaceae		*Crinum sp.*																				
Anthericaceae		*Arthropodium milleflorum*														+	+					
		Dichopogon fimbriatus												in c			+					
Cyperaceae		*Carex inversa*												+	+	+	+			1		
		Cyperus gracilis		1						1	1	1										
		Cyperus sp.	1		1	1	1	1					1									
	*	*Cyperus tenellus*															+					
		Fimbristylis dichotoma																				
		Lepidosperma sp.													+							
		Scleria mackaviensis																				
Juncaceae		*Juncus subsecundus*												+			+					
Lomandraceae		*Lomandra filiformis*																+				

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
		Lomandra longifolia												1								
		Lomandra multiflora	2	1		1	2	2	1	1	1	1	1	1	+	+		+	+			
		Lomandra sp.	1			1																
Orchidaceae		*Cymbidium canaliculatum*																				
		Pterostylis sp.			1	1				1		1										
Phormiaceae		*Dianella longifolia*																				
Ferns																						
Adiantaceae		*Cheilanthes distans*	1	1	1			1			1				+	+						
		Cheilanthes sieberi	1	1	1	1	1	1	1			1		+	+	+	+	+		+		
Vines																						
Apocynaceae		*Parsonsia eucalyptophylla*																				
Fabaceae (Faboideae)		*Glycine clandestina*												+	+	+	+			+		
		Glycine microphylla																		+		
		Glycine tabacina			1	1	1	1	1	1	1	1	1				+				+	
Ranunculaceae		*Clematis glycinoides*																				
		Clematis microphylla var. leptophylla			1	2						1	1									
		Clematis sp. (seedling)																		+		

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Grasses																						
Poaceae		*Aristida jerichoensis var.jerichoensis*																				
		Aristida ramosa																		+		
		Aristida sp.	2	1	2	4	3	1	1	1	1	1										
		Aristida vagans					2							+			+	+	+	+		
		Austrodanthonia bipartita	4		1			1	1	1	1											
		Austrodanthonia fulva																				
		Austrodanthonia induta																				
		Austrodanthonia racemosa												+	+	+	+					
		Austrodanthonia richardsonii																				
		Austrodanthonia sp.													+						+	
		Austrostipa scabra	1	1										1	1	+	+	+		+		
		Austrostipa sp.	1		1		1	1	1	1			1									
		Austrostipa verticillata																				
	*	*Avena sp.*																				
		Bothriochloa decipiens																				
		Bothriochloa macra															+					
		Bothriochloa sp.			1	1			1	1												

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
	*	*Bromus catharticus*																				
		Chloris truncata															+					
		Chloris ventricosa	2		2	1			1		1							+				
		Chloris sp.																				
		Cymbopogon refractus	1	2		1	1	1	1	1	1	1	1	+	+		+					
		Cynodon dactylon																				
		Dichanthium sericeum																			2	
		Dichelachne crinita																				
		Dichelachne sp.															+		+			
		Digitaria sp.																				
		Elymus scaber															+					
		Enneapogon avenaceus												+	+	+	+					
		Eragrostis brownii												+								
		Eragrostis leptostachya																				
		Eragrostis sp.									1											
		Lachnagrostis filiformis (syn. Agrostis avenacea)													+		+					+
	*	*Lolium perenne*																				
		Microlaena stipoides																				

Table G.1 Quadrat Data (Quadrats 1-20)

Family		Scientific Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
		Panicum effusum																				
		Paspalidium caespitosum																				
		Paspalidium distans															+					
		Paspalidium sp.																				
		Poa sieberiana																				
		Poa sp.														+	2			+		
		Sporobolus creber																				
		Sporobolus sp.		1	1			2				1	1				+					
		Themeda australis														+						
	*	*Vulpia bromoides*																				

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
Trees																				
Apocynaceae		*Alstonia constricta*													+					
Casuarinaceae		*Casuarina cristata*													1	3				
Cupressaceae		*Callitris glaucophylla*	2	2	2	2	1	1	1		3	2	2	2			+			
Loranthaceae		*Amyema miquelii*		+																
Loranthaceae		*Amyema sp.*																	+	
Moraceae		*Ficus rubiginosa*						+												
Myrtaceae		*Eucalyptus albens*	3	3			2	3	2	3			1			2			1	2
		Eucalyptus blakelyi									+							2		
		Eucalyptus crebra			3						2	4		2			+	3		
		Eucalyptus dwyeri							1		2			1			+			
		Eucalyptus melanophloia				3	1													
		Eucalyptus melliodora	3																	
		Eucalyptus pilligaensis		2																
		Eucalyptus populnea		3			2													
		Eucalyptus sp.																		
		Melaleuca bracteata														2				
Santalaceae		*Exocarpos cupressiformis*																		
Sapindaceae		*Dodonaea sinuolata subsp. sinuolata*								+										

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
Sterculiaceae		*Brachychiton populneus*																		
Shrubs																				
Asteraceae		*Cassinia arcuata*																		
		Cassinia quinquefaria									+	2								
		Cassinia sp.																		
		Xanthium spinosum																+		
Capparaceae		*Capparis mitchellii*													+					
Chenopodiaceae		*Atriplex semibaccata*						+	+	1										
		Atriplex sp.															+			
		Maireana microphylla														+		+	+	
Cupressaceae		*Callitris glaucophylla (regeneration)*																		
Ericaceae (Styphelioideae)		*Leucopogon sp.*																		
		Melichrus urceolatus										+								
Euphorbiaceae		*Beyeria viscosa*			+			3	2	2		+					+			
Fabaceae (Caesalpinioideae)		*Senna sp.*			+															
Fabaceae (Faboideae)		*Bossiaea sp.*																		

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
		Hovea sp. (bush)											adj.							
		Indigofera adesmiifolia	+								1	+								
		Indigofera australis var. australis	+		+															
		Indigofera sp.																		
		Pultenaea daphnoides									+	1								
		Swainsona galegifolia	+	1	+			+	+	+	+	+					+	+		
		Templetonia stenophylla																		
Fabaceae (Mimosoideae)		*Acacia buxifolia*																		
		Acacia cheelii																		
		Acacia deanei	+	+	+						1									
		Acacia decora	+		1						+									
		Acacia hakeoides																		
		Acacia salicina																		
		Acacia sp.																		
Goodeniaceae		*Goodenia ovata*																		
Lamiaceae	*	*Marrubium vulgare*																+		
Myoporaceae		*Eremophila mitchellii*											3						+	
Myrtaceae		*Melaleuca lanceolata*				2														

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
Oleaceae		*Notelaea linearis*																		
		Notelaea microcarpa	+			+		+	+	1	+									
		Notelaea microcarpa var. microcarpa											1	1			1		1	+
		Notelaea sp.		+																
Phyllanthaceae		*Breynia oblongifolia*									+									
Pittosporaceae		*Pittosporum phillyreoides*																		
Proteaceae		*Grevillea sp.*																		
Rubiaceae		*Canthium sp.*																		
Rutaceae		*Geijera parviflora*	2	+	1	+		2	+	1			2	2	3	2	2	2	+	1
Sapindaceae		*Dodonaea august? (entire leaf margin)*												1						
		Dodonaea viscosa ssp angustifolia	+	+	2			2	1											
		Dodonaea viscosa ssp. cuneata																		
Solanaceae	*	*Lycium ferocissimum*																		
		Solanum cinereum																		
		Solanum ellipticum																		
		Solanum esuriale																		
		Solanum ferocissimum																		
		Solanum linearifolium																		
Sterculiaceae		*Gilesia biniflora*																		

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
Thymelaeaceae		*Pimelea curviflora*																		
		Pimelea linifolia ssp. linifolia	+		+	+		+	1											+
		Pimelea neo-anglica																		
		Pimelea sp.												+						
		Pimelea stricta																		
Dicots																				
Acanthaceae		*Brunoniella australis*	+	+	+		+	+		+	+	+	1			+	+		+	
		Rostellularia adscendens															+			
		Rostellularia adscendens var. adscendens	+	+	+		+				+	+								
Aizoaceae	*	*Galenia pubescens*													+	+		+		
Amaranthaceae		*Alternanthera denticulata*		+																
Apiaceae		*Daucus glochidiatus*		+		+		+					+	+			+	+	+	+
Apocynaceae		*Marsdenia sp.*				+	+				+						+			
		Marsdenia viridiflora																		
Asteraceae	*	*Aster subulatus*												+						
		Calotis cuneifolia							+			+								
		Calotis lappulacea	+		+	+	+			+	+		2	+		+	+		+	
		Calotis sp.		+	+							+								

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
	*	*Carthamus lanatus*											+					+	+	
	*	*Chondrilla juncea*											+							
		Chrysocephalum apiculatum			+						+	+								
		Chrysocephalum semipapposum												+						
	*	*Conyza sp. (bonariensis?)*											+							
	*	*Conyza sp.*				+										+				
		Cymbonotus lawsonianus																		
		Euchiton sphaericus				+														
		Euchiton sp. (big)											+							
		Euchiton sp.											+							
	*	*Facelis sp.*											+							
		Glossocardia bidens												+			+			
		Glossogyne tannensis		+	+		+													
	*	*Gnaphalium sp.*								+										
		Helichrysum sp.																		
	*	*Lactuca sp.*													+				+	
		Olearia elliptica			+		+	1	+	3	+									
	*	*Schkuhria pinnata*													+					
		Senecio hispidulus																		

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
		Senecio lautus								+										
		Senecio quadridentatus													+					+
		Senecio sp.		+							+									
		Sigesbeckia sp.																		
		Solenogyne bellioides																		
	*	*Sonchus asper*																		
	*	*Sonchus oleraceus*				+		+						+	+		+			+
	*	*Tagetes minuta*																+		
		Vittadinia cuneata											+	+		+			+	
		Vittadinia cuneata var. hirsuta	+								+									
		Vittadinia sulcata		+	+	+	+	+		+		+								
		Xerochrysum viscosum			+	+														
Boraginaceae	*	*Echium plantagineum*																+		
Brassicaceae	*	*Lepidium bonariense*											1					+	+	
		Lepidium pseudohyssopifolium					+													
	*	*Rapistrum rugosum*																		+
Cactaceae	*	*Opuntia stricta*	+	+	+		+	+		+									+	
	*	*Opuntia tomentosa*																		
Campanulaceae		*Wahlenbergia communis*	+		+	+		+		+										

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
		Wahlenbergia fluminalis																		
		Wahlenbergia gracilis			+															1
		Wahlenbergia sp.																		
		Wahlenbergia stricta											+	+					+	
Caryophyllaceae	*	*Petrorhagia dubia*				1							+	+			+		+	+
Chenopodiaceae		*Einadia hastata*	+	+	+	+	+		+	+	+		+							
		Einadia nutans											+		+					
		Einadia polygonoides		+		+	+									+		1		
		Einadia trigonos														+		1		
		Enchylaena tomentosa			+															
		Sclerolaena birchii (syn. Bassia birchii)				+							+			+			+	
Convolvulaceae		*Convolvulus erubescens*												+						
		Dichondra repens	+	+	+	3	3		+	+	+	1	+	+	+	1	1	+	+	+
Crassulaceae		*Crassula sp.*		+																
Dilleniaceae		*Hibbertia obtusifolia*									+	+								
Euphorbiaceae		*Chamaesyce drummondii*	+	+	+	+	+		+		+		+	+			+			+
Fabaceae (Faboideae)		*Desmodium brachypodum*		+	+					+	+	2								
		Desmodium varians							+					+			+			
	*	*Medicago sp.*																		

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
		Pultenaea foliolosa																		
	*	*Trifolium arvense*				+														
Fabaceae (Mimosoideae)	*	*Mimosa sp.*													+					
Gentianaceae	*	*Centaurium erythraea*				+														
Geraniaceae		*Erodium crinitum*												+						
		Geranium solanderi				+	+		+											+
Goodeniaceae		*Goodenia cycloptera*																		
		Goodenia hederacea									+	+								
Haloragaceae		*Gonocarpus sp.*																		
Lamiaceae		*Ajuga australis*	+	+								+					+			
		Oncinocalyx betchei												+						
Linaceae		*Linum marginale*												+						
Lobeliaceae		*Pratia purpurascens*																		+
Malvaceae	*	*Modiola caroliniana*														+				
		Sida corrugata			+	+	+						+			+	+	+	+	
		Sida cunninghamii				+	+						+	+						
	*	*Sida rhombifolia*	+										+			+			+	
Myoporaceae		*Eremophila debilis*		1																
Myrsinaceae	*	*Anagallis arvensis*		+						+										

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
Nyctaginaceae		*Boerhavia dominii*													+	1	+	+	+	+
Orchidaceae		*Glossodia* sp.																		
Oxalidaceae		*Oxalis chnoodes*					+													
		Oxalis exilis															+			+
		Oxalis perennans	+	+		+	+						+	+	+	+		+	+	+
Phyllanthaceae		*Phyllanthus sp.*	+	+	+															
		Phyllanthus virgatus																		
Phytolaccaceae	*	*Phytolacca octandra*													+					
Plantaginaceae		*Plantago debilis*		+		+			+							+		+		+
Polygonaceae		*Polygonum sp.*				+														
		Rumex brownii		+													+	+		+
Rubiaceae		*Asperula conferta*												+						
		Asperula sp.																		
		Galium gaudichaudii					+	+	+											
		Galium sp.															+			
		Opercularia sp.																		
		Pomax umbellata																		
Santalaceae		*Santalum sp.*																		
Scrophulariaceae		*Verbascum sp.*																		

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
Solanaceae		*Solanum sp.*					+													
Stackhousiaceae		*Stackhousia viminea*	+	+	+		+				+			+			+			
Urticaceae	*	*Urtica dioica*				+												+		
Monocots																				
Amaryllidaceae		*Crinum sp.*				+														
Anthericaceae		*Arthropodium milleflorum*		+		+		+								+	+			
		Dichopogon fimbriatus					+													
Cyperaceae		*Carex inversa*	+						+											
		Cyperus gracilis					+							+		+	2	2	1	+
		Cyperus sp.		+																
	*	*Cyperus tenellus*						+			+	+								
		Fimbristylis dichotoma												+					+	
		Lepidosperma sp.																		
		Scleria mackaviensis															+			
Juncaceae		*Juncus subsecundus*				+														
Lomandraceae		*Lomandra filiformis*															+			
		Lomandra longifolia									1									
		Lomandra multiflora	+	+		+	+				+	+								

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
		Lomandra sp.																		
Orchidaceae		*Cymbidium canaliculatum*													+					
		Pterostylis sp.																		
Phormiaceae		*Dianella longifolia*		+							+									
Ferns																				
Adiantaceae		*Cheilanthes distans*		1				+					1						+	
		Cheilanthes sieberi		+			+				+	+	+	+		+	+		+	
Vines																				
Apocynaceae		*Parsonsia eucalyptophylla*					+							+		+	+			
Fabaceae (Faboideae)		*Glycine clandestina*	+	+	+		+		+			+							+	
		Glycine microphylla					+	+	+		+		2				+			
		Glycine tabacina	+	+		+	+	+	+	+	+		2	+		+		+	+	+
Ranunculaceae		*Clematis glycinoides*	+				+													
		Clematis microphylla var. leptophylla																		
		Clematis sp. (seedling)																		
Grasses																				

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
Poaceae		*Aristida jerichoensis var.jerichoensis*											4							
		Aristida ramosa				+							1	1						
		Aristida sp.																		
		Aristida vagans	+	1				+	+	+	+									
		Austrodanthonia bipartita						+	+			+								
		Austrodanthonia fulva														1		1	+	+
		Austrodanthonia induta		2																
		Austrodanthonia racemosa	+	+	+	1	+			+	+	+								
		Austrodanthonia richardsonii		+	+		+				+									
		Austrodanthonia sp.			+								1		+		1			
		Austrostipa scabra	+	+	1	+	3	+	+	1	+	+	2	1			2	2	3	+
		Austrostipa sp.																		
		Austrostipa verticillata			+	+	+						1		+	2		1		
	*	*Avena sp.*				+														
		Bothriochloa decipiens											+	1			+			3
		Bothriochloa macra				+	+													
		Bothriochloa sp.																		
	*	*Bromus catharticus*				+												+		+
		Chloris truncata	+		+	+										+			1	

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
		Chloris ventricosa	+													+				
		Chloris sp.											+							
		Cymbopogon refractus		1	+	+	+		+	+		+		+						
		Cynodon dactylon														+	+			
		Dichanthium sericeum	+	+	+	+				1									1	3
		Dichelachne crinita									+									
		Dichelachne sp.				+						+		+						
		Digitaria sp.		1	+			+		+										
		Elymus scaber				1														
		Enneapogon avenaceus					+			+										
		Eragrostis brownii												+					+	
		Eragrostis leptostachya									1									
		Eragrostis sp.																		
		Lachnagrostis filiformis (syn. Agrostis avenacea)				+						+								
	*	*Lolium perenne*																		
		Microlaena stipoides				2	+										1			
		Panicum effusum												+	+					+
		Paspalidium caespitosum											1							

Table G.2 Quadrat Data (Quadrats 21-38)

Family		Scientific Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
		Paspalidium distans	+	+		+	+	+			+					+			+	+
		Paspalidium sp.			+															
		Poa sieberiana		+		1	+	+			+					2				
		Poa sp.																		
		Sporobolus creber															+		+	
		Sporobolus sp.		1		+														
		Themeda australis																		
	*	*Vulpia bromoides*		+		+														

Appendix H

H.

Threatened Flora and Fauna of Box Gum Woodland

Table H.1 Threatened Species and Ecological Communities that May Occur in Box-Gum Grassy Woodland Listed Under Commonwealth, State And Territory Legislation and/or on IUCN Red List1.

SPECIES	COMMON NAME	IUCN[1]	Cwlth[2]	ACT[3]	NSW[4]	Qld[5]	Vic[6]
Flora							
Acacia atrox	Myall Creek Wattle				E		
Acacia omalophylla	Yarran Wattle						E
Ammobium craspedioides	Yass Daisy		V		V		
Bothriochloa biloba	Lobed Redgrass		V			V	V
Dichanthium setosum	Bluegrass		V		V	R	
Digitaria porrecta	Finger Panic Grass		E		E	R	
Discaria pubescens	Australian Anchor Plant					R	V
Diuris pedunculata	Small Snake Orchid		E		E		
Diuris punctata var. punctata	Purple Diuris						V
Goodenia macbarronii	Narrow Goodenia				V		V
Glycine canescens	Silky Glycine						E
Hibbertia humifusa ssp. erigens	Euroa Guinea-flower		V				V
Homopholis belsonii	Belson's Panic		V			E	
Leucochrysum albicans var. tricolor	Hoary Sunray (white form)	E	E				
Picris evae	a hawkweed		V		V	V	
Prasophyllum petilum	Tarengo Leek Orchid		E	E			
Rutidosis leptorrhynchoides	Button Wrinklewort		E	E			E
Senecio garlandii	Woolly Ragwort		V		V		E

Table H.1 Threatened Species and Ecological Communities that May Occur in Box-Gum Grassy Woodland Listed Under Commonwealth, State And Territory Legislation and/or on IUCN Red List1.

SPECIES	COMMON NAME	IUCN[1]	Cwlth[2]	ACT[3]	NSW[4]	Qld[5]	Vic[6]
Swainsona recta	Small Purple Pea		E	E	E		E
Swainsona sericea	Silky Swainson-pea				V		V
Thesium australe	Austral Toadflax		V		V	V	V
Fauna							
Anomalopus mackayi	Five-clawed Worm-skink		V		E	E	
Aprasia parapulchella	Pink-tailed Worm-lizard		V		V		E
Burhinus grallarius	Bush Stone-curlew	NT			E		E
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)			V	V		
Chthonicola sagittata	Speckled Warbler	LC			V		V
Dasyurus maculatus maculatus	Spotted-tail Quoll	NT	E	V	V	V	E
Delma impar	Striped Legless Lizard	V	V	V	V		E
Geophaps scripta	Squatter Pigeon	LC			E	V	
Grantiella picta	Painted Honeyeater	NT		V	V	R	V
Hieraaetus morphnoides	Little Eagle	LC					
Hoplocephalus bitorquatus	Pale-headed Snake				V		
Lathamus discolor	Swift Parrot	E	E	V	E	E	E
Lophoictinia isura	Square-tailed Kite	LC			V	R	V
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	LC		V	V		
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	LC			V	R	

Table H.1 Threatened Species and Ecological Communities that May Occur in Box-Gum Grassy Woodland Listed Under Commonwealth, State And Territory Legislation and/or on IUCN Red List1.

SPECIES	COMMON NAME	IUCN[1]	Cwlth[2]	ACT[3]	NSW[4]	Qld[5]	Vic[6]
Neophema pulchella	Turquoise Parrot	LC			V	R	NT
Ninox connivens	Barking Owl	LC			V		E
Paralucia spinifera	Bathurst Copper Butterfly	E	V				
Pedionomus torquatus	Plains Wanderer	E	V		E	V	
Perunga ochracea	Perunga Grasshopper			V			
Petaurus norfolcensis	Squirrel Glider	LC			V		E
Phascogale tapoatafa	Brush-tailed Phascogale	NT			E		V
Phascolarctos cinereus	Koala	LC			V	V	
Polytelis swainsonii	Superb Parrot	V	V	V	V		E
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	LC			V		E
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	LC			V		
Stagonopleura guttata	Diamond Firetail	NT			V		V
Suta flagellum	Little Whip Snake				V		
Synemon plana	Golden Sun Moth		CE	E	E		E
Tympanocryptis pinguicolla	Grassland Earless Dragon		E	E		E	CE
Tyto novaehollandiae	Masked Owl	LC			V		E
Underwoodisaurus sphyrurus	Border Thick-tailed Gecko	NT	V		V	R	
Varanus rosenbergi	Rosenberg's Goanna				V		V
Xanthomyza phrygia	Regent Honeyeater	E	E	E	E	E	CE

(Reproduced from NSW DECCW, 2010)

CE: *Critically Endangered;* ***E:*** *Endangered;* ***V:*** *Vulnerable;* ***NT:*** *Near Threatened;* ***LC:*** *Least Concern;* ***R:*** *Rare.*

[1] ***IUCN:*** *2008 Red List of Threatened Species*

[2] ***CwIth:*** *Environment Protection and Biodiversity Conservation Act 1999*

[3] ***ACT:*** *Nature Conservation Act 1980*

[4] ***NSW:*** *Threatened Species Conservation Act 1995 & Fisheries Management Act 1994*

[5] ***Qld:*** *Nature Conservation Act 1992*

[6] ***Vic:*** *Flora and Fauna Guarantee Act 1988*

Appendix I

I.

Assessments of Significance

I.1 INTRODUCTION

This appendix contains formal Tests of Significance according to Section 5a of the EP&A Act, known as Assessments of Significance. There is no legal requirement to perform such tests for projects that are to be assessed under Part 3A of the EP&A Act, as they are generally performed to determine the need for the preparation of a Species Impact Statement (SIS) – a document that is not part of the 3A assessment process.

However, the Assessments of Significance provide a means by which to gauge the significance of predited impacts to threatened species, populations and ecological communities and so they have been prepared to help examine the magnitude of impacts to local occurences of threatened biota.

Each Assessment of Significance is a series of questions (shown as italicised text below) for which a response has been supplied beneath in plain text. The responses have been prepared under the scenario that no mitigation or compensatory measures are applied. That is, to determine the significance of impacts, the Assessments of Significance consider the impacts without amelioration.

The Project now includes substantial amelioration measures including on-site mitigation measures, such as rehabilitation and erosion control, and off-site compensatory habitat. The ultimate conclusions to this ecological assessment report take such measures into consideration when assessing the long term implications for flora and fauna.

I.2 ECOLOGICAL COMMUNITIES

I.2.1 White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland and Derived Grasslands)

White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland and Derived Grasslands) is listed as an Endangered Ecological Community (EEC) under the TSC Act. It is listed as a Critically Endangered Ecological Community (CEEC) under the EPBC Act. Approximately 944 ha of this community is found within the Project Boundary, of which 544 ha is proposed to be cleared. This is comprised of 458 ha of woodland and 86 ha of Derived Native Grassland that is associated with the threatened community.

Box-Gum Woodland and Derived Grasslands was once a widespread and floristically diverse community that extended from Victoria to Queensland. In NSW the community is found on relatively fertile soils on the tablelands and western slopes which are preferred landscapes for agriculture; as a result, most of the community was historically cleared. It now exists as isolated and fragmented remnant paddock trees or patches with reduced structural complexity and little evidence of regeneration (NSW DECCW, 2010). This community now supports a low diversity of flora and fauna species.

Historically, the community was a floristically diverse complex of communities that occupied a range of landscape positions on a gradation of semi-fertile to fertile soils. These

communities are dominated by one or a combination of the following pure of intergrade tree species: *Eucalyptus albens* (White Box), *E. melliodora* (Yellow Box) and *E. blakelyi* (Blakely's Red Gum). The understorey is characterised by native grasses and wild flowers.

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

Not applicable to ecological communities.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

And

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

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

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

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

The Project Boundary lies within the known range of Box-Gum Woodland and Derived Grasslands. Due to the already reduced extent and degraded nature of this community, and as the community remains poorly represented in the national conservation reserve system (being situated largely on fertile, arable land), the conservation of remaining remnants are critical to the recovery of the community. As a result, any clearance of Box-Gum Woodland

and Derived Grasslands is considered likely to result in a significant loss of the community within the locality and adversely impact on overall conservation efforts.

Box-Gum Woodland and Derived Grasslands has suffered a large decline in the past and remaining remnants (an estimated 405000 ha, NSW DECCW, 2010) are recognised to be under continued threat from further land clearing due to ongoing land use for agriculture, horticulture, urban expansion and public infrastructure (NSW DECCW, 2010). The removal of 944 ha of EEC may also introduce edge effects and exacerbate weed and feral animal invasion. As remnant patches become more fragmented and isolated, they become even less resilient to damaging forces and will require active management to counter the effects of continued degradation.

Box-Gum Woodland and Derived Grasslands is recognised to be highly fragmented across its former range. Approximately 544 ha of this community in the western portion of Leard State Forest is proposed to be removed as part of the Project which will reduce the overall extent of the community in the locality.

The estimated total of 544 ha of Box Gum Woodland and Derived Grasslands to be directly cleared is a conservative estimate of impact based upon measurement of the concept plan that entails buffers around some proposed infrastructure. The proponent has committed to aim to avoid impacts on the community during the final design where ever possible. The actual impact on Box Gum Woodland and Derived Grasslands is therefore expected to be lower than this figure.

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

No critical habitat for Box-Gum Woodland has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest do not constitute critical habitat for this EEC, however it is considered to be important for the local viability of the community.

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

As the Project will require the direct removal of 544 ha and additional indirect impacts on the community are expected, the Project will not be consistent with the National Recovery Plan. However, the Biodiversity Offset Strategy, which is proposed to compensate for the Project impacts, will be consistent with the plan as it will result in:

- An increase in the area of the listed ecological community and degraded sites under conservation management agreements and/or within the formal reserve system;
- An increase in areas which meet the minimum condition criteria for the nationally listed ecological community;

- Maintenance of floristic diversity, structural complexity and ecological function of the ecological community across its distribution;
- A reduction in the level of specific threats;
- An improvement in the landscape connectivity for remnants of the listed ecological community; and
- An improvement in the overall condition of Box-Gum Grassy Woodland remnants within formally reserved areas by conserving properties adjacent to the Leard State Conservation Area and the Mount Kaputar National Park that act as a buffer to surrounding land use.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to Box-Gum Woodland:

- Clearing of native vegetation as this reduces the area habitat available for this EEC;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Invasion of native plant communities (by various exotic species) that readily invade disturbed sites and communities as they can dominate and suppress native flora species by reducing the availability of shelter and nutrient resources.

Continued clearance for agriculture and grazing, roadworks, edge effects and invasive feral animals are also considered major threats to this EEC as these actions destroy and degrade suitable habitat and prevent natural regeneration.

Conclusion

The Project will result in the direct loss of 944 ha of Box Gum Woodland and Derived Grasslands. Further degradation of the remaining areas of this community is expected without active management. Box Gum Woodland and Derived Grasslands is a Critically Endangered Ecological Community and is recognised to have suffered a large reduction in extent through past clearing, Without active management of the remaining areas and without provision of Biodiversity Offsets, the Project is likely to result in a significant impact on this community.

I.2.2 Native vegetation on cracking clay soils of the Liverpool Plains (Plains Grassland)

Native vegetation on cracking clay soils of the Liverpool Plains (Plains Grassland) is listed as an Endangered Ecological Community (EEC) under the TSC Act. It is listed as a Critically Endangered Ecological Community (CEEC) under the EPBC Act. A small patch of this EEC is located next to the proposed rail transport corridor (Parsons Brinckerhoff Australia Pty Ltd, 2010) to the south west of the Project Boundary. It is currently grazed but is in moderate condition.

Plains Grassland is a natural grassland community that occurs on vertosols, deep alluvial cracking clay-loam soils derived from basalts, within the Liverpool Plains Catchment (DEWHA, 2008). The extensive black soil plains, undulating volcanic hills and alluvial floodplains of the Namoi Valley once supported large tracts of closed grasslands dominated by *Austrostipa aristiglumis* (Plains Grass) together with an array of sub-dominant grasses (*Panicum* spp., *Austrodanthonia* spp., *Dichanthium* spp., *Bothriochloa* spp. and *Chloris* spp.). The floristic structure of the EEC is grass-dominated with a canopy of less than 10% projective foliage cover. Shrubs and trees are generally sparse but may be locally common; this is attributed to a mixture of fine-textured soil, climate and topography which tends to restrict water availability (DEWHA, 2008). As these areas are highly fertile, much of these lands have been cleared for cultivation, grazing and other agricultural activities.

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

Not applicable to ecological communities.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

And

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

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

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

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

The Project Boundary lies within the current known range of Plains Grassland which is a small proportion of its original distribution. Approximately 1 ha of this EEC is located next to the proposed rail transport corridor to the south west of the Project Boundary where it is currently grazed and in moderate condition. No area of this EEC is to be directly impacted (i.e. cleared) by the Project.

Due to the already reduced extent and degraded nature of this community, and as the EEC is not conserved in any national reserve system (being situated largely on fertile, arable land), the conservation of remaining remnants are critical to the recovery of the EEC. As a result, any clearance of Plains Grassland is considered likely to result in a significant loss of the community within the locality and adversely impact on overall conservation efforts.

Plains Grassland has suffered a significant decline in its distribution, with an estimated loss of 85% (Sim & Unwin 1983). The majority of the patches of this community within the Liverpool Plains are estimated to be less than 100 ha and this is likely to be due to land clearing since European settlement (DEWHA, 2008). Remaining remnant patches are recognised to be under continued threat from further land clearing due to ongoing land use for agriculture, horticulture, urban expansion and public infrastructure. Salinity, erosion and deposition are also considered to be an increasing problem to this vegetation (Sim & Unwin 1983). Most of the surviving remnants of this EEC are found on travelling stock routes through the plains and thus subject to livestock trampling and grazing.

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

No critical habitat for Plains Grassland has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest do not constitute critical habitat for this EEC, however it is considered to be important for the local viability of the community.

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

Recovery plans have not been prepared for this community. No other threat abatement plans are relevant to this community.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to Plains Grassland:

- Clearing of native vegetation as this reduces the area habitat available for this EEC;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Invasion of native plant communities (by various exotic species) that readily invade disturbed sites and communities as they can dominate and suppress native flora species by reducing the availability of shelter and nutrient resources.

Continued clearance for agriculture and grazing, roadworks, edge effects and invasive feral animals are also considered major threats to this EEC as these actions destroy and degrade suitable habitat and prevent natural regeneration.

Conclusion

The Project is unlikely to have a significant impact on Plains Grassland as no areas of the community are proposed to be cleared for the Project.

I.3 FLORA

I.3.1 Pomaderris queenslandica

Pomaderris queenslandica (Scant Pomaderris) is listed as Endangered under the TSC Act. The species has previously been recorded within Leard State Forest (Parsons Brinckerhoff Australia Pty Ltd, 2010) and outside Mt Kapatur National Park. Potential habitat for this species occurs within the Project Boundary in pockets of sheltered shrubby woodland and along creeks, but has not been located during targeted surveys within the Project Boundary.

The Scant Pomaderris is a small to medium sized shrub most commonly found within moist eucalypt forests and woodlands with a grassy and shrubby understorey, on rich soils of basaltic geologies (DEC (NSW), 2005k1). It has also been found to inhabit riparian corridors along creekbanks. The species is found within a variety of habitat within the Brigalow Belt Bioregion, including Black Cypress Pine - Narrow-leaved Stringybark heathy, Black Cypress Pine shrubby woodland, Blue-leaved Ironbark heathy woodland, Brown Bloodwood - cypress - ironbark heathy woodland, Dwyer's Red Gum woodland on siliceous substrates, Narrow-leaved Ironbark shrubby woodland, White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest, White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest (DEC (NSW), 2005k1). The Scant Pomaderris flowers in spring; the buds are visible many months before flowers open (Harden, 1990-1993).

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

The Project will remove potential habitat for *Pomaderris queenslandica*, however this is unlikely to have an adverse effect on the life cycle of any individuals that may occur within the Project Boundary. Little is known about the reproduction and seed dispersal of the species, but successful pollination is likely to rely on insects. The species has previously been recorded elsewhere in Leard State Forest, of which large areas of habitat will be retained to the east and south of the Project. This will ensure the viability of known and potentially occurring populations. As such, the Project is unlikely to place the species at risk of extinction.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project Boundary lies within the known range of Pomaderris queenslandica, and the species has been recorded elsewhere in Leard State Forest. Individuals have previously been recorded within the offset areas in Narrow-leaved Ironbark – White Cypress Pine shrubby open forest. The species is considered likely to occur within the Project Boundary due to the availability of suitable habitat and proximity to known populations.

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

No critical habitat for Pomaderris queenslandica has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest do not constitute critical habitat for this species.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to *Pomaderris queenslandica*:

- Clearing of native vegetation as this reduces the area habitat available for this species;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land; and
- Invasion of native plant communities (by various exotic species) that readily invade disturbed sites and communities as they can dominate and suppress native flora species by reducing the availability of shelter and nutrient resources.

Conclusion

The Project is expected to impact on potential habitat for this species through direct and indirect impacts. However, the Project Boundary is not considered to provide significant habitat for this species and the remainder of Leard State Forest will continue to provide an extensive area of suitable habitat. The Project is not likely to have a significant impact on *Pomaderris queenslandica*.

I.3.2 Lepidium aschersonii (Spiny Peppercress)

Lepidium aschersonii (Spiny Peppercress) is listed as Vulnerable under the TSC Act. This species was not recorded within the Project are despite targeted surveys during the flowering period. Potential habitat for this species occurs within the western edge of the Project Boundary and, as it is a small plant, it could potentially occur, though it has not been located during targeted surveys within the Project Boundary. The species is known to occur in Leard State Conservation Area (OEH (NSW), 2011)

Spiny Peppercress is a perennial herb endemic to mainland southern Australia, with limited and patchy distribution in NSW. It occurs on cracking clays in periodically wet areas like Gilgai depressions and lake margins and shows adaptation to the seasonal filling and drying of wetlands (Peake, 2006, NSW Scientific Committee, 2009a, Carter, 2010). The species grows as a component of the ground flora in grey, loamy clays in communities dominated by Brigalow (*Acacia harpophylla*) and *Austrodanthonia* and/or *Austrostipa* species in the understorey. Agricultural practices have removed much of this species' habitat, and remaining populations are small, isolated and at risk of threats including grazing, weed invasion, alteration of hydrology and wetland drainage and other forms of habitat destruction (Carter, 2010). There are an estimated 25,000–100,000 plants remaining in about 30 wild populations. The species flowers from Spring to Autumn.

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

The Project will remove potential habitat for *Lepidium aschersonii*, however this is unlikely to have an adverse effect on the life cycle of any individuals that may occur within the Project Boundary. Little is known of the reproductive biology and ecology of the species, but the number of established plants can fluctuate from year to year in response to the availability of bare soil (Carter, 2010). The species has previously been recorded elsewhere in Leard State Forest, of which large areas of habitat will be retained to the east and south of the Project. This will ensure the viability of known and potentially occurring populations. As such, the Project is unlikely to place the species at risk of extinction.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

The Project Boundary lies within the known range of Lepidium aschersonii in the Brigalow Belt South. In NSW *Lepidium aschersonii* appears to be concentrated within the Narrabri LGA where it has been recorded from at least 14 locations in the last 20 years in discrete

populations. Almost half of these populations exist in degraded habitat along roadsides which places the species at particular risk from roadworks, firebreak construction and utilities installation and maintenance (Carter, 2010). The rest are found in nature reserves and private land. The largest remaining population of the species is believed to occur within Brigalow Park Nature Reserve near Narrabri (DEC (NSW), 2005f1, Carter, 2010). The species is considered likely to occur within the Project Boundary due to the availability of suitable habitat and proximity to known populations in the area.

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. The Project is not likely to fragment adjoining habitat or affect connectivity as the species is not located within the Project Boundary.

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

No critical habitat for *Lepidium aschersonii* has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest do not constitute critical habitat for this species, but they do support preferred habitat for the species.

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

A National Recovery Plan has been prepared for this species under the EPBC Act, the general aims of which include the protection, management and enhancement of habitats for the recovery of this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to *Lepidium aschersonii*:

- Clearing of native vegetation as this reduces the area habitat available for this species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and

- Invasion of native plant communities (by various exotic species) that readily invade disturbed sites and communities as they can dominate and suppress native flora species by reducing the availability of shelter and nutrient resources.

Grazing, altered hydrology, roadworks and grazing and soil disturbance by feral rabbits and pigs are also considered major threats to this species as these actions destroy and degrade suitable habitat.

Conclusion

The Project is expected to impact on potential habitat for this species through direct and indirect impacts. However, the Project Boundary is not considered to provide significant habitat for this species and the remainder of Leard State Forest will continue to provide an extensive area of suitable habitat. The Project is not likely to have a significant impact on *Lepidium aschersonii*.

I.3.3 Finger Panic Grass (Digitaria porrecta)

Finger Panic Grass (*Digitaria porrecta*) is listed as Endangered under the TSC Act. The species was potentially recorded in the wider study area. Habitat within the Project Boundary is considered to provide marginal habitat for the species.

Finger Panic Grass is a perennial grass that occurs over an area of approximately 1000km in four disjunct areas in Queensland and NSW. In NSW, the population is estimated to be 200,000 individuals and occurs within the Border Rivers–Gwydir, Namoi and Central West regions (DSEWPC, 2011b). The species prefers grasslands on extensive basaltic plains, and in undulating woodlands and open forests with an underlying rich, basaltic geology. It usually occurs on dark and fine textured soils with some degree of seasonal cracking (DSEWPC, 2011b). The species is commonly found in disturbed environments including road verges and stock routes surrounded by beef cattle grazing or cultivation and where there are occasional fire events (DEC (NSW), 2005k).

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

The Project will remove potential habitat for *Digitaria porrecta*, however this is unlikely to have an adverse effect on the life cycle of any individuals that may occur within the Project Boundary. The species seeds from March to April but also reproduces vegetatively by dying back to the tussock base, from which it resprouts in summer (DEC (NSW), 2005k; Halford, 1995).

The species has previously been recorded elsewhere in Leard State Forest, of which large areas of habitat will be retained to the east and south of the Project. This will ensure the viability of known and potentially occurring populations. As such, the Project is unlikely to place the species at risk of extinction.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

The Project Boundary lies within the known range of *Digitaria porrecta* in the Border Rivers–Gwydir, Namoi and Central West regions (DSEWPC, 2011b). The species is considered to have potential to occur within the Project Boundary due to the availability of suitable habitat and proximity to known populations in the wider study area. Known populations of this species exist in degraded habitat along roadsides and stock routes which are continuously disturbed by livestock trampling and grazing, and clearing for agriculture (Threatened Species Scientific Committee, 2008d). *Digitaria porrecta* also persists in persist in fallow paddocks, but its capability to maintain a viable population is unknown (Halford, 1995; DSEWPC, 2011b)

Approximately 2079 ha of woodland, forest and grassland in the western portion of Leard State Forest is proposed to be removed as part of the Project. The Project is not likely to fragment adjoining habitat or affect connectivity. .

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

No critical habitat for *Digitaria porrecta* has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest do not constitute critical habitat for this species, but they do support preferred habitat for the species.

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

Recovery plans have not been prepared for this species, although approved conservation advice has been issued under the EPBC Act. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to *Digitaria porrecta*:

- Clearing of native vegetation as this reduces the area habitat available for this species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Invasion of native plant communities (by various exotic species) that readily invade disturbed sites and communities as they can dominate and suppress native flora species by reducing the availability of shelter and nutrient resources.

Clearing and habitat fragmentation; roadworks; fire; trampling and grazing by livestock; physical disturbance by machinery; and urban expansion (DEC (NSW), 2005k) are also considered major threats to this species as these actions destroy and degrade suitable habitat.

The main potential threat to *Digitaria porrecta* is competition from introduced grasses such as Rhodes Grass (*Chloris gayana*) and Liverseed Grass (*Urochloa panicoides*) (Halford, 1995; DSEWPC, 2011b).

Conclusion

The Project is expected to impact on potential habitat for this species through direct and indirect impacts. However, the Project Boundary is not considered to provide significant habitat for this species and the remainder of Leard State Forest will continue to provide an extensive area of suitable habitat. The Project is not likely to have a significant impact on *Digitaria porrecta*.

I.3.4 Bluegrass (Dichanthium setosum)

Dichanthium setosum is listed as Vulnerable under the TSC Act. The species was not recorded in the Project Boundary despite repeated surveys. The species is considered to have potential to occur as suitable habitat exists within the Project Boundary and elsewhere in Leard State Forest.

Bluegrass is an erect, perennial grass with limited distribution in NSW and Queensland. In NSW the species occurs within the Border Rivers−Gwydir, Central West, Northern Rivers and Namoi regions (NSW Scientific Committee, 2004d). The species is most commonly found in habitat with heavy basaltic black soils or hardsetting loam with a clay subsoil (DSEWPC, 2011c). *Dichanthium setosum* grows in grassland and open woodland but is also commonly found in disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. The species flowers in summer.

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

The Project will remove potential habitat for *Dichanthium setosum*, however this is unlikely to have an adverse effect on the life cycle of any individuals that may occur within the Project Boundary. The species has previously been recorded elsewhere in Leard State Forest, of which large areas of habitat will be retained to the east and south of the Project. This will ensure the viability of known and potentially occurring populations. As such, the Project is unlikely to place the species at risk of extinction.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

The Project Boundary lies within the known range of *Dichanthium setosum* in the Border Rivers−Gwydir, Central West, Northern Rivers and Namoi regions (NSW Scientific Committee, 2004d). The species is considered to have potential to occur within the Project Boundary due to the availability of suitable habitat and proximity to known populations in the wider study area. Known populations of this species exist in degraded habitat including cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. This species is vulnerable to habitat fragmentation and loss from agricultural practices such as cropping, frequent fire events, invasive weeds and heavy livestock grazing and trampling. The extent to which this species tolerates disturbance is unknown (NSW Scientific Committee, 2004d).

Approximately 2079 ha of woodland, forest and grassland in the western portion of Leard State Forest is proposed to be removed as part of the Project. The Project is not likely to fragment adjoining habitat or affect connectivity.

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

No critical habitat for *Dichanthium setosum* has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest do not constitute critical habitat for this species, but they do support preferred habitat for the species.

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

Recovery plans have not been prepared for this species, although approved conservation advice has been issued under the EPBC Act. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to *Dichanthium setosum*:

- Clearing of native vegetation as this reduces the area habitat available for this species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Invasion of native plant communities (by various exotic species) that readily invade disturbed sites and communities as they can dominate and suppress native flora species by reducing the availability of shelter and nutrient resources.

Clearing and habitat fragmentation; fire; heavy trampling and grazing by livestock and roadworks are also considered major threats to this species as these actions destroy and degrade suitable habitat.

The main potential threat to *Dichanthium setosum* is competition from introduced grasses such as Coolatai grass (*Hyparrhenia hirta*), Lippia (*Phyla canescens*) and African Lovegrass (*Eragrostis curvula*) (NSW Scientific Committee, 2004d; DSEWPC, 2011c).

Conclusion

The Project is expected to impact on potential habitat for this species through direct and indirect impacts. However, the Project Boundary is not considered to provide significant habitat for this species and the remainder of Leard State Forest will continue to provide an extensive area of suitable habitat. The Project is not likely to have a significant impact on *Dichanthium setosum*.

I.4 FAUNA

I.4.1 Woodland Birds

This group of Assessments of Significance apply to the following species of small woodland birds that are known to occur or have the potential to occur in the Project Boundary or surrounding habitat of Leard State Forest:

- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*);
- Hooded Robin (*Melanodryas cucullata cucullata*);
- Speckled Warbler (*Pyrrholaemus saggitatus*);
- Diamond Firetail (*Stagonopleura guttata*);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Turquoise Parrot (*Neophema pulchella*); and
- White-browed Woodswallow (*Artamus superciliosus*).

i. Brown Treecreeper (eastern subspecies) (Climacteris picumnus victoriae)

The Brown Treecreeper (eastern subspecies) *(Climacteris picumnus victoriae)* is listed as Vulnerable under the TSC Act. There are 104 records of the species within the LGA. The species is considered locally abundant in the locality and has consistently been recorded within Leard State Forest and the Project Boundary since the 1980s.

The Brown Treecreeper is an insectivorous woodland species endemic to eastern NSW. They are a sedentary species most commonly found in open woodlands and dry forest with an open grassy understorey for foraging, and in grasslands with scattered mature trees (Birds Australia, 2011; Garnett & Crowley, 2000). Suitable nesting and foraging habitat typically contains a high abundance of important habitat components such as fallen timber, hollows in stags and live trees (NSW Scientific Committee, 2004l; Garnett & Crowley, 2000). The species is dependent on the availability of small tree hollows for nesting, and as such, prefers patches of remnant vegetation which contain trees of hollow-bearing age of at least 150 years old.

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

The Project will remove known and potential forage and breeding habitat for the Brown Treecreeper, which is likely to have an adverse effect on the life cycle of individuals known to occur within the Project Boundary. The Project will displace known subpopulations of Brown Treecreepers which will impact on population dynamics within the area; however the local population is unlikely to be placed at risk of extinction due to the local abundance of the species. Remaining areas of Leard State Forest adjacent to the Project will continue to provide good quality habitat for Brown Treecreepers.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Brown Treecreeper. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project Boundary lies well within the known range of the Brown Treecreeper. The species has been consistently recorded in the Project Boundary and surrounds, which

indicates that habitat within the Project Boundary constitutes core habitat and forms part of the 11 ha territorial range of some local populations.

The species' sedentary nature and limited capacity for dispersal means they are generally unable to move across open country greater than 100m, making them susceptible to habitat fragmentation and genetic isolation (Cooper et al, 2002, Doerr et al, 2011). The species requires areas of habitat that are at least 300 ha to maintain viable populations. The remaining habitat within Leard State Forest and the wider locality will provide areas of suitable habitat, including important ground habitat features such as nesting debris and foraging substrates. However, limiting resources such as hollows may affect the emigration and nesting success of some individuals.

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

No critical habitat for the Brown Treecreeper has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, it does represent core habitat for local subpopulations, particularly as the species is sedentary and has limited dispersal capabilities.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Brown Treecreeper:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;

- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.

Staged clearing starting on the western edge should allow individuals to relocate into adjacent woodland without assistance by using surrounding habitat connectivity to facilitate dispersal.

Conclusion

The Project is expected to impact on approximately 1665 ha of habitat for this species through direct and indirect impacts. This includes the removal of known forage, roosting and breeding habitat for locally occurring populations of the species. The Brown Treecreeper is a woodland bird likely to occur elsewhere in Leard State Forest; however the Project will clear a large area of known habitat that provides limiting habitat resources for this sedentary species, resulting in the likely displacement and loss of individuals. As such, the Project is considered to have a significant impact on the local occurrence of the Brown Treecreeper.

ii. Hooded Robin (Melanodryas cucullata cucullata)

The Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*) is listed as Vulnerable under the TSC Act. There are 25 records of the species within the LGA. The species has been recorded on multiple occasions within Leard State Forest and the Project Boundary since the 1980s.

The Hooded Robin (south-eastern form) is a woodland species with a sparse distribution in south-eastern Australia. It is a mostly sedentary species that prefers open and lightly timbered acacia or eucalypt woodlands, particularly box-ironbark, that are structurally diverse and often at the edges of clearings and grassland (Birds Australia, 2011). The species forages on the ground, perching on fallen timber and low-lying branches to feed on insects. The species breeds between July and November, building nests in tree forks, hollows or crevices at heights between one – five metres{DECC (NSW) 2005 #4208}(NSW Scientific Committee, 2010d).

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

The Project will remove known and potential forage and breeding habitat for the Hooded Robin, which is likely to have an adverse effect on the life cycle of individuals known to occur

within the Project Boundary. The Project is likely to displace individuals of the species; however, the remaining areas of Leard State Forest adjacent to the Project will continue to provide good quality habitat for Hooded Robins and the Project is unlikely to place a local population of this species at risk of extinction.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes potential forage, breeding and nesting habitat for the Hooded Robin.

The Project Boundary lies within the known range of the Hooded Robin. The species has been recorded in the Project Boundary and surrounds on a number of occasions, which indicates that habitat within the Project Boundary may form part of the territorial range of a local population.

The species is particularly affected by understorey clearing which impacts on their foraging and nesting success. The species' sedentary nature and limited capacity for dispersal

means they are susceptible to habitat fragmentation and genetic isolation; even in large remnant patches Hooded Robins are unable to sustain populations in the long term, which can lead to local extinctions (Birds Australia, 2011). Once forced from a fragment they are is unlikely to recolonise new habitat without assistance (Cooper et al, 2002, Garnett & Crowley, 2000).

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

No critical habitat for the Hooded Robin has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, it does provide suitable nesting and forage habitat.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Hooded Robin:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.

Staged clearing starting on the western edge should allow individuals to relocate into adjacent woodland without assistance by using surrounding habitat connectivity to facilitate dispersal.

Conclusion

The Project is expected to impact on approximately 1665 ha of habitat for this species through direct and indirect impacts. This includes the removal of known forage, roosting and breeding habitat for locally occurring populations of the species. The Hooded Robin is a woodland bird likely to occur elsewhere in Leard State Forest; however the Project will clear a large area of known habitat that provides limiting habitat resources for this sedentary species, resulting in the likely displacement and loss of individuals. As such, the Project is considered to have a significant impact on the local occurrence of the Hooded Robin.

iii. Speckled Warbler (Chthonicola saggitatus)

The Speckled Warbler (*Chthonicola saggitatus)* is listed as Vulnerable under the TSC Act. There are 136 records of the species within the LGA and the species is considered locally abundant within the locality. The species has been consistently recorded throughout the Project Boundary, including 16 records during 2010 surveys.

The Speckled Warbler is a woodland species endemic to south-eastern Australia. The species is most commonly found in eucalypt-dominated dry sclerophyll forest and woodland with a grassy understorey (NSW Scientific Committee, 2010e) particularly on the western slopes and tablelands of the Great Dividing Range and along the drier sections of the coast (Garnett & Crowley, 2002). It is a territorial, sedentary species with a typical home range of approximately 10 ha (NSW Scientific Committee, 2010e). It forages on the ground for seeds and insects around tussocks and under shrubs and trees, and nests on the ground in undergrowth and thick litter.

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

The Project will remove known and potential forage and breeding habitat for the Speckled Warbler, which is likely to have an adverse effect on the life cycle of individuals known to occur within the Project Boundary. The Project will displace known populations of the species which will impact on population dynamics within the area. This may affect the capacity of some individuals to disperse and relocate elsewhere in Leard State Forest and to surrounding habitat in the locality; however it is unlikely to place the local population at risk of extinction due to the local abundance of the species.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Speckled Warbler. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project Boundary lies well within the known range of the Speckled Warbler. The species has been consistently recorded in the Project Boundary and surrounds, which indicates that habitat within the Project Boundary constitutes core habitat for local subpopulations.

The Project is expected to have some adverse affects on the relocation of individuals of the local subpopulation as the species has limited capacity to disperse due to its sedentary nature. Remnant subpopulations species have been known to decline some 30 years after isolation as a result of smaller, fragmented habitat (Garnett & Crowley, 2000). However, the long-term genetic viability of the species in the locality is unlikely to be impacted as remaining areas of forest will still provide extensive habitat greater than 100 ha. This is considered the minimum area of habitat required to support and maintain viable populations of the species (Higgins & Peter, 2002). Also, the remaining forest will provide associated habitat features for the species including structurally intact habitat and complexity, important

ground habitat features such as nesting debris and foraging substrates such as fallen timber and leaf litter (NSW Scientific Committee, 2010e).

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

No critical habitat for the Speckled Warbler has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, it does provide suitable nesting and forage habitat.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Speckled Warbler:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of potential forage and shelter habitat;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.

Staged clearing starting on the western edge should allow individuals to relocate into adjacent woodland without assistance by using surrounding habitat connectivity to facilitate dispersal.

Conclusion

The Project is expected to impact on approximately 1665 ha of habitat for this species through direct and indirect impacts. This includes the removal of known forage, roosting and breeding habitat for locally occurring populations of the species. The Speckled Warbler is a woodland bird likely to occur elsewhere in Leard State Forest; however the Project will clear a large area of known habitat that provides limiting habitat resources for this sedentary species, resulting in the likely displacement and loss of individuals. As such, the Project is considered to have a significant impact on the local occurrence of the Speckled Warbler.

iv. Diamond Firetail - Stagonopleura guttata

The Diamond Firetail (*Stagonopleura guttata*) is listed as Vulnerable under the TSC Act. There are 20 records of the species within the LGA. The species has been recorded on a number of occasions within Leard State Forest and the Project Boundary since the 1980s.

The Diamond Firetail is a woodland species endemic to south-eastern Australia with scattered distribution in NSW (NSW Scientific Committee, 2010f). This species occurs predominantly west of the Great Dividing Range, although populations are known from drier coastal areas such as the Cumberland Plain of western Sydney and the Hunter, Clarence, Richmond and Snowy River valleys. They are a mainly sedentary, ground-foraging species most commonly found in or on the edge of lightly timbered open eucalypt forest and woodlands including box-ironbark and casuarina associations (NSW Scientific Committee, 2010f). They also occur in farmland and grassland with remnant trees and a sparse understorey, and along watercourses (Birds Australia, 2011).

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

The Project will remove known and potential forage and breeding habitat for the Diamond Firetail, which is likely to have an adverse effect on the life cycle of individuals known to occur within the Project Boundary. The Project will displace individuals of the species known to occur within the vicinity of the Project Boundary which will impact on population dynamics within the area. This may affect the capacity of some individuals to disperse and relocate to surrounding habitat within Leard State Forest and elsewhere in the locality; however it is unlikely to place the local population at risk of extinction.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Diamond Firetail. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project Boundary lies well within the known range of the Diamond Firetail. The species has been consistently recorded in the Project Boundary and surrounds, which indicates that habitat within the Project Boundary constitutes core habitat and is within the territorial range of a local population.

The species is vulnerable to fragmentation and genetic isolation due to its sedentary nature and dispersal capacity is restricted to local movements. Populations appear unable to persist in areas which lack remnant native vegetation larger than 200 ha (NSW Scientific Committee, 2010f). The long-term genetic viability of the species in the locality is unlikely to be impacted as remaining areas of forest will still provide suitable habitat, including important ground habitat features such a grassy understorey for foraging, thus supporting and maintaining viable local populations of the species (Higgins & Peter, 2002).

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

No critical habitat for the Diamond Firetail has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, it does provide suitable nesting and forage habitat.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Diamond Firetail:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.

Staged clearing starting on the western edge should allow individuals to relocate into adjacent woodland without assistance by using surrounding habitat connectivity to facilitate dispersal.

Conclusion

The Project is expected to impact on approximately 1665 ha of habitat for this species through direct and indirect impacts. This includes the removal of known forage, roosting and breeding habitat for locally occurring populations of the species. The Diamond Firetail is a woodland bird likely to occur elsewhere in Leard State Forest; however the Project will clear a large area of known habitat that provides limiting habitat resources for this sedentary species, resulting in the likely displacement and loss of individuals. As such, the Project is considered to have a significant impact on the local occurrence of the Diamond Firetail.

v. Grey-crowned Babbler (eastern subspecies) (Pomatostomus temporalis temporalis)

The Grey-crowned Babbler (eastern subspecies) *(Pomatostomus temporalis temporalis)* is listed as Vulnerable under the TSC Act. There are 153 records of the species within the LGA. The species is considered locally abundant in the locality and has consistently been recorded within Leard State Forest and the Project Boundary since the 1980s.

The Grey-crowned Babbler (eastern subspecies) is a woodland insectivorous species endemic to eastern Australia. The species is abundant and widespread in northern Queensland, but is in considerable decline in the southern part of its range in Victoria and NSW. It is a ground-dwelling, sedentary species most commonly found in open forest and woodland dominated by acacias or eucalypt box-ironbark associations where they live in extended family groups (NSW Scientific Committee, 2010g). The species forages for insects on trunks and branches of eucalypts and other woodland trees, and on the ground amongst litter and tussock grasses (Garnett & Crowley, 2000).

The species is only found in habitat containing all of the following elements: woodland or open forest on fertile or heavy soils; abundant trees, with a high proportion of large, mature eucalypts with a trunk measuring >90 cm diameter at breast-height (dbh); an understorey of shrubs with dbh of 10–30 cm, for nesting and sheltering; and an open ground layer with much leaf litter and fallen timber debris, and sparse grass cover (Birds Australia, 2011).

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

The Project will remove known and potential forage and breeding habitat for the Grey-crowned Babbler, which is likely to have an adverse effect on the life cycle of individuals known to occur within the Project Boundary. The Project will displace known subpopulations of the species which will impact on population dynamics within the area. This may affect the capacity of some individuals to disperse and relocate to surrounding habitat within Leard State Forest and the locality, leading to social consequences such as smaller group size and reduced breeding success. However, the Project is unlikely to place the local population at risk of extinction due to the local abundance of the species. Remaining areas of Leard

State Forest adjacent to the Project will continue to provide good quality habitat for Grey-crowned Babblers.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 2079 ha of woodland, forest and grassland in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Grey-crowned Babbler. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project Boundary lies well within the known range of the Grey-crowned Babbler. The species has been consistently recorded in the Project Boundary and surrounds, which indicates that habitat within the Project Boundary constitutes core habitat for local populations.

The Project is expected to have some adverse affects on the relocation of individuals of the local population due to a loss of critical habitat features listed above and as the species has limited capacity to disperse due to its sedentary nature. The species is highly susceptible to

habitat fragmentation; laboured flight and their inability to cross large open areas greater than 900m (Blackmore et al, 2011), combined with a lack of habitat connectivity and decrease in territory size can disrupt dispersal and increase the population's vulnerability to inbreeding depression and thus local extinction (Birds Australia, 2011). Once lost from a fragment, natural recolonisation is unlikely (Garnett & Crowley, 2000). However, the long-term genetic viability of the species in the locality is unlikely to be impacted as remaining areas of forest will still provide extensive habitat greater than 100 ha. This is considered the minimum area of habitat required to support and maintain viable populations of the species (Higgins & Peter 2002). Also, the remaining forest will provide critical habitat features for the species including structurally intact habitat and complexity, and important midstorey and ground habitat features such as nesting debris and foraging substrates (NSW Scientific Committee, 2010f)

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

No critical habitat for the Grey-crowned Babbler has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, it does provide suitable nesting and forage habitat.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Grey-crowned Babbler:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;

- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project is expected to impact on approximately 2079 ha of habitat for this species through direct and indirect impacts. This includes the removal of known forage, roosting and breeding habitat for locally occurring populations of the species. The Grey-crowned Babbler is a woodland bird likely to occur elsewhere in Leard State Forest; however the Project will clear a large area of known habitat that provides limiting habitat resources for this sedentary species, resulting in the likely displacement and loss of individuals. As such, the Project is considered to have a significant impact on the local occurrence of the Grey-crowned Babbler.

vi. Varied Sittella (Daphoenositta chrysoptera)

The Varied Sittella (*Daphoenositta chrysoptera)* is listed as Vulnerable (preliminary) under the TSC Act. There are 41 records of the species within the LGA. The species has consistently been recorded within Leard State Forest and the Project Boundary since the 1980s, including the sighting of an individual in 2010.

The Varied Sittella is an insectivorous woodland species endemic and widespread in across mainland Australia. They are a sedentary species most commonly found in eucalypt woodlands and dry forest, and acacia woodland containing mature trees and dead branches (Birds Australia, 2011). The species feeds on arthropods and insects on stags, dead branches, in decorticating bark and in the canopy. The Varied Sittella often re-uses the same fork or living tree to build its nest in successive years (NSW Scientific Committee, 2010c).

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

The Project will remove known and potential forage and breeding habitat for the Varied Sittella, which is likely to have an adverse effect on the life cycle of individuals known to occur within the Project Boundary. The Project will displace known subpopulations of Varied Sittella which will impact on population dynamics within the area. Also, as the Varied Sittella often re-uses the same fork or living tree to build its nest, the Project may impact on nesting and breeding success of some individuals. Despite this, the local population as a whole is

unlikely to be placed at risk of extinction as remaining areas of Leard State Forest adjacent to the Project will continue to provide good quality habitat for Varied Sittella.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Varied Sittella. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project Boundary lies well within the known range of the Varied Sittella. The species has been consistently recorded in the Project Boundary and surrounds, which indicates that habitat within the Project Boundary constitutes core habitat and forms part of the territorial range of some local populations.

The main reasons for the species' decline include a reduction of habitat patch size and quality; susceptibility to habitat isolation and reduction in vegetation cover(NSW Scientific Committee, 2010c). The species' sedentary nature and limited capacity for dispersal means

they are generally unable to move across open country, which is also attributed to their decline. However, the long-term genetic viability of the species in the locality is unlikely to be impacted as remaining areas of forest will still provide extensive habitat greater than 100 ha. This is considered the minimum area of habitat required to support and maintain viable populations of the species (Higgins & Peter 2002). The remaining habitat within Leard State Forest will provide areas of suitable habitat, including habitat complexity and diversity and important forage substrate such as fallen debris and litter.

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

No critical habitat for the Varied Sittella has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, it does represent core breeding and forage habitat for local subpopulations, particularly as the species is sedentary and has limited dispersal capabilities.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Varied Sittella:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;

- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project is expected to impact on approximately 1665 ha of preferred habitat for this species through direct and indirect impacts. This includes the removal of known forage, roosting and breeding habitat for locally occurring populations of the species. The Varied Sittella is a woodland bird likely to occur elsewhere in Leard State Forest; however the Project will clear a large area of known habitat that provides limiting habitat resources for this sedentary species, resulting in the likely displacement and loss of individuals. As such, the Project is considered to have a significant impact on the local occurrence of the Varied Sittella.

vii. Turquoise Parrot (Neophema pulchella)

The Turquoise Parrot (*Neophema pulchella*) is listed as Vulnerable under the TSC Act. There are 134 records of the species within the LGA and the species is considered locally abundant within the locality. The species has been consistently recorded throughout the Project Boundary, including 11 records during 2008 surveys.

The Turquoise Parrot is a woodland species endemic to south-eastern Australia with patchy distribution in NSW. It occurs on the western side of the tablelands and inland slopes, plains and some dry coastal valleys in eastern NSW (Pizzey & Knight, 2003). The species is most commonly found in open, grassy woodland composed of mixed assemblages of eucalypt species, including box-ironbark, with abundant hollow-bearing trees and stags for nesting (NSW Scientific Committee, 2010h). The Turquoise Parrot occurs solitarily, in pairs, in family groups, or in small flocks. It breeds in solitary pairs, though pairs are possibly clumped in favoured nesting patches. Turquoise Parrots are generally resident in an area, but some local seasonal movement occurs. Foraging is typically ground-based among seeding grasses and weeds, and sometimes near cropland (Birds Australia, 2011).

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

The Project will remove known and potential forage and breeding habitat for the Turquoise Parrot, which is likely to have an adverse effect on the life cycle of individuals known to occur within the Project Boundary. The Project will displace known and potential subpopulations of

the species which will impact on population dynamics within the area. The species is highly territorial and defends nest sites against others of the species. This, combined with a limited home range and the sedentary nature of the species, may affect the capacity of some individuals to disperse and successfully relocate to surrounding habitat within Leard State Forest to breed. However, it is unlikely to place the local population at risk of extinction due to the local abundance of the species elsewhere in the forest.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Turquoise Parrot. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project Boundary lies well within the known range of the Turquoise Parrot. The species has been consistently recorded in the Project Boundary and surrounds, including records of 11 individuals during 2008 surveys, which indicates that habitat within the Project Boundary constitutes core habitat and forms part of the territorial range of a local population.

The Project Boundary has potential to support a large population of Turquoise Parrots as breeding density can be between four to seven breeding pairs per hectare, with nests as little as 8m apart in suitable habitat (NSW Scientific Committee, 2010h). Also, Turquoise Parrots are generally resident species with limited home territories ranging up to 1.4km, though feeding mostly occurs within 100m of the nest. They have infrequent seasonal movements between forested and open areas, typically less than 10km along treed corridors. As such, the Project is expected to have some adverse affects on the relocation of individuals of the local population.

However, the long-term genetic viability of the species is unlikely to be impacted as remaining areas of forest will still provide extensive habitat greater than 100 ha. This is considered the minimum area of habitat required to support and maintain viable populations of the species (Higgins & Peter, 2002). Also, the remaining forest will provide associated habitat features for the species including structurally intact habitat and complexity. This includes important nesting features such as vertical hollows in living trees and stags and stumps, and ground forage habitat in grassy areas (NSW Scientific Committee, 2010h).

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

No critical habitat for the Turquoise Parrot has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, it does provide known nesting and forage habitat.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Turquoise Parrot:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;

- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.
- Predation by the feral cat (Felis catus) as this directly reduces species abundance, particularly as they predate on nests and nesting females.

Conclusion

The Project is expected to impact on approximately 1665 ha of preferred habitat for this species through direct and indirect impacts. This includes the removal of known forage, roosting and breeding habitat for locally occurring populations of the species. The Turquoise Parrot is a woodland bird likely to occur elsewhere in Leard State Forest; however the Project will clear a large area of known habitat that provides limiting habitat resources for this sedentary species, resulting in the likely displacement and loss of individuals. As such, the Project is considered to have a significant impact on the local occurrence of the Turquoise Parrot.

I.4.2 Nectivorous Birds

This group of Assessments of Significance apply to the following species of nectivorous birds that are known to occur or have the potential to occur in the Project Boundary or surrounding habitat of Leard State Forest:

- Painted Honeyeater (*Grantiella picta*);
- Little Lorikeet (*Glossopsitta pusilla*);
- Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*);
- Swift Parrot (*Lathamus discolor*); and
- Regent Honeyeater (*Xanthomyza phrygia*).

i. Painted Honeyeater - Grantiella picta

The Painted Honeyeater (*Grantiella picta*) is listed as Vulnerable under the TSC Act. There are 22 records of the species within the LGA. The species has been recorded once by Cumberland Ecology during surveys of the Project Boundary.

The Painted Honeyeater is a woodland species endemic to eastern Australia. It is rare throughout its range and has sparse distribution in south-east NSW (NSW Scientific Committee, 2010i). The species often occurs singly or in pairs and is most commonly found in dry open woodland and forest, such as box-ironbark, which support parasitic mistletoe species, with which the species is closely associated (Pizzey & Knight, 2003). The species has a general north-south seasonal movement linked to the fruiting of mistletoe species. It also feeds on nectar and insects in tree canopies. Breeding occurs south of Queensland on inland slopes of the Great Dividing Range.

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

The Project will remove potential forage and breeding habitat for individuals of the species that may occur within the Project Boundary and surrounds. However, the remaining areas of Leard State Forest adjacent to the Project will continue to provide good quality habitat for Painted Honeyeaters and the Project is unlikely to place a local population at risk of extinction due to infrequent occurrences in the area, the population's general low density and sparse distribution of the species.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes potential forage, breeding and nesting habitat for the Painted Honeyeater. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project Boundary lies within the known range of the Painted Honeyeater. One individual of the species has been recorded across all previous surveys of the area, which indicates the sparse distribution of the species, and that habitat within the Project Boundary does not constitutes core habitat.

The species is a known seasonal migrant with distribution dictated by the presence of mistletoes. The long-term genetic viability of the species in the locality is unlikely to be impacted as remaining areas of forest will still provide extensive habitat greater than 100 ha. This is considered the minimum area of habitat required to support and maintain viable populations of the species (Higgins & Peter 2002). The species relies on large mature trees that support mistletoe and extensive areas of remnant habitat which will still be available in remaining habitat within Leard State Forest.

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

No critical habitat for the Painted Honeyeater has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, it does provide potential nesting and forage habitat.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Painted Honeyeater:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.

The species has a high capacity for dispersal; however staged clearing starting on the western edge should allow individuals to relocate into adjacent woodland without assistance by using surrounding habitat connectivity to facilitate dispersal.

Conclusion

The Project is expected to impact on approximately 1665 ha of forest and woodland that has been used as habitat for this species through direct and indirect impacts. This includes the removal of potential forage, roosting and breeding habitat for locally occurring populations of the species. The Painted Honeyeater is a partly nomadic nectivorous bird that follows flowering mistletoe and is likely to occur elsewhere in Leard State Forest.

Although only limited records exist for this species in the Project Boundary, on a precautionary basis it is concluded that due to the extent of forest and woodland removal, the project is likely to have a significant impact on the local occurrence of the Painted Honeyeater.

ii. Little Lorikeet (Glossopsitta pusilla)

The Little Lorikeet (*Glossopsitta pusilla*) is listed as Vulnerable under the TSC Act. There are 38 records of the species within the LGA. The species has been recorded on a number of occasions within Leard State Forest and the Project Boundary since the 1980s. Sixteen records exist for the species from the 2010 survey of the Project Boundary.

The Little Lorikeet is a nectivorous species endemic to eastern mainland Australia. In NSW, the species is most commonly found in dry, open sclerophyll forests and woodlands dominated by eucalypts, from the coast to the western slopes of the Great Dividing Range and extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri (Pizzey & Knight, 2003). The species has been found in both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes, where it forages in the canopy. It is generally thought to be nomadic in response to food availability, though in some areas it is considered resident, particularly during breeding season from April to December (NSW Scientific Committee, 2010j).

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

The Project will remove known and potential forage and breeding habitat, which is likely to have an adverse effect on the life cycle of individuals known to occur within the Project Boundary. The Project will displace known populations of Little Lorikeet which will impact on population dynamics within the area; however the local population is unlikely to be placed at risk of extinction due to species' dispersal capabilities. Remaining areas of Leard State Forest adjacent to the Project will continue to provide good quality habitat for Little Lorikeets.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Little Lorikeet. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project Boundary lies well within the known range of the Little Lorikeet. The species has been consistently recorded in the Project Boundary and surrounds, which indicates that habitat within the Project Boundary constitutes core habitat and forms part of the territorial range of a local population.

The Project is expected to have some adverse affects on the relocation of individuals and short term breeding success through a loss of food resources and nesting requirements. The species relies on suitable nest trees and hollows, which are limiting resources, to construct nests at heights of between 2-15m (NSW Scientific Committee, 2010j). However, the long-term genetic viability of the species in the locality is unlikely to be impacted as the species will be able to disperse to remaining areas of forest that will still provide extensive habitat greater than 100 ha. This is considered the minimum area of habitat required to support and maintain viable populations of the species (Higgins & Peter 2002). Also, the remaining forest will provide important habitat features for the species including structurally intact habitat and complexity.

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

No critical habitat for the Little Lorikeet has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, it does represent core forage and breeding habitat for local populations.

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

The "Threat Abatement Plan for Beak and Feather Disease affecting endangered psittacine species" is relevant to the Little Lorikeet. The Proposal is unlikely to increase the likelihood of extinction or escalate the threatened status of psittacine birds and is therefore consistent with the objectives of this plan.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Little Lorikeet:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.
- Infection by Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species and populations as this can lead to a severe reduction in populations.

Conclusion

The Project is expected to impact on approximately 1665 ha of known habitat for this species through direct and indirect impacts. This includes the removal of known forage, roosting and breeding habitat for locally occurring populations of the species. The Little Lorikeet is partly nomadic in response to food availability and is likely to occur elsewhere in Leard State

Forest; however the Project will clear a large area of known habitat for this species, resulting in the likely displacement of individuals.

It is concluded that due to the extent of forest and woodland removal, the project is likely to have a significant impact on the local occurrence of the Little Lorikeet.

iii. Black-chinned Honeyeater (eastern subspecies) (Melithreptus gularis gularis)

The Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*) is listed as Vulnerable under the TSC Act. There are 4 records of the species within the LGA. The species has been recorded once during previous surveys of the Project Boundary.

The eastern subspecies of the Black-chinned Honeyeater is endemic to eastern Australia from inland slopes of the Great Dividing Range to the coast (Pizzey & Knight, 2003). The species is declining in the wheat-belt region of western NSW where large areas would have once contained suitable habitat. The species is most commonly found in the upper levels of dry open eucalypt woodlands and forest containing box-ironbark associations where they build suspended nests and feed on insects, nectar and lerps (NSW Scientific Committee, 2010k).

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

The Project will remove potential forage and breeding habitat for the Black-chinned Honeyeater. However, low LGA records and a single record from surveys of the Project Boundary indicate the species does not frequent the locality and the Project is unlikely to place the species at risk of extinction. Remaining areas of Leard State Forest adjacent to the Project will continue to provide good quality habitat for Black-chinned Honeyeaters.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes potential forage and nesting habitat for the Black-chinned Honeyeater. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project Boundary lies within the known range of the Black-chinned Honeyeater. The species has only been recorded once in the Project Boundary and surrounds, which indicates that habitat within the Project Boundary is not core habitat and does not form part of the territorial range of a local population.

The long-term genetic viability of the Black-chinned Honeyeater in the locality is unlikely to be impacted as the species is an infrequent visitor, is mobile and has the capacity to disperse to remaining areas of forest that will still provide extensive habitat greater than 100 ha. This is considered the minimum area of habitat required to support and maintain viable populations of the species (Higgins & Peter, 2002). Also, the remaining forest will provide important habitat features for the species including structurally intact habitat and complexity.

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

No critical habitat for the Black-chinned Honeyeater has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, suitable forage and nesting habitat does exist.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Black-chinned Honeyeater:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project is expected to remove approximately 1665 ha of forest and woodland that includes habitat for this species. This includes the removal of potential forage, roosting and breeding habitat for locally occurring populations of the species.

Although only limited records exist for this species in the Project Boundary, on a precautionary basis it is concluded that due to the extent of forest and woodland removal, the project is likely to have a significant impact on the local occurrence of the Black-chinned Honeyeater.

iv. Regent Honeyeater (Xanthomyza phrygia) and Swift Parrot (Lathamus discolor)

This test assesses the Regent Honeyeater and Swift Parrot together as the species have similar habitat requirements and are affected by the same potential threats as a result of the Project. These species have not been detected in the Project Boundary but are considered to have potential to forage in the area during winter migrations, as Leard State Forest is within the historic range of both bird species.

The Regent Honeyeater (*Xanthomyza phrygia*) is listed as Endangered under the TSC Act. There are 7 records of the species within the LGA, and the species has been reliably detected in the Bundarra-Barraba area from 1994-1997 (Oliver, 1998, 2000). The species has not been recorded within the Project Boundary, but has potential to occur during migrations.

The Regent Honeyeater is a nectivorous migratory species endemic to south-eastern Australia where it is widespread but sparsely scattered in temperate woodlands and open forests. In NSW the species mainly occurs around the Great Dividing Range, but has been recorded in the Hunter Valley and Pilliga regions (Pizzey & Knight, 2003; Birds Australia, 2011). They prefer box-ironbark associations in wet, fertile sites along creeklines and river valleys. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region (DEC (NSW), 2005a1). Numbers fluctuate greatly between years and sites, and movement outside of breeding season is poorly understood. Only 1500 individuals are thought to make up the single subpopulation of this species. Regent Honeyeaters forage in the canopy tops of mature feed trees, but roost in saplings (Oliver, 1998). This suggests that the species requires a more extensive area of habitat than other similar nectivorous species.

The Swift Parrot (*Lathamus discolor)* is listed as Endangered under the TSC Act. The species is known to occur in the area on occasion, and has previously been recorded in Mt Kaputar National Park (DEC (NSW), 2006b). The species has not been recorded within the Project Boundary, but has potential to occur during migrations.

The parrot only breeds in Tasmania and migrates to south-eastern Australia from March to October (Pizzey & Knight, 2003). In NSW they are found in dry sclerophyll eucalypt forests and woodlands such as box-gum woodlands (DSEWPC, 2011a). The species is semi nomadic in winter and generally found in Victoria and New South Wales with other populations found in south-eastern Queensland. The timing of their migration causes a heavy reliance on winter flowering eucalypts: *Eucalyptus robusta, Corymbia maculata, C. gummifera, E. sideroxylon,* and *E. albens* (Kennedy & Tzaros, 2005; Saunders & Heinsohn, 2008) The species has high site fidelity and returns to sites on a cyclic basis. However, this site fidelity depends on availability of foraging resources.

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

On current data Swift Parrots are unlikely to make significant recurrent use of the site. However, the Regent Honeyeater originally occurred across the locality and is likely to have

made use of the ironbark and other forage trees in the forest historically. There is no current evidence that it regularly visits the site.

The project will remove 1665 ha of forest and woodland that would once have been used by Regent Honeyeaters and which is likely, on occasion, to be used by Swift Parrot. Such clearance is not however likely to make local populations at risk of extinction.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

The forest and woodland areas of the Project Boundary have potential to be “stepping stone” habitat within the wider locality and region, particularly for the Regent Honeyeater which at least historically used the area.

Approximately 1665 ha of forest and woodland in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes potential forage habitat for the Regent Honeyeater and Swift Parrot. The Project is not likely to fragment adjoining habitat or affect connectivity.

The long-term genetic viability of the Swift Parrot is unlikely to be impacted by the Project as the species are infrequent visitors; are highly mobile; and have the capacity to disperse to remaining areas of forest that will still provide extensive habitat.

The clearance of large areas of forest and woodland habitat within the historic range of Regent Honeyeaters, that originally moved between habitats to the east of the Project Boundary (in the Great Dividing Ranges) and the Pilliga, represents a potentially significant area of habitat that could interfere with the recovery of the species when cleared. It could remove a stepping stone of habitat containing important flowering resources that were (or in future could be) locally significant for Regent Honeyeater, particularly in times of drought or poor flowering events because remnant patches are already a limiting resource within the locality.

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

No critical habitat for the Regent Honeyeater and Swift Parrot has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, suitable forage habitat does exist.

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

Recovery plans have been prepared for the Swift Parrot and the Regent Honeyeater.{#3385} The general aims of these plans include the protection and enhancement of key breeding and foraging habitats for these species. The Project Boundary does not occur in any key breeding or foraging areas for these species and is therefore consistent with these plans.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Swift Parrot and Regent Honeyeater:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;

- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.

Conclusion

On current data Swift Parrots are unlikely to make significant recurrent use of the site. However, the Regent Honeyeater originally occurred across the locality and is likely to have made use of the ironbark and other forage trees in the Project Boundary, at least historically. There is no current evidence that it currently visits the habitats within the Project Boundary.

Approximately 1665 ha of forest and woodland is proposed to be removed as part of the Project. This includes potential forage habitat for the Regent Honeyeater and Swift Parrot.

The long-term viability of the Swift Parrot is unlikely to be impacted by the Project as the species is an infrequent visitor to the locality with very few records in the LGA; it is highly mobile; and has the capacity to disperse to remaining areas of forest that will still provide extensive habitat.

The clearance of large areas of forest and woodland habitat within the historic range of Regent Honeyeaters, that originally moved between habitats to the east of the Project Boundary (in the Great Dividing Ranges) and the Pilliga, would remove a potentially significant area of habitat that could interfere with the future recovery of the species.

The Project is not likely to significantly impact Swift Parrot. However, it has potential to have a significant impact upon Regent Honeyeater by removing a large block of habitat within the historic range, potentially hampering recovery of the species in the future.

I.4.3 Diurnal Raptors and Large Owls

These Assessments of Significance apply to the following species of diurnal raptors and large owls that are known to occur or have the potential to occur in the Project Boundary or surrounding habitat of Leard State Forest:

- Spotted Harrier (*Circus assimilis*);
- Little Eagle (*Hieraaetus morphnoides*);
- Square-tailed Kite (*Lophoictinia isura*);
- Barking Owl (*Ninox connivens*); and,
- Masked Owl (*Tyto novaehollandiae*).

All of these species require relatively large home ranges (measured in square kilometres) to obtain adequate prey. The removal of vegetation under the Project is unlikely to result in a significant reduction in forage habitat for these species.

For the purposes of the following assessments of significance, for such widely dispersed raptorial birds with relatively large territories, it is assumed that a viable local population may be as little as a single nesting pair of birds.

i. Spotted Harrier (Circus assimilis);

The Spotted Harrier (*Circus assimilis*) is listed as Vulnerable under the TSC Act. There are 5 records of the species within the LGA but it is likely to be a species that is not commonly reported or recorded. The Spotted Harrier has not been recorded within the Project Boundary, but has been recorded elsewhere in Leard State Forest on two occasions. There is potential for a nesting pair to forage in and around the Project Boundary.

The Spotted Harrier is a partly nomadic raptor with widespread but sparse distribution across mainland Australia (Pizzey & Knight, 2003). The species is most commonly found in grassy open woodland including remnant vegetation, riparian woodland and native grassland. The species nests in live trees in open or remnant woodland, often close to food sources such as crops (NSW Scientific Committee, 2010b). The species is irruptive in response to local availability of key prey species such as terrestrial grassland birds, including quail, pipits and larks.

For widely dispersed raptorial birds with large territories, a viable local population may be as little as a single nesting pair of birds and so on current data there is likely to be a viable local population within the vicinity of the Project Boundary.

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

The Project will remove potential 2079 ha of forest, woodland and grassland that could include foraging and nesting habitat for this species. Assuming that a viable local population could consist of just a single pair of birds, the Project has potential to make a viable local poplation become extinct by clearing and disturbing habitat.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 2079 ha of forest, woodland and grassland in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Spotted Harrier. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project Boundary lies well within the known range of the Spotted Harrier. Current locality records, results from previous surveys, distributional range and habitat requirements indicate the species has potential to utilise habitat within the Project Boundary. Spotted Harriers prefer foraging in open woodland margins, grassland and agricultural land which provide suitable habitat for key prey species such as terrestrial grassland birds, including quail, pipits and larks. As Leard State Forest is surrounded by agricultural land, suitable forage habitat will still exist for the species regardless of the Project. The long-term genetic viability of the species in the locality is unlikely to be impacted as the species is highly mobile and will be able to disperse to remaining areas of forest that will still provide suitable habitat.

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

No critical habitat for the Spotted Harrier has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, it does provide suitable forage and nesting habitat. The highly mobile and irruptive nature of the species means they can readily migrate in response to local conditions and can utilise woodland margins and surrounding agricultural land elsewhere in the locality.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Spotted Harrier:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and

- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project will remove potential 2079 ha of forest, woodland and grassland that could include foraging and nesting habitat for this species. Assuming that a viable local population could consist of just a single pair of birds, the Project has potential to make a viable local poplation become extinct by clearing and disturbing habitat. As such, the Project is considered likely to have a significant impact on the local occurrence of the Spotted Harrier.

ii. Little Eagle (Hieraaetus morphinoides)

The Little Eagle (*Hieraaetus morphinoides*) is listed as Vulnerable under the TSC Act. There are 19 records of the species within the LGA. The species has previously been recorded within the Project Boundary and Leard State Forest.

The Little Eagle is a small, territorial raptor, uncommon but with widespread distribution across mainland Australia (Pizzey & Knight, 2003). The species is considered partly migratory, with adults generally resident and sedentary, while the juvenile birds tend to disperse. The species is most commonly found in open eucalypt forest and woodland with abundant prey availability, Sheoak or acacia woodlands and riparian woodlands (Debus, 1984). The species is tolerant of agricultural landscapes provided woodland habitat is available for nesting (Marchant & Higgins, 1993), where they require a tall living tree within a remnant patch.

For widely dispersed raptorial birds with large territories, a viable local population may be as little as a single nesting pair of birds and so on current data there is likely to be a viable local population within the vicinity of the Project Boundary.

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

The Project will remove potential 2079 ha of forest, woodland and grassland that does include foraging and nesting habitat for this species. Although the Little Eagle is considered likely to have territory sizes considerably larger than 2079 ha, assuming that a viable local population could consist of just a single pair of birds, the Project has potential to make a viable local poplation become extinct by clearing and disturbing important habitat within what is otherwise an agricultural landscape.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

The Project Boundary lies well within the known range of the Little Eagle. The Little Eagle requires tall, mature living trees in open eucalypt woodland in which to build nests. While the Project will remove a portion of this potential habitat, the remainder of Leard State Forest will continue to provide suitable nesting and forage habitat. The Little Eagle may actually benefit from clearing as it may open new feeding grounds.

Approximately 2079 ha of woodland, forest and grassland in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Little Eagle, however its removal is not considered likely to adversely affect the species as it does not represent core habitat. The Project is not likely to fragment adjoining habitat or affect connectivity. The long-term genetic viability of the species in the locality is unlikely to be impacted as the species is highly mobile, has a large home range and naturally sparse distribution, and will be able to disperse to remaining areas of forest that will still provide extensive habitat.

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

No critical habitat for the Little Eagle has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species, however, it does provide suitable forage and nesting habitat.

The highly mobile and irruptive nature of the species means they can readily migrate in response to local conditions and can utilise woodland margins and surrounding agricultural land elsewhere in the locality.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Little Eagle:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project will remove potential 2079 ha of forest, woodland and grassland that could include foraging and nesting habitat for this species. Assuming that a viable local population could consist of just a single pair of birds, the Project has potential to make a viable local

poplation become extinct by clearing and disturbing habitat. The Project could have a significant impact upon the species.

iii. Square-tailed Kite (Lophoictinia isura)

The Square-tailed Kite (*Lophoictinia isura*) is listed as Vulnerable under the TSC Act. There are 14 records of the species within the LGA. One individual of the species has been recorded in the Project Boundary since the 1980s.

The Square-tailed Kite is a raptor endemic to Australia, with widespread but sparse distribution in coastal and sub-coastal areas (Birds Australia, 2011). The species is most commonly found in open forests and woodlands associated with ridge and gully forests, with particular preference for timbered watercourses; it is a regular resident along the major west-flowing river systems of NSW (NSW NPWS, 1999b; Marchant & Higgins, 1993). The Square-tailed Kite has a large home range of over 100 square kilometres. The species is specialist hunter of passerines (particularly honeyeaters) and foliage insects, with most prey taken from the outer foliage of the tree canopy (NSW NPWS, 1999b).

Except when breeding, this species tends to be a solitary bird, usually seen hunting alone high in, or just above the tree canopy in coastal or sub-coastal rainforest, forest or woodland. Breeding occurs from July to February and nest sites are usually located near watercourses in a fork or large horizontal branches of eucalypts (Birds Australia, 2011; Debus & Czechura, 1989).

For widely dispersed raptorial birds with large territories of up to 100 square kilometres, a viable local population may be as little as a single nesting pair of birds and so on current data there is potential for a viable local population to include part of the Project Boundary within its territorry.

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

The Project will remove potential habitat for this species however it is unlikely to have an adverse effect on the life cycle of the Square-tailed Kite. As a higher order predator, the species naturally occurs in low numbers and have large home ranges. The species has sparse but widespread distribution across most of Australia, and current locality records and results from previous surveys indicate the species infrequently forages in the area. The species is highly mobile and has the capacity to disperse and relocate to surrounding habitat within Leard State Forest and elsewhere in the locality.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

The Project Boundary lies well within the known range of the Square-tailed Kite. While the Project will remove a portion of this potential habitat, the remainder of Leard State Forest will continue to provide suitable nesting and forage habitat. The Square-tailed Kite may actually benefit from clearing as it may open new feeding grounds for prey such as terrestrial mammals reptiles and fledgling birds.

Approximately 2079 ha of woodland, forest and grassland in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes potential forage and nesting habitat for the Square-tailed Kite. The Project is not considered likely to adversely affect the species as it does not represent core habitat and the species is an infrequent visitor. The Project is not likely to fragment adjoining habitat or affect connectivity. The long-term genetic viability of the species in the locality is unlikely to be impacted as the species is highly mobile, has a large home range and naturally sparse distribution, and will be able to disperse to remaining areas of forest that will still provide suitable habitat.

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

No critical habitat for the Square-tailed Kite has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species, however, it may provide suitable forage and nesting habitat. The highly mobile and irruptive nature of the species means they can readily migrate in response to local conditions and can utilise woodland margins and surrounding agricultural land elsewhere in the locality.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Square-tailed Kite:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (Apis mellifera) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project is expected to impact on approximately 2079 ha of preferred habitat for this species through direct and indirect impacts. This includes the removal of potential roosting,

breeding and forage habitat, including the removal of suitable habitat for prey species. However, this species is highly mobile, has an extremely large home range and is an infrequent visitor to the locality. As such, the Project is not considered likely to have a significant impact on the local occurrence of the Square-tailed Kite.

iv. Barking Owl (Ninox connivens) and Masked Owl (Tyto novaehollandiae)

This test assesses the Barking Owl and Masked Owl together. Both species are affected by the same threats and are likely to share the same potential impacts as a result of the Project. They have similar habitat requirements including large hollow-bearing trees as nesting habitat and dense vegetation as roosting habitat.

The Barking Owl (*Ninox connivens*) is listed as Vulnerable under the TSC Act. There are 154 records of the species within the LGA and the species has been recorded on multiple occasions within Leard State Forest and the Project Boundary since the 1980s.

The Barking Owl is a sedentary, medium-sized owl widespread on the mainland. The species is most commonly found in dry open sclerophyll woodland and open forest dominated by eucalypts such red gums (Birds Australia, 2011). It also inhabits fragmented remnant patches, partly cleared farmland and casuarinas along watercourses which contain large roost trees (NSW NPWS, 2003b). The species roosts in shaded portions of dense tree canopies, including tall mid-storey trees with dense foliage such as acacia and casuarina species. It nests in hollows of large, old Eucalypt trees and requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 ha, with 2000 ha being more typical in NSW habitats (NSW Scientific Committee, 2004m).

The Masked Owl (*Tyto novaehollandiae*) is listed as Vulnerable under the TSC Act. There are 9 records of the species within the LGA but the species has been recorded on two occasions within the Project Boundary by the present study.

The Masked Owl is restricted to the coast of NSW and Victoria (Pizzey & Knight, 2003). The species is found within a diverse range of habitats that provide large hollow-bearing trees for roosting and nesting, typically in riparian vegetation, and adjacent open areas for foraging. The Masked Owl is also tolerant of disturbed areas and has a close association with drier, unlogged, or selectively logged forests (Kavanagh, 2002). It is most commonly found within dry eucalypt forests and woodland from sea level to 1100m. Pairs of Masked Owls have a large home range of 500-1000 ha (NSW Scientific Committee, 2010l). The species is threatened by clearing which reduces habitat availability, particularly by limiting nesting resources, and because regrowth after logging makes the habitat less suitable for foraging on key prey such as terrestrial mammals.

For owls with large territories, a viable local population may be as little as a single nesting pair of birds and so on current data there is likely to be a viable local population of both species in and around the Project Boundary.

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

The Project will remove 1665 ha of forest and woodland that is likely to constitute foraging and breeding habitat for at least a pair of each of thes species. Given that a viable local population may consist of as little as a pair of these birds, it is possible that the Project could remove habitat (eg tree hollows for roosting) that could make the local population at risk of extinction.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of thse species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

The Project Boundary lies well within the known range of the Barking Owl and Masked Owl. The Project is not likely to fragment adjoining habitat or affect connectivity.

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes known and potential habitat for both the Barking Owl and Masked Owl as vegetation within the Project Boundary is likely

to support both potential breeding sites (tall remnant trees) and foraging resources (abundant mammal and bird prey) for these species. The loss of hollow-bearing trees may lead to short term impacts on locally occurring individuals, however the long-term genetic viability of these species in the locality is unlikely to be impacted as the species are highly mobile and have large home ranges. The species also have a naturally sparse distribution, and will be able to disperse to remaining areas of forest that will still provide suitable habitat.

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

No critical habitat for either the Barking Owl or Masked Owl has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for these species, however, it is likely to provide suitable forage and nesting habitat. The highly mobile nature of the species and large home ranges mean they can readily migrate in response to local conditions and can utilise woodland margins and surrounding agricultural land elsewhere in the locality.

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

The Project is consistent with the objectives and actions of the "Large Forest Owl Recovery Plan" (covering the Masked Owl) and the 2003 Draft "Recovery Plan for the Barking Owl". No Threat Abatement Plans apply to these species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Barking Owl and Masked Owl:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;

- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project will remove 1665 ha of forest and woodland that is likely to constitute foraging and breeding habitat for at least a pair of this species. Given that a viable local population may consist of as little as a pair of these birds, it is possible that the Project could remove habitat (eg tree hollows for roosting) that could make the local population at risk of extinction.

There is a possibility of significant impacts upon both Masked and Barking Owls as a result of this Project.

I.5 MAMMALS

I.5.1 Microchiropteran Bats

These Assessments of Significance apply to the following species of microchiropteran bats that are known to occur or have the potential to occur in the Project Boundary or surrounding habitat of Leard State Forest. They are separated by habitat requirements into hollow-roosting species and cave-roosting species:

- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*);
- Little Pied Bat (*Chalinolobus pictatus*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*);
- Greater Long-eared Bat (*Nyctophilus timoriensis*);
- Large-eared Pied Bat (*Chalinolobus dwyeri*); and
- Eastern Cave Bat (*Vespadelus troughtoni*)

I.5.2 Hollow-roosting Microbat Species

i. Yellow-bellied Sheathtail-bat (Saccolaimus flaviventris);

The Yellow-bellied Sheathtail-bat is listed as Vulnerable under the TSC Act. There are 50 records of the species within the LGA and the species has been recorded on multiple occasions within Leard State Forest and the Project Boundary since the 1980s.

The Yellow-bellied Sheath-tail Bat is a tree-hollow roosting species with wide-ranging distribution through tropical Australia, although is considered rare in south-eastern Australia. It is an insectivorous species that primarily forages above the tree canopy in almost all habitats (DEC (NSW), 2005I1). Most records in NSW have been obtained between January and May, leading to speculation that the species may be migratory in the southern portion of its range, although very little is currently known about seasonal movements. This species roosts in large tree-hollows in groups of between two and thirty (Churchill, 2008).

ii. Greater Long-eared Bat (Nyctophilus timoriensis)

The Greater Long-eared Bat (*Nyctophilus timoriensis*) is listed as Vulnerable under the TSC Act. There are 58 records of the species within the LGA. The species has been recorded on multiple occasions within Leard State Forest and the Project Boundary since the 1980s.

The Greater Long-eared Bat is an insectivorous, hollow-dependent species with rare distribution around south-eastern Australia (Churchill, 2008; NSW Scientific Committee,

2010m). The species is most commonly found in inland woodland vegetation types including box-ironbark dominated communities and mallee. Little is known about the species, but it is expected to roost solitarily in tree crevices and shedding bark, and forage in flight, on the ground or around parches of trees (Lunney et al, 2000).

iii. Eastern Falsistrelle (Falsistrellus tasmaniensis)

The Eastern Falsistrelle (*Falsistrellus tasmaniensis)* is listed as Vulnerable under the TSC Act. There are 58 records of the species within the LGA. The species was previously recorded within Leard State Forest.

The Eastern Falsistrelle is an insectivorous, hollow-roosting species endemic to south-eastern Australia. The species is most commonly found in open forest, wet sclerophyll and coastal forest and mallee, with trees greater than 20m in height and a dense understorey (Churchill, 2008). The species has a home range of up to 136 ha and generally roosts in colonies of three to 80 in the hollow trunks of old eucalypt trees; different roosts are used each night, typically 750m-3.5km apart (Van Dyck & Strahan, 2008). They are absent from small patches of remnant forest, preferring continuous forest where they can forage along tracks, creeks and river.

iv. Little Pied Bat (Chalinolobus picatus)

The Little Pied Bat is listed as Vulnerable under the TSC Act. There are 6 records of the species within the LGA. The species has previously been recorded within Leard State Forest.

The Little Pied Bat is an insectivorous, hollow and cave-roosting species generally found in the semi-arid interior regions of eastern Australia to west of the Great Dividing Range (Van Dyck & Strahan, 2008). The species is most commonly found in mallee and mixed species woodland, riverine open forest and dry open woodland. Colonies typically roost in large mature trees with dead limbs, hollowed stumps, caves and artificial construction such as mines and buildings (Churchill, 2008). The species often roost alone and move roost location regularly, although that is generally within a 200m area.

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

The Project will remove potential forage and roosting habitat for populations of the Yellow-bellied Sheathtail-bat, Greater Long-eared Bat, Eastern Falsistrelle or Little Pied Bat that may occur within the Project Boundary and surrounds. However, the remaining areas of Leard State Forest adjacent to the Project will continue to provide an extensive area of good quality habitat for these species. It is therefore unlikely that the Proposal will affect the life cycle of these species such that a viable local population is placed at risk of extinction.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the*

endangered population such that a viable local population of the species is likely to be placed at risk of extinction

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes potential forage and roosting habitat for the Yellow-bellied Sheathtail-bat, Greater Long-eared Bat, Eastern Falsistrelle and Little Pied Bat which have previously, but infrequently, been recorded within the forest. Low records for these species within Leard State Forest indicate that the forest does not represent core habitat for the hollow-roosting species. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project is not considered likely to adversely affect the foraging behaviour of these species as they typically fly great distances to feed and extensive forage habitat will still be available in the remaining forest. There is potential for the Project to affect the roosting success of these species; despite being highly mobile species that regularly move roost locations, the Project may impact the relocation of individuals through a loss of available roosting resources within their normal ranges (e.g. 200m for the Little Pied Bat, and up to 3.5km for the Eastern Falsistrelle). However, similar habitat, including mature trees will remain available to these species in the remainder of Leard State Forest.

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

No critical habitat for the Yellow-bellied Sheathtail-bat, Greater Long-eared Bat, Eastern Falsistrelle and Little Pied Bat has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for these species, however, it may provide suitable forage and roosting habitat. The highly mobile and irruptive nature of the species means they can readily migrate in response to local conditions and can habitat elsewhere in the locality.

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

Recovery plans have not been prepared for these species. No other threat abatement plans are relevant to these species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Yellow-bellied Sheathtail-bat, Greater Long-eared Bat, Eastern Falsistrelle and Little Pied Bat:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and

- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project is expected to impact on approximately 1665 ha of preferred habitat for these species through direct and indirect impacts. This includes the removal of potential forage, roosting and breeding habitat. These microbat species are mobile but as they have consistently been recorded within the locality and Project Boundary, it is likely that habitat such as hollows for roosting, falls within their variable home ranges and is important for local populations. As such, the Project is considered likely to have a significant impact on the local occurrence of the Yellow-bellied Sheathtail-bat, Greater Long-eared Bat, Eastern Falsistrelle and Little Pied Bat.

I.5.3 Cave-roosting Microbat Species

i. Eastern Cave Bat (Vespadelus troughtoni)

The Eastern Cave Bat (*Vespadelus troughtoni*) is listed as Vulnerable under the TSC Act. There are 2 records of the species within the LGA. The species has previously been recorded within Leard State Forest.

The Eastern Caved Bat is a cave-roosting species typically found in dry open forest and woodland (Churchill, 2008; Van Dyck & Strahan, 2008). It generally roosts near cave entrances in moderately well-lit areas or in crevices of cliffs and overhangs. It has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals (NSW Scientific Committee, 2004n).

ii. Eastern Bentwing Bat (Miniopterus orianae oceanensis)

The Eastern Bentwing Bat (*Miniopterus orianae oceanensis*) is listed as Vulnerable under the TSC Act. There are 7 records of the species within the LGA. The species has previously been recorded within Leard State Forest.

The Eastern Bentwing Bat is an insectivorous species that almost exclusively roost in caves and artificial constructions such as mines along the east coast of Australia (Churchill, 2008). The species occurs in large colonies of up to 150,000 individuals and forages above the canopy over forested areas for insects. In south-eastern Australia it hibernates in underground sites in winter (usually large caves with a constant microclimate). It requires very specific conditions in terms of temperature and humidity for maternity sites (Van Dyck & Strahan, 2008) The species changes roosts in response to seasonal needs, and long-distance movements occur occasionally (DECC (NSW), 2005).

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

The Project will remove potential forage habitat for the Eastern Bentwing Bat and Eastern Cave Bat. However, the remaining areas of Leard State Forest adjacent to the Project will continue to provide a large area of good quality habitat for these species. It is therefore unlikely that the Proposal will affect the life cycle of these species such that a viable local population is placed at risk of extinction.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

The Eastern Cave Bat and Eastern Bentwing Bat are predominantly cave-roosting species, although bentwing-bat species have also been known to roost in mine shafts, culverts, roof cavities and other artificial structures. It is unlikely that Leard State Forest and the Project Boundary would provide suitable roosting habitat for these species. Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes potential forage habitat for the species, although it is likely that they only frequent the area while foraging at night, and would return to roost sites outside of the Project Boundary each morning. The Project is also not likely to fragment adjoining habitat or affect connectivity for these species. Thus, the Project is not

considered likely to adversely affect the foraging behaviour of these species as they typically fly great distances to feed and forage habitat will still be available in the remaining forest.

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

No critical habitat for the Eastern Bentwing Bat and Eastern Cave Bat has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species, however, it may provide suitable forage habitat. The highly mobile nature of the species and large foraging ranges means they can readily migrate in response to local conditions and can forage elsewhere in the locality.

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

Recovery plans have not been prepared for these species. No other threat abatement plans are relevant to these species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Eastern Bentwing Bat and Eastern Cave Bat:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species.

Conclusion

The Project is expected to impact on approximately 1665 ha of preferred habitat for these species through direct and indirect impacts. This includes the removal of potential forage habitat. These microbat species are cave-roosting species that tend to have large forage ranges. While the species may utilise the Project Boundary on occasion, they are not reliant on it, and the remainder of Leard State Forest will be available to provide forage habitat. As such, the Project is not considered likely to have a significant impact on the local occurrence of the Eastern Bentwing Bat and Eastern Cave Bat.

I.5.4 Koala (Phascolarctos cinereus)

The Koala (*Phascolarctos cinereus)* is listed as Vulnerable under the TSC Act. There are 396 records of the species within the LGA. The species has been recorded on two occasions within Leard State Forest and the Project Boundary since the 1980s.

Koalas are large arboreal mammals with wide but fragmented distribution in eastern Australia ranging from the temperate south to the tropical north. The species is most commonly found in eucalypt forests, on the foliage of which the species feeds almost exclusively (Strahan, 1995; Department of Planning, 1995). They are a solitary, sedentary and largely nocturnal species that spend most of the day sleeping in a low fork and climbing into the canopy to feed at dusk (DECC (NSW), 2008b). They often change trees at night and, as favoured trees may be several hundred metres way, they spend a considerable amount of time on the ground. Koala home ranges can vary in size depending on the abundance of local feed trees; in quality habitat, individual home ranges may be as small as 1-2 ha and overlap, while in semi-arid country they are generally discrete and around 100 ha (Van Dyck & Strahan, 2008). The species is vulnerable to a lack of suitable food and fragmentation which can make them more susceptible to disease and predation (DECC (NSW), 2008b).

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

The Project will remove known and potential forage and breeding habitat for the Koala. However this is unlikely to have an adverse effect on the life cycle of individuals that potentially occur within the Project Boundary. The Project may displace individuals of the species whose home ranges fall within the Project Boundary. Based on the sedentary nature of the species, this may affect the capacity of some individuals to disperse and relocate to surrounding habitat. Even though Koalas are solitary, this may lead to social consequences such as smaller group size and reduced breeding success within the locality. However, the Project is unlikely to place the local population at risk of extinction due to the local abundance of the species. Remaining areas of Leard State Forest adjacent to the Project will continue to provide similar quality habitat for Koalas.

(b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

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

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

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

Not applicable to threatened species.

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

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

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

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

Approximately 1665 ha of woodland and forest in the western portion of Leard State Forest is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Koala. The Project is not likely to fragment adjoining habitat or affect connectivity.

The Project Boundary lies within the known range of the Koala. The species has been recorded twice in the Project Boundary and surrounds, which indicates that habitat within the Project Boundary falls within the home range of some individuals.

The Project is expected to have some adverse affects on the relocation of individuals of the local population as the species has limited capacity to disperse due to its sedentary nature, and because it is dependent on the availability of suitable feed trees. The species is highly susceptible to habitat fragmentation; a lack of habitat connectivity and decrease in territory size can disrupt dispersal and increase the population's vulnerability to inbreeding depression, predation and disease. However, the long-term genetic viability of the species in the locality is unlikely to be impacted as remaining areas of Leard State Forest will still provide suitable habitat.

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

No critical habitat for the Koala has been identified by the Director-General of OEH under the TSC Act.

The Project Boundary and surrounding habitat within Leard State Forest does not constitute critical habitat for this species. However, it does provide suitable forage habitat due to the availability of secondary eucalypt feed trees.

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

A Recovery Plans has been prepared for the Koala. The general aims of this plan are to identify actions to be taken to ensure the long-term viability of the koala in nature and the parties who are responsible for undertaking these actions.

The Project Boundary does not occur in any key breeding or foraging areas that will disrupt this species and is therefore consistent with these plans.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Koala:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources.

The Koala is also likely to be susceptible to disease in areas of fragmented vegetation.

Conclusion

The Project is expected to impact on approximately 1665 ha of potential (secondary) habitat for this species through direct and indirect impacts. This includes the removal of potential forage and breeding habitat. The Koala is a sedentary species reliant on particular eucalypt species and habitat connectivity within large remnant patches of vegetation to forage. Trees within the Project Boundary are secondary feed tree species that may provide suitable forage habitat for local populations, however due to few local records it is unlikely that individuals are dependent on habitat within the Project Boundary. As such, the Project is not considered likely to have a significant impact on the local occurrence of the Koala.

Appendix J

J.

Biodiversity Offset Strategy - Further Details on SEWPAC Matters

The table below provides additional details on the proposed offset properties. The information in the table relates to the condition and area of Box Gum Woodland and Derived Grasslands on the proposed offset properties, as well as the area of suitable habitat for the Regent Honeyeater, Swift Parrot and Greater Long-eared Bat. Please note that the information in this table is based on preliminary information only and will be subject to revision following further detailed survey of the offset properties. Detailed baseline surveys of the offset properties are imminent.

Table J.1 EPBC MNES Information for Proposed Offset Properties

OFFSET PROPERTY						Box Gum Woodland and Derived Grasslands provided (ha)			HABITAT for EPBC Matters of National Environmental significance (Regent Honeyeater, Swift Parrot and Greater Long-eared Bat)	
Property (describe each discrete property separately)	*Size property (ha)*	*Location property (map coordinates)*		*Current tenure (+security of acquisition)*	*[1]Proposed long-term protection mechanism (covenant, CA, National Parks etc)*	*Condition 'A' (not included in EPBC listing)*	*Condition 'B' (patches of >0.1 ha with more than 12 species)*	*Condition 'C' (patches of >2 ha with at least 20 mature trees per ha*	*High condition remnant forest and woodland habitat (ha)*	*Low condition derived native grassland habitat to be re-vegetated to moderate condition habitat in the medium to long term (ha)*
		Latitude	Longitude							
Property A	723.14	30°31'7.3 S	150°5'47.4 E	Private ownership	CA or other	0	0	2.6	31.07	0
Property B	291.69	30°31'58.8 S	150°6'38.7 E	Agreement in place	CA or other	0	0	60.51	65.93	51.56
Property C	329.76	30°32'2.6 S	150°7'26.2 E	Agreement in place	CA or other	0	0	25.81	34.46	160.21
Property D	281.7	30°30'57.6 S	150°7'38.1 E	Private ownership	CA or other	0	0	35.98	38.66	103.28

Property E	666.42	30°30'47.9 S	150°9'56.4 E	Private ownership	CA or other	0	0	15.82	30.34	0
Property F	579.16	30°31'25.0 S	150°11'15.1 E	Private ownership	CA or other	0	0	55.79	79.26	0
Property G	604.12	30°32'17.7 S	150°10'19.1 E	Private ownership	CA or other	0	0	29.34	160.17	0.52
Property H	499.02	30°36'26.1 S	150°3'36.3 E	Private ownership	CA or other	0	0	16.49	342.6	156.42
Teston	1272.5	30°34'5.7 S	150°7'0.1 E	Aston Coal Owned	CA or other	0	55.18	63.51	229.76	55.18
Velyama	909.52	30°36'9.5 S	150°5'5.9 E	Aston Coal Owned	CA or other	0	10.87	40.28	111.74	313.44
Longueville	458.89	30°34'53.3 S	150°4'59.8 E	Agreement in place	CA or other	0	0	151.45	189.81	2
Olivedeen	193.37	30°35'24.4 S	150°3'9.4 E	Aston Coal Owned	CA or other	0	0	0	13.24	0
Warriahdool	1003.91	30°31'22.5 S	150°8'40.7 E	Agreement in place	CA or other	0	0	65.47	90.2	31.36
Mt Lindesay	2259.1	30°19'42.1 S	150°16'57.1 E	Aston Coal Owned	NP, CA or other	0	880.7	1241.66	1241.66	880.7
Wirradale	4029.03	30°22'54.6 S	150°15'47.8 E	Under option	NP, CA or other	0	1022.86	1022.88	2132.7	1152.28
Shared Property	884.47	30°38'44.7 S	150°1'12.7 E	Boggabri / Aston Coal Owned	CA or other	0	0	0	355.34	0
TOTAL	**14985.8**					**0**	**1969.61**	**2827.59**	**5146.94**	**2906.95**

[1]Aston Resources are committed to securing the offset properties for conservation in perpetuity. As discussed in section 6.4 of the ecology report, the final outcome will depend on negotiation and agreement with relevant agencies.

HANSEN BAILEY

DESKTOP ASSESSMENT OF THE POTENTIAL IMPACTS ON STYGOFAUNA FROM MAULES CREEK COAL PROJECT

June 2011

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1 Introduction

1.1 Background

Hansen Bailey has engaged the ALS Water Sciences Group to review existing information and assess the likelihood that the Maules Creek Coal Project (MCCP) will impact stygofauna.

1.2 Location

The Maules Creek Coal Project (CL375) is situated approximately 18 km north-east of Boggabri in northern New South Wales. The Willow Tree Range runs roughly in a north-easterly direction between the MCCP and the already existing Boggabri Coal Mine. Most of the combined area of the two leases is included in the Leard State Forest. There are three coal mines already operating in the area: Boggabri Coal Mine abuts the Goonbri Coal Lease to the east, and Tarrawonga Coal Mine to the south.

1.3 Project objectives

This report uses existing information to assess the potential impacts on stygofauna in the vicinity of the MCCP. The report will include the following components:

- A brief overview of stygofauna ecology;
- An assessment of the likelihood that significant stygofauna communities occur in the region impacted MCCP;
- An assessment of the potential impacts on stygofauna communities posed by the MCCP;
- Suggested measures for mitigating any impacts on stygofauna, including any proposed monitoring or survey program if needed.

1.4 Stygofauna ecological requirements

Stygofauna are groundwater invertebrates consisting mostly of crustaceans less than 2 cm long. Stygofauna are intricately linked to the aquifer environment and are adapted to the relative stability of their surroundings. Compared to surface environments, groundwater fluctuates less in level and in physico-chemical variables such as electrical conductivity, temperature, and pH (Hancock et al. 2005). Groundwater is also generally lower in dissolved oxygen and has less readily available organic matter than surface water environments (Humphreys 2002). As there is no direct photosynthesis in aquifers, stygofauna, rely on connections to the land surface to provide them with food. These connections may be hydrological, with infiltrating water bringing dissolved or particulate organic matter to form the basis of subterranean food webs, or it may be more direct, with tree roots that extend below the water table providing leachates or organic carbon or fine rootlets for food (Hancock et al 2005). Generally, stygofauna biodiversity is highest near the water table and declines with depth

(Datry et al 2005). Stygofauna biodiversity is also higher in areas of recharge where the water table is close (< 10 m) to the land surface (Humphreys 2000, Hancock and Boulton 2008). This is because the water table is likely to have the highest concentration of oxygen and organic matter. Stygofauna still occur at considerable depth below the water table, but are fewer in number, have lower diversity, and may be different species (Datry et al 2005). In some karstic aquifers, where there is relatively high vertical exchange, or flow does not come into contact with large microbial surface areas (such as occurs in sedimentary aquifers), stygofaunal communities can occur at depths exceeding 100 m (Humphreys 2000).

In Australia, stygofauna are known from alluvial, limestone, fractured rock, and calcrete aquifers (Hancock et al 2005; Humphreys 2008). As yet, no species are known from coal aquifers apart from a copepod from central Queensland that occurred in a shallow seam adjacent to an alluvial aquifer (ALS *unpublished*). As stygofauna require a space to live, the porosity of the sediments, degree of fracturing, or extent of cavity development must be sufficient, as must the connectivity between the living spaces.

There are three critical factors that threaten stygofauna communities in aquifers impacted by human activity. Many species need stable conditions, and groundwater communities require links to the surface environment to provide organic matter and oxygen. It is likely that stygofauna are able to tolerate natural fluctuations in water level, electrical conductivity, and temperature, and this has been demonstrated experimentally (Tomlinson *unpublished*, Hancock *unpublished*) for stygofaunal amphipods, copepods, and syncarids. However, drawdown that is too rapid, or created too much separation between the land surface and the water table, could lead to loss of biodiversity. Likewise, an increase in EC could also reduce biodiversity.

The third critical factor that makes stygofauna vulnerable to human activity is their high degree of endemism (Humphreys 2008). This comes about because, unlike many surface-dwelling aquatic invertebrates, stygofauna do not have aerially dispersing life stages. To migrate between areas, stygofauna must be able to swim or crawl, and any barriers to this, such as an area of lower porosity, sections of poor water quality, or other disruptions, prevent natural species migration. This also means that stygofauna are also poorly equipped to re-colonise an area once it has been disturbed.

Many species of stygofauna are restricted to small geographical areas. This is particularly the case in non-alluvial aquifers such as some of the calcrete aquifers in Western Australia, where one or more species are known only from a single aquifer, or part of an aquifer (Humphreys 2002). This means that any process that threatens the aquifer, potentially threatens an entire species. There is also a high degree of endemism in alluvial aquifers, even between adjacent systems (Hancock and Boulton 2008). However, providing there is sufficient hydrological connectivity within the aquifer, and physico-chemical conditions are suitable, the distribution of species will not be restricted to small parts of an aquifer.

1.5 Processes that threaten stygofauna

Stygofauna are potentially threatened by activities that change the quality or quantity of groundwater, disrupt connectivity between the surface and aquifer, or

remove living space. Examples of some of the processes that threaten stygofauna include (from Humphreys 2000; 2002; Hancock et al 2005):

- Over-extraction of groundwater for irrigation, mining, and town water supplies;
- Increasing the electrical conductivity or salinity of groundwater;
- Excavation of aquifer material;
- Significant changes to recharge patterns by either increasing or decreasing the rate of groundwater recharge;
- Contamination of groundwater by agricultural, industrial, or petrochemicals; and
- Trans-aquifer water transfers or leakage.

2 Geology and hydrogeology of study area

2.1 Geology

The Boggabri Volcanics form the bedrock strata for the site and outcrops along the western part of the MCCP. The volcanic layer is overlain by the Maules Creek Formation, which consist of a regularly layered Permean sedimentary sequence dipping to the east and gradually thickening to 800 m at the Mooki thrust fault. The Maules Creek Formation outcrops across both the BCM and MCCP sites. Quaternary alluvium from Maules Creek, Namoi River, and Bollol Creek, border the outcropping Maules Creek Formation and Boggabri Volcanic strata to the north, west, and south respectively.

2.2 Hydrogeology

2.2.1 Alluvial aquifers

To the north of the MCCP boundary, an alluvial plain extends east-west along Maules Creek. Here, the Quaternary alluvial deposit reaches a maximum width of approximately 10 km (Figure 1). Alluvium associated with the central channel of Maules Creek has a transmissivity of between 1100 m^2/day and 2000 m^2/d, while more distant bores from the channel have a transmissivity of between 5 m^2/day and 20 m^2/day. The floodplain is constricted by outcrops of the Maules Creek formation to the north of the MCCP boundary. Upstream of the constriction, the area of the floodplain is approximately 90 km^2. West of the constriction, the alluvial deposits widen considerably before joining the Namoi alluvial aquifer.

The Namoi alluvial aquifer runs along the western margin of the outcropping Boggabri Volcanics. To the south of the BCM Lease, the alluvial aquifer of Bollol Creek runs east-west along the southern margin of the outcropping Maules Creek Formation.

The Namoi alluvial sediments are up to 125 m thick, but most areas are between 25 and 75 m thick (AGE 2011). Water levels in the Maules Creek alluvial aquifer are between 2.5 to 35 m below ground level. Recharge of the alluvial aquifers is predominantly from rainfall, runoff, and from good interconnections with the Namoi River. There is also some recharge from aquifers of the Maules Creek Formation and Boggabri Volcanics. There is a seasonal variation in water level of between 1 and 2 metres.

MCCP is contained in the Maules Creek Formation and does not overlie any part of the alluvium. The nearest section of the alluvial aquifer to the MCCP is a tongue of alluvium that extends into the south-western section of the Boggabri Volcanics. Here, the alluvium is approximately 1.7 km from the mine.

2.2.2 Shallow Bedrock Aquifer

The volcanic bedrock regolith is largely dry in the elevated areas of Leard State Forest, but acts as a temporary water storage in wet periods and as a source for recharge to underlying aquifers. The bedrock outcrops to the west of the mine.

The depth of weathering in the bedrock extends to 60 m, but averages 25 m deep, depending on the extent and frequency of fracturing (AGE 2011). The weathered rock aquifer is generally 40 to 50 m thick and provides a connection between coal seam aquifers of the Maules Creek Formation and the alluvial aquifer (PB 2005).

2.2.3 Permian Aquifers

The main water-bearing strata in the Permian Maules Creek Formation are the coal seams, which are low to moderately permeable (AGE 2011). Sandstones and conglomerates have low primary porosity, but have greater secondary porosity from weathering, faulting, and jointing, so flow in this strata is likely to be via fractures. However, the weathered profile is largely unsaturated (AGE 2011). Groundwater flow in the Maules Creek Formation is controlled by lateral flow within coal seams. Depth to water ranges from 25 to 70 m (AGE 2010).

Recharge of the coal seam aquifers occurs in topographically high areas, with discharge occurring in the lower valleys. Discharge from the fractured rock aquifer occurs as underflow into the weathered volcanics and alluvium. In the MCCP, hydraulic transmissivity is 0.0086 m^2/day to 0.85 m^2/day.

3 Stygofauna in the Maules area

3.1 Previous surveys

Stygofauna sampling in the Maules Creek alluvial aquifers yielded a unique fauna with several endemic species (Anderson 2008; conversation with P. Serov, Department of Environment, Climate Change, and Water, 2 June 2011). The stygofauna community included Bathynellacea, Anaspidacea, Isopoda (at least 2 taxa), Amphipoda, Ostracoda, Cyclopoida, Harpacticoida, Insecta (at least 2 species), and Oligochaeta (Table 1). The presence of these taxonomic groups in the relatively small Maules Creek alluvial aquifer is impressive, and makes the system comparable to other larger alluvial aquifers such as those along the Hunter River, Pioneer River, and Peel River. It is likely that many of the taxa collected in the Maules Creek alluvial aquifers are endemic to the system, but this will require additional sampling of nearby aquifers, and further taxonomic scrutiny to determine (Peter Serov, conversation 2 June 2011).

Stygofauna have previously been collected from the Namoi alluvial aquifer (Peter Serov *unpublished*) and further north in the Gwydir River alluvium (Kath Korbel *unpublished*). Diverse stygofauna communities have also been collected from the Peel River alluvium, a major tributary that joins the Namoi River downstream of Lake Keepit (Moya Tomlinson *unpublished,* Hancock and Boulton 2008).

Table 1. Stygofauna known from alluvial aquifers along the Namoi, Peel, and Gwydir Rivers. Single ticks indicate at least one species is present. Double ticks indicate that at least two species are present.

	Peel	Namoi	Gwydir	Maules
Microturbellaria	✓			
Oligochaeta	✓✓	✓✓	✓✓	✓
Ostracoda	✓✓	✓	✓	✓✓
Cyclopoida	✓	✓	✓	✓
Harpacticoida	✓✓	✓✓	✓✓	✓
Anaspidacea	✓			✓
Bathynellacea	✓✓	✓	✓	✓
Isopoda	✓			✓✓
Amphipoda	✓			✓
Mollusca	✓			
Insecta	✓✓			✓✓

3.2 Likelihood that stygofauna will occur in Maules Creek Formation

No stygofauna surveys have been conducted in aquifers of the Maules Creek Formation or Boggabri Volcanics. It is possible that stygofauna are present in these aquifers through historical or current hydrological links to the alluvial aquifers. If stygofauna are present in the Maules Creek Formation and Boggabri

Volcanic aquifers, then the communities are likely to contain similar species to those found in the Maules Creek Alluvium.

Only one stygofauna taxon is known from a coal seam aquifer: a species of harpacticoid collected from central Queensland (ALS *unpublished*). This specimen occurred in a shallow coal seam (5 m deep), with low electrical conductivity (< 2000 uS/cm), a moderate to high amount of fracturing, and a good connection to a small alluvial aquifer. Most (57 %) of the EC measurements taken from the Permian aquifers of the Maules Creek Formation in 2010 were less than 1500 uS/cm (AGE 2011), and so likely to be suitable for stygofauna (Hancock and Boulton 2008). As the highest measurement in 2010 was 2760 uS/cm, it is unlikely that groundwater salinity will be too high for stygofauna.

Depth below ground surface is another factor that can limit stygofauna distribution, since groundwater foodwebs rely on vertical hydrological exchange to deliver carbon and oxygen (Hancock et al 2005). Water level in the Permian aquifer is between 25 and 70 m below ground level, so is not beyond the possible depth of stygofauna habitation.

Stygofauna require interconnected pores as living space within an aquifer (Humphreys 2002). Many taxa are small, with adults measuring less than 0.5 mm, but there must be connectivity between pore spaces to allow interaction between animals and migration. For the purpose of assessing suitability as stygofauna habitat, hydraulic transmissivity may be used as a proxy for porosity. Transmissivity of the Maules Creek alluvial aquifer is between 5 m^2/day and 400 m^2/day (AGE 2011). This is much higher than the average transmissivity of the Maules Creek Formation beneath Maules Creek Coal Project (0.0086 - 0.85 m^2/day), so it is unlikely that significant stygofauna communities will be present unless there are areas of high fracturing and connectivity.

4 Possible impacts to aquifers of Maules Creek Coal Project

Impacts to the aquifers associated with the MCCP are detailed in AGE (2011). The main points of this report are summarised below.

4.1 Expected impacts from Maules Creek Coal Project

Drawdown from the MCCP is likely to be restricted to the Maules Creek Formation and Boggabri Volcanics for the first 10 years of operation (AGE 2011). During this time, the maximum level of drawdown will be 50 m, centring on the mine pit. Drawdown of 1 m is expected to occur near the boundary of the alluvial aquifers to the west and south west of the project boundary. Modelling demonstrates that the 1 m drawdown contour will extend approximately 200 m into the edge of the alluvial aquifer by Year 15. This will occur to the west of the mine site in a shallow section of alluvial aquifer bounded by Boggabri Volcanics.

Following the completion of mining after 21 years, approval may be sought to extract additional coal resources. If approval is not granted, the mine pit will be rehabilitated by leaving a final void. This will slowly fill to form a lake, and water levels will be slightly lower than pre-mining once equilibrium is reached in approximately 1000 years, between evaporation, rainfall, and groundwater recharge.

4.2 Expected cumulative impacts from Maules Creek and nearby mines

The overall decline in flow to the alluvial aquifer when Boggabri, Maules Creek, and nearby Tarrawonga Mine are operational will be approximately 1.5 ML/day. Modelling indicates that combined drawdown contour could extend up to 3 km into the alluvial aquifer to the south-west of the mining area (Figure 1; AGE 2011). Drawdown will also increase in the alluvium of Nagero Creek. There will be drawdown throughout most of the Maules Creek Formation, and the Boggabri Volcanics (AGE 2011).

Overburden from the mines will generate slightly alkaline and low-salinity runoff following surface exposure and it is unlikely that this will present any significant changes to groundwater quality (AGE 2011).

4.3 Impacts from other activities on stygofauna

Numerical groundwater modelling predicts an average loss of recharge to the alluvium of 50 ML per year due to the Boggabri and Maules Creek Coal Mine (AGE 2011). Most of this loss will occur in Groundwater Management Zones 4 and 5 (NOW 2006), to the south and west of the mines. These two zones receive a combined recharge of 41 700 ML/year, and a reduction of inflow of 50 ML/year is expected to have less of an impact on stygofauna than the combined extraction of water for other purposes. Other users of the aquifer include local water utilities of Gunnedah (3900 ML/year) and Boggabri (760 ML/year), and stock and domestic users (929 ML/year for Zones 4 and 5). Combined stock and

domestic extraction, although spread throughout the water management zone, is substantially larger than the loss of infiltration forecast by the model. In other regions where there is extensive agricultural use of groundwater (e.g. Pioneer Valley, Burnett Region, Peel Valley, Hunter Valley), alluvial floodplains support diverse stygofaunal communities of up to 35 taxa (Hancock and Boulton 2008). The Maules Creek alluvial aquifer, which is in Management Zone 11, has a licenced extraction of 210 ML/year despite its relatively small size. Nevertheless, this aquifer is able to support a diverse stygofaunal community of at least 12 taxa, many of which are known only from this aquifer, even though there is a large amount of irrigation from the aquifer.

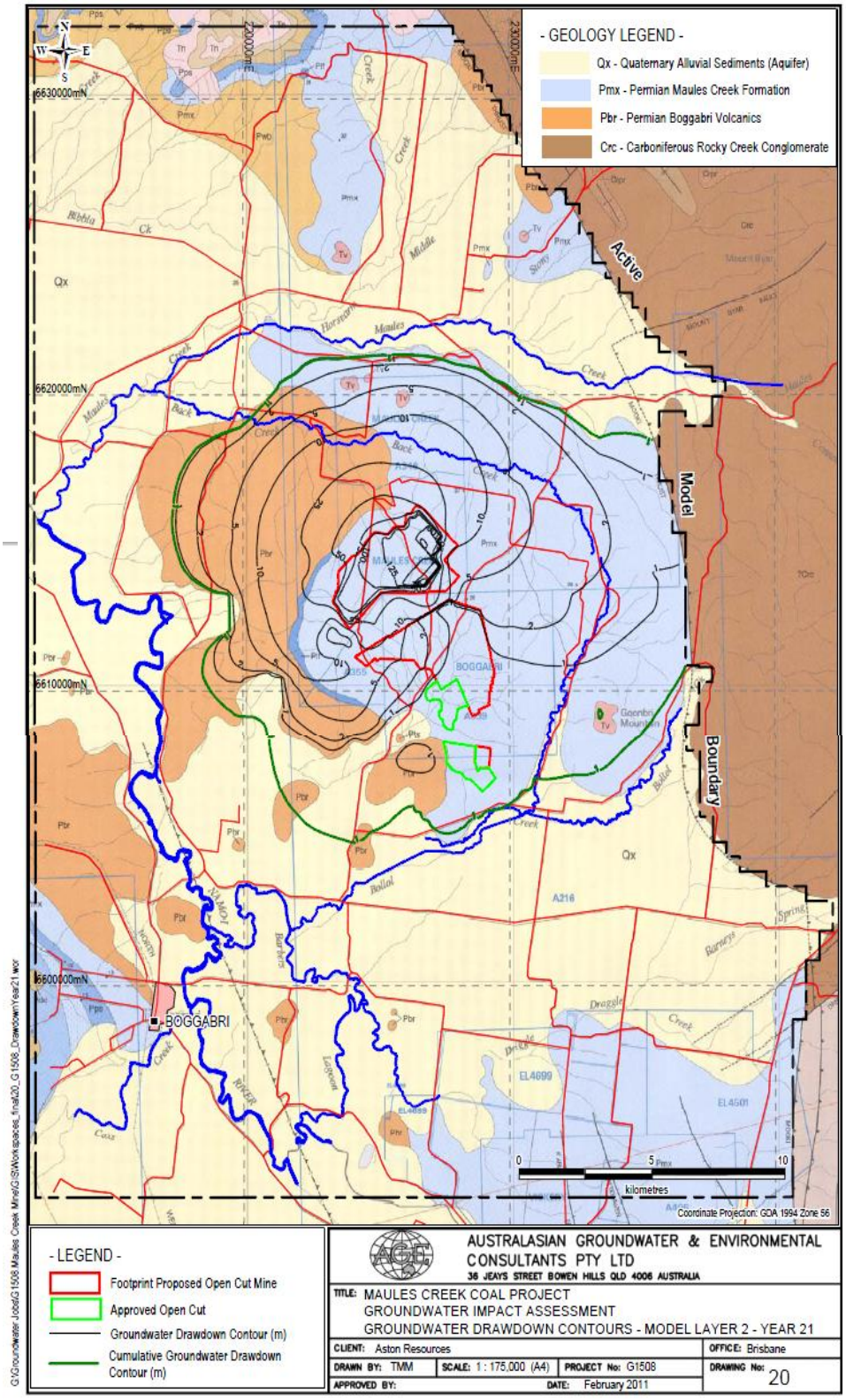

Figure 1. Final drawdown contours for combined impact of Maules Creek Coal Project and Boggobri Coal Mine.

5 Potential impacts of Maules Creek Coal Project on stygofauna

Diverse stygofauna communities exist in the alluvial aquifer of Maules Creek to the north of the MCCP. Many of these species appear to be endemic, and found only in this aquifer (Peter Serov, Pers comm., June 2011). However, groundwater modelling (AGE 2011) shows that the mine is unlikely to cause any substantial drawdown in this aquifer, so is unlikely to threaten the community. Stock and domestic licences totalling 210 ML/per year are currently allocated in the Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources (NOW 2006). It is uncertain whether this level of extraction will impact on the Maules Creek aquifer stygofauna community, since other areas with similar or greater licenced extraction have as many or more species than those that occur in the Maules Creek alluvium. Stygofauna in the Maules Creek alluvial aquifer exist in diverse communities despite already extensive irrigative extraction, so it is unlikely that extraction from mining will have a substantial impact, particularly since impact on the Maules Creek alluvium is modelled to be negligible.

No stygofauna samples are known to have been collected from the Permian Maules Creek Formation or the Boggabri Volcanics to date. These aquifers are the main areas receiving impact from the mines. It is possible, though unlikely given the low transmissivity, that aquifers in these units contain stygofauna, due to their proximity to the Maules Creek Alluvial Aquifer, and the relatively low electrical conductivity of groundwater (<1500 uS/cm). It is likely (though not certain) that any species collected in the Maules Creek Formation and Boggabri Volcanics in the future will also be present in the Maules Creek Alluvial Aquifers. However, it is impossible to determine the composition of the stygofauna community, if it exists, without sampling.

Parts of the Bollol Creek alluvial aquifer will experience a drawdown of 1 to 2 m near its confluence with the Namoi River Alluvium by year 21 of the MCCP. This is within the range of natural annual fluctuations and is not likely to have a significant impact on any stygofauna present in the area. No stygofauna surveys have been conducted from this part of the aquifer, so it is unclear whether any species are present. Given the extent of the adjacent alluvium it is very unlikely that species will be endemic to parts of the aquifer experiencing drawdown.

6 Recommendations

6.1 Monitoring impacts in the alluvial aquifers

Groundwater modelling has indicated that there will be no impact on groundwater levels or quality in the Maules Creek Alluvial Aquifer (AGE 2011), which is known to have diverse stygofaunal communities (P Serov, Pers comm; Anderson 2008). Water levels and water quality measurements taken during routine groundwater monitoring should be examined regularly. If there is an unforseen drop in water level or decline in water quality that is attributable to mining, then stygofauna sampling should be considered to ensure that the community is not threatened.

As the stygofauna community of Maules Creek alluvial aquifer has already been sampled, and since there is unlikely to be any impact on this alluvium, no sampling of the Maules Creek alluvium is recommended unless significant changes to water quality and water level are observed during mining.

Drawdown of up to two metres is expected in three areas of the alluvium by year 21 of mining: in a narrow alluvial valley of Goonbri Creek to the south east of Boggabri Coal Mine, a larger area immediately adjacent to the south-western outcropping of Boggabri Volcanics where the Bollol Creek alluvium joins the Namoi River alluvium, and a small area of the Namoi alluvial aquifer to the west of the Boggabri Volcanics. None of these areas have yet been sampled for stygofauna, but it is very unlikely that species occurring in these areas will be endemic.

No drawdown is modelled to occur in the alluvial aquifers of Bollol Creek and Namoi River for at least 15 years after mining commences. No immediate sampling for stygofauna is required in these aquifers unless there are any unforeseen declines on water level or water quality that are attributable to mining. If a stygofauna survey is required and there is no data from pre-impact surveys, then bores both inside and outside of impact areas should be sampled to help determine whether the changes to aquifer conditions have altered the stygofauna community.

6.2 Determining whether stygofauna are present in the Maules Creek Formation and Boggabri Volcanics

The main areas of impact from the Maules Creek Coal Project are the aquifers of the Maules Creek Formation and Boggabri Volcanics. To date no stygofauna have been collected from these areas, and their presence here is unlikely given the low transmissivity of the aquifers. However, proximity to the Maules Creek Alluvial Aquifer, the low electrical conductivity of the groundwater, and the shallow water table, still make it possible that stygofauna still may be present. If stygofauna are present, then they probably migrated into the Permian aquifers via linkages to the surrounding alluvium and are unlikely to be endemic.

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