EPURON
POWER FOR PORTFOLIOS

Proposed development of

Stage 1, Silverton Wind Farm,

far western New South Wales

Biodiversity Assessment
FINAL

March 2008

ngh environmental

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nghenvironmental

Suite1 216 Carp Street (PO Box 470) Bega NSW 2550
phone (02) 6492 8333 fax (02) 6492 8399 email ngh@nghenvironmental.com.au

a division of Nicholas Graham Higgs Pty Ltd abn 38 711 349 561

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Draft	January 2008	name	Steven Sass (Project Officer - Ecologist) Brooke Marshall (Project Officer)	name	Nick Graham-Higgs	name	Nick Graham-Higgs
Final	March 2008	name	Steven Sass (Project Officer - Ecologist) Brooke Marshall (Project Officer)	name	Nick Graham-Higgs	name	Nick Graham-Higgs

Cover photos: Tawny Rock Dragon, feral goats and general view of study area

CONTENTS

Figures

Tables

Maps

1 INTRODUCTION

This Biodiversity Assessment presents the findings of investigations into biodiversity values and likely impacts associated with Stage 1 of a proposed wind farm at Silverton, near Broken Hill in far western New South Wales. The Assessment has been undertaken by **ngh**environmental to support the Environmental Assessment (EA) report and has been prepared on behalf of the proponent Silverton Wind Farm Developments Pty Ltd.

This Biodiversity Assessment:

- Provides a summarised description of the proposed works
- Outlines the regional context of the study area in terms of biodiversity values
- Identifies and describes the biodiversity values of the subject site, including descriptions of methodologies and results of detailed flora and fauna surveys
- Identifies species and communities of conservation significance which are present or have potential to be present at the subject site, including potential threatened flora and fauna habitat and Endangered Ecological Communities
- Identifies and assesses the significance of the potential impacts and risks associated with the proposed works in relation to biodiversity values
- Assesses the significance of the potential impacts of the proposal on identified threatened species and communities listed in the *Threatened Species Conservation Act 1995* (Assessment of Significance, Appendix D)
- Assesses the significance of the potential impacts of the proposal on Matters of National Environmental Significance listed in the *Environmental Protection Biodiversity Conservation Act 1999*
- Specifically assesses the risks from bladestrike and habitat impacts to bird species at the site (Appendix E)
- provides a series of recommended mitigation measures designed to reduce risks and minimise the impacts of the development on flora, fauna and ecological communities

This Biodiversity Assessment is intended to meet the assessment requirements under Part 3A of the *Environmental Planning and Assessment Act 1979* and the *Threatened Species Conservation Act 1995*.

Further background information relating to the site and the proposal is contained in the accompanying Environmental Assessment.

2 THE PROPOSAL

2.1 Description of the site

The Silverton proposal site is located on leasehold land within the Barrier Ranges, approximately 25 kilometres north-west of Broken Hill, New South Wales (Map 2-1). The site is of a north-south orientation and is v-shaped in nature.

The Barrier Ranges form a series of north-east and north-west trending ridges rising up to 300m above the surrounding plains. The geology of the area includes schist and gneiss, intrusive granites, amphibolites and very coarse pegmatites (Morgan & Terrey 1992).

No major watercourses are present, however, several ephemeral watercourses exist within the study site including Umberumberka Creek, Lakes Grave Creek, Lakes Creek, Eldee Creek and Mundi Mundi Creek. The first three creeks drain into Umberumberka Dam, which provides part of the water requirements for Broken Hill and Silverton. In some areas, the creeks have formed steep-sided gorges, such as Lords Gorge, where sheltered waterholes exist when water is present. Beyond the Barrier Ranges, the creeks expand as alluvial fans, distributing sediment onto the Mundi Mundi Plain.

The tenure of land at the subject site is leasehold under the authority of the *Western Lands Act 1901.* The wind farm and part of the powerline is located in Unincorporated land while the powerline near Broken Hill is within the Broken Hill local government area. The land is currently used for agricultural purposes (sheep and feral goats). Stage one of the wind farm would directly involve two properties, while the powerline route traverses these, and an additional five properties closer to Broken Hill.

2.2 Proposed works

This Stage 1 proposal would involve the construction, operation and eventual decommissioning of a wind farm with capacity up to 370MW (All Stages would be 1000MW). This Stage 1 proposal includes:

- 120 wind turbines, each with three blades up to 55m long mounted on a tubular steel tower 80m to 100m high
- Electrical connections between wind turbines using a combination of underground cable and overhead power lines
- An onsite substation and control room
- 25km transmission 220 kV power line linking the wind farm to the Transgrid sub station at Broken Hill
- Access roads around the site, and upgrades of the Silverton and Daydream Mine roads, for installation and maintenance of wind turbines

Additional temporary construction infrastructure will be required during the construction and decommissioning phases such as concrete batching plant, storage of construction machinery, equipment and materials and site offices.

Stage 1 of the wind farm would have a capacity of up to 370 megawatts, and an operational life of up to 30 years. The area of the development footprint would be approximately 83 hectares (refer to Table 4-2).

The wind farm proposal encompasses a number of possible turbine layouts. The Biodiversity Assessment has been conducted on the basis of a broad development envelope which takes in all of the possible turbine sites and associated access tracks and cabling routes. Map 2-1 illustrates the proposed Stage 1 wind farm potential development envelope.

2.3 Approach of this assessment

The preparation of the Biodiversity Assessment involved desktop research, consultation with people with local and specialist knowledge, fieldwork, data analysis, significance assessment and report compilation.

2.3.1 Desktop research and consultations

Information was sourced on threatened species, populations, and communities having potential to be present at the subject site and in the wider study area. A range of reference books, research papers, conference papers, wind farm assessments and web tools and publications were sourced, focusing on relevant species and the study area. Several experts were contacted, and are cited in the relevant sections and the Acknowledgements. In addition, government representatives and landholders provided local information.

2.3.2 Fieldwork

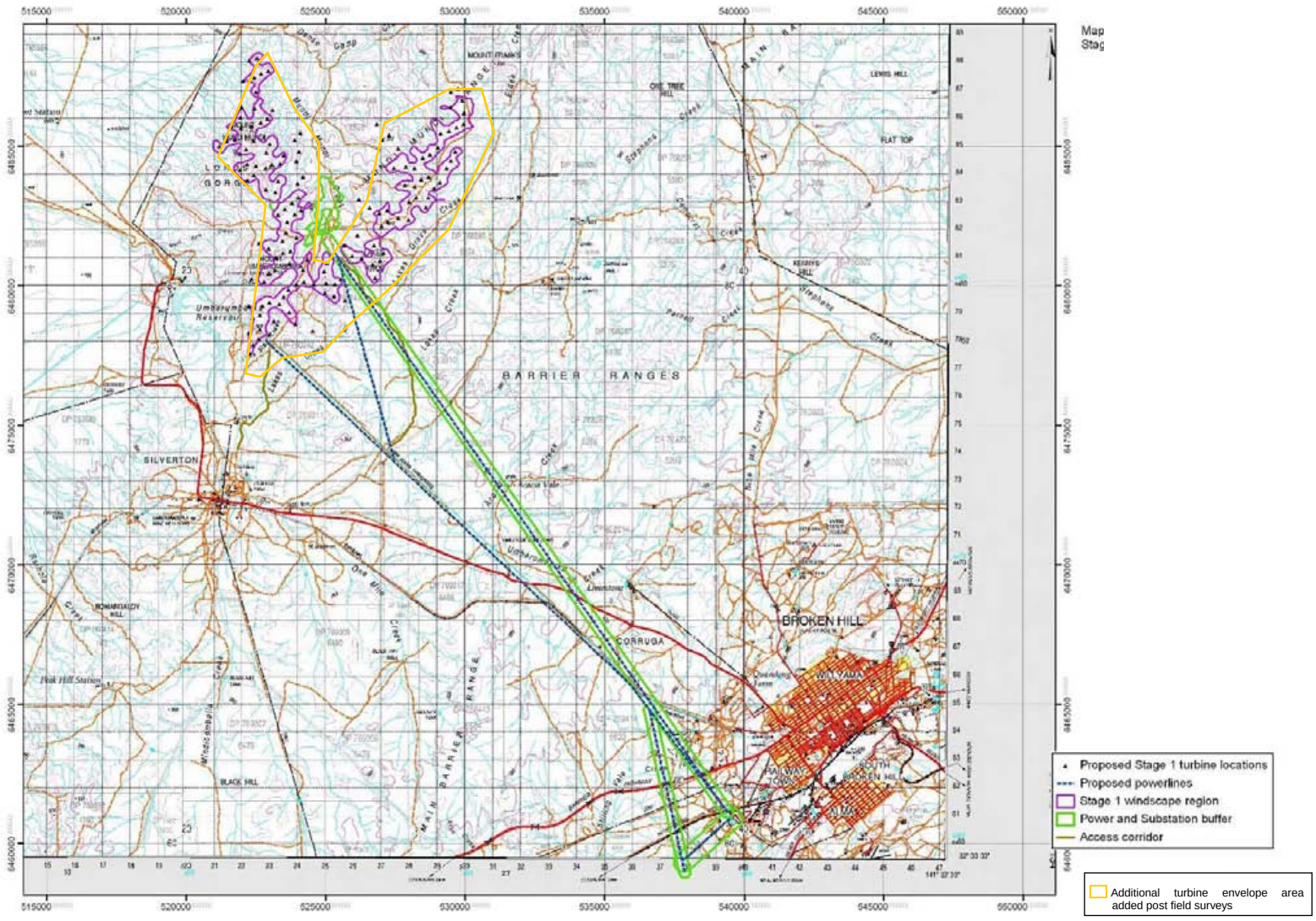
Site fieldwork was carried out between 24 September and 1 October 2007 and 26th and 30th November 2007. Fieldwork sought to describe and measure key biodiversity attributes, assess the presence and condition of significant values and determine the nature and extent of impacts likely to result from the proposal. Field activities included general broad scale surveys and targeted surveys for threatened species and Endangered Ecological Communities known to be present, or with potential to be present at the site.

Field work focussed on an envelope defined by Epuron in October 2006 (Map 3-1 pink outline). Since that date, the turbine envelope has been increased, due in large part to the delineation of large 'high biodiversity constraint' areas within the initial envelope. The additional area does not involve additional turbine numbers, as turbines have been relocated within the envelope. As the added area is immediately adjacent to the original envelope, important features within this area were largely evident while accessing the original envelope. **ngh**environmental consider that the results obtained from field work within the original envelope can be extrapolated to the additional areas of works, defined in March 2008, and indicated in yellow on Map 3-1.

2.3.3 Analysis, assessment and report compilation

Data collected during fieldwork was analysed to determine threatened species habitat suitability, representation of vegetation types and the significance of biodiversity values present at the proposal site. The Biodiversity Assessment report was structured using the conventional values-impacts-significance assessment format, for flora, ecological communities and fauna. Dedicated assessments of impact significance are presented for threatened species and communities, consistent with State and Commonwealth legislative requirements. A specific risk assessment for birds has also been undertaken, focusing on significant and vulnerable species. A series of recommended mitigation measures to avoid and reduce impacts on flora and fauna at the site has been developed, based on identified values and potential impacts.

Vegetation mapping, database searches and assessments of movement corridors and bird utilisation were conducted at large enough scale so as to include the additional area (added after field works were completed; yellow outline on Map 3-1). Mitigation measures have been added to this report to address the additional area of works.



Map 2-1: Location of the proposed wind farm and the development envelope.

Grid lines: GDA94 Zone 54

Several iterations of the power line route have been assessed, all with the same type and degree of constraints. Mitigation has been developed specific to the need to retain some flexibility in the final route location.

3 REGIONAL CONTEXT

Regional context is important in the consideration of rarity and conservation significance. Interactions between the subject site and surrounding habitats, and potential wind farm impacts beyond the immediate subject area should be considered.

A review of biodiversity features has been undertaken at two scales:

1. Region scale

   Using data compiled for established regionalisations (Broken Hill Complex Bioregion). Key regional attributes include the abundance, distribution and conservation status of communities and species and the prevalence of threats and disturbance regimes

2. District scale

   Examining an area around the proposal site over a radius of up to 30 kilometres. Species and habitat interactions within this area include foraging and breeding ranges, dispersal patterns and migration routes for fauna, and dispersal and genetic exchange opportunities for flora species

3.1 Region scale

3.1.1 Regionalisations

INTERIM BIOREGIONALISATION OF AUSTRALIA (IBRA 5.1)

The study area is located in the Broken Hill Complex Bioregion of the Interim Bioregionalisation of Australia (IBRA 5.1) (Thackway & Cresswell 1995), within the Barrier Ranges, Barrier Alluvial Plains and Barrier Downs sub-regions (NSW NPWS 2003). The Bioregion lies in the far west of New South Wales and spans an area of 5,691,042 hectares across New South Wales and South Australia, with 3,811,697 hectares (66.98%) of the bioregion being located within New South Wales (NSW NPWS 2003).

The Bioregion is geologically unique with the western portion comprising of ancient basement rocks of the Adelaide Fold Belt while the eastern portion is the edge of much younger rocks of the Tasman Fold Belt (NSW NPWS 2003). The sub-regions typically support Mulga shrublands, River Red Gum along larger creek lines and chenopod shrublands.

WESTERN CATCHMENT PLAN

The proposal site also occurs within the boundaries of the Western Catchment Management Authority (WCMA) and within the Barrier Range CMA subregion (DECC 2007). The Western Catchment Plan (2005) was developed to improve management of the natural resources of the catchment over a ten-year period. The Plan builds upon the Western Catchment Blueprint (2001) as a wide-scale and long-term plan and specifies Catchment and Management Targets, which are used to measure the health of the Catchment. The vision of this plan provides a framework for these targets, with four objectives highlighting the community's values of the region. The four objectives are:

1. Diverse values equitably reflected in the integrated management of natural resources for present and future communities
2. Land and vegetation managed on a landscape basis to achieve an acceptable balance between environmental, productivity, cultural and social values for present and future communities
3. Native biological diversity is conserved and, where possible, improved in the Western Catchment

4. Water resources supporting the environmental, productive, cultural and social values for present and future communities

3.1.2 Context of climate change

The NSW Scientific Committee has determined that there is evidence that modification of the environment by humans may result in future climate change (DECC 2007). This may involve both changes in average conditions and changes to the frequency of occurrence of extreme events. It has been listed as a Key Threatening Process by the NSW Scientific Committee.

Climate change provides an important context to this proposal for two reasons:

1. In arid and semi-arid landscapes, the combination of drought and grazing combine to place natural ecosystems under severe pressure. The effects of climate change threaten to exacerbate this process and therefore require consideration in the identification and management of biodiversity impacts at the site
2. As a renewable energy project, the proposed development would address, to some extent, rising green house gas emissions, and thereby the future impact of climate change, by providing a source of energy that is not dependent on the burning of fossil fuels. Reviewing the impact of wind farms on bird abundance, Stewart *et al.* 2007 suggests the impact of wind farm development on bird populations must also be viewed in the context of the impact of climate change in the absence of wind farms

Specific mention is given to the future of rangelands in the Australian Greenhouse Office (2003) publication *Climate Change: An Australian Guide to the Science and Potential Impacts*. This publication advises that, in their natural state, rangelands are adapted to relatively large short-term variations in rainfall and temperature. In rangelands, grazing, artificial water sources, tree clearing, introduced predators and plants, and changes in fire regimes are key drivers of impacts on rangeland biodiversity (Whitehead 2000; Woinarski 2000). These impacts can produce land degradation, habitat loss, habitat degradation and fragmentation, overall homogenisation of ecological systems and lead to a loss of biodiversity. Climate change, adds to this impact overall, especially through broad-scale habitat change (Howden *et al.* 2003).

In combination with climatic factors, land degradation, salinisation, woody weed invasion and subsequent decreases in food production result (Australian Greenhouse Office 2003). Major changes in vegetation composition will come through shifts in rainfall patterns and increased runoff distribution and will favour the establishment of woody vegetation and encroachment of unpalatable woody shrubs in many areas (Australian Greenhouse Office 2003). In modified landscapes, the ability of organisms to survive climate change through dispersal may be limited (Brasher & Pittock 1998, Australian Greenhouse Office 1998, cited in DECC 2007). Species at particular risk from the effects of climate change include those species with long generations, poor mobility, narrow ranges, specific host relationships, isolated and specialised species and those with large home ranges (Hughes & Westoby 1994, cited in DECC 2007). Pest species may also be advantaged by climate change.

Applied to the local biodiversity attributes of the Barrier Ranges and surrounding alluvial fans and plains, the following species of flora and fauna could be considered to be at particular risk from the impacts of future climate change:

'A Saltbush' (*Atriplex infrequens)*	Speculated to require relatively undisturbed and ungrazed drainage lines and plains, and therefore at risk from land degradation. This species is listed as vulnerable in the TSC Act
Brolga	Reliance on grasslands and wetlands which may come under stress from conversion of grasslands to woody vegetation and extended dry periods. This species is listed as vulnerable in the TSC Act.
Redthroat, Forrest's Mouse, Kultarr, Thick-billed Grasswren, Striated Fieldwren	Affected by feral goat grazing and associated indirect impacts of goats, likely to be exacerbated by climate change. The Redthroat Forrest's Mouse and striated field wren are vulnerable and the Kultarr Thick-billed Grasswren is listed as endangered within the TSC Act
Tawny Rock Dragon	A rocky outcrop specialist with potential for dispersal to be adversely affected by feral goat grazing. This species is Endangered

3.1.3 Matters of National Environmental Significance

Matters of national environmental significance listed under the *Environment Protection and Biodiversity Conservation Act 1999* within a 50 kilometre buffer of the study site were identified using the EPBC Act search tool (http://www.deh.gov.au/erin/ert/epbc/index.html) in December 2007.

In summary, the report indicates the following matters for consideration:

- One wetland of international significance: Lake Pinaroo is located approximately 350 km from the proposed development. There would be no potential for impact on this wetland directly. Avian movement corridors are considered in Section 3 of this Biodiversity Assessment
- Six threatened species: Purple-wood Wattle, Thick-billed Grasswren, Plains-wanderer, Australian Painted Snipe, Eastern Long-eared Bat and Murray Cod. The potential for these species to be adversely affected by the proposal is considered in Section 3 and Appendix C of this Biodiversity Assessment
- Eight migratory species: White-throated Needletail, Great Egret, Cattle Egret, Latham's Snipe, Australian Painted Snipe, Painted Snipe, Rainbow Bee-eater and Fork-tailed Swift. The potential for these species to be adversely affected by the proposal is considered in Section 3 and Appendix C of this Biodiversity Assessment

3.1.4 Vegetation and Flora

Diverse vegetation communities occur across the Broken Hill Complex Bioregion, varying according to topography, soils and micro-climate. Mulga (*Acacia aneura*) communities and chenopod shrubland communities dominate the vegetation of the bioregion (Morgan & Terrey 1992).

Although 95 per cent of the Western Division of NSW is uncleared, the composition and structure of vegetation communities within the bioregion has been modified as a result of grazing by stock (including goats) and altered fire regimes (DNR 2005).

Over 300 flora species occur in the region. There are 9 threatened plant species known to, or predicted to occur in the Barrier Range CMA subregion; 5 are listed as endangered, 4 are listed as vulnerable (DECC 2007). Two endangered ecological communities are also known to, or are predicted to occur in the subregion. These are Neila Woodland and the Aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River (DECC

2007). Previous threatened flora records from the district sourced from the DECC NSW Atlas of Wildlife database (which has a flora component) are shown on Map 3-1.

3.1.5 Disturbance to vegetation

The vegetation of the region has suffered significant disturbance since European occupation. A series of events has lead to the widespread degradation of the vegetation communities, in particular, Mulga dominated communities.

The first explorers described the communities that dominate the study area as being so dense in structure that men had to walk their horses through it (Barrier Miner 2007). However with the arrival of sheep and the requirements for timber for use in the mining and pastoral industries, the denudation of the broader landscape began (Murray/Darling Study Group 2004).

From the 1840s, the wool industry became dominant in the Western Division, with sheep grazing on native vegetation becoming the dominant land use. However, as a result of legislative changes to land tenure from the 1860s, many of the original pastoral holdings were divided into two equal parts, with the resumed area being made available to new settlers (Lunney 2001). The original settlers were forced into the position of having to graze all their sheep on half the original land area they had utilised; the new settlers then grazed their sheep on the residual or resumed land (Lunney 2001) placing additional pressures on the vegetation communities of the Western Division. By the late 1880s, paddock fencing and vermin proof fences were constructed over most of the grazing land in New South Wales. Sheep numbers were still increasing at this time and as well, by the 1880s, so to were rabbit populations. By the 1890s, a severe drought was crippling pastoralism in the Western Division, and it is documented that Mulga was the principal tree species to have been cut for drought feed early in the 1890s and that it's subsequent regeneration was prevented in most areas by continued drought feeding and grazing by both sheep and rabbits (Oxley 1987).

The 1901 Royal Commission of the Western Lands acknowledged the negative effects of these grazing regimes and reported that the carrying capacity of the Western Lands had been overestimated, and that the overstocking of sheep and the effects of feral rabbits had resulted in the destruction of almost all vegetation.

Significant changes to the vegetation of the Broken Hill area came with the progression of the mining industry and the paddle steamer industry in the late 1880's. Mulga was also the favoured species for fence posts, with their use common from the 1870s through until World War 2 when steel posts became more cost efficient (Pickard 1992). The result being that almost all large trees were cut down within a few days travel of Broken Hill (Murray/Darling Study Group 2004). When most of the local timber was removed in the bioregion, initiating erosion and contributing to serious dust storms, builders and miners brought timber in from Adelaide to alleviate the lack of supply (NSW NPWS 1991).

The introduction of rabbits into the landscape also added to the effects of sheep grazing on native vegetation. Rabbits competed directly with the domestic herbivores for palatable herbage and shrubs and so exacerbated the impact of already high stocking rates. Virtually no Mulga regeneration occurred between 1899 and the 1950s, when rabbit numbers decreased (Oxley 1987).

Feral goats have also contributed to the disturbance of the vegetation communities of the study area. Since the late 1800s when the goat wool industry failed, many goats were abandoned leading to a widespread feral population. The grazing of goats on many semi-arid zone plant species has been found to have a deleterious effect. Goats have played a leading role in the cessation of regeneration of key species such as Mulga (Benson *et al* 2006). When both rabbit and goat populations occupy the same area the combined effect of the grazing habits of both species has been found to almost totally inhibit plant regeneration on a broad scale (Auld 1993).

3.1.6 Fauna

A range of habitats occur in the IBRA Broken Hill Bioregion, including acacia shrublands, chenopod shrublands, wetlands and rocky ranges.

Thirty-seven mammal, 195 bird, 5 frog and 58 reptile species have been recorded in the Broken Hill Complex bioregion (NSW NPWS 2003). The vegetation and fauna habitats over much of the region are threatened by feral goats, rabbits and weed infestation. Within the Barrier Range CMA subregion, there are 33 fauna species listed as threatened, consisting of 7 mammals, 15 birds, 1 fish, 1 invertebrate and 9 reptiles (DECC 2007).

Many areas of the bioregion have been degraded by grazing, altered fire regimes, feral animals and weed invasion which are recognised as threats to fauna habitats. Many species of ground nesting bird and fauna species that feed on terrestrial invertebrates have undergone a serious decline in the bioregion (NSW NPWS 2003). This is likely to be partly attributable to grazing across extensive areas of habitat which has resulted in the loss of breeding and feeding resources (NSW NPWS 2003).

Significant fauna of the bioregion include the endangered yellow-footed rock wallaby (*Petrogale xanthopus*). This species has a limited distribution, known currently from only one population in NSW which is located within Mutawinjii National Park (NSW NPWS 2003), however historical anecdotal records place them just north of the Stage 1 proposal. The Tawny Rock Dragon (*Ctenophorus decresii*) has a restricted national distribution and is listed as endangered in NSW. This species is known from only one population in NSW within Mutawinjii National Park (Swan *et al.* 2004).

Waterbirds are likely to move between large waterbodies and wetland habitats at the regional scale.

Bancannia Lake (c. 100 kilometres north-east of the subject site), part of the Menindee Lakes (120 kilometres to the south-east), Stephens Creek Reservoir (20 kilometres to the south-east), major rivers in the region and to a lesser extent Umberumberka Dam (2 kilometres south of the subject site) are likely to form part of the foraging range for several mobile waterbird species. Bancannia Lake is an important aggregation site for waterbirds, including the threatened Freckled Duck (*Stictonetta naevosa*) and Blue-billed Duck (*Oxyura australis*) (NSW NPWS 2003). The Blue-billed Duck has also been recorded at Stephens Creek Reservoir.

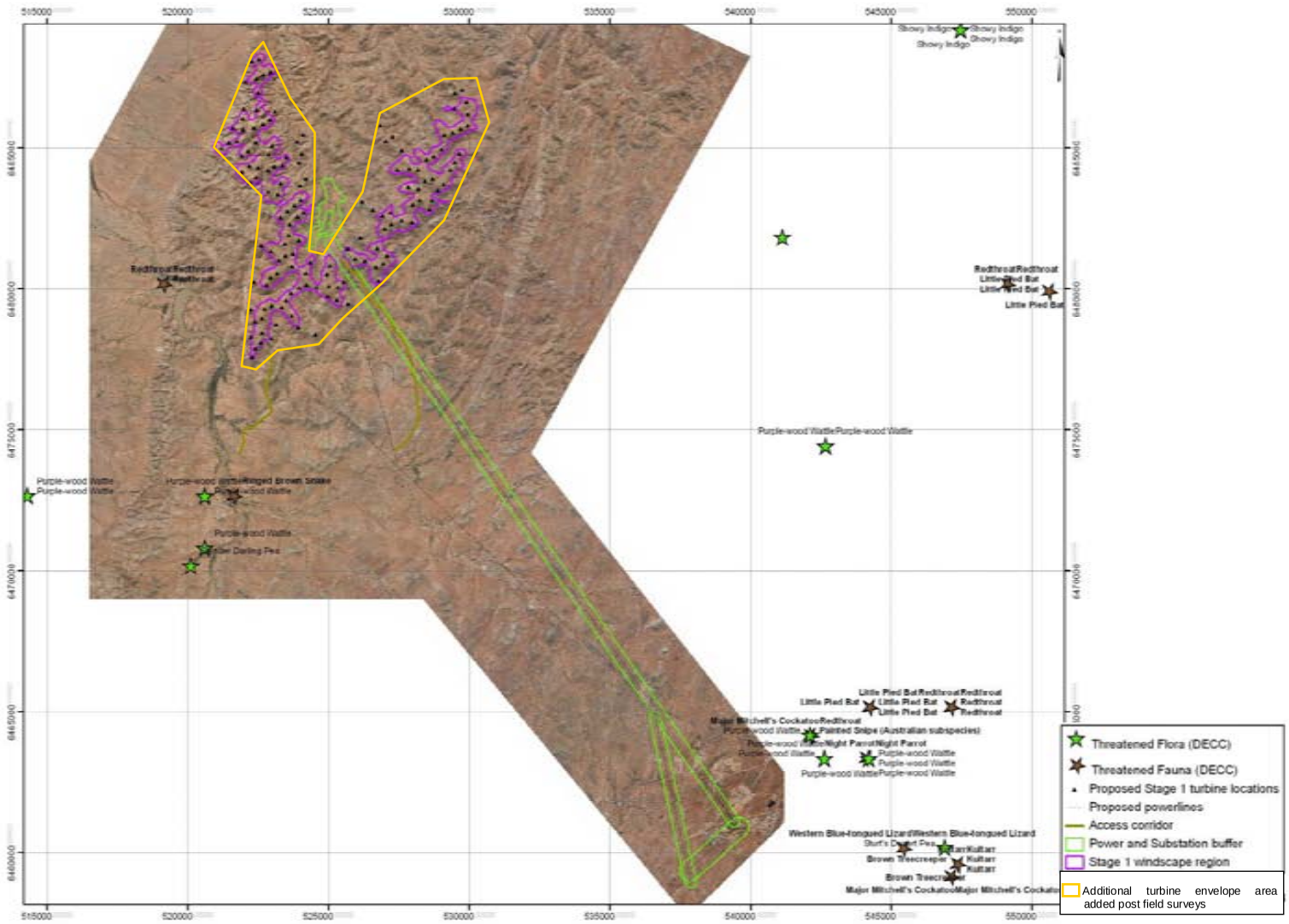
Previous threatened fauna records from the district sourced from the DECC NSW Atlas of Wildlife database are shown on Map 3-1.

3.1.7 Conservation and environmental management

The Broken Hill Complex Bioregion has around 96,078 hectares or 2.52 per cent under conservation management, with National Parks and Nature Reserves making up the largest proportion of this (NSW NPWS 2003). Much of this lies within the Mutawinjii National Park and Mutawinjii Nature Reserve, with parts of the Kinchega National Park also included in this bioregion. These three gazetted lands occupy 2.1 per cent of the bioregion. The Mutawinjii Wilderness Area, gazetted under the Wilderness Act 1987, comprises of 47,895 hectares or 1.26% of the bioregion (NSW NPWS 2003). This area provides additional protection for conservation outside of the National Parks and Wildlife Act.

The Western Division is one of the few areas in NSW that has not experienced large scale land clearing or habitat fragmentation, with as much as 95 per cent of the Western Division of NSW remaining uncleared (DNR 2005). However, the composition and structure of these vegetation communities has been significantly modified as a result of grazing by stock and feral animals such as goats, and altered fire regimes (DNR 2005).

There are no lands managed under the Forestry Act 1916 (NSW NPWS 2003) within the bioregion.



Map 3-1: Previous threatened flora and fauna records in the district (source: DECC 2007).

3.1.8 Potential Movement Corridors

Arid zone landscapes across the world have been the focus of many studies exploring patterns of faunal distribution and movements. For most species of arid environments, the distribution of resources are important in explaining patterns of faunal diversity in these arid ecosystems (Dickman *et al.* 2007). Arid zone ecosystems are often referred to as 'boom or bust', whereby rainfall events typically dominate movement and subsequent distribution of fauna (Roshier *et al.* 2002). While small, ground dwelling fauna occur within small home ranges, being limited in their ability to move large distances through the landscape (eg, Stafford-Smith *et al.* 1990). Mobile fauna such as waterbirds have become models for research in the arid areas of Australia as they are highly mobile with population structures that are likely to be the direct result of ephemeral changes in resource distribution in these dynamic landscapes (Roshier & Read 2003).

The wetlands of arid Australia are dynamic entities, continually changing as elements of the landscape periodically dry and fill with rainfall events (Kingsford & Porter 1994). In western NSW, these wetlands also influence large-scale movements of waterbirds (Roshier 1999) and have been identified as important for the conservation of waterbirds in arid Australia (Kingsford *et al.* 1994). Using satellite data and spectral matching, the wetlands of the region larger than 120ha were mapped (Roshier & Rumbachs 2004) (Figure 3-1). The majority of the wetlands are more than 200km from the proposed development, with an obvious bias towards the Darling River floodplain and Paroo Overflow areas.

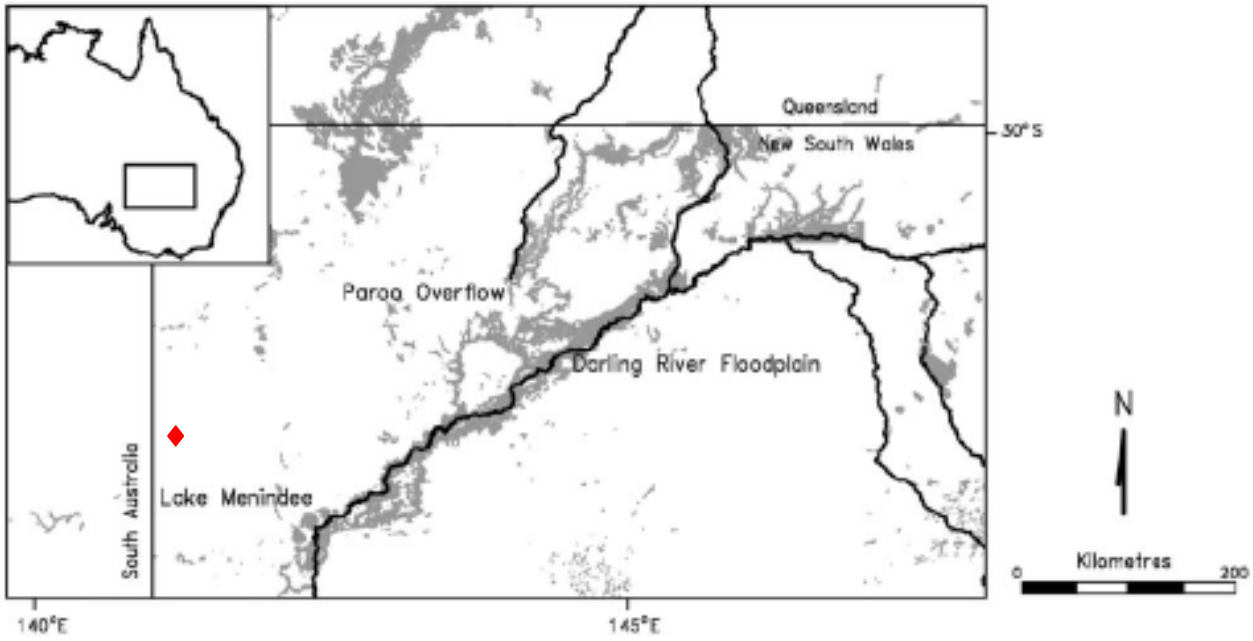


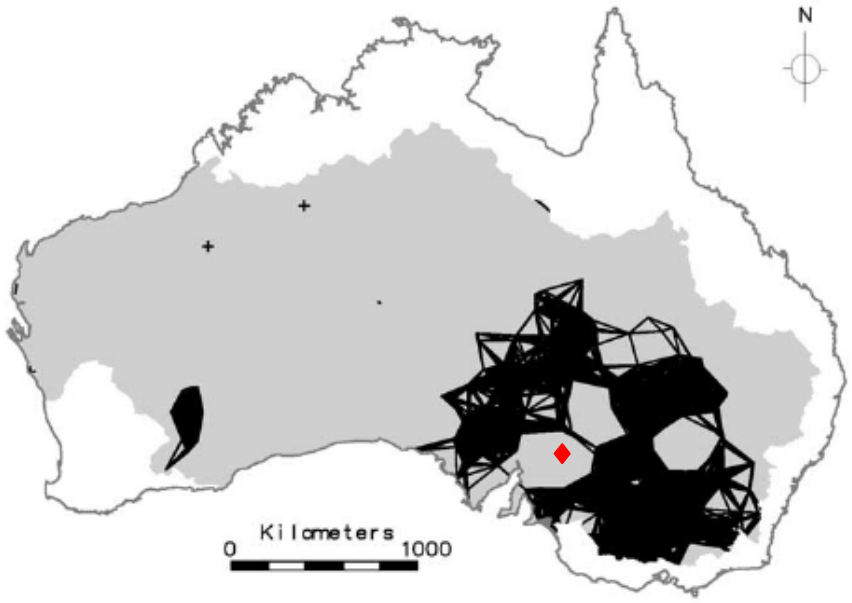
Figure 3-1: Wetlands mapped by Roshier & Rumbachs (2004)

Mapped using satellite imagery. Approximate location of proposed wind farm has been added and is shown by a red diamond (♦).

As most wetlands in arid areas generally retain water for only short periods of time relative to the lifespan of individuals, waterbirds must respond quickly to find feeding and breeding habitat (Roshier *et al.* 2002). Continental-scale interactions between available habitat and water birds have shown that broad pathways exist between arid zone ephemeral wetlands that occur as a mosaic across the landscape (Roshier *et al.* 2001b). Habitat availability for waterbirds is dependent on the scale at which individual species interact with this wetland mosaic. To facilitate waterbird movements, there is a level of dependence on the connectivity between an individual's current location and other wetlands. Research into wetland connectivity between the Lake Eyre Basin and

the wetlands of south-east Australia, in which the proposed development is located between, has determined that they are highly connected along broad pathways (Roshier *et al.* 2001b). However, during dry periods, this connectivity becomes more fragmented, and the extent of these pathways is reduced (Figure 3-2).

MAP A



MAP B

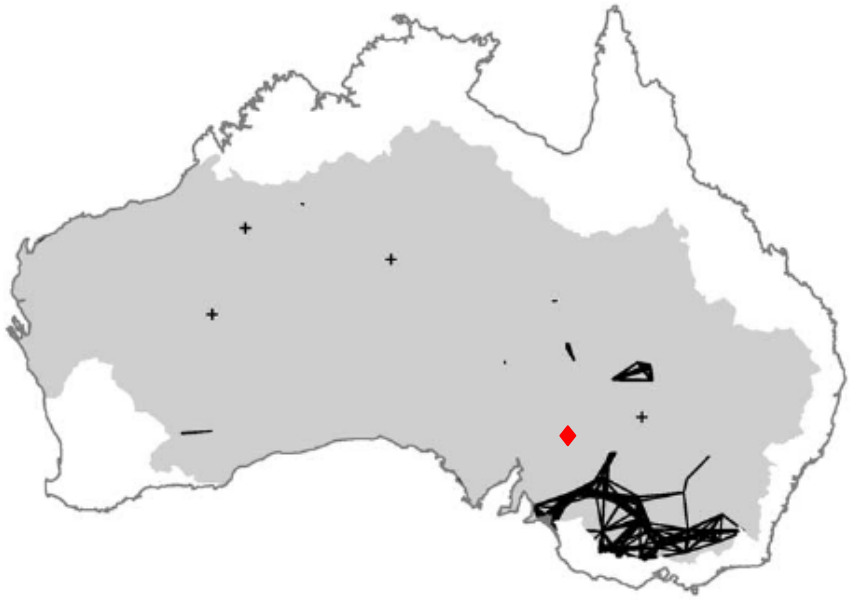


Figure 3-2: Wetland pathway connectivity mapped by *Roshier et al. 2001b*

Connectivity between Lake Eyre Basin and south-east Australia as detailed by Roshier et al. (2001b). Approximate location of proposed wind farm has been added and is shown by a red diamond (♦). Greater connectivity is evident during a wetter period (Map A) while wetland pathways decrease in drier periods (Map B).

In each representation by Roshier, Robertson, Kingsford and Green (2001b), connectivity influencing movements of large numbers of waterbirds is some distance away from the proposed

development predominantly to the north and east (Figure 3-2). Variation of these pathways is shown (Map A) whereby greater connectivity and pathways between wetlands allow for greater movements of waterfowl. However, in drier periods, these pathways are greatly reduced, with ephemeral wetlands drying and less potential for waterfowl movement.

Waterfowl movements were recently studied using Grey Teal (*Anas gracilis*). Movements of this species in the Lake Eyre Basin and the Murray Darling Basin populations were tracked using satellite transmitters between September 2003 and November 2004 (Roshier *et al.* 2006). These birds were found to move large distances, up to 343kms in several hours, whereas some individuals travelled more than 2000km in one year. Previously it was suggested that rice crops in the Murray-Darling Basin were being threatened by large-scale movements of waterfowl from inland Australia. However, no movements of birds were recorded from the Lake Eyre Basin into the Murray Darling Basin in this study, despite the persistent drought when movements would be expected to be high.

3.2 District scale

A district-scale review of habitats in the area was conducted with reference to aerial photography and topographic maps, vehicle-based survey results and contacts with local landholders and authorities. In particular, the locations of important wetland, woodland and forest habitat areas, and potential connectivity with the subject site was examined. The assessment was limited by air photograph quality, road access and the inability to ground-truth, but does give a broad indication of district-level habitat quality and the relative significance of habitat at the subject site.

For the purposes of this report, the district occupies an area surrounding the proposal site over a radius of 20 kilometres from the wind farm.

3.2.1 District habitat features

WATERCOURSES AND WETLANDS

There are no major watercourses present, however, several ephemeral watercourses exist. These include Umberumberka Creek, Lakes Grave Creek, Lakes Creek and Mundi Mundi Creek. The first three creeks drain into Umberumberka Dam, which provides part of the water requirements for Broken Hill and Silverton. In some areas, the creeks have formed steep-sided gorges, such as Lords Gorge, where sheltered waterholes exist when water is present. Beyond the Barrier Ranges, the creeks expand as alluvial fans, which are likely to form ephemeral wetlands on Mundi Mundi Plain in periods of extended rainfall.

The highly ephemeral watercourses, waterholes and wetlands are likely to provide locally important habitat for some species of waterbirds. Umberumberka dam has been dry on numerous occasions. Since 1971, the dam has been dry on eight occasions for periods of up to eight months (Country Water, pers. com, Jan 2008).

NATIVE VEGETATION

Vegetation of the district is similar to the composition of the region, with Mulga (*Acacia aneura*) communities and chenopod shrubland communities dominating. River Red Gum occurs within the more well defined drainage lines of the district.

Much of the district is well vegetated with only very minor areas of clearing apparently the result of past mining activities, timber felling for mines, fence posts and road construction. Similarly to the catchment and regional scale, the district has also endured modification to the natural vegetation through feral animals such as goats and rabbits, and changes to natural fire regimes.

3.2.2 Conservation reserves in the district

There are no conservation reserves gazetted within the district.

However, there are two reserves that could be considered to act as surrogates for district conservation. These are the Silverton Common and the Umberumberka Dam.

Silverton Common is located at Silverton and comprises 4,000 hectares. Although the main intention of the common is for grazing stock, few animals appear to have grazed the common in recent times. The main vegetation community of the common is chenopod shrubland.

Umberumberka Dam is located 9 kilometres west of Silverton. This dam provides water to the city of Broken Hill and the Silverton township. The dam covers around 145 hectares in area, and has a capacity of 8.98 mega litres. The dam is flanked by a River red Gum community and surrounded by chenopod and acacia shrublands.

4 FLORA AND VEGETATION COMMUNITIES

4.1 Approach and methodology

4.1.1 Preliminary assessments

Fieldwork was preceded by a desktop assessment to identify species and communities of conservation significance potentially present in the study area. Topographic maps, air photographs, previous research and assessments and records contained in national and state databases were sourced to identify known and potential values. Key web-based databases including the Commonwealth Protected Matters search tool using a 30 kilometre buffer, Bionet and the DECC Wildlife Atlas (based on the Corona, Fowler's Gap, Broken Hill and Taltingan 1:100,000 map sheet areas) were source.

The DECC Threatened Species Database was also used to assess the habitat potential for threatened species in the Barrier Range sub-region of the Broken Hill Complex Bioregion which have been recorded, or are predicted to occur, based on known ecological relationships (DECC 2007b).

4.1.2 Field survey and mapping

Areas that incorporated the proposed turbine development zone, inter-turbine cable routes, new track routes and grid connection powerline route were surveyed for flora values between the 24th September and the 1st October 2007. Additional work that involved validation of vegetation maps generated following the initial site visit was undertaken between the 26th and 30th November 2007. The methods and outputs of the assessment are developed to meet the requirements contained in the Draft Guidelines for Threatened Species Assessment (DEC, DPI 2005).

The flora survey was undertaken by stratifying the study area into vegetation communities by a series of air photo interpretation and on-ground validation. Flora surveys were then undertaken in areas that would potentially be directly or indirectly affected by the proposal, with an appropriate buffer. Vegetation communities and locations of flora surveys are shown (Maps 4.1, 4.2, 4.3 and 4.4).

The survey areas comprised a subset of:

- Ridge crests and upper slopes where turbines are proposed for construction
- Twenty metre wide corridors centred on the proposed new tracks and cable routes
- A 100 metre wide corridor centred on the proposed overhead powerline connecting the turbine sites to the substation and Transgrid system in Broken Hill

The subject site was stratified into broad homogeneous survey zones based on vegetation communities identifiable by air photo interpretation.

In addition, the periphery of existing tracks at the site which may be used during the construction phase of the proposal were examined for significant or sensitive vegetation features that would potentially be impacted by increased traffic load or road improvement works.

Species lists were compiled for each of the vegetation communities surveyed. Areas carrying native vegetation were surveyed using the 'random meander' method (Cropper 1993), rather than quadrats, to maximise opportunities for detecting significant or sparsely distributed plant species. Species recorded are listed in Appendix A. In addition, dedicated searches in specific habitat areas were undertaken for threatened species which were assessed as having at least a moderate potential to be present at the site (refer Appendix C).

The identification of vegetation types was initially based on Pickard & Norris (1994). However, a review of the mapping provided, revealed five broad vegetation classifications, largely developed from air photo interpretation and little on ground validation during their works. More recent

research on the vegetation communities of western NSW builds on this initial knowledge to describe 213 plant communities for the NSW Western Plains. This classification was developed for the New South Wales Vegetation Classification and Assessment database and is detailed in Benson (2006) and Benson *et al.* (2006). These vegetation types are classified primarily on the basis of landscape position and vascular plant structure. This report describes the vegetation communities as detailed by Benson (2006) and Benson *et al.* (2006).

Botanical nomenclature follows Harden (1990-2001), except where recent taxonomic changes have occurred. Noxious weeds identified are those declared for the Broken Hill local government and the Unincorporated control area under the *Noxious Weeds Act 1993*.

Map references locating significant vegetation features and noxious weeds were obtained using a hand-held 12 channel GPS unit, and are based on the GDA datum to mirror aerial imagery that was available for the study area.

4.1.3 Threatened species and communities

Threatened species and communities declared under the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* were specifically targeted in the assessment. Threatened species or communities recorded in the study area, or with potential to occur there, were identified using;

i) Broad scale vegetation mapping (Pickard & Norris 1994)

ii) DECC Wildlife Atlas searches (which have a flora component) based on the based on the Corona, Fowler's Gap, Broken Hill and Taltingan 1:100,000 map sheet areas

iii) DECC Threatened Species Database based on the Barrier Range sub-region of the Broken Hill Complex Bioregion which provides information on species or communities known to or that are predicted to occur in the area

The Commonwealth online Protected Matters search tool was used to identify flora and other values in the study area listed under the EPBC Act.

A precautionary approach has been adopted where distribution and habitat information is incomplete or uncertain.

4.1.4 Survey limitations

Given the large area of the proposed development site, and uncertainty regarding precise areas of impact, a random meander search was undertaken to survey each zone within the survey area. Survey intensity was increased toward the centre of the survey areas, where impacts are more likely.

While the range of environmental variation was covered within each vegetation community, not every part of each community was inspected in fine detail. Rather, a subset of surveys was undertaken within each vegetation community that enabled a broad scale assessment of each community type.

Vegetation mapping is based on a combination of aerial photo interpretation with some on-ground validation carried out during field work between the 24th September and 1st October 2007 and the 26th and 30th November 2007. Due to the large area of the proposed development site, not all vegetation boundaries were assessed in detail. Rather, the mapping shown provides an indicative estimate of the extent of vegetation communities across the study area.

Specific areas that would be impacted by access road construction, realignment, widening or other improvement works were not well defined at the time of survey and were not surveyed in detail. Access track road verges were surveyed from a slow-moving vehicle for threatened species and to assess likely habitat potential.

The survey was undertaken in mid spring to coincide with the peak detectability of the majority of ground flora species before they desiccate in the extended heat. This timing means that some

annual or geophytic species (such as terrestrial orchids) which flower outside the survey period would not have been recorded. While the region had been experiencing an extended dry period in the twelve months preceding this survey, 275.4mm of rainfall had been recorded at the Broken Hill weather station between November 2006 and November 2007 (BOM 2007). Considering the yearly average (since records began in 1889) is 253mm, survey conditions could be considered to be good. It should be noted however, that as much of this was in January 2007 (108mm), many herbaceous and annual species may not have been present during the survey. Ephemeral species which flower in response to irregular rainfall or disturbance events such as fire will also have gone unrecorded. In view of this and as a precautionary approach, the known habitat requirements of threatened species which have been recorded or are predicted to occur in the region, have been analysed against the vegetation communities of the study area to evaluate their potential for occurrence. The probability of species of conservation significance having been omitted due to seasonal factors is further discussed in Appendix C and section 4.2.5.

The subject site is currently grazed by domestic stock (sheep), feral goats and rabbits. This is likely to affect the ability to record some grazing-sensitive species.

4.2 Assessment and survey results

4.2.1 Vegetation communities

Ten vegetation communities were identified from a mix of air photo interpretation and some on-ground validation. Full diagnostic species lists and information for these vegetation types mentioned are contained in Benson (2006) and Benson *et al.* (2006). The approximate extent of vegetation communities is shown on Maps 4.3 and 4.4.

MULGA – DEAD FINISH ON STONY HILLS

This tall open shrubland is dominated by Mulga (*Acacia aneura*) and Dead Finish (*Acacia tetrogonophylla*) with Belah (*Casuarina pauper*) also present. In the study area, this community occurs on skeletal or shallow, stony soils which occur on the steep slopes, hillcrests, midslopes and terraced flats of elevated landscapes. Much of the windscape region, which will be impacted by turbines, is within this vegetation community. Over much of the study area, evidence of dieback and a general absence of regeneration is regarded as significant. Benson *et al.* (2006) suggest that overgrazing by feral goats is the main reason for this phenomenon. The understorey is typically sparse, with the study area being no exception. However, scattered shrubs present included Silver senna (*Senna artemisiodes*), Bastard Mulga (*Acacia sibrica*) and Umbrella Mulga (*Acacia brachystachya*). The ground vegetation consists of numerous chenopod shrubs such as Black Bluebush (*Maireana pyamidata*) and Copperburs (*Sclerolaena* spp.). In most areas across the subject site, this vegetation community is highly degraded. Dieback of Mulga is common across the site (see Figure 4-1, and Photos 2, 4, 6 & 18), and a lack of regeneration of these key species suggests a long-period of degradation to this community likely to be caused by timber cutting and grazing by feral goats and rabbits. The sparse cover of ground vegetation is also likely to be impacted by feral animal grazing and is expected to have eliminated many floral species from this community.

This community in composition and landscape position corresponds with the vegetation identification 123 '*Mulga-Dead Finish on stony hills mainly of the Channel Country and Broken Hill Complex Bioregions* ' as described by Benson *et al.* (2006). This vegetation type is predicted to become a threatened community if the regeneration of key species does not occur (Benson *et al.* 2006).

PRICKLY WATTLE OPEN SHRUBLAND OF DRAINAGE LINES

This shrubland is found in both stony hills and ranges and the low hills of the Barrier Range Complex Bioregion along ephemeral drainage lines. The dominant shrub in this community is Prickly Wattle (*Acacia victoriae*) while the understorey of chenopod shrubs includes Black Bluebush (*Maireana pyramidata*) and Thorny Saltbush (*Rhagodia spinescens*). Lemon Grass (*Cymbopogon ambiguous*) was present, mainly within the stony hills. On the stony ranges, this community grades into Mulga-Dead Finish while elsewhere chenopod shrublands. The presence of smooth mustard (*Sisymbrium erysimoides*) throughout many examples in the study area indicates this community is conducive to weed infestation. This may also be the influence of many grazing animals congregating in or near to these ephemeral drainage lines.

This community, in composition and landscape position, corresponds with the vegetation identification 136 '*Prickly Wattle open shrubland of drainage lines on stony rises and plains of the arid climate zone*' as described by Benson *et al.* (2006). While this community is recognized as being of 'least concern', the main threats associated to continued degradation include grazing management and changes in natural fire regimes, which are likely to effect wattle seed germination.

BLUEBUSH SHRUBLAND ON STONY RISES AND DOWNS OF THE ARID ZONE

This chenopod shrubland community comprises of numerous bluebush species. Throughout the study area, this community is dominant along the proposed powerline route towards Broken Hill and in the vicinity of the proposed substation where red or brown clays or red loams occur. Across some communities, the formation of a gibber like appearance is common, in particular, along the stony rises of the study area where this vegetation type occurs. The shrubs Black Bluebush (*Maireana pyramidata*), Pearl Bluebush (*M. sedifolia*), Copperburrs (*Sclerolaena* spp) and Ruby Saltbush (*Enchylaena tomentosa*) form a major component of this community.

This community, in composition and landscape position, corresponds with the vegetation identification 155 '*Bluebush shrubland on stony rises and downs of the arid zone*' as described by Benson *et al.* (2006). Degradation by long-term grazing is considered to be a threat to this vegetation community. Benson *et al.* (2006) suggests that without total active management of all pastoral leases across western NSW of grazing and feral herbivore control, bluebush shrubland could become threatened over the long term.

BLADDER SALTBUSH SHRUBLAND ON STONY PLAINS AND DOWNS OF THE ARID ZONE

Another chenopod shrubland, Bladder saltbush occurs primarily along the powerline route close to Broken Hill. This vegetation community is dominated by Bladder Saltbush (*Atriplex versicaria*) with many other chenopod species also present such as Copperburs and Bluebush.

This community, in composition and landscape position, corresponds with the vegetation identification 156 '*Bladder Saltbush shrubland on stony plains and downs of the arid zone*' as described by Benson *et al.* (2006). While this community is regarded as threatened by heavy grazing, particularly in the east portion of western NSW, the presence of bladder saltbush suggests that current grazing management across many areas of the study site is sympathetic to its current ecological integrity.

RIVER RED GUM OPEN WOODLAND

This open woodland community occurs on sandy or loamy soils in sandy creeks and is dominated by River Red Gum (*Eucalyptus camaldulensis* subsp. *obtusa*). Within the study area, it occurs along major drainage lines such as Umberumberka Creek and Lakes Creek. Typically, the understorey is sparse in this community and is usually influenced by adjacent vegetation. Nonetheless, typical understorey species included Silver Senna (*Senna artemisiodes*), Prickly Wattle (*Acacia victoriae*) and Emubush (*Eremophilia longifolia)*. Other species common throughout include Black Bluebush (*Maireana pyramidata*) and the grasses *Aristida echinata* and *Aristida contorta*. Many areas appear to be heavily grazed either by domestic stock and/or feral animals.

This community in composition and landscape position corresponds with the vegetation identification 41 '*River Red Gum Open Woodland of Intermittment Watercourses mainly of the arid climate zone*' as described by Benson *et al.* (2006). This community is regarded as of 'least conservation concern' as it is relatively common and undisturbed in the landscape.

Benson *et al.* (2006) reveal that this community is well represented in protected areas and is not threatened by clearing. However, changes to hydrological regimes, overgrazing by stock and localized weed infestations are the major threats to this vegetation community.

RIVER RED GUM WOODLAND OF ROCKY CREEKS

While this vegetation community is also dominated by River Red Gum (*Eucalyptus camaldulensis* subsp. *obtusa*), the presence of species such as Mulga (*Acacia aneura*) and Dead Finish (*Acacia stenophylla*) typically associated with rocky hills, indicate the landscape position of this community which is confined to gravelly creeks on hillsides or rocky gorges. Sticky Hopbush (*Dodonea viscosa* subsp. *angustissima)* and Cough Bush (*Cassinia laevis*) provide a very sparse shrub layer in places. Grasses such as Kanagroo Grass (*Themeda australis*) and *Digitaria brownii* contribute to a very sparse ground layer of vegetation, typical of this community. The main threat to this community is heavy grazing, which has the ability to inhibit regeneration which occurs after localized flooding. Few areas within the study area showed signs of recent regeneration, likely due to the impact of goats.

This community in composition and landscape position corresponds with the vegetation identification 234 '*River Red Gum Woodland of rocky creeks in the ranges of the arid climate zone*' as described by Benson *et al.* (2006). This community is of 'least conservation concern' as it is relatively common and undisturbed in the landscape.

PORCUPINE GRASS – RED MALLEE – GUM COOLIBAH HUMMOCK GRASSLAND / LOW SPARSE WOODLAND

This community is presently undescribed as per Benson *et al.* (2006) (John Benson, Royal Botanic Gardens, pers.com., Dec 2007), and has not been identified elsewhere in NSW. Therefore, the study area provides the only known occurrence of this vegetation community in NSW.

This community is dominated by Red Mallee (*Eucalyptus socialis*) and Gum Coolibah (*Eucalyptus intertexta*). The occurrence of these species is extremely unusual on rock ranges and this may also be the western-most occurrence of Gum Coolibah in NSW (John Benson, pers.com, Dec 2007). Some areas on the ranges are devoid of trees and are hummock grasslands, while other areas contain scattered trees.

A description of this vegetation community is currently being written by John Benson which provides the following information. The community will be known as vegetation identification 359 'Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland / low sparse woodland on metamorphic ranges on the Barrier Range, Broken Hill Complex Bioregion' (John Benson, pers.com, Dec 2007.

A number of threats are likely in relation to this community including climate change and overgrazing which may impact on seedling survival of trees and shrubs. Soil and water erosion have also been identified as threatening processes.

It is suggested that this community is likely to recover considerably if these causal factors, especially over grazing, that are likely threats are removed (John Benson, Royal Botanic Gardens, pers.com, Dec 2007).

BLACK BLUEBUSH LOW OPEN SHRUBLAND OF THE ALLUVIAL PLAINS AND SAND PLAINS OF THE ARID AND SEMI-ARID ZONES

This vegetation community is found adjacent to the study area on the Mundi Mundi Plain on the Barrier Range Alluvial Fans. This community is generally dominated by Black Bluebush (*Marieana pyramidata*) and other chenopods such as Copperburrs and occurs primarily on deep, sandy-loam soils of drainage depressions.

This community, in composition and landscape position closely corresponds with the vegetation identification 153 '*Black Bluebush low open shrubland of the alluvial plains and sand plains of the arid and semi-arid zones*' as described by Benson *et al.* (2006). Grazing of this vegetation community is recognized as a key factor in floral degradation, and will continue to be a threat, should inappropriate grazing management continue.

SAND PLAIN MULGA

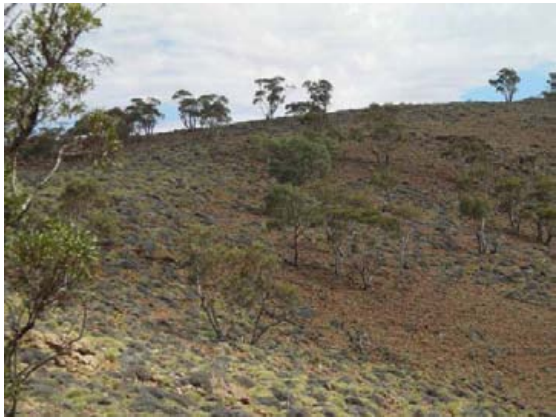
This tall open shrubland is dominated by Mulga (*Acacia aneura*) with other shrub species such as Belah (*Casuarina pauper*), Turpentine Bush (*Eremophilia sturtii*) and Punty Bush (*Senna* form taxon '*filifolia*'). In the study area, this community occurs in the small patches near ephemeral drainage lines and on sandy areas in the eastern portion of the study area.

This community in composition and landscape position corresponds with the vegetation identification 119 '*Sand plain Mulga tall open shrubland of the seme-arid and arid climate zones*' as described by Benson *et al.* (2006). These authors also predict that the community may be threatened in the future if heavy grazing pressures continue in some areas inhibiting the regeneration of key species.

BLACK OAK WOODLAND

This low open woodland is dominated by Black Oak (Casuarina pauper) and Western Rosewood (*Alectryon oleifolius*). In this study area, this community was recorded in a small area of the north-western section on rocky hills.

This community in composition and landscape position corresponds with the vegetation identification 60 '*Black Oak – Western Rosewood – Blue Bush/Saltbush low sparse woodland on gravelly downs in the arid climate zone'* as described by Benson *et al.* (2006). These authors identify that overgrazing by stock, rabbits and goats has affected regeneration and this community could be under long term threat if these factors are not removed.



Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland / low sparse woodland

River Red Gum open woodland.

Mulga-Dead Finish on stony hills

Sand plain Mulga

Black Bluebush shrubland

Black Oak woodland

River Red Gum woodland of rocky creeks

Prickly Wattle open shrubland

Bluebush shrubland on stony rises

Bladder Saltbush shrubland

Figure 4-1: Examples of vegetation communities of the study area

4.2.2 Conservation status of vegetation communities

The conservation status of each of the natural vegetation types present in the study area is summarised in Table 4-1 based on data presented in Benson *et al.* (2006).

Table 4-1: Conservation status of natural vegetation types in the study area

Vegetation type	Pre-1750 extent (ha)	Current Extant (ha)	Reserves Total Area (ha)
Vegetation ID 123: Mulga-Dead Finish on stony hills	600,000 (+-30%)	500,000 (+-30%)	26,210
Vegetation ID 153: Black Bluebush low open shrubland	1,500.000 (+-30%)	900,000 (+-30%)	53,030
Vegetation ID 155: Bluebush Shrubland on stony rises and downs	300,000 (+-30%)	150,000 (+-30%)	30,603
Vegetation ID 156: Bladder Saltbush shrubland	1,000,000 (+-30%)	500,000 (+-30%)	6,300
Vegetation ID 41: River Red Gum open woodland	40,000 (+-30%)	35,000 (+-30%)	6,920
Vegetation ID 234: River Red Gum woodland of rocky creeks	10,000 (+-50%)	9,000 (+-50%)	1,340
Vegetation ID 359: Porcupine Grass – Red Mallee – Gum Coolibah hummock grassland / low sparse woodland	Unknown	Currently, the community found in the study area is the only known occurrence within NSW (Approximately 250 ha)	None
Vegetation ID 136: Prickly Wattle open shrubland	5,000 (+-50%)	4,000 (+-50%)	None
Vegetation ID 119: Sand plain Mulga	2,200,000 (+-30%)	1,200,000 (+-30%)	35,352
Vegetation ID : Black Oak Woodland	50,000 (+-50%)	30,000 (+-50%)	3,600

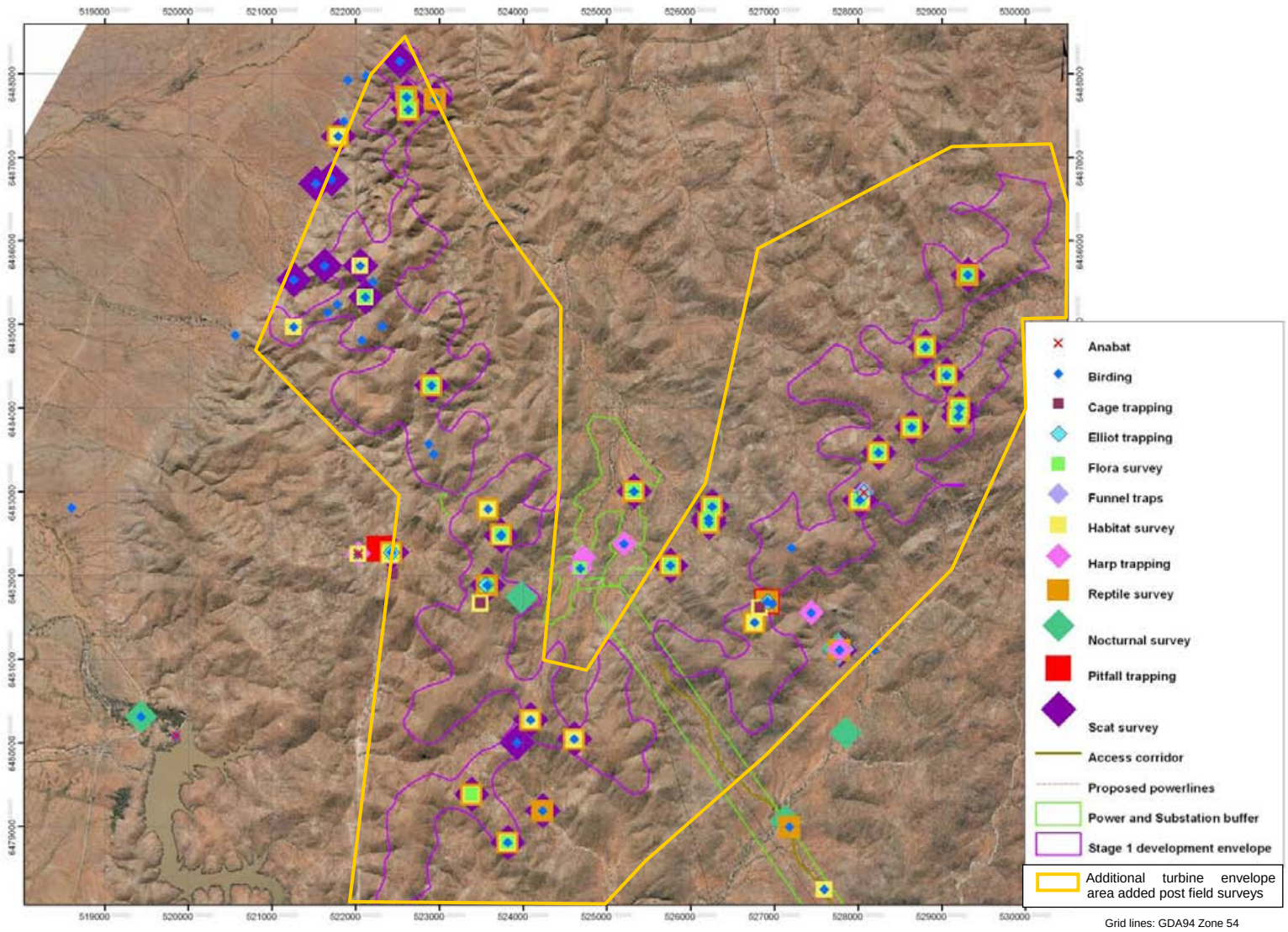
4.2.3 Vegetation communities of conservation significance

While no Endangered Ecological Community as listed under Schedule 3 of the NSW *Threatened Species Conservation Act 1995* is present in the study area, the identification of an undescribed vegetation community is regarded as significant.

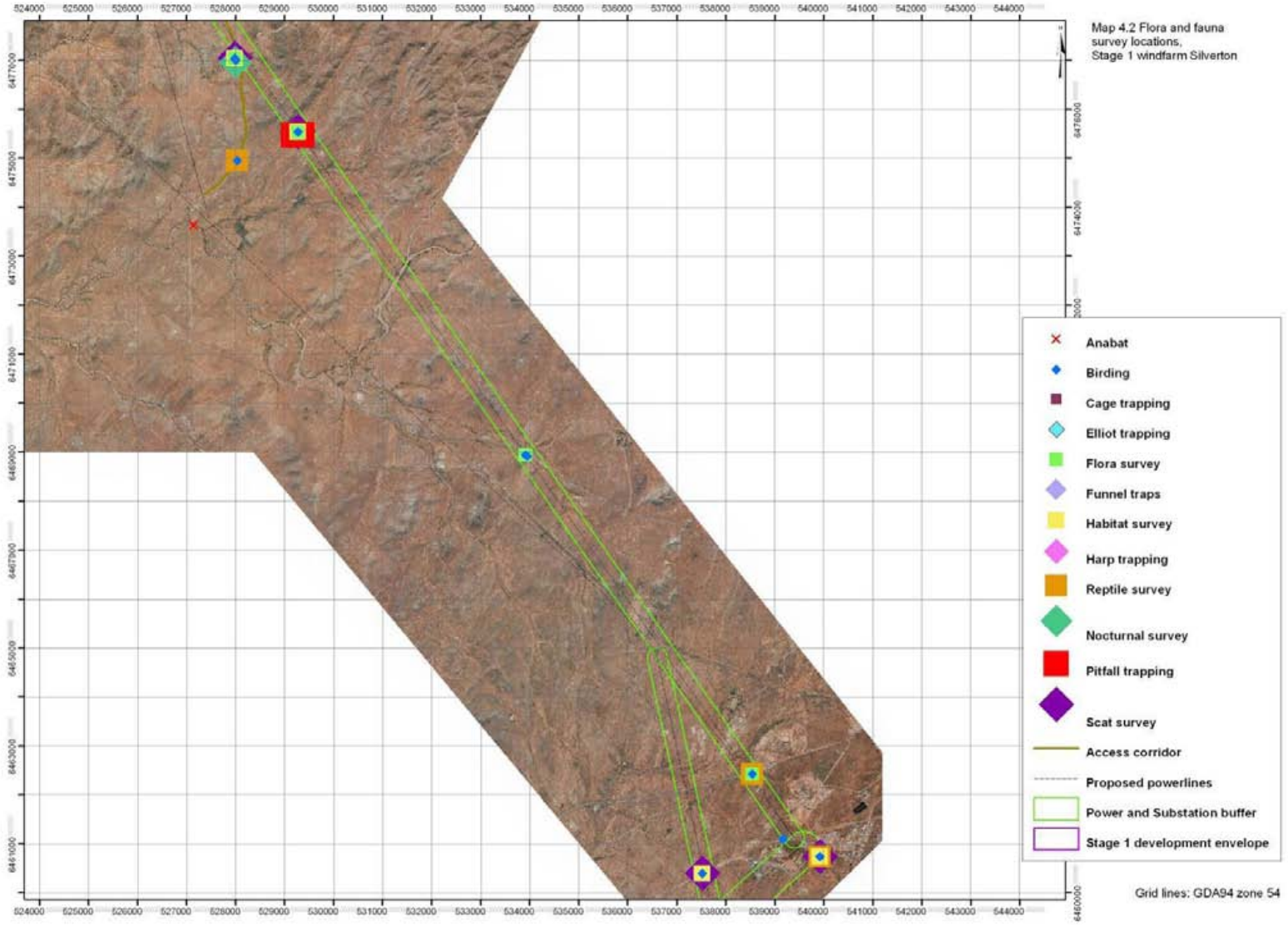
The community is currently being described by Dr. John Benson of the Royal Botanic Gardens which will be known as 'Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland / low sparse woodland on metamorphic ranges on the Barrier Range, Broken Hill Complex Bioregion'. The dominant tree species are Red Mallee (*Eucalyptus socialis*) and Gum Coolibah (*Eucalyptus intertexta*). Red mallee generally occurs on red aeolian sand (Harden 1991), and its presence on rocky ridges in the study area is significant. Gum Coolibah is generally found east of the study area, and its presence here is considered an outlying population of the species (John Benson, pers.com, Dec 2007).

The community is similar in some respects to vegetation ID 169 Curly Mallee that occurs on the Barrier Range further north but this community is not dominated by Triodia nor does it contain the two eucalypt species that are present in this community.

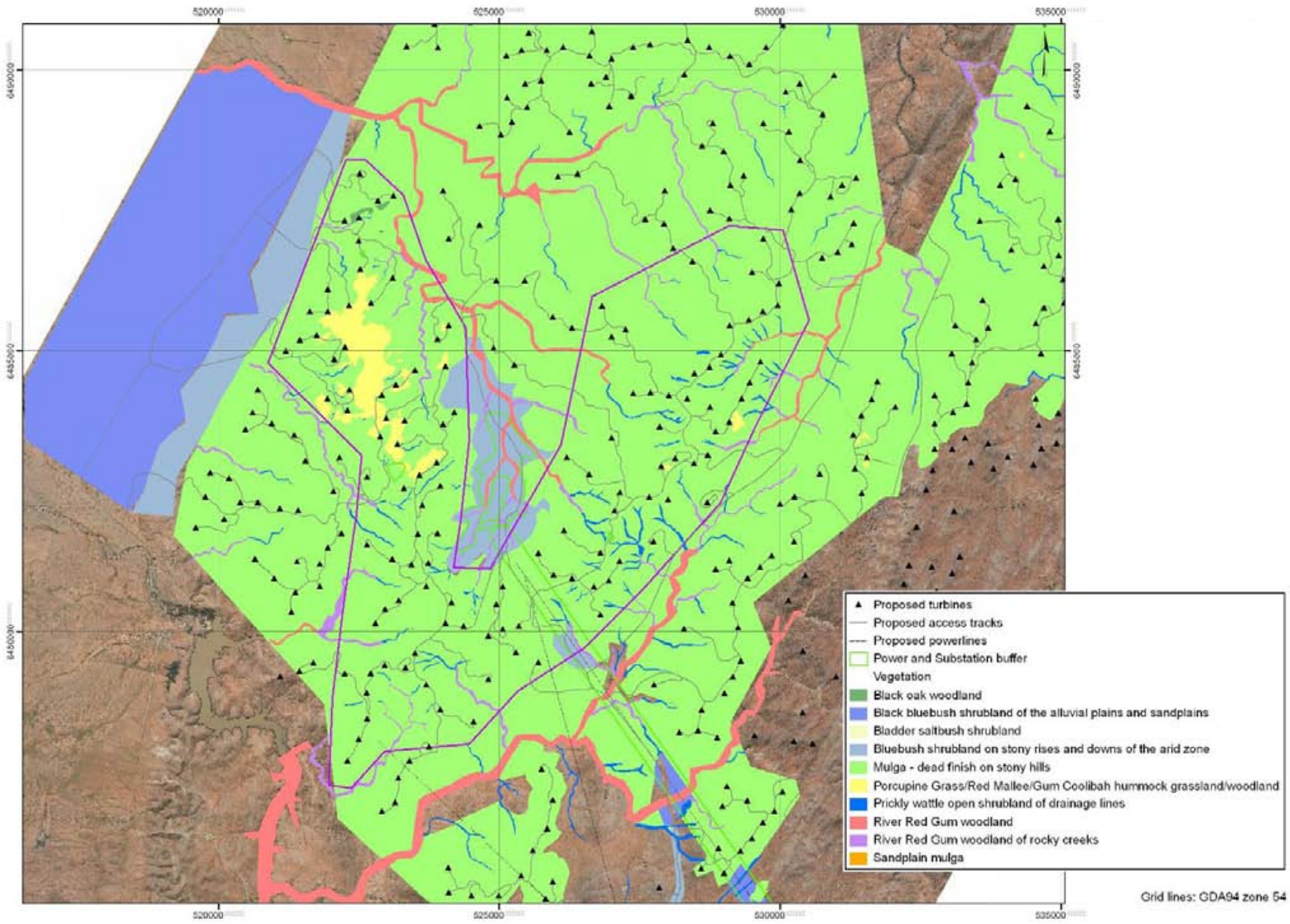
This community represents an unusual occurrence of Red Mallee and Gum Coolibah growing with spinifex grass on rocky ranges in the arid zone. The extent of the vegetation community is small in context of the entire site, covering approximately 250 hectares (see Map 4.3 & 5 for extent).



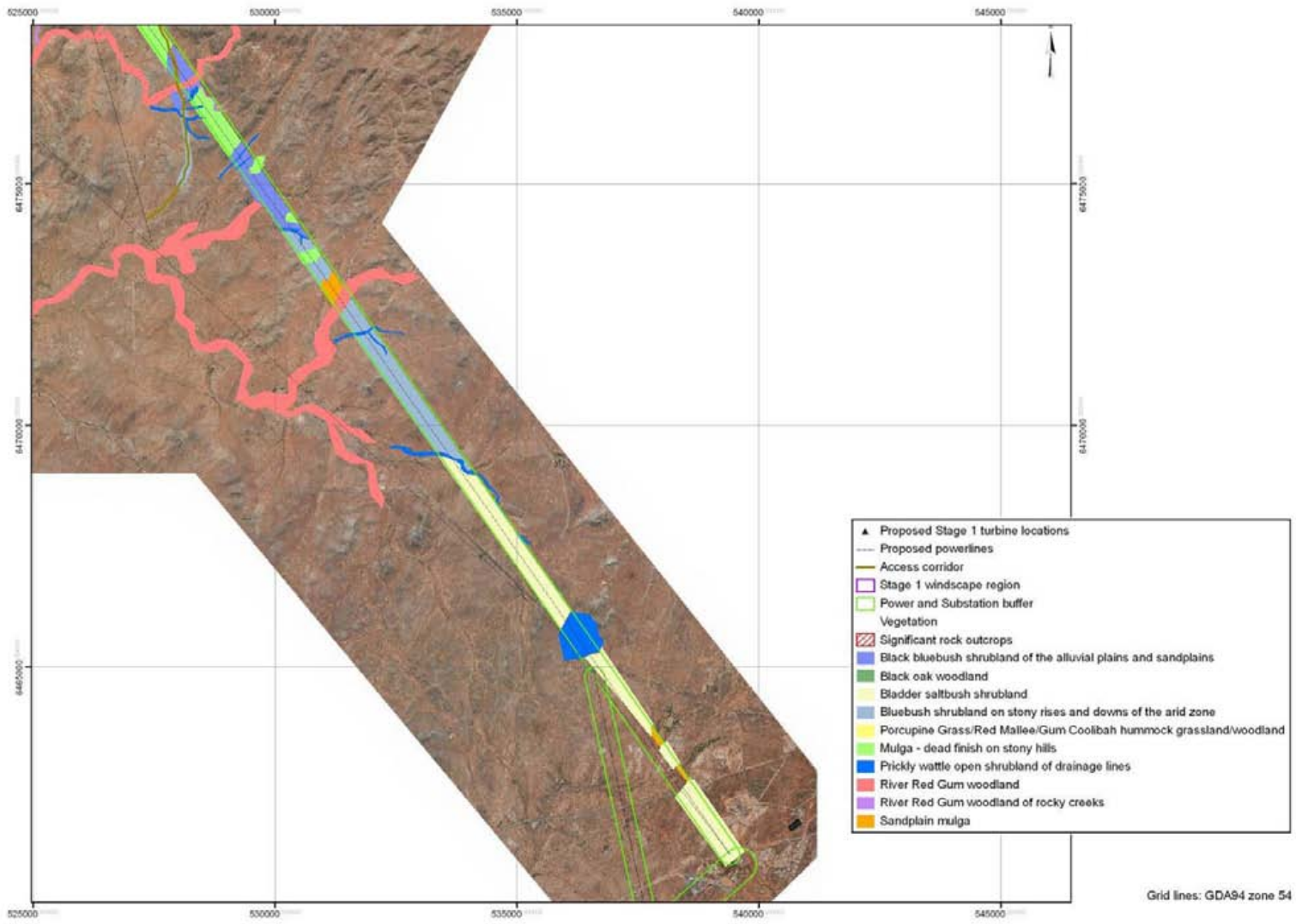
Map 4-1: Flora and fauna survey locations across the study area



Map 4-2: Flora and fauna survey locations across the study area



Map 4-3: Approximate extent of vegetation communities (Stage 1 windscape region)



Map 4-4: Approximate extent of vegetation communities (powerline route).

4.2.4 Species recorded at the subject site

A total of 89 plant species were recorded during the flora survey, including 11 exotic species. A full list of species recorded is provided in Appendix A. As noted above, this list is not exhaustive due to the extensive nature of the study area, and the omission of some species which grow or flower outside the survey period, or after periods of heavy rainfall, may have occurred.

4.2.5 Species of conservation significance

No threatened plant species or Endangered Ecological Communities (EECs) were detected within areas that would be affected by the proposal. The development envelope is large and it is likely that not all species within it were recorded. However, flora surveys targeted representative vegetation types and habitat known to be favoured by threatened species and therefore it is considered highly unlikely that threatened species or EECs within the development envelope went undetected.

There are nine threatened plant species known to, or predicted to, occur in the Barrier Range CMA subregion; these include species listed under either the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (Bionet and DECC threatened species predictor tool based on the Barrier Range sub-region of the Broken Hill Complex Bioregion and Protected Matters search tool using a 30 kilometre buffer, respectively). These are:

- Purple-wood Wattle *Acacia carneorum*
- Silver Wattle *Acacia rivalis*
- Saltbush *Atriplex infrequens*
- *Dysphania platycarpa*
- Spike-rush *Eleocharis obicis*
- Showy Indigo *Indigofera longibractea*
- Yellow-keeled Swainsona *Swainsona flavicarinata*
- Slender Darling Pea *Swainsona murrayama*
- Creeping Darling Pea *Swainsona viridis*

Two endangered ecological communities are also known to, or are predicted to, occur in the subregion. These are:

- Neila woodland
- Aquatic ecological communities in the natural drainage system of the lowland catchment of the Darling River (DECC 2007)

An evaluation of species of conservation significance with potential to be affected by the proposal was undertaken using searches from the Bionet search tool (Broken Hill Bioregion) and the EPBC Matters of Environmental Significance search tool (using a buffer of 50kms from the site). Three species were evaluated as having potential to be affected:

- Showy Indigo *Indigofera longibractea*
- Yellow-keeled Swainsona *Swainsona flavicarinata*
- Creeping Darling Pea *Swainsona viridis*

Guided by the NSW *Threatened Species Conservation Act 1995*, a 7-part test was undertaken to properly characterise the potential impacts on these species (Appendix D. Note: This Act is not applicable for Part 3A Major Projects however, the 7-part test is considered by the authors of this

report to provide the most appropriate and transparent characterisation of potential impact). The assessment concluded that the potential for significant impact on these species is low.

4.2.6 Disturbance and weeds

The study area has suffered significant disturbance, as with other parts of the Western Division since European occupation. A series of events has lead to the widespread degradation of the vegetation communities; in particular, Mulga dominated communities. These events are discussed in section 3.1.5 and provide some insight into the ongoing changes to vegetation structure and subsequent effects on long-term viability should threatening processes such as inappropriate grazing continue in the study area.

The vegetation communities of the study area are within the Western Division and would have been significantly disturbed since European occupation. The condition of the Mulga-Dead Finish vegetation community in the study area is poor, and characteristic of past land use practices across the Western Division. In most areas, the key tree species are absent or very few, being dominated by dead stags of these species. There is very little regeneration of key species such as Mulga and Dead Finish across most of the development area.

The impacts of feral grazing on the vegetation communities of western NSW have been long recognised. Field investigations of the study area identified that the southern areas of the study area appeared to have a higher number of goats and greater numbers of scats (south of the existing monitoring tower), and there was a qualitative correlation between the condition of the vegetation increasing with an increasing distance from Umberumberka Dam; likely a key resource for feral goat populations in the area.

Continuing degradation of the vegetation communities of the study area is further highlighted by increasing sedimentation of the local water storage dams. Wasson and Galloway (1986) report that sediment deposition was around 50 times greater in Umberumberka Dam than before European settlement, while Ghassemi and White (2007) report that Stephens Creek Reservoir had a silt depth of up 2.4m deep. While the exact causes of the sedimentation are unknown, it is likely that the changes in vegetation structure across the study area and wider locality would have resulted in increased sedimentation of water bodies.

However, Condon (1983) and Wasson and Galloway (1986) have noted that the cover of vegetation in the area around Broken Hill has increased during the last 30 years, and that as a result the rates of erosion have fallen. Much of the reason for this moderate recovery has been attributed to a drop in the rabbit population. However, the farming of feral goats continues across the Western Division, and the practice continues to impact on the vegetation communities, including those within the study area.

Despite the degradation and structural changes to these communities occurring as a result of past and current land use practices, the study area is dominated by native flora species, with only 11 introduced species recorded. No noxious weeds were recorded as declared by the *Noxious Weeds Act 1993* for the Broken Hill local government area or the Unincorporated area.

4.3 Impact assessment

Although the development may have substantial environmental benefits in terms of reducing green house gas emissions and the impacts of climate change, it may also result in a number of adverse impacts to local biodiversity. These can be considered in terms of the three phases of the development: construction, operation and decommissioning.

4.3.1 Construction impacts

Direct impacts
The proposal would result in the removal of vegetation within the development footprint, including turbine towers and the surrounding hardstand areas, control building, substation, new and widened access tracks and powerline poles associated with the internal power lines and the 25 km 220kV power line (linking the wind farm to Broken Hill). Underground cable corridors would generally follow access tracks constructed to and between the wind turbines and other facilities.

Table 4.2 provides an estimate of the type and quantum of native vegetation loss required for the development of the wind farm (illustrated on Map 4-5). Based on these calculations, Stage 1 works would displace approximately 83 hectares of native vegetation. Approximately eight hectares of native vegetation would be disturbed to enable the construction of the turbines; this could be rehabilitated after the construction phase. An additional 60 hectares could be rehabilitated after the life of the project. Approximately 13 hectares of native vegetation would be permanently displaced (footings would remain insitu after the project is decommissioned) even after decommissioning.

Significant areas of constraint were identified early in the biodiversity investigations with specific regard to the identification of an undescribed vegetation community now being described as 'Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland / low sparse woodland on metamorphic ranges on the Barrier Range, Broken Hill Complex Bioregion' (Benson & Sass 2008). This community is significant from a vegetation perspective (it is highly likely to be nominated for listing as an Endangered Ecological Community in NSW) and because it provides habitat to two endangered spinifex-obligate reptiles also found onsite (Slender Mallee Blue-tongue Lizard and Marble-headed Snake-lizard).

Iterative project design using the biodiversity constraints maps has enabled the area of proposed impact to be substantially reduced in the occurrences of Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland onsite. No turbines would now be located in this vegetation type. Access roads would be minimised in length and width and would be located on the periphery of this vegetation rather than through it, where ever practical. The net result is that 0.81 (1.3km x 6m) hectares of this community is proposed to be impacted by tracks, rather than the original 4.68 hectares (7.8km x 6m) shown in the early design drawings (refer to Map 4-6).

Additionally, several iterations of the power line route have been assessed, all with the same type and degree of constraints. Mitigation has been developed specific to the need to retain some flexibility in the final route location.

Risks regarding habitat loss, modification and fragmentation remain, but have been substantially reduced. The following measures have been formulated to ensure the resulting risk to this community and the habitat it provides is addressed, and there is a net gain in relation to the condition and long term viability of this community onsite, including:

- Track location micro siting prior to construction. Targeted surveys led by an experienced herpetologist would survey the proposed areas of direct impact to determine the status of Slender Mallee Blue-tongue Lizard and Marble-headed Snake-lizard within areas proposed to be impacted. The aim of this work would be to microsite access tracks to avoid key cohorts of these species. This will also ensure that any key cohorts are not impacted by habitat fragmentation and isolation.

- During construction, track width through spinifex vegetation would be minimised. Where possible, strategies would include avoiding routes that require extensive cut and fill, maximising the use of single lane access tracks and clear demarcation of the Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland to contractors to ensure that work and access is minimised within this community.

- Post construction, tracks through spinifex would be modified to further reduce their width. Ideally, this would include using rocks or artificial habitat such as roof tiles or pavers to reduce the track width and concurrently provide refuge to dispersing fauna and some protection to germinating grasses. The aim of this measure is to reduce fragmentation.

- Post construction, a program to minimise goat impacts on Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland onsite would be implemented. The vegetation is degrading under current management practices. The goal of this measure is to achieve a net gain within Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland onsite, taking into account the direct loss to tracks.
- Post construction, a Recovery Plan would be prepared for the Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland vegetation community which occurs onsite and the threatened reptile fauna which rely on it. This Plan would incorporate the results of monitoring of goat minimisation, and identify appropriate long term management strategies to prevent its continued degradation in the long term. Its aim would be to achieve a net gain within this vegetation type and protect it from threatening processes.

Map 4-5: Infrastructure proposed showing extent of vegetation impact

The Stage 1 wind turbine envelope, showing proposed turbine sites and access track locations.

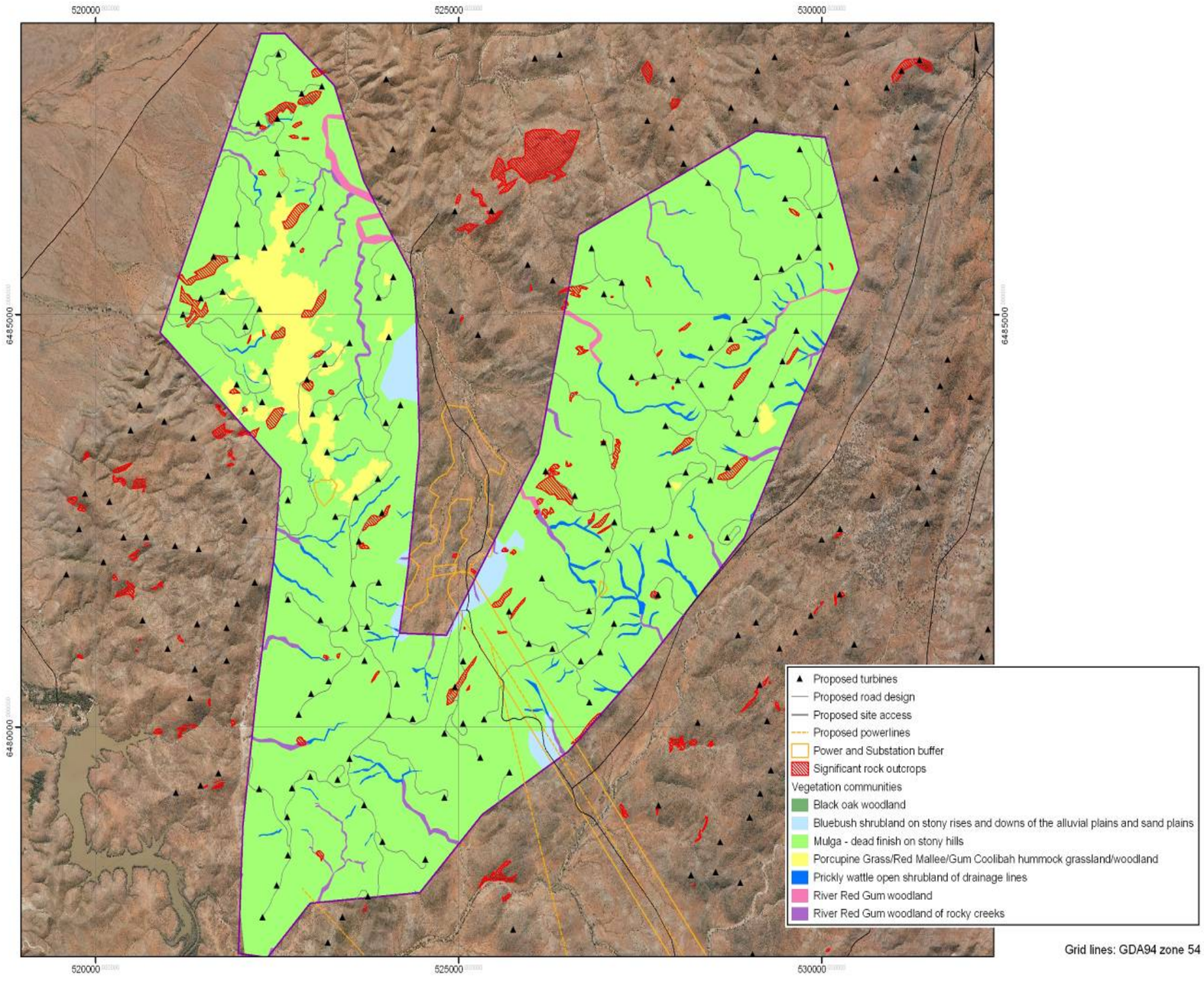


Table 4-2: Estimated extent of vegetation loss

Where possible, the area of impact for proposed infrastructure has been estimated. Turbines and tracks are overlaid on vegetation types, Map 4-5 overleaf. For tracks and building / turbine footings, this would constitute a loss of habitat. For transmission lines, a small area would be removed to install poles. The greater proportion of the transmission line may require lopping where vegetation height exceeds 4m and minimal impact where vegetation is below 4m in height. There is some scope to microsite infrastructure based on flora values at the time of development.

	Quantity or length	Dimensions	Total area (hectares)	Impact area within each vegetation community (hectares)						
				Mulga – Dead Finish	Prickly Wattle shrubland	Bluebush shrubland	Bladder Saltbush	River Red Gum open woodland	River Red Gum of rocky creeks	Porcupine Grass - sparse woodland
Transmission switchyard [3]	1	300 x 300m	**9.00**	0	0	9.00	0	0	0	0
Site substation [3]	1	100 x 100m	**1.00**	0	0	1.00	0	0	0	0
Control and communications building [3]	1 control room	20 x 30m	**0.06**	0	0	0.06	0	0	0	0
Maintenance facility [3]	1	60 x 50	**0.30**	0	0	0.30	0	0	0	0
Construction compound [1]	1	200 x 100	**2.00**	0	0	2.00	0	0	0	0
Concrete batch plants [1]	3	150 x 150m	**4.50**	0	0	4.50	0	0	0	0
Turbine towers and footings [3]	120 turbines	15 x 15m	**2.70**	2.68 (119 turbines)	0.02 (1 turbine)	0	0	0	0	0
Access tracks onsite [2]	86.45km	minimum 6m	**51.87**	50.17 (83.61km)	0.13 (0.22km)	0.68 (1.13km)	0	0.04 (0.07km)	0.05 (0.08km)	0.81 (1.34km)
Underground powerline cabling onsite [2]	45.0km	2m	**9.00** [5]	6.0	0.5	1.0	0	0.5	0.5	0.5
Total (hectares)			**82.68** [6]	**58.85**	**0.65**	**18.79**	**0**	**0.54**	**0.55**	**1.31**

[1] Areas which could be rehabilitated after the construction phase = 8.75 hectares

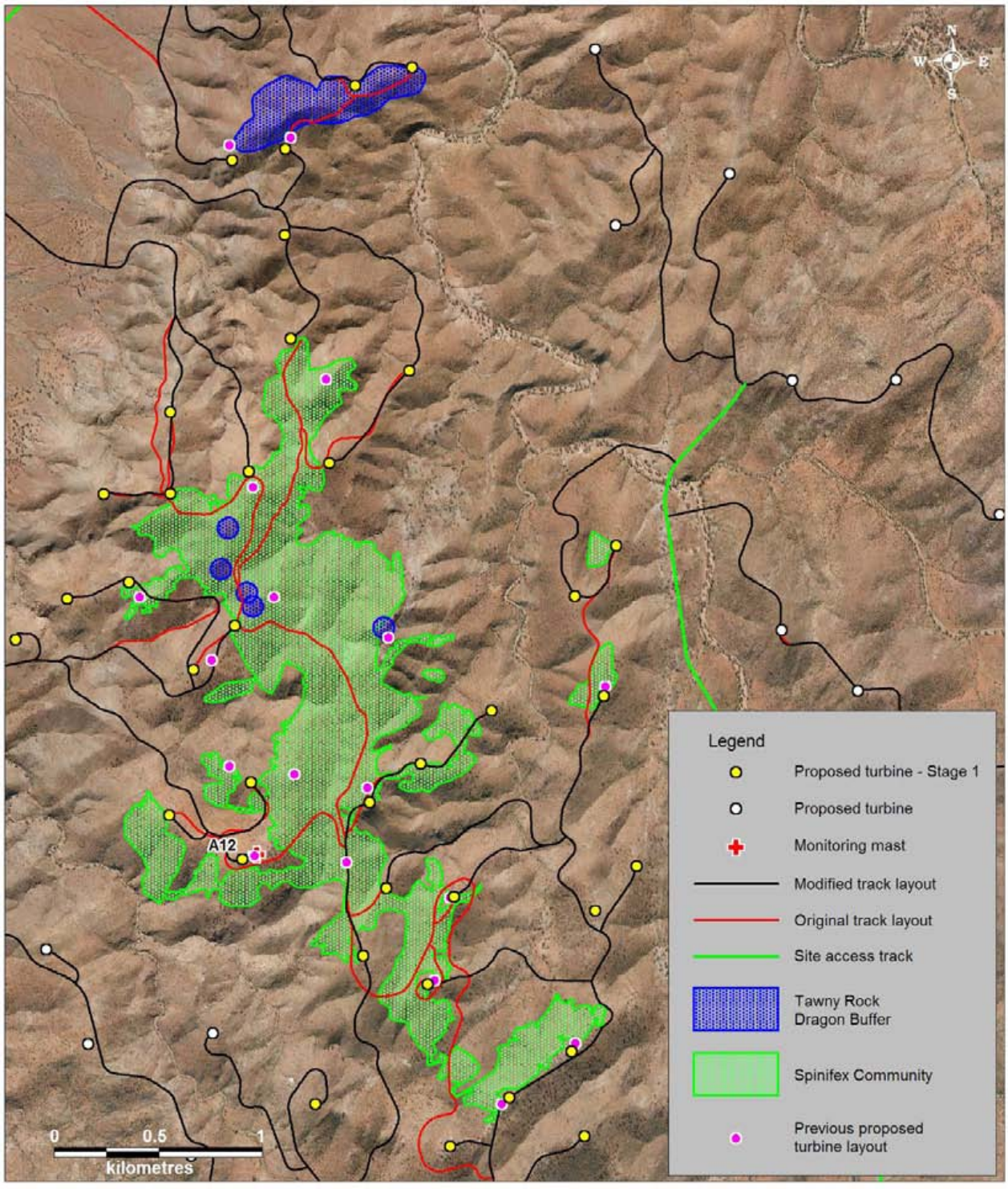
[2] Areas which could be rehabilitated after the life of the project = 60.87 hectares

[3] Areas permanently impacted (includes all footings) = 13.06 hectares

[4] Access tracks onsite are largely existing farm tracks that would require upgrades

[5] Located within access tracks onsite where possible; these areas represent an estimated worst case scenario which is that no tracks could be located within access roads

[6] As the precise location of some infrastructure has not yet been determined, vegetation subtotals do not equal the total impact area of 82.68 hectares



Map 4-6: Changes to infrastructure layout to minimise impact on Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland / low sparse woodland

Turbine and access track locations have been altered to minimise impact on this vegetation community.

Indirect and peripheral impacts

Vegetation surrounding the development footprint would be affected by vehicle access and parking, materials laydown and spoil deposition and retrieval. Peripheral impacts may include soil compaction, soil erosion and sedimentation. The works have the potential to introduce and spread weed species. The concrete batch plant and associated flush pit, if used, would alter local subsoil conditions over the medium term.

Pollution risks are associated with the concrete batch plant, fuels and lubricants and construction chemicals used at the site. With appropriate safeguards and practices (refer to the Environmental Assessment), these risks to native vegetation are expected to be low. Similarly, the increased bushfire risks to vegetation caused by construction activities are expected to be manageable and acceptable. Dust would be generated from the excavation and building activities at the construction sites, and by traffic using unsealed access routes, over the construction period. The limited duration of dust deposition is not expected to significantly affect soils and vegetation at the site.

Impacts on threatened species and communities

The impacts of the proposal on the threatened flora species are identified and assessed in the Assessment of Significance presented in Appendix D. Showy Indigo, Creeping Darling Pea and Yellow-keeled Swainsona were assessed via a TSC Act 7-part test. The assessment concluded that the potential for significant impact on these species is low. The assessment also identified a common threat to several species, that being habitat degradation caused by heavy grazing in combination with drought.

Additionally, avoiding impact to the vegetation mapped as Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland / low sparse woodland is recommended. This community is considered significant considering that the only known extent is within the study area. Microscale selection of infrastuture which has a flexible location such as tracks and cabling should be used by having an appropriately qualified ecologist to avoid any threatened flora species should they be present during the construction period. This is an appropriate action considering the highly ephemeral nature of many threatened flora species and that the subject land was not surveyed in its entirety.

CONCLUSION

In view of the local abundance of the majority of the vegetation communities present and the low development ratio of the subject land, the proposal is not expected to significantly affect flora values at the site. Conversely, management of current levels of grazing through intensive control of feral goats, will aid in the long-term sustainability of the vegetation communities within the study area, and potentially further into the surrounding locality. This management activity would allow recruitment of species currently subject to intensive grazing, and increase vegetative cover over the entire site. This is considered to be a net gain.

The following general and project specific measures are proposed to ensure that the flora values and vegetation communities of the study area are not expected to be significantly affected at the site. In general, if the locations of works (including temporary activities such as concrete batching) are situated in already cleared areas or sparsely vegetated areas, biodiversity impacts in relation to vegetation would not be of a significant level.

General measures

- Site stabilisation and rehabilitation would be undertaken without delay, following the guidelines in the EA

- Works would avoid impacts to mature shrubs and trees wherever possible and would be confined to cleared areas and sparsely vegetated areas as much as possible, avoiding denser shrub and woodland patches
- As a general rule, existing clearings would be used for vehicle and machinery access, materials laydown, stockpiling of cleared vegetation and the deposition and retrieval of spoil whenever practicable
- Wherever practical, works would be avoided during, and immediately following heavy rainfall events to protect soils and vegetation at the site
- Any compaction of soil resulting from vehicle access and laying of materials, particularly during saturated soil conditions, would be avoided and remediated as necessary
- Excavated topsoil, subsoil and weathered rock would be stored separately and replaced in a manner that approximates the original profile as closely as possible
- Appropriate fire fighting equipment would be held on site and an appropriate number of people onsite would be trained in its use
- Machinery and vehicles used in construction works would go through a wash zone before and after site access to reduce the introduction and spread of weeds and pathogens
- Laydown sites for excavated spoil, equipment and construction materials would be weed-free or treated for weeds wherever practicable
- Post construction weed monitoring should be undertaken after the first significant rainfall event to ensure that no weed infestations have resulted from the works
- Imported materials such as sand and gravel would be sourced from sites which do not show evidence of noxious weeds or *Phytophthora* infection

Project-specific measures

- **ngh**environmental recommend that infrastructure placement avoid where ever possible the biodiversity constraints identified in Map 5-2
- Contractors and staff should be made aware of the significance and sensitivity of the 'Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland / low sparse woodland vegetation community. These areas of vegetation should be protected from peripheral and indirect impacts and should not be used for materials/equipment laydown
- An appropriately qualified ecologist should be used to guide micro scale selection of infrastructure in the 'Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland / low sparse woodland vegetation community including tracks and cabling routes to avoid any threatened flora species should they be present prior to construction commencing. This is appropriate considering the highly ephemeral nature of many threatened flora species and that the subject land was not surveyed in its entirety. Contractors and staff would also be made aware of the threatened flora species that may occur within the study area disseminated in 'toolbox' talks should any become present during the construction period
- Works would avoid impacts to mature shrubs and trees wherever possible and should be confined to cleared areas and sparsely vegetated areas as much as possible, avoiding denser shrub and woodland patches
- Weed and sediment erosion controls should be implemented to prevent degradation to native vegetation during and following the proposed works. A Construction Environmental Management Plan would be the appropriate framework for these controls
- All areas of disturbed soil should be rehabilitated progressively as soon as practicable after disturbance, in order to resist erosion and colonisation by weeds. Design and implementation of specific erosion and sediment controls will be required to ensure that landforms are not destabilised and erosion is not increased onsite. This may rely on physical controls such as netting to stabilise slopes. Landforms in many areas are steep and

unstable and as such revegetation unlikely to be possible. Means to trap soil and moisture and stabilise slopes will provide the best potential for natural regeneration in the long-term

- Where cement is included in cable trench backfill, at least 20 centimetres of cement-free topsoil would be replaced as the top layer in the backfill

4.3.2 Operational impacts

The operational impacts of the proposal may include alteration to the prevailing grazing regime at the turbine sites, and some alteration to native fauna use of the sites. Inspection, maintenance and monitoring visits would be required, although existing tracks would be used and impact on vegetation is expected to be minimal. Access tracks would be maintained to minimise ongoing erosion and sedimentation impacts. The maintenance program would also include regular inspections for weed and rabbits, and control as required. Maintenance access would be confined to existing tracks, hardstand or heavily disturbed areas.

The impacts of major repairs would be similar in nature to construction impacts, but more limited in extent. The proposal would produce an ongoing pollution risk from the oil-cooled substation; design measures have been incorporated to ensure that any spill would be contained by bunding and the spill treated expeditiously.

4.3.3 Decommissioning impacts

Decommissioning impacts would be similar but not as extensive as construction impacts. The area of impact would be reduced because underground footings and cabling would not be removed from the site. Access tracks would be upgraded as required and appropriate weed hygiene and rehabilitation measures would be implemented. The decommissioning phase of the proposal may temporarily affect the use of habitat at the site by fauna, but is not expected to significantly affect local floral populations in the medium-long term.

nghenvironmental recommend the following measures to address operational impacts of the proposal:

- A flora assessment would be undertaken prior to decommissioning to identify biodiversity constraints
- Weed and sediment erosion control principles should be developed and implemented
- Disturbed ground should be stabilised and rehabilitated as soon as practicable after works

5 FAUNA

5.1 Approach and methodology

5.1.1 Preliminary assessments

A preliminary assessment of fauna habitat values and the likelihood of threatened fauna species being present was undertaken based on species distribution records and known habitat requirements. The results of previous fauna survey work in the region were also reviewed for threatened fauna records. Habitat requirements were drawn from a range of sources, including reference books, scientific papers, local research and author experience.

5.1.2 Field surveys and mapping

The fauna survey was carried out for nocturnal and diurnal species over the period 24th September and the 1st October 2007. The survey was intended to provide preliminary qualitative data to determine whether higher level investigation is warranted. As such, further assessment was undertaken between 26th and 30th November 2007 for specific threatened herpetofauna surveys and additional raptor nest searches. In particular, the surveys focused on rare and threatened species, species protected under international conventions, species which may be dependent on habitat in the study area, large or unusual concentrations of a species and species which may be especially sensitive to wind farm developments.

The survey provides data for use in assessments of impact significance and risk, for the monitoring of impacts during the operational phase and for the development of mitigation strategies.

The fauna survey techniques involved included:

- Bird censuses: targeted bird surveys occurred at 72 sites across the study area for a period of 20 minutes each including at the nearby Umberumberka Dam. Opportunistic sightings of threatened species were also recorded while travelling across the study area
- Habitat assessment, including searches for species signs (scats, runways, feeding signs etc), for a total of 9 hours to identify food and shelter resources, limiting or specialised habitat features such as hollows and other features known to be used by the threatened fauna that are known to, or predicted to occur in the study area
- Pitfall and Funnel Trapping targeting small mammals and reptiles occurred at 5 sites across the study area consisting of 150mm PVC tubes or where rock or shallow soil precluded the installation of these tubes, funnel traps were substituted. At each site, two traps were connected by 20 metres of drift fence to divert animals into these traps and each was opened for a minimum of three days. A total of 32 trap nights was undertaken
- Reptile hand searches were undertaken at 33 sites for a period of 20 minutes at each site, giving a total survey effort of 11 hours. Additional target searches for threatened reptiles was undertaken after the first survey period by four persons over 5 days for a minimum of 96 hours
- Elliot and Cage trapping was also used to target small mammals and reptiles where the rocky ground did not allow the installation of drift fences between pitfall or funnel traps. This was undertaken at four sites across the study area using 25 elliot traps and 2 cage traps at each site for three nights at each site. A total of 300 elliot trap and 4 cage trap nights was undertaken. These traps were baited with rolled oats, peanut butter and cat food as an attractant to mammals and reptiles
- Bat trapping was undertaken using 'harp traps' at 7 sites across the study area. At each site, one harp trap was erected for a total of two nights, giving a total of 14 trap nights

- Bats were also targeted using 'Anabat' ultrasonic call detection recording equipment. This was undertaken at 5 sites across the study area for a period of one night at each site, giving a total survey effort of 5 nights. With an absence of drinking sources across the site which microbats tend to visit regularly, one of these nights was at the nearby Umberumberka Dam to acquire additional data for the locality
- Nocturnal surveys were undertaken at six locations in the study area. These surveys included nocturnal call playback for the threatened Masked and Barking owls, listening for calling frogs and spotlighting for fossorial and arboreal fauna (both on foot and in vehicle). Each of the six sites was surveyed for a minimum of 20 minutes, giving a minimum survey effort of 120 minutes

The survey effort is summarised in Table 5-1.

The locations of the survey sites are indicated on Map 4.1 and 4.2. The fauna surveys sampled the range of habitats in areas that would be directly impacted by the proposal, particularly the turbine ridges. The survey also covered areas in and adjacent to the subject site which have greatest likelihood of providing habitat for threatened fauna, including threatened reptiles, woodland birds and microbats.

Map references locating surveys sites, transects and features of interest were obtained using a hand-held 12 channel GPS unit, and are based on the GDA datum.

5.1.3 Threatened and other significant species

The DECC NSW Atlas of Wildlife database was consulted for records of threatened species and other species of conservation significance in the study area based on the Corona, Fowler's Gap, Broken Hill and Taltingan 1:100,000 map sheet areas.

Other state and national databases were used to identify known and modelled significant fauna species distributions, including Bionet, Commonwealth Protected Matters search tool using a 30 kilometre buffer around the subject site. A list of threatened fauna with potential to occur at the site was compiled to assist the field survey design and species targeted (Appendix C). A precautionary approach has been adopted where distribution and habitat information is incomplete or uncertain.

5.1.4 Survey limitations

The spring timing of the fauna surveys (September - October and November 2007), provided mild to warm temperatures conducive to maximising detection of reptiles, birds and mammals. During the second survey session, rainfall provided conditions conducive to detecting frogs.

Considering the quality and diversity of habitats at the subject site, the selected survey methods and intensity are considered appropriate to determining the key biodiversity constraints of the site and for characterising the potential for impact of species that could occur onsite but went undetected. The limited duration and intensity of the surveys is sure to have resulted in the omission of some cryptic, sparsely distributed, ephemeral or seasonal species. For example, during wetter seasons, increased activity is expected in drainage lines within the study area as ephemeral watercourses provide a flush of resources. The survey duration and intensity were however considered to have been sufficient for the evaluation of biodiversity constraints.

Table 5-1: Summary of fauna survey effort during this study.

Technique	Target group	No. of sites	Timing	Total survey effort	Other comments
Bird censuses	Diurnal birds	72 including Umberumberka dam	20 minutes at each site	24 hours	Opportunistic records also collected while driving between sites and within the general study area
Pitfall and Funnel traps (with interconnecting drift fences)	Reptiles and small, ground dwelling mammals	5	Traps at each site were opened for a minimum of 3 days	32 trap nights	
Hand searches	Reptiles	33	20 minutes at each site	11 hours	Opportunistic records of larger species such as shinglebacks and sand goannas were also collected while driving between sites and within the general study area
Additional Hand searches	Tawny rock dragons, Slender mallee blue tongues and Marble-headed snake-lizards	Across the study area	Four persons for 5 days	96 hours	Opportunistic records of other fauna taxa were also collected
Elliot and Cage trapping	Small ground dwelling mammals, larger carnivorous mammals, reptiles	4	25 elliot traps and two cage traps at each site for 3 nights.	300 elliot trap nights/24 cage trap nights	Used where rocky ground prohibited the installation of pitfall traps and drift fences
Harp trapping	Bats	7	One harp trap for two nights at each site	14 trap nights	
Anabat call detection	Bats	5 including Umberumberka dam	1 anabat detector for one night at each site	5 nights	
Nocturnal surveys (call playback, spotlighting)	Nocturnal birds, mammals, reptiles and frogs	6	20 minutes at each site	120 minutes	Opportunistic records while driving between sites using car headlights and spotlighting.
Habitat assessment	Reptiles, Birds, Mammals, Frogs, Bats	36	Average of 15 minutes at each site, dependant on habitat complexity.	9 hours	Opportunistic records of all taxa were collected.

5.2 Assessment and survey results

5.2.1 Fauna habitats in the study area

Four general habitat types are available within the study area and can be summarised as rocky outcrops and ridges, woodland and grassland slopes, plains and ephemeral drainage lines. Additional habitat features were found to include hollow-bearing and mature vegetation and mine shafts and caves. These habitats play an important role in sustaining native fauna populations on site and potentially, in the locality, as described below.

ROCKY OUTCROPS AND RIDGES

The rocky outcrops range in area from discrete to extensive; in some cases outcrops were less than one metre square, in others entire ridgelines were covered by large partially buried boulders. The size of the rocks also varied from small fragments typical of scree slopes to large consolidated rock shelves. Rocks and crevices provided a large variety of refuge for reptiles and mammals, large and small. Some of the larger outcrops appeared to be preferred sites for goat occupation. In these areas goat scat was abundant and vegetation was sparse.

The distinct delineation of ridges rising above the surrounding plains creates updrafts and roost sites preferred by raptors such as the Wedge-tail Eagle. Prey available to raptors onsite includes goat kids, rabbits, small mammals and reptiles.

SHRUBLANDS

Trees, which were mostly low growing, were sparse over most of the site. In more sheltered landscape positions (lower slopes and south facing slopes), more dense concentrations of Mulga trees provided roosting and nesting habitat for birds and bats (Babbler nests were abundant in these areas).

Large areas of tree die back were evident across the study area. Evidence of goat grazing and drought is apparent. These areas provide limited habitat to native fauna.

HUMMOCK GRASSLANDS

Spinifex grassland is distributed predominantly in the north-west of the study area, on ridges, saddles and slopes under Mallee. It was not found on the lower landscape plains. Ridges are an unusual landscape position for Spinifex in NSW. Large numbers of old plants have expired (seemingly in one event such as an extended drought several years ago) but continue to provide important refuge for small reptiles and potentially mammals. Regrowth is evident, providing an excellent microhabitat for reptiles and potentially for small mammals.

PLAINS

The plains contain low ground cover, shrubs and trees, usually of very sparse density. Soils were fine and clay based but non-cracking, probably containing a substantial component of wind blown Aeolian sand. Fauna habitat was limited in these areas with rocks and fallen timber providing a limited refuge for ground-dwelling reptiles and mammals.

WATERCOURSES AND WETLANDS

Umberumberka Dam provides the only source of free standing water within close proximity of the site (2.5 km west of the development envelope). It is an artificial structure constructed in 1915, covering 145 hectares and capable of storing nine mega litres. One large ephemeral creek, Mundi Mundi Creek, crosses the site in the proposed substation area. Additionally, Lakes Grave Creek and Lakes Creek are present to the east of the development envelope (1km and 3km respectively). All three creeks are likely to provide free water and moist seeps for some time following larger rainfall events. They also contain large hollow-bearing trees, increasing the value of this fauna habitat as a refuge and source of water. Ephemeral drainage lines are also present in gullies (including extensive gorges such as Lords Gorge) and incised plains.

HOLLOW-BEARING AND MATURE TREES

Large hollows are present in the mature River Red Gums growing within the major drainage lines within the study area. These include drainage lines west of the range adjacent to the Mundi Mundi plains, near the area proposed for the substation, and east of the range, between the Day Dream Mine Road and Lakes Knob. These large hollows (>10cm diameter) occur only in association with ephemeral drainage lines in this landscape. Therefore, species requiring large hollows (including owls, arboreal mammals and colonial bats) will be dependant on these areas for refuge.

Smaller hollows are present in Mallee vegetation on ridges and slopes. These hollows are suitable refuge for woodland birds and bats. The degree of exposure to strong winds may lessen the value of these hollows in certain ridge and upper slope locations, particularly on westerly facing slopes which may bear the brunt of strong, hot and dust laden winds.

Dense concentrations of Mulga and Mallee trees were most often present in association with south facing slopes, presumably due to the higher moisture retention in these more protected areas. Given the extensive amount of die back over the many parts of the study area, the refuge provided in these protected areas constitutes an important resource. Babbler nests were often abundant in these areas.

Mature trees suitable for raptor nests are sparse within the study area. These occur most often in association with drainage lines, as discussed above, but are also present as scattered trees on ridges and slopes. Even stunted trees were found to be used by Wedge-tailed Eagles, with nests as low as 1.5m from the ground.

MINE SHAFTS AND CAVES

The site has a history of mining use. Several shafts were observed. As well, a small number of caves and overhangs were observed in the rocky and gorge areas. These sites can provide refuge for microbats. The site is subject to extremes of temperature increasing the importance of thermoregulation for bats (and reptiles). The lack of free standing water however, reduces the likelihood that bats regularly use these areas. Harp traps and Anabat detectors were used to detect the use of these features by bats.

Rocky outcrops

Mine shafts and natural caves are present in some areas.

Shrublands and grasslands

Mulga and Mallee woodland and spinifex grasslands provide varying degrees of refuge.

Plains

Fairy wrens and reptiles were recorded in the sparsely vegetated plains either side of the range.

Ephemeral drainage lines

Drainage lines dissecting the plains were the only areas where mature trees bearing large hollows are present.

Figure 5-1: Examples of fauna habitat types present in the study area

5.2.2 Field survey results

SPECIES RECORDED DURING THE SURVEY

One hundred and twenty-two fauna species were recorded in total during the field surveys. These include 78 bird species, 27 reptile species, 16 terrestrial mammal species (including six microchiropteran bat species and six introduced species) and one frog species (see Appendix B for details).

Of interest, the site features high avian and reptile diversity, found to be concentrated in the more intact rocky ridges, grassland and drainage line habitats. Low native mammal diversity was recorded. No mammal species were captured in Elliot, Cage, funnel or pitfall traps, nor were any small native mammals recorded incidentally. The study area provides refuge and connectivity for such species, however, their naturally low densities, drought, combined with high levels of grazing by feral goats causing modification and disturbance to these habitats, is the likely reason why none of the taxa were recorded during the study.

Specialist analyses of scats collected identified a number of species, including echidnas, foxes, cats, wedge-tailed eagles and dogs. Further analysis found that the scats of dogs, foxes and cats were found to have consumed rabbits, sheep, goats and kangaroos.

Foxes and rabbits were recorded onsite but appeared in low abundance. This is most likely attributable to recent drought in combination with heavy grazing, which has produced a paucity of ground cover for refuge for both species and feed for rabbits. Goats were the most abundant mammal onsite and the effect of their grazing was evident across all habitat types.

EFFECTS OF GRAZING BY GOATS

Goat grazing was found to be a key factor currently determining the level and quality of habitat on the site for many native species. They were found to be utilizing the plains, slopes and ridges. Evidence of their occupation (including scat and browsed vegetation). Their abundance appeared greater in the southern and western sections of the proposed development envelope. Conversations with land holders indicated that the goats are currently harvested more regularly from the eastern side arm of the development envelope.

Feral goats are usually sedentary when feed is available but are capable of moving large distances when feed is limited (Henzell 2000). Movement patterns vary according to topography, harvesting

pressure and feed availability (Freudenberger and Barber 1999). Few obstacles to movement occur across the proposed development envelope. In semi-arid woodlands of western New South Wales, feral goats were found to make daily movements of 3.1 km, focussing movements around intermittent lakes and creeks with abundant tree and shrub cover (Freudenberger and Barber 1999). Umberumberka Dam is likely to be a key resource to goats in the local area.

The NSW Scientific Committee has listed 'Competition and habitat degradation by Feral Goats' as a Key Threatening Process. Twenty-three threatened species were listed in the Committee's determination as being at risk due to this process, including the Yellow-footed Rock Wallaby, a species that has been recorded in the local area. Feral goats are competitors with native animals for water and shelter and may thereby leave native animals at increased risk of predation by foxes and eagles, both of which occur on site. There is evidence that the high amounts of scat and high levels of browsing associated with goats degrades habitat and adversely affects the dispersal of native reptiles. Goat kids also attract Wedge-tail Eagles and may allow a higher than usual density of this predator to be supported (an issue relevant to wind farm development).

The distribution and long-term viability of the threatened Tawny rock dragon may also be threatened by the presence of feral goats. Many crevices were filled, or partially filled with goat scats, particularly in the southern end of the proposed development, where goat numbers appeared substantially higher than in the northern section of the site, and where the Tawny rock dragon was noticeably absent. Feral goats have already been attributed to the degradation of rocky habitats for other rock-crevice specialists such as the Broad-headed snake (*Hoplocephalus bungaroides*) (Murphy 1996) and the Centralian Ranges Rock-skink (*Egernia margaretae*) NSW NPWS 2000).

Goat grazing can significantly affect native vegetation and thereby, the landscape's ability to resist erosion. Goats have a high reproductive potential. Females attain sexual maturity at around six months of age and produce one to three kids every eight months (Henzell 2000), or twice every 12 months under favourable conditions (Menkhorst 1995).

5.2.3 Profile of potential bird usage

The use of the site by birds is of particular relevance to wind farm development, as avoidance behaviour and direct collision impacts have potential to affect local populations.

GENERAL DESCRIPTION OF AVIFAUNA

The recorded abundance and diversity of birds within the development envelope was generally low. Flocking species included the Little Corella and Black Kite, active on the plains surrounding the range. Galahs and Wedge-tail Eagles were also commonly seen flying over the range at heights that would place them at risk of collision with operational wind turbines. Babblers were present in more dense clusters of Mulgas, predominantly in the more protected lower slopes. Drainage lines harboured the greatest diversity of birds recorded onsite, including Tawny Frogmouths, Red-backed Kingfishers, several species of honeyeater as well as White-winged Fairy Wrens. No wetland species were recorded on site.

RAMSAR WETLANDS AND MIGRATORY WETLAND SPECIES

There are no Ramsar wetlands close to the study area. Umberumberka dam is an expansive water body covering 145 hectares and may attract migratory wetland species. It is an artificial dam and is therefore unlikely to be an important regional resource for water birds. However, it has been in place since 1915 and is the only source of permanent free standing water in the locality.

Distinctive ephemeral drainage lines were found to contain a high proportion of the avian diversity on site. This is likely to be because of the mature and hollow-bearing trees in these areas creating a rare refuge rather than because of the water resource that is only ephemerally present. These drainage lines are likely to be preferred movement corridors for many birds onsite, due to the cover they provide.

RARE OR LIMITING HABITAT FEATURES

Rare and limiting habitat features in the locality include mature hollow-bearing trees required for roosting and nesting as well as the distinct ridges rising above the surrounding plains which create updrafts and roost sites preferred by raptors. While mature and hollow-bearing trees occur predominantly within the drainage lines on the plains that would be only minimally affected by the proposal, the use of the ridges is likely to be influenced by the placement of turbines. Wedge-tail Eagle nests were observed both in the drainage line west of the turbine development envelope as well as on the upper slope of a ridge in the north-west of the development envelope.

No rare or limiting food sources for threatened bird species are expected to be located at the site. The rabbit and goat population, coupled with the ridge slope updraft may provide an important and limiting hunting resource for the Wedge-tailed Eagle and potentially other raptors. Nest sites, as discussed, are limited on the site.

GEOGRAPHICAL FEATURES THAT CONCENTRATE BIRD MOVEMENTS

The proposal is located on a series of ridges surrounded by expansive plains. The range, which provides a greater degree of refuge (including trees, shrubs, gorges and the general topographic shielding of winds in lower slope positions) may concentrate hunting, foraging, roosting and nesting behaviour for some species, particularly raptors. The likelihood of avoidance and collision impacts is therefore increased in the ranges, in comparison to the surrounding plains.

MIGRATION CORRIDORS

Daily and seasonal migration corridors for waterbirds in the study area are not known. The subject site is not located between significant habitat areas, and as a result bird movements across the site may be diffuse and irregular (following rain), rather than concentrated and seasonal. No congregations of waterbirds were recorded at the subject site during the survey, and, given the habitat scale and quality, none would be expected to occur there. Umberumberka Dam may occasionally attract migrating species. This may lead to movements across the site on occasion.

No movement corridors were identified in the study area in recent research of large-scale movements of waterbirds between the Lake Eyre Basin and south-east Australia (see section 3.1.7 for more detail). However, localised movements are likely to occur given the occurrence of Umberumberka Dam (2 kilometres south of the subject site) and Stephens Creek Reservoir (20 kilometres to the south-east). Large numbers of waterbirds were not present at Umberumberka Dam during the study. The habitat at the dam consists primarily of an open body of water lined by a River Red Gum community. Large areas of other habitats such as sedges, lignum and shallow water and open shorelines conducive for foraging and breeding habitat for many waterbirds was not evident. If such localized movements did occur, a likely route between these two waterbodies occurs to the south of the proposed development.

Daily and seasonal migration corridors for woodland birds and other species in the study area are not known. Most woodland passerines in the study area are likely to use habitat with at least some tree cover. Many threatened woodland species are poor dispersers and are unlikely to venture far from remnant woodland patches and would therefore be most likely to be confined to the ranges and riparian corridors. However, several species found in the study area are known to move long distances and are regarded as highly nomadic. Particularly, honeyeaters are highly nomadic across the arid zone (Keast 1968), and for many species their distribution, abundance and breeding events are determined by mistletoe presence (Keast 1968, Barea & Watson 2007, Yan 1993). Spiny checked and Singing honeyeaters were abundant during the field work, while the Pied Honeyeater was also observed on numerous occasions across the study area. One individual Painted Honeyeater was also recorded. Mistletoe plants were widely distributed across the study area, with a distributional pattern conforming within drainage lines. Distribution patterns of parasitic plants such as mistletoe are tightly defined by host distribution and movement patterns (Watson 2001). This would imply that movement corridors for these mistletoe dependant honeyeaters would be predominately confined to riparian areas.

Grassland species are most likely to be concentrated on the plains and in association with riparian corridors. These species are predominantly sedentary.

5.2.4 Threatened species

THREATENED SPECIES RECORDED ONSITE

Eight threatened fauna species were recorded during field work, including four birds, one bat and three reptiles:

Birds

Pied Honeyeater	Painted Honeyeater
Redthroat	Pink Cockatoo

Mammals

Little Pied Bat

Reptiles

Slender Mallee Blue-tongue Lizard (not previously recorded in the region, nor predicted to occur)

Marble-headed Snake-lizard (not previously recorded in the region, nor predicted to occur)

Tawny Rock Dragon (previously only known from Mutawinjii NP in NSW)

The threatened reptiles identified in the study area were the most interesting from a biodiversity point of view.

The Marble-headed Snake-lizard and Slender Mallee Blue-tongue Lizard are known only from spinifex on sand plains and sand dunes (Sass 2006, Swan *et al.* 2004). These species were both recorded in spinifex on rocky ridges during the wind farm development envelope assessment. While it is unusual to find these species on rocky ridges and slopes instead of sand, the spinifex on rocky ridges appears to be the critical resource for the local populations of these species. The populations of these two species in the study area are highly significant from a regional and western NSW perspective and add a value contribution to the relatively few records of each species across NSW. Neither species has been recorded in the region prior to this study. Records for both species occur some 140 kilometres south where mallee occurs on sand dunes and plains. Spinifex habitat has been extensively cleared or highly degraded in NSW (Sass *et al*. 2005). The highly fragmented and in many cases, poor condition of many areas of spinifex in NSW and the apparent absence of Spinifex on rock outcrops in NSW (apart from a very small area in Mutawinjii NP) reinforces the importance of this habitat type in the study area.

The Tawny Rock Dragon, prior to this study, was known only from two locations in NSW; the main location is Mutawintji National Park where an extensive population is known. A single specimen was lodged with the Australian Museum from Koonenberry Mountain to the north of Mutawinjii. Searches of the latter site in 2001 failed to reveal any individuals, although it may still be present, albeit in very low abundance (Gerry Swan, pers.com. Dec 2007).

Little is known of the ecology of the Tawny Rock Dragon, except that it is a species that is restricted to rock outcrops in ranges and gorges (DECC 2005aj). Searches for this species across areas where it has been predicted to occur have failed to reveal their presence (DECC 2005aj). False absences are unlikely to be an issue with this species, as their diurnal activity (Swan *et al.* 2004) and the territorial nature of males (Osborne 2005), make this species very visible on rock outcropping during hot weather where they use these vantage points for territorial and mating activities. Absences from apparently suitable habitat suggests that other factors may be limiting their existence.

The study area was extensively searched across all areas featuring rocky features. These searches revealed that a large cohort of Tawny Rock Dragon is present in the north-western corner of the study area. Smaller cohorts were scattered across other parts of the study area, mainly in the north. The low dispersal capability of reptiles make these locations extremely important for their

continued presence in the area. As such, it could be said that if they are present elsewhere in the study area, they are likely to occur in such low numbers that detectability during the survey was limited (Bailey *et al.* 2004; Sass 2007). The species was also recorded north of the site near Mount Robe approximately 14 kilometres north of the proposed Stage 1 wind farm.

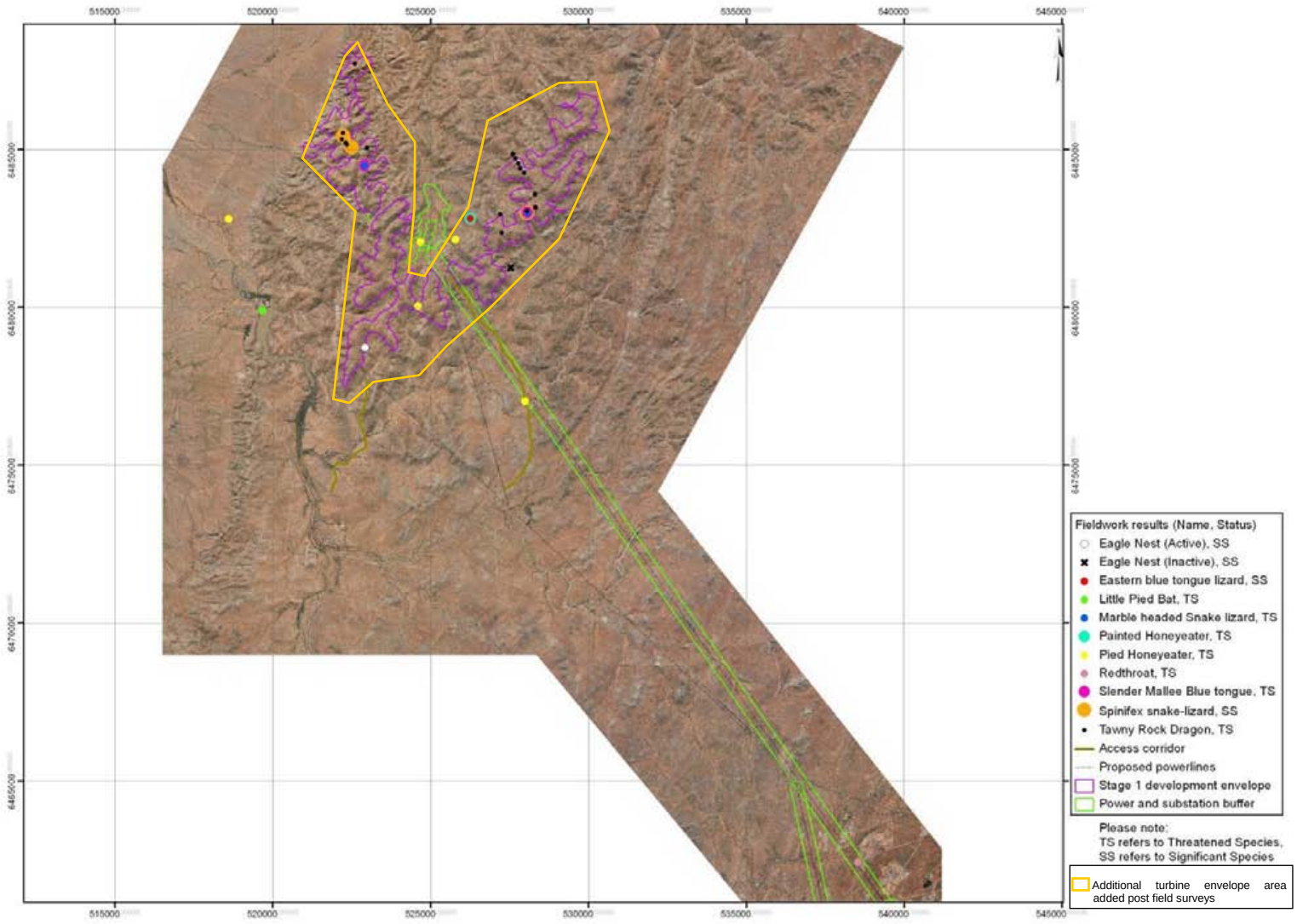
Two regionally significant reptile species were also identified:

- Eastern Blue-tongue Lizard
- Spinifex Snake-lizard.

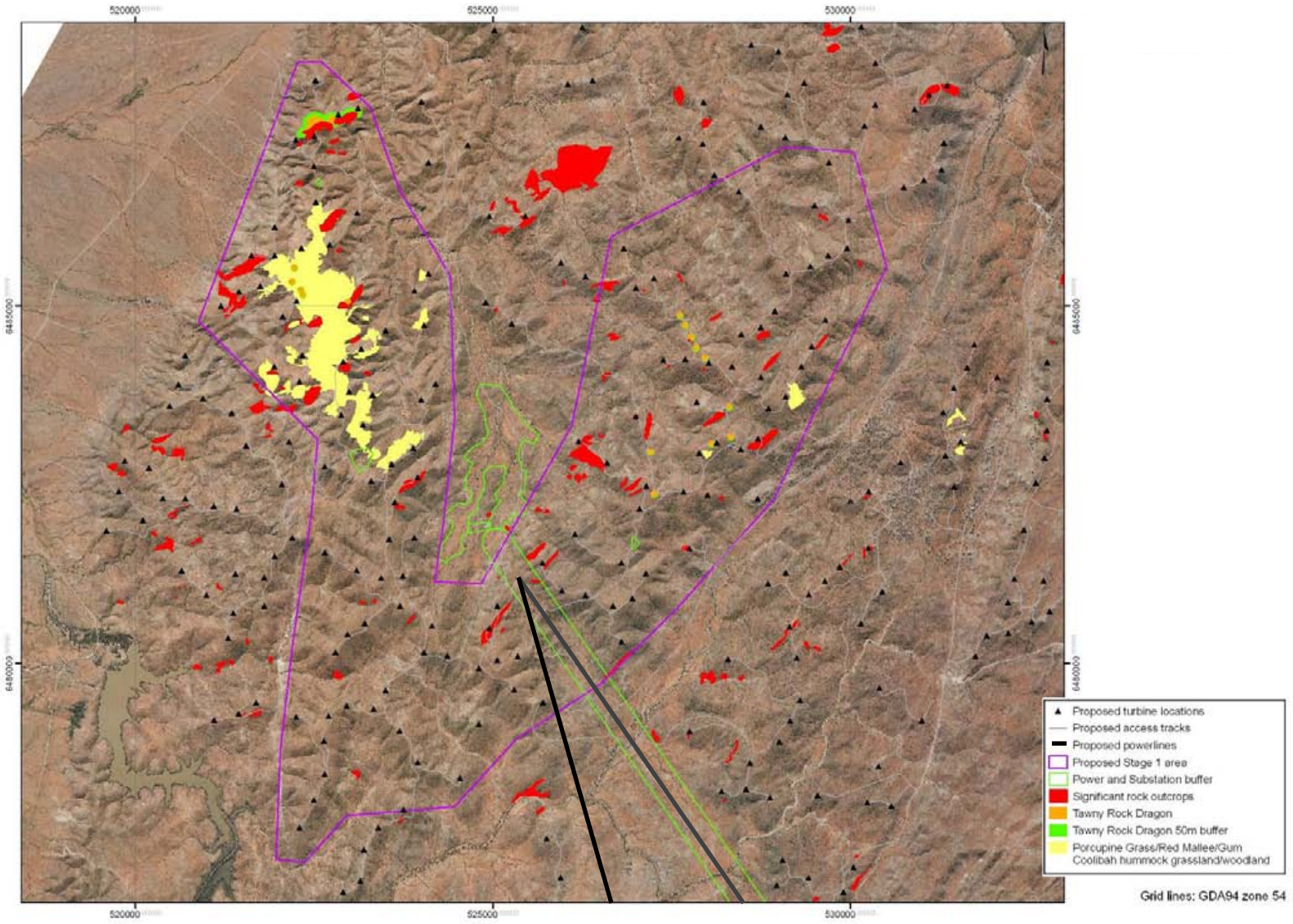
Eastern blue tongue lizards are generally distributed in eastern Australia (Cooger 2000). Previous to this study, this species was known to occur west across the Cobar Peneplain (Gerry Swan, pers.com, Dec 2007, Sass 2007) with scattered records in western NSW that are the likely result of wetter periods in geological time with only relict isolated populations remaining. An example is the small population of this species in a rocky outcrop gorge in north-western South Australia (Johnson 1992).

The Spinifex Snake-lizard is also a pygopod species that is known only from areas of Spinifex on sand dunes and plains (DECC 2007a, Sass *et al.* 2005, Swan *et al.* 2004). Although not listed as a threatened species, it has not previously been recorded in the region and its presence on rocky ridges is outside of the known ecological attributes of the species and is regarded as equally significant.

Records of threatened and significant fauna from this study are shown (Map 5.1)



Map 5-1: Threatened and significant fauna recorded during this study



Map 5-2: Biodiversity constraints within the study area

THREATENED SPECIES WITH POTENTIAL FOR IMPACT

An evaluation of species of conservation significance with potential to be affected by the proposal was undertaken using searches from the Bionet search tool (Broken Hill Complex Bioregion) and EPBC search engine (50km buffer). Twenty-seven species were evaluated as having potential to be affected:

Birds

Thick-billed Grasswren	Rufous Fieldwren
Pink Cockatoo	Scarlet-chested Parrot
Pained Honeyeater	Pied Honeyeater
Rainbow Bee-eater	White-throated Needle-tail
Barking Owl	Masked Owl
Black-breasted Buzzard	Square-tailed Kite
Australian Bustard	Grey Falcon
Fork-tailed Swift	

Mammals

Little Pied Bat	Inland Forest Bat
Kultarr	Forrest's Mouse
Stripe-faced Dunnart	Yellow-bellied Sheathtail-bat
Sandy Inland Mouse	

Reptiles

Tawny Rock Dragon	Slender Mallee Blue-tongue Lizard
Ringed Brown Snake	Marble-headed Snake-lizard
Woma	

Guided by state and commonwealth legislation, 'assessments of significance' were undertaken to properly characterise the potential impacts on these species (Appendix D). These assessments concluded that, *without* the adoption of mitigation measures, there is potential for the proposed works to generate lifecycle impacts sufficient to affect local viable populations, if present onsite, for 16 of the 27 fauna species considered. The risk relates to:

1. Loss or modification of important habitat - four species

   (Tawny Rock Dragon, Ringed Brown Snake, Slender Mallee Blue-tongue Lizard, Marble-headed Snake-lizard, Woma)

2. Ongoing collisions with turbine infrastructure – 12 species

   (Pink Cockatoo, Scarlet-chested Parrot, Painted Honeyeater, Pied Honeyeater, Masked and Barking Owls, Grey Falcon, Black-breasted Buzzard, Square-tailed Kite, Inland Forest Bat, Yellow-bellied Sheathtail-bat, Little Pied Bat)

The assessment identified habitat and habitat features important to threatened species onsite as rocky outcrops, spinifex grasslands and the Barrier Range ridge system (for wide ranging raptors). The assessment also identified a common threat to several species, that being habitat degradation caused by heavy grazing by feral goats and potentially rabbits in combination with drought. Specific mitigation measures were developed based on identified impacts and have been included in Section 4. With the effective implementation of these measures, **ngh**environmental consider that a significant impact on the subject species can be avoided.

5.3 Impact assessment

The development of the proposed Silverton wind farm would result in a number of impacts to local biodiversity. These can be considered in terms of the three phases of the development: construction, operation and decommissioning.

5.3.1 Construction impacts

HABITAT LOSS AND MODIFICATION

Table 4-2 summarises the areas of impact that would be associated with the development of the Stage 1 wind farm during infrastructure construction. Note that cabling between turbines may be installed within the access road easement and therefore may not necessitate additional disturbance. Turbine development is focused on upper slope and ridge locations where native vegetation is sparse. The substation would be located on the plain adjacent to Mundi Mundi Creek.

The ridges and upper slopes are used by reptiles, birds, macropods, goats and rabbits. Removal of habitat in ridge locations would include substrate for reptiles and small mammals. Mallee trees provide habitat for birds, particularly perch sites for Wedge-tail Eagles and other raptors. Some Mallee trees would require removal. Track and turbine footprints would be discrete and are not likely to substantially alter the forage and refuge habitat available to most species. For rock outcrop and spinifex specialists, development of these habitats may reduce important areas of habitat affecting the viability of local populations.

The routing of the powerline is predominantly through plains from Mundi Mundi Creek, continuing in a south-easterly direction. Again, this infrastructure would require a discrete loss of habitat including trees and shrubs. Vegetation is sparse in this landscape and the overall pattern and extent of clearing is unlikely to have an adverse effect on local fauna. Several iterations of the power line route have been assessed, all with the same type and degree of constraints. Mitigation has been developed specific to the need to retain some flexibility in the final route location.

DUST, NOISE AND VIBRATION

The installation of tracks, turbines, cable laying and associated infrastructure would generate temporary impacts. The dust, noise, vibration and activity associated with the construction phase may affect the foraging behaviour of local fauna species, particularly birds and macropods. Trenches required for the installation of cabling, predominantly within access roads, will present a trap hazard for local fauna for the time that they are open. Given the local abundance of similar habitat, this temporary effect on habitat utilisation is not likely to significantly affect local populations of these generally highly mobile species.

POLLUTION RISK

The concrete batch plant, construction activities using concrete and the storage and use of fuels, lubricants and construction chemicals carries a pollution risk.

In general, if the locations of works (including temporary activities such as concrete batching) are situated in already cleared areas or sparsely vegetated areas, biodiversity impacts should be low. To ensure impacts are minimised, **ngh**environmental recommend the following measures:

- A properly timed (November – December) Tawny Rock Dragon survey would be undertaken prior to construction in rocky outcrops located in the additional turbine envelope areas identified in Map 2. Micro-siting of tracks and turbines would then be undertaken to ensure buffer zones are located around areas of important habitat for this species.
- Infrastructure should be confined to cleared areas and/or sparsely vegetated areas as much as possible, avoiding denser shrub and woodland patches. Installation of new access tracks through these areas would not be appropriate (upgrade of existing tracks is acceptable)
- A buffer should apply to mature hollow-bearing trees to ensure indirect impacts (such as noise and dust) are minimised where practical
- Areas of with substantial rocky outcrops and spinifex should be avoided where possible (as per Map 5.2). A buffer should be applied to Tawny Rock Dragon habitat based on the known ecology of the species (and others in the *Ctenophorus* genus) in order to ensure that they are not adversely affected
- Clusters of rocks and boulders should be avoided where possible. Where rocks and boulders cannot be avoided, they should be placed directly adjacent to the works area to preserve the availability of refuge
- Standing dead trees and woody debris should be avoided where possible. Where they require removal to allow for the tracks and hardstand areas, they should be placed adjacent to the impact areas, to retain these refugia in the immediate area
- Trenches required for the installation of cabling would be open for the minimal period achievable. They would be checked at first light and any trapped fauna removed by an experienced handler
- Weed and sediment erosion controls should be implemented to prevent onsite habitat degradation during and following the proposed works. A Construction Environmental Plan would be the appropriate vehicle for these controls
- All areas of disturbed soil should be rehabilitated progressively as soon as practicable after disturbance, in order to resist erosion and colonisation by weeds. Design and implementation of specific erosion and sediment controls will be required to ensure that landforms are not destabilised and erosion is not increased onsite. This may rely on physical controls such as netting to stabilise slopes. Landforms in many areas are steep and unstable, which combined with the arid environment introduces significant issues in relation to revegetation. Means to trap soil and moisture and stabilise slopes will provide the best potential for natural regeneration in the long-term

5.3.2 Operational impacts

The key operational impacts of the proposal relate to the operation of the wind turbines. The potential bladesweep area of the turbines would range from approximately 34 to 155 metres above the ground. The impacts of the wind farm would be most acutely felt by those species utilising aerial habitat within the bladesweep zone; birds and microchiropteran bats. Other terrestrial fauna may be affected by turbine noise and blade flicker, although, given the low fauna diversity and abundance at the site, these impacts are likely to be limited.

AVOIDANCE AND COLLISION RISKS

There are two types of risk posed by the operational turbines.

i. Collision with wind turbines, or 'bladestrike'. For these purposes, 'bladestrike' refers to mortality caused by direct collision with turbine blades and by birds being swept down by the wake behind a turbine blade. The significance of the mortalities is specie-specific. If the

species is at low density in the landscape or susceptible to multiple collision events (such as for flocking species), collisions may threaten a local population. If the species is a top order predator or key stone species, there may be ecological ramifications for other species

ii. 'Avoidance' behaviour caused by the presence of the turbines and associated infrastructure. Depending on where the turbines are located, this may affect foraging patterns, nesting, roosting or movements around the site. It equates to a loss of modification of habitat and therefore can have resultant impacts on the carrying capacity of the site

A qualitative risk assessment for birds and bats, combining assessments of likelihood and consequence, was carried out to produce a final risk assessment of low, moderate or high risk for selected species (refer to discussion and full evaluation, Appendix F). Likelihood incorporates biological, behavioural and environmental risk factors. Consequence includes the significance of habitat loss and bladestrike in terms of habitat rarity and importance, population impacts, recovery potential and species conservation status. A distinction is drawn between the significance of impacts to individual birds at the site and impacts to the wider population. The assessment draws on the Interim Standards for Risk Assessment relating to birds and wind farms (Brett Lane and Associates 2005) and the Australian Standards for Risk Assessment (AS/NZS 4360) and Environmental Risk Management (HB203:2000). The risk assessment is summarised below.

Table 5-2 Overall impact risk for bird and bats (bladestrike and avoidance impacts)

The risk assessment focuses on bird groups which have been shown to be at particular risk in studies at other wind farms (raptors, waterbirds, migratory species), as well as rare, threatened or protected birds and bats with potential to be present in the study area. They are listed in order of decreasing risk to a local population.

Species	Risk to individuals at site	Risk to population
Wedge-tailed Eagle	Moderate	Moderate-high
Brown Falcon	Moderate	Moderate
Diamond Firetail	Low	Moderate
Parrots: Superb Parrot, Turquoise Parrot, Scarlet-chested Parrot, Night Parrot	Low	Moderate
Pink Cockatoo	Low	Moderate
Ducks: Blue-billed Duck, Freckled Duck	Low	Moderate
Owls: Barking Owl, Masked Owl, Grass Owl, Barn Owl	Low-moderate	Low-moderate
Bats: Yellow-bellied Sheathtail-bat, Inland Forest Bat, Little Pied Bat	Low	Low-moderate
Australian Hobby	Moderate	Low
Spotted Harrier	Moderate	Low
White-throated Needle-tail	Low-moderate	Low
Australian Kestrel	Low-moderate	Low
Peregrine Falcon	Low-moderate	Low
Tawny Frogmouth	Low	Low
Painted Snipe, Latham's Snipe	Low	Low
Egrets: Cattle Egret, Great Egret	Low	Low

nghenvironmental recommend the following measures to address operational impacts of the proposal:

- Infrastructure placement should avoid the constraints identified in Map 5.2
- Marker lights, if required should be minimised in number and fitted to reduce their ability to attract migrating birds and insects. Red lights are preferred, with the least number of flashes per minute. Cowls may also shield the light when viewed from the ground and reduce potential to attract wetland birds taking off at dusk. It is understood that CASA requirements will prevail
- Guy lines should not be fitted to towers or associated structures, where possible.
- The turbine towers should not provide perching opportunities.
- Electrical connection lines should be installed underground where possible.
- Power poles would be designed to minimise perching and roosting opportunities where practical.
- Power poles and overhead powerlines would be designed to reduce impacts to birds (for example by using flags or marker balls, large wire size, wire insulation, wire and conductor spacing) in areas of elevated risk of bird strike.
- To reduce the attractiveness of the site to foraging raptors, goats should be controlled onsite and carrion should be removed from beneath turbines as quickly as possible.
- An adaptive management monitoring program should be designed to document mortalities, remove carcasses and assess the effectiveness of controls. Timing should be specific to the most at-risk target species. Standardised and publicly available data should be collected to increase the knowledge base on this subject. If mortalities exceed a pre-determined threshold (set out in the monitoring program), additional mitigation measures should be considered, such as diversion structures, blade painting (refer Hodos *et al.* 2001), turning off turbines at critical times, further turbine ridge habitat modification and enhancement of off-site habitats.
- There would be benefits for several subject species in controlling heavy grazing by feral goats onsite. Implementation of a feral goat management program as part of the development of the wind farm site would assist in offsetting environmental impacts and halt the degradation that heavy goat grazing is causing across many areas of the site.

5.3.3 Decommissioning impacts

Decommissioning impacts would be similar but not as extensive as construction impacts. The area of impact would be reduced because underground footings and cabling would not be removed from the site. Access tracks would be upgraded as required. The decommissioning phase of the proposal may temporarily affect the use of habitat at the site by fauna, but is not expected to significantly affect local fauna populations in the medium-long term.

nghenvironmental recommend the following measures to address operational impacts of the proposal:

- A flora and fauna assessment should be undertaken prior to decommissioning to identify biodiversity constraints
- Weed and sediment erosion control principles should be developed and implemented
- Disturbed ground should be stabilised and rehabilitated as soon as practicable after works

6 CONCLUSIONS

A number of environmental gains are associated with wind farm development. They have potential to address Human-caused Climate Change, a process recognised in New South Wales as a Key Threatening Process, by reducing reliance on the burning of fossil fuels for energy. Climate change may involve both changes in average weather conditions and changes to the frequency of occurrence of extreme weather events. Consequent changes in habitat quality and composition have been identified as likely to place many Australian species at risk. Nonetheless, the proposal poses several risks to local biota.

This assessment has identified important habitats and habitat features onsite as well as several threatened species with potential to be adversely impacted either directly or indirectly by the proposal. Direct impacts to flora and fauna habitat will be minimal, as the infrastructure footprint is comparatively small and areas of conservation significance have been mapped to allow infrastructure placement to avoid them. Indirect habitat impacts can similarly be managed to reduce the risk of habitat degradation. Indirect impacts, such as avoidance behaviour, may affect the utilisation of resources in the local area. These impacts are considered to be manageable.

Risk of direct mortalities exists for species which can move at the height of turbines (birds and bats). A risk assessment was carried out for bird groups which have been shown to be at particular risk in studies at other wind farms (raptors, waterbirds, migratory species) and are known from the study area, as well as threatened birds and bats with potential to be present in the study area. On the basis of these investigations, the site does not appear to constitute an important habitat for migratory species or waterbirds although the ridge system does and will continue to attract raptors exploiting thermal currents. While studies have shown that for appropriately sited installations the number of birds killed per unit of wind generated energy produced is low (compared to other human-related causes of death; for example, vehicle collision and power line electrocution), a risk of population level impact remains which can be addressed in this proposal by way of adaptive management monitoring.

There are measures which can be taken to monitor and otherwise mitigate the risk of collision impacts. This report contains information that should be used as the basis for a tailored adaptive management monitoring program which would document mortalities, remove carcasses and assess the effectiveness of controls. Timing should be specific to the most at-risk target species. Standardised and publicly available data should be collected to increase the knowledge base on this subject. If mortalities exceed a pre-determined threshold (set out in the monitoring program), additional mitigation measures should be considered, such as further turbine ridge habitat modification and enhancement of off-site habitats.

This report has also established that there would be benefits for several subject species in controlling heavy grazing by feral goats onsite. Implementation of a feral goat management program as part of the development of the wind farm site would assist in offsetting environmental impacts and halt the degradation that heavy goat grazing is causing across many areas of the site.

The key mitigation strategies considered necessary to reduce the potential impacts to an acceptable level have been stated in Section 4 and 5 of this report. On the basis of these measures, no species or community listed under the NSW *TSC Act* or Commonwealth *EPBC Act* are considered likely to be subjected to a significant adverse impact.

7 ASSESSMENT PERSONNEL

The following personnel contributed to the field surveys and writing of this assessment.

Name	Role	Specialist skills and abilities
Nicholas Graham-Higgs	**Project Manager – Project management and senior review**	Nicholas has worked as an environmental planning and resource consultant since 1992, specialising in natural resource management. A wide range of assignments covering diverse natural and modified environments, have enabled Nick to develop a broad knowledge base in the area of natural resource planning and management.
Steven Sass B. App. Sci. (Environmental Science) (Hons) CSU	**Ecologist – Flora & Fauna surveys**	Steven joined **ngh**environmental in August 2006 with expertise in environmental consulting and biodiversity assessment. In the four years prior, he played a key role at Charles Sturt University, undertaking flora and fauna impact assessment for the Johnstone Centre (Environmental Consulting) and as a senior research officer within the biodiversity research and education team with much of his work in western NSW. Steven is an experienced ecologist having undertaken more than 400 aquatic and terrestrial threatened flora and fauna surveys and habitat assessments. His ecological expertise is used to design and implement landscape scale biodiversity surveys. These include studies of frog and reptile populations in the Murrumbidgee Irrigation Area (over 200,000 hectares) through surveys and habitat assessments at 160 sites, terrestrial biodiversity surveys and habitat assessments in the Upper Billabong Creek Catchment Area (around 30,000 hectares) and the impact of fire on biodiversity in a large reserve system (over 250,000 hectares) in western NSW. Steven has also managed numerous biodiversity assessments for large mining developments in western NSW. Steven has extensive experience and knowledge of the threatened species of western NSW having undertaken research and monitoring on a variety of species with a focus on threatened species management.

Name	Role	Specialist skills and abilities
Brooke Marshall	**Ecologist – Fauna surveys and habitat assessment**	Brooke is a first class honours Natural Resources graduate of the University of New England (UNE). She specialised in wildlife management, ecosystem rehabilitation and natural resource management in developing countries and was awarded a University Medal in recognition of high academic achievement. Brooke completed her honours project in association with CRC Pest Animal Control at CSIRO Sustainable Ecosystems Canberra, investigating conditioned aversion (CA) as a means to reduce the impact of fox predation upon colonies of threatened ground-nesting birds. Since joining **ngh**environmental, Brooke has prepared impact assessment and biodiversity assessment reports relating to a variety of infrastructure development (including roads, windfarms, telecommunications, water supply management and residential development) as well as river modification and prescribed burning works. These reports have included threatened floral and fauna species assessments, research, fieldwork and GIS components. Her major projects have included design of monitoring program for a potentially threatened population of Yellow-bellied Gliders on the South Coast, impact assessments and biodiversity assessments for a number of wind farm developments on the Southern Tablelands, a Species Impact Statement involving 33 subject species near Eden, and strategic biodiversity planning reports for the Snowy River Shire and Bega Valley Shire.
Gerry Swan	**Ecologist – Reptile and Frog surveys**	Gerry is a renowned herpetologist with current research interests with the Australian Museum and other collaborations. Gerry has over 30 years field experience throughout NSW and he is particularly interested in the reptiles of Western NSW. Recently, Gerry co-authored a field guide to the reptiles of NSW. His other research interests include the long term fluctuations in reptile populations and the effects of land use and habitat change on species diversity. Recent collaborations include a study of the reptile and frog communities of the vegetation remnants of the Murrumbidgee Irrigation Area with Steven Sass (now with nghenvironmental) and others from Charles Sturt University
Amy Currey	**Ecologist – Fauna surveys**	Amy graduated from Charles Sturt University with a double degree in Bachelor of Applied Science (Parks, Recreation and Heritage) and (Ecotourism), majoring in Wildlife Ecology and Management. She is currently enrolled to complete a Graduate Certificate in Ornithology, also with Charles Sturt University. Amy has over 18months professional experience in environmental management, planning and biodiversity surveys. Amy has 2 years experience in biodiversity surveys and assessments with a focus on avifauna surveys. During this time, she has gained extensive experience in undertaking surveys of birds, mammals, reptiles and amphibians, co researched the post fire avifauna monitoring program within the Pilliga region and undertaken full fauna surveys within a number of National Parks and reserves across NSW and northern Victoria.

Name	Role	Specialist skills and abilities
Shane Priddle B. Sc (Marine Science) UOW	**Spatial Analyst Field mapping and in-house map production**	Shane has expertise in GIS (Geographic Information Systems) in the area of resource management, carrying out the majority of **ngh**environmental's in-house mapping primarily with ESRI's Arcmap (Arcview) 9.2 software. This has included data collection, manipulation, analysis, interpretation and map generation for a variety of projects for both government and non-government organisations. Recent examples include mapping for the Visual Impact Assessment for Western Power's proposed transmission line upgrade between Busselton and Margaret River (southwest WA), a desktop Visual Impact Assessment based on GIS mapping for over 400kms of proposed transmission line between Kojonup-Albany-Wellstead (south coast WA), bushfire hazard mapping and generation of Asset Protection Zones (APZs) for the Perisher Range Resort areas (alpine NSW), and constraints mapping for several proposed transmission line upgrades for Country Energy between Bega and Eden (NSW south coast). He has also completed extensive mapping for two SIS projects on the NSW South Coast and a number of Part 3A Major

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APPENDIX A: FLORA SURVEY RESULTS

A total of 89 vascular plant species was recorded during the flora survey, 11 of which were introduced species.

Surveys were undertaken in the vegetation communities shown in the Biodiversity Assessment.

Species of conservation significance are bolded. Introduced species are denoted by an asterisk. Noxious weeds declared for the Unincorporated and Broken Hill control area under the *Noxious Weeds Act 1993* are indicated with a '*****' symbol.

Where uncertainty exists due to the unavailability of mature reproductive material, the taxon is preceded by a question mark, or plants are identified to genus level only.

Botanical nomenclature follows G.J. Harden (ed) (1990-2002) Flora of New South Wales, UNSW Press, except where recent changes have occurred.

Scientific name	Common name	Family
TREES		
Acacia anuera	Mulga	Mimosoideae
Acacia brachystachya	Umbrella Mulga	Mimosoideae
Acacia cana	Boree	Mimosoideae
Casuarina pauper	Black Oak	Casuarinaceae
Eucalyptus camaldulensis	**River Red Gum**	**Myrtaceae**
Eucalyptus intertexta	**Gum Coolibah**	**Myrtaceae**
Eucalyptus socialis	Red Mallee	Myrtaceae
Grevillea striata	Beefwood	Proteaceae
Hakea leucoptera	Needlewood	Proteaceae
SHRUBS, SUB-SHRUBS		
Acacia rigens	Needle Wattle	Mimosoideae
Acacia salincia	Cooba	Mimosoideae
Acacia tetragonophylla	Dead Finish	Mimosoideae
Acacia victoriae	Prickly Wattle	Mimosoideae
Atriplex vesicaria	Bladder Saltbush	Chenopodiaceae
Capparis mitchellii	Wild Orange	Capparaceae
Cassinia laevis	Cough Bush	Asteraceae
Chenopodium desertorum	Desert Goosefoot	Chenopodiaceae
Dodonaea lobulata	A Hopbush	Sapindaceae
Dodonaea viscosa subsp. Angustissima	A Hopbush	Sapindaceae
Eremophila duttonii	Budda	Myoporaceae
Eremophila longifolia	Emu Bush	Myoporaceae
Eremophila sturtii	Turpentine	Myoporaceae
Euphorbia eremophila	Desert Spurge	Euphorbiaceae
Hakea tephrosperma	Hooked Needlewood	Proteaceae
**Lycium ferocissimum*	African Boxthorn	Solanaceae
Maireana pyramidata	Black Bluebush	Chenopodiaceae
Maireana sedifolia	Pearl Bluebush	Chenopodiaceae
Myoporum montanum	Western Boobialla	Myoporaceae
Rhagodia spinescens	Spiny Saltbush	Chenopodiaceae
Senecio anethifolius	Feathery Groundsel	Asteraceae
Senna artemisioides	Silver Cassia	Caesalpinioideae
Senna barclayana	Smooth Senna	Caesalpinioideae
Senna form taxon 'petiolaris' http://www.anbg.gov.au/cgi-	Woody Cassia	Caesalpinioideae

Scientific name	Common name	Family
bin/apni?00TAXON_NAME=Senna+form		
Sida intricate	Twiggy Sida	Malvaceae
Sida petrophila	Rock Sida	Malvaceae
Solanum sturtianum	Thargomindah Nightshade	Solanaceae
VINES AND TWINERS		
Glycine clandestina	Twining Glycine	Fabaceae
FORBS		
**Acetosa vesicaria*	Rosy Dock	Polygonaceae
**Brassica sp.*	Wild Turnip	Brassicaceae
Calotis cuneifolia	Purple Burr Daisy	Asteraceae
Calotis hispidula	Bogan Flea	Asteraceae
**Carthamus lanatus*	Saffron Thistle	Asteraceae
Centipeda cunninghamii	Commmon Sneezeweed	Asteraceae
Chondrilla juncea	Skeleton Weed	Asteraceae
Chrysocephalum semicalvum subsp. *Semicalvum*	Hill Everlasting	Asteraceae
Cuphonotus humitatus	Mother Of Misery	Brassicaceae
Daucus glochidiatus	Native Carrot	Apiaceae
**Echium plantagineum*	Pattersons Curse	Boraginaceae
Einadia nutans	Climbing Saltbush	Chenopodiaceae
Enchylaena tomentosa	Ruby Saltbush	Chenopodiaceae
Erodium crinitum	Blue Crowfoot	Geraniaceae
Goodenia fascicularis	Silky Goodenia	Goodeniaceae
* *Hedypnois rhagadioloides*	Cretan Weed	Asteraceae
Helichrysum apiculatum	Yellow Buttons	Asteraceae
Lepidium phlebopetalum	Veined Peppercress	Brassicaceae
Malva preissiana	Australian Hollyhock	Malvaceae
Maireana georgei	Slit-Wing Bluebush	Chenopodiaceae
Oenothera stacta	Evening Primrose	Onagraceae
Persicaria decipiens	Slender Knotweed	Polygonaceae
Portulaca oleracea	Pigweed	Portulacaceae
Ptilotus obovatus var. *obovatus*	Silver Tails	Amaranthaceae
Rhodanthe floribunda	Common White Sunray	Asteraceae
Salvia verbenaca	Vervain	Lamiaceae
Senecio lautus	Variable Groundsel	Asteraceae
Senecio quadridentatus	Hill Fireweed	Asteraceae
Sclerolaena birchii	Galvanized Burr	Chenopodiaceae
Sclerolaena brachyptera	Short-Winged Peppercress	Chenopodiaceae
Sclerolaena lanicuspis	Woolly Copperburr	Chenopodiaceae
Sisymbrium erysimoides	Smooth Mustard	Brassicaceae
**Taraxacum officinale*	Dandelion	Asteraceae
**Tagetes minuta*	Stinking Roger	Asteraceae
**Verbascum virgatum*	Twiggy Mullein	Scrophulariaceae
Vittadinia cuneata	Fuzzweed	Asteraceae
Wahlenbergia communis	Tufted Bluebell	Campanulaceae
GRASSES		
Austrostipa nitida	A Grass	Poaceae
Aristida jerichoensis	Jericho Wiregrass	Poaceae
Avena fatua	Wild Oats	Poaceae
Bromus arenarius	Sand Broome	Poaceae
Cymbopogon ambiguus	Lemon Grass	Poaceae

Scientific name	Common name	Family
Chloris truncata	Windmill Grass	Poaceae
**Chloris virgata*	Feathertop Rhodes Grass	Poaceae
Digitaria brownii	Cotton Panic Grass	Poaceae
**Pennisetum setaceum*	Fountain Grass	Poaceae
Stipa scabra	Rough Spear-grass	Poaceae
Themeda australis	Kangaroo Grass	Poaceae
Triodia scariosa	Spinifex Grass	Poaceae
FERNS		
Cheilanthes sieberi subsp. *sieberi*	Mulga Fern	Adiantaceae
PARASITIC PLANTS		
Lysianna excocarpi	Harlequin Mistletoe	Loranthaceae
Amyema maidenii	Pale Leaf Mistletoe	Loranthaceae

APPENDIX B: FAUNA SURVEY RESULTS

1. Fauna species list

Common name	Scientific name	
Eastern Free-tail Bat	*Mormopterus Sp.3*	Bat
Gould's Wattled Bat	*Chalinolobus gouldii*	Bat
Inland Forest Bat	*Scotorepens balstoni*	Bat
Little Forest Bat	*Vespadelus vulturnus*	Bat
Little Pied Bat (V)	*Chalinolobus picatus*	Bat
Unidentified Long-eared Bat	*Nyctophilus sp.*	Bat
Australian Magpie	*Gymnorhina tibicen*	Bird
Australasian Grebe	*Tachybaptus novaehollandiae*	Bird
Australian Raven	*Corvus coronoides*	Bird
Banded lapwing	*Vanellus tricolour*	Bird
Black-faced cuckoo-shrike	*Coracina novaehollandiae*	Bird
Black-faced Woodswallow	*Artemus cinereus*	Bird
Black Honeyeater	*Certhionyx niger*	Bird
Black Kite	*Milvus migrans*	Bird
Brown Falcon	*Falco berigora*	Bird
Budgerigar	*Melopsittacus undulatus*	Bird
Chestnut-crowned babbler	*Pomatostomus ruficeps*	Bird
Chestnut-rumped thornbill	*Acanthiza uropygialis*	Bird
Chestnut Quail-thrush	*Cinclosoma castanotus*	Bird
Chestnut Teal	*Anas castanea*	Bird
Chirruping Wedgebill	*Psophodes cristatus*	Bird
Cinnamon Quail-Thrush	*Cinclosoma cinnamomeum*	Bird
Cockatiel	*Nymphicus hollandicus*	Bird
Common Bronzewing	*Phaps chalcoptera*	Bird
Crested Pigeon	*Ocyphaps lophotes*	Bird
Crimson Chat	*Epthianura tricolor*	Bird
Diamond dove	*Geopelia cuneata*	Bird
Dusky Woodswallow	*Artamus cyanopterus*	Bird
Emu	*Dromaius novaehollandiae*	Bird
Eurasian Coot	*Fulica atra*	Bird
Galah	*Cacatua roseicapilla*	Bird
Golden Whistler	*Pachycephala pectoralis*	Bird
Grey Butcherbird	*Cracticus torquatus*	Bird
Grey Shrike-thrush	*Colluricincla harmonica*	Bird
Grey Teal	*Anas gracilis*	Bird
Inland thornbill	*Acanthiza apicalis*	Bird
Jacky Winter	*Microeca fascinans*	Bird
Laughing Kookaburra	*Dacelo novaeguineae*	Bird
Little Corella	*Cacatua sanguinea*	Bird
Little Raven	*Corvus mellori*	Bird
Mallee Ringneck	*Barnardius barnardi*	Bird
Masked Woodswallow	*Artamus personatus*	Bird
Mulga Parrot	*Psephotus varius*	Bird
Musk Duck	*Biziura lobata*	Bird
Nankeen Kestrel	*Falco cenchroides*	Bird
Naretha Blue Bonnet	*Northiella haematogaster*	Bird
Orange Chat	*Epthianura aurifrons*	Bird

Common name	Scientific name	
Pacific Black Duck	*Anas superciliosa*	Bird
Painted Honeyeater (V)	*Grantiella picta*	Bird
Pallid cuckoo	*Cuculus pallidus*	Bird
Peaceful dove	*Geopelia striata*	Bird
Pied Butcherbird	*Cracticus nigrogularis*	Bird
Pied Honeyeater (V)	*Certhionyx variegatus*	Bird
Pink Cockatoo (V)	*Cacatua leadbeateri*	Bird
Rainbow bee-eater (Migratory)	*Merops ornatus*	Bird
Redthroat (V)	*Pyrrholaemus brunneus*	Bird
Red-backed Kingfisher	*Todiramphus pyrrhopygia*	Bird
Red-capped Robin	*Petroica goodenovii*	Bird
Richard's Pipit	*Anthus novaeseelandiae*	Bird
Singing Honeyeater	*Lichenostomus virescens*	Bird
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	Bird
Spotted Bowerbird	*Chlamydera maculata*	Bird
Splendid Fairy-wren	*Malarus splendens*	Bird
Striated Pardalote	*Pardalotus striatus*	Bird
Tawny Frogmouth	*Podargus strigoides*	Bird
Tree Martin	*Hirundo nigricans*	Bird
Varied Sittella	*Daphoenositta chrysoptera*	Bird
Variegated Fairy-wren	*Malarus lamberti*	Bird
Wedge-tailed Eagle	*Aquila audax*	Bird
Weebill	*Smicrornis brevirostris*	Bird
Welcome Swallow	*Hirundo neoxena*	Bird
Western Gerygone	*Gerygone fusca*	Bird
Whistling Kite	*Haliastur sphenurus*	Bird
White-breasted Woodswallow	*Artamus leucorynchus*	Bird
White-browed Woodswallow	*Artamus superciliosus*	Bird
White-browed Babbler	*Pomatostomus superciliosus*	Bird
White-plumed honeyeater	*Lichenostomus penicillatus*	Bird
White-winged Fairy-wren	*Malarus leucopterus*	Bird
White-winged Triller	*Lalage suerii*	Bird
Willie Wagtail	*Phipidura leucophrys*	Bird
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	Bird
Yellow Thornbill	*Acanthiza nana*	Bird
Yellow-throated Miner	*Manorina flavigula*	Bird
Zebra Finch	*Taeniopygia guttata*	Bird
Echidna	*Tachyglossus aculeatus*	Mammal
Euro	*Macropus robustus*	Mammal
*Dog	*Canis familiaris*	Mammal
*Goat	*Capra hircus*	Mammal
*House Cat	*Felis catus*	Mammal
*Rabbit	*Oryctolagus cuniculus*	Mammal
*Red Fox	*Vulpes vulpes*	Mammal
*Sheep	*Ovis aries*	Mammal
Red Kangaroo	*Macropus rufus*	Mammal
Western Grey Kangaroo	*Macropus fuliginosus*	Mammal
Gibber gecko	*Diplodactylus byrnei*	Reptile
Tree dtella	*Gehyra variegata*	Reptile
Prickly gecko	*Heteronotia binoei*	Reptile
Beaked gecko	*Rhynchoedura ornata*	Reptile
Eastern spiny-tailed gecko	*Strophurus williamsi*	Reptile
Marble-headed snake-lizard (E1)	*Delma australis*	Reptile

Common name	Scientific name	
Spinifex snake-lizard	*Delma butleri*	Reptile
Burtons snake-lizard	*Lialis burtonis*	Reptile
Tawny rock-dragon (E1)	*Ctenophorus decresii*	Reptile
Central netted dragon	*Ctenophorus nuchalis*	Reptile
Central bearded dragon	*Pogona vitticeps*	Reptile
Four-pored earless dragon	*Tympanocryptis tetraporophora*	Reptile
Sand goanna	*Varanus gouldii*	Reptile
Wall lizard	*Cryptoblepharus carnabyi*	Reptile
No common name	*Ctenotus olympicus*	Reptile
Robust Ctenotus	*Ctenotus robustus*	Reptile
Barred wedge-snout Ctenotus	*Ctenotus schomburgkii*	Reptile
Southern Spinifex slender blue-tongue (E1)	*Cyclodomorphus melanops*	Reptile
Gidgee skink	*Egernia stokesii*	Reptile
Tree skink	*Egernia striolata*	Reptile
Three-toed Lerista	*Lerista muelleri*	Reptile
Chenapod Morethia	*Morethia adelaidensis*	Reptile
Boulengers Morethia	*Morethia boulengeri*	Reptile
Shingleback lizard	*Tiliqua rugosa*	Reptile
Common blue-tongue	*Tiliqua scincoides*	Reptile
Mulga snake	*Pseudechis australis*	Reptile
Western brown snake	*Pseudonaja nuchalis*	Reptile
Desert tree frog	*Litoria rubella*	Frog

APPENDIX C: THREATENED SPECIES EVALUATION

C.1 Flora

Table C-1: Threatened flora evaluation.

Evaluation of the potential for impact on threatened flora. Species list sourced from the Bionet search tool (Broken Hill Bioregion) and the EPBC Matters of Environmental Significance search tool (using a buffer of 50kms from the site). For each species, the potential for impact has been determined in the last column as either:

Nil No habitat is present for this species in areas that would be directly or indirectly affected by the proposal

Unlikely Suitable habitat is present, but is marginal or would not be greatly affected by the proposal

Possible Suitable habitat is present and would be affected by the proposal (*Assessment of Significance* required to properly evaluate impact).

Species and Status*	Ecology	Presence of habitat	Potential for impact
Acacia carneorum Purple-wood Wattle V v	Grows in grassland and woodland in red, sandy soil; also found in Mulga communities on sand dunes, level sandy sites and alluvial accumulations along watercourses (DECC 2005a). Preferred soils are shallow, calcareous and loamy, and include brown earths, crusty alkaline soils and neutral red duplex soils (DECC 2005a). Observed as common in gregarious groupings on sandhills and ridges (DECC 2005a).	Known to occur in the region. Marginal habitat exists for this species on sandy plains within the development envelope. In these areas, access tracks and a substation would be developed. It was not recorded during extensive surveying of the development envelope but was recorded nearby off Silverton Road in a previous survey.	Unlikely
Acacia rivalis Silver Wattle E	Confined to woodland communities bordering ephemeral creeks and streams and along watercourses, in NSW, growing in a variety of stony soils, often with limestone content (DECC 2005b). In the Western Division, it is thought to be associated with arid shrublands, forested wetlands and semi-arid woodlands and is identifiable at any time of year (DECC 2005b).	Known to occur in the region. Marginal habitat exists for this species along ephemeral drainage lines on plains and in the ranges. In these areas, access tracks and a substation would be developed. This species was not recorded during extensive surveying of the development envelope.	Unlikely

Species and Status*	Ecology	Presence of habitat	Potential for impact
Atriplex infrequens A Saltbush V v	Associated with broad drainage tracts, clay plains and possibly occasionally inundated habitats. Critical habitat components are speculated to be relatively undisturbed and ungrazed drainage lines and plains (DECC 2005c). In the Western Division, it is thought to be associated with arid shrublands, freshwater and saline wetlands and semi-arid woodlands and is identifiable at any time of year (DECC 2005b).	Predicted to occur in the region. Marginal habitat exists for this species on the plains to the east and west of the site and within the central flat area where the substation is proposed. In these areas, access tracks and a substation would be developed. Most of this area has been extensively degraded by a combination of heavy grazing and drought. This species was not recorded during extensive surveying of the development envelope.	Unlikely
Dysphania platycarpa E	Grows on heavy soils near ephemeral water, generally in clay or mud by fresh water (DECC 2005d). Recorded in Sturt National Park from previously flooded plains within the sandplain. Interstate habitats include claypan margins, sand above the Samphire level of a flooded clay plain, and in Gidgee scrub (DECC 2005d).	Predicted to occur in region. No suitable habitat would be affected directly or indirectly by the proposed works.	Nil
Eleocharis obicis Spike-rush V v	Grows in ephemerally wet situations including roadside drains and depressions, usually in low-lying grasslands (DECC 2005e). Sites include depressions with heavy clay soils on the Lachlan River floodplain, with *Eragrostis australasica, Atriplex vesicaria and A. nummularia* shrublands, low-lying claypans near an irrigation channel, and a shallow open ditch on a low ridge with *Eucalyptus populnea* in red sandy soil over clay. In the Western Division, it is known to be associated with arid shrublands, freshwater wetlands and semi-arid woodlands and is identifiable at any time of year (DECC 2005e).	Known to occur in region. Marginal habitat exists for this species along ephemeral drainage lines on plains and in the ranges. In these areas, access tracks and a substation would be developed. This species was not recorded during extensive surveying of the development envelope.	Unlikely
Indigofera longibractea Showy Indigo E	Grows on rocky hills and in creek beds, in limited numbers in shallow stony soils among rock outcrops. Across its range it occupies a variety of rocky habitats, ranging from creeks to scree slopes and ridges. Preferred soils are skeletal and sandy (DECC 2005f). In the Western Division, it is known to be associated with arid shrublands, including Acacia and Chenopod sub-formations (DECC 2005f).	Known to occur in the region. Suitable habitat is present in many areas within the development envelope. In these areas, tracks, turbines and the substation are proposed. Extensive searches were conducted in the wind farm development envelope and this species was not detected.	Possible

Species and Status*	Ecology	Presence of habitat	Potential for impact
Swainsona flavicarinata Yellow-keeled Swainsona E	Grows in deep red sand. Recorded from a roadside on a treeless plain and in Mulga communities on red earths and on stony soils supporting Bladder Saltbush. Also found on sandy plains and ridges, in grassland, and in watercourses and floodplains near creeks or rock holes DECC 2005g). In the Western Division, it is known to be associated with arid shrublands and freshwater wetlands (DECC 2005g).	Known to occur in area. Suitable habitat is present. In these areas, tracks, turbines and the substation are proposed. This species was not detected during extensive searches in the wind farm development envelope.	Possible
Swainsona murrayana Slender Darling Pea V v	Known from clay-based soils (including grey, red and brown cracking clays to red-brown earths and loams). 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 (DECC 2005h). Found in remnant native grasslands or grassy woodlands that have been intermittently grazed, this species may require some disturbance (DECC 2005h). In the Western Division, it is known to be associated with arid shrublands, freshwater wetlands, grasslands and semi-arid woodlands (DECC 2005h).	Known from the region. Marginal habitat is present on the plains to the east and west of the site and within the central flat area where the substation is proposed. In these areas, access tracks and a substation would be developed. This species was not detected during extensive searches in the wind farm development envelope.	Unlikely
Swainsona viridis Creeping Darling Pea E	Grows in dry, sandy or stony areas on the banks or in the beds of creeks.. Also collected along a roadside sandplain in sandy-loam soil. Can occur as a 'large and plentiful' population or infrequently (DECC 2005i). In the Western Division, it is known to be associated with arid shrublands, forested wetlands and semi-arid woodlands (DECC 2005i).	Known to occur in region. Found in the Broken Hill area on sandy soils near watercourses. Suitable habitat is present along drainage lines within the development envelope. In these areas, access tracks and a substation would be developed. Not detected during extensive surveying within the wind farm development envelope.	Possible

V Listed as Vulnerable on the *NSW Threatened Species Conservation Act, 1995*

E Listed as Endangered on the *NSW Threatened Species Conservation Act, 1995*

v Listed as Vulnerable on the Commonwealth *Environmental Protection Biodiversity Conservation Act, 1999*

e Listed as Endangered on the Commonwealth *Environmental Protection Biodiversity Conservation Act, 1999*

C.2 Fauna

Table C-2: Threatened fauna evaluation.

Evaluation of the potential for impact on threatened fauna. Species list sourced from the Bionet search tool (Broken Hill Bioregion) and the EPBC Matters of Environmental Significance search tool (using a buffer of 50kms from the site). Species listed as *E4 Presumed Extinct* have been excluded. For each species considered, the potential for impact has been determined in the last column as either:

Nil No habitat is present for this species in areas that would be directly or indirectly affected by the proposal

Unlikely Suitable habitat is present, but is marginal or would not be greatly affected by the proposal

Possible Suitable habitat is present and would be affected by the proposal (*Assessment of Significance* required to properly evaluate impact).

Species and Status*	Ecology	Presence of habitat	Potential for impact
BIRDS			
Black-breasted Buzzard *Hamirostra melanosternon* V	The Black-breasted Buzzard is found sparsely in areas of less than 500mm rainfall, from north-western NSW and north-eastern South Australia to the east coast at about Rockhampton, then across northern Australia south almost to Perth, avoiding only the Western Australian deserts. It lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat. Also hunts over grasslands and sparsely timbered woodlands. Not a powerful hunter, despite its size, mostly taking reptiles, small mammals, birds, including nestlings, and carrion. Also specialises in feeding on large eggs, including those of emus, which it cracks on a rock (DECC 2005j).	Known to occur in region. This species was not detected during surveys within the development envelope. Several Wedge-tail Eagles were observed nesting and foraging onsite, which may be competitively excluding the presence of this species onsite. Breeding is undertaken near water, making areas around Umberumberka Dam more suitable than the development envelope. The site features suitable foraging habitat for this species. Turbines would represent a collision risk to this species.	Possible
Australian Bustard *Ardeotis australis* E	Inhabits tussock and hummock grasslands, low shrublands and low open grassy woodlands. Breeding now only occurs in the north-west region of NSW. 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, likely to be in response to habitat and climatic conditions. Can converge on areas with high mice numbers and in recently burnt areas (DECC 2005u).	Known to occur locally in the Barrier Ranges. It is not likely that resources important to this species would be adversely impacted. However, turbines may represent a collision risk to this species if it travels over the site. A convergence of this species at the site would increase potential level of impact.	Possible

Species and Status*	Ecology	Presence of habitat	Potential for impact
Square-tailed Kite *Lopoictinia isura* V	In NSW, scattered records of the species throughout the state indicate that the species is a regular resident along the major west-flowing river systems. Shows a particular preference for timbered watercourses. Is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage (DECC 2005k). In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland (DECC 2005k).	Known to occur in the region. However, there are no recordings of the species within the study area. Due to the extent and location of works, it is not likely this species would be affected by this proposal. Mature shrubs and trees should be avoided. Timbered water courses would not be affected. The site features suitable foraging habitat for this species. Turbines would represent a collision risk to this species.	Possible
Grey Falcon *Falco hypoleucos* V	This species inhabits open woodland in inland Australia, chiefly throughout the Murray-Darling Basin. The breeding range has contracted since the 1950s with most breeding now confined to arid areas, believed to be extinct in areas with more than 500mm rainfall in NSW (DECC 2005q). Usually restricted to shrubland, grassland, wooded watercourses and wetlands where surface water attracts prey. Predates primarily on birds, especially parrots and pigeons, using high-speed chases and stoops; reptiles and mammals are also taken. Like other falcons it utilises old nests of other birds of prey and ravens, usually high in a living eucalypt near water or a watercourse.	Known to occur in the region. However, there are no records within the study area and this species was not detected during assessment for the wind farm development envelope. Habitat and foraging resources in the study area are suitable for this species. Turbines would represent a collision risk to this species if it travels over the site.	Possible
Masked Owl *Tyto novaehollandiae* V	This species forages in a range of forest and woodland types but requires large tree hollows for nesting. Forested areas adjacent to areas of dense and sparse ground cover within close proximity are required for foraging (Garnett 1993 & Peake *et al.* 1993). This species also occurs in fragmented forest-pastoral land usually near creek lines and in open grassy woodland.	Not recorded within the study area. Potential nesting and foraging habitat occurs within the study area. Turbines may represent a collision risk to this species if it travels around and over the site.	Possible
Grass Owl *Tyto capensis* *V*	Preferred habitat includes areas of tall grass, including grassy plains, swampy heath, and flood plains. They nest in trodden-down grass.	Not known from the area. The site would represent marginal habitat for this species. Turbines may represent a collision risk to this species if it travels around and over the site.	Unlikely
Barking Owl *Ninox connivens* *V*	Inhabits eucalypt woodland, open forest, swamp woodlands and timbered watercourses, roosting in denser vegetation. Forages on prey including invertebrates, birds and mammals. Territories range from 30 to 200 hectares and birds are present all year.	Predicted to occur in the Barrier Range outwash, fans and plains. Turbines may represent a collision risk to this species if it travels around and over the site.	Possible

Species and Status*	Ecology	Presence of habitat	Potential for impact
Brolga *Grus rubicundus* V	The Brolga is still abundant in the northern tropics, but very sparse across the southern part of its range. Brolgas often feed in dry grassland but dependent on wetlands, especially shallow swamps, where they will forage with their head entirely submerged (DECC 2005r).	There have been many recordings of this species to the north and north-west of the region. However, they occur in this area only as vagrants (M. Herring, Murray Wildlife Pty. Ltd., August 2007). Habitat for this species is poor within the study area. Turbines would represent a collision risk to this species if it travels over the site.	Unlikely
Chestnut Quail-thrush *Cinclosoma castanotus* *V*	Occurs in a wide range of arid and semi-arid habitats including low shrubs and undergrowth of mallee and acacia scrub. Most abundant in areas more recently burnt. Forages on the ground, often among spinifex clumps, on invertebrates, seeds and berries. Ground nesting.	The site is probably too sparsely vegetated for this species. Predicted to occur in the Barrier Range outwash, fans and plains. Turbines may represent a collision risk to this species if it travels around and over the site.	Unlikely
Brown Treecreeper *Climacteris picumnus* *V*	Occupies eucalypt woodlands, usually with an open grassy understorey. Found in mallee and River Red Gum forest bordering wetlands. It is sedentary but gregarious and usually observed in pairs or small groups of eight to 12 birds. Forages in trees and on the ground. Hollows are essential for nesting.	Not known from the area or predicted to occur. Turbines may represent a collision risk to this species if it travels around and over the site.	Unlikely
Gilbert's Whistler *Pachycephala inornata* *V*	Occurs mostly in mallee shrubland, woodlands and River Red Gum forests. Often found in association with an understorey of spinifex and low shrubs. Forages on or near the ground on spiders and insects. Patches of dense understorey shrubs associated with woodland are essential for breeding. Aggregations are sometimes recorded though this species does not make regular large-scale movements.	Not known from the area or predicted to occur. Turbines may represent a collision risk to this species if it travels around and over the site.	Unlikely
Diamond Firetail *Stagonopleura guttata* V	Found in grassy eucalypt woodlands and riparian areas. Feeds exclusively on the ground, on seeds, leaves and insects (especially in the breeding season). Usually encountered in flocks of between five to 40 birds, separating into small colonies to breed, between August and January. Nests are built in shrubs. Appears to be sedentary, though some populations move locally.	The site is probably too sparsely vegetated for this species. Predicted to occur in the Barrier Range outwash, fans and plains. Turbines may represent a collision risk to this species if it travels around and over the site.	Unlikely
Halls Babbler *Pomatostomus halli* *V*	Inhabits dry Mulga scrub with a grassy understorey including spinifex, on ridges and plains with either sandy or stony soils. Occasionally occurs in open dry woodland and eucalypt-lined watercourses. Forages on the ground. Builds nests in low trees and is often observed in flocks of up to 20 individuals.	Not known or predicted for the area. Works would be unlikely to affect this species if present.	Unlikely

Species and Status*	Ecology	Presence of habitat	Potential for impact
Plains-wanderer *Pedionomus torquatus* E, v	This ground-dwelling species occurs in sparse native grasslands, typically on hard red-brown soils. Grassland structure is important, with a combination of bare earth, fallen timber and forbs required. Solitary individuals or pairs occupy territories of around 12 - 18 hectares.	Not known or predicted for the area. Works would be unlikely to affect this species if present.	Unlikely
Blue-billed Duck *Oxyura australis* V	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 (DECC 2005l). Blue-billed Ducks will feed by day far from the shore, particularly if dense cover is available in the central parts of the wetland. They feed on the bottom of swamps eating seeds, buds, stems, leaves, fruit and small aquatic insects such as the larvae of midges, caddisflies and dragonflies. They 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. Blue-billed Ducks usually nest solitarily in Cumbungi over deep water between September and February. They will also nest in trampled vegetation in Lignum, sedges or Spike-rushes, where a bowl-shaped nest is constructed (DECC 2005l).	Known to occur in the region. However, all records that exist are well outside the area that would be affected by the proposed works. Turbines would represent a collision risk to this species if movements are undertaken across the site.	Unlikely
Freckled Duck *Stictonetta naevosa* V	Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. Generally rest in dense cover during the day, usually in deep water. Feed at dawn and dusk and at night on algae, seeds and vegetative parts of aquatic grasses and sedges and small invertebrates (DECC 2005m).	Known to occur in the region. However, no records exist within the study area. No suitable habitat is present in areas that would be affected by the proposed works. Turbines would represent a collision risk to this species if movements are undertaken across the site.	Unlikely
Great Egret *Stictonetta naevosa* *m*	The Great Egret is partially migratory. It is found feeding in shallow water or drier habitats on fish, frogs or insects. It breeds in colonies in vegetation near permanent water.	Not observed onsite. Suitable habitat is not present. Turbines would represent a collision risk to this species if it travels over the site.	Unlikely
Cattle Egret *Oxyuro australis* *m*	The Cattle Egret is a wide ranging species, found in dry grassy habitats where it feeds on insects. It is usually found large animals which disturb insects.	Not observed onsite. Suitable habitat is not present. Turbines would represent a collision risk to this species if it travels over the site.	Unlikely

Species and Status*	Ecology	Presence of habitat	Potential for impact
Latham's Snipe *Gallinago hardickii* *m*	A cryptic waterbird, possibly nomadic. Occupies ephemeral wetlands, foraging on seeds and invertebrates at the water's edge. This species is not known to congregate in large numbers.	Not observed onsite. Turbines would represent a collision risk to this species if it travels over the site.	Unlikely
Painted Snipe *Rostulata benghalensis* E	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Feeds on worms, molluscs, insects and some plant-matter. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds. Breeding is often in response to local conditions, generally occurring from September to December. The nest consists of a scrape in the ground, lined with grasses and leaves.	No records of this species occur locally although it is predicted to occur in the Barrier Ranges (DECC 2005w). No suitable habitat present for this species in areas that would be affected by the proposed works.	Unlikely
Australian Painted Snipe *Rostulata australis* v	Endemic to Australia. Usually lumped with the Painted Snipe however, differences suggest recognition of a separate taxa may be warranted. Habitat preferences are as for the Painted Snipe.	No records of this species occur locally. No suitable habitat present for this species in areas that would be affected by the proposed works.	Unlikely
Pink Cockatoo (Major Mitchell's) *Cacatua leadbeateri* V	Found across arid and semi-arid inland. In NSW it is found regularly as far east as about Bourke and Griffith, and sporadically further east. Inhabits a wide range of treed and treeless inland habitats, always within easy reach of water. Feeds mostly on the ground, especially on the seeds of native and exotic melons and on the seeds of species of saltbush, wattles and cypress pines. Normally found in pairs or small groups, though flocks of hundreds may be found where food is abundant. Nesting, in tree hollows, occurs throughout the second half of the year; nests are at least 1 km apart, with no more than one pair every 30 square kilometres (DECC 2005o).	Known to occur in the region with numerous recorded sightings within the Western CMA Region and within the development envelope (recorded during fauna assessments). No important habitat resources would be affected for this species. Turbines would represent a collision risk to this flocking species.	Possible
Red-tailed Black Cockatoo *Calyptorhynchus banksii* V, e	Found in a wide variety of habitats. In NSW, one population occurs on the north-western slopes and plains but another small isolated population is found in the coastal north-east. Nests in hollows greater than 2m off the ground and 12cm in diameter. Threats include loss of native forest and riparian vegetation and overgrazing.	Predicted to occur in the Barrier Range outwash, fans and plains by DECC catchment modelling. Turbines may represent a collision risk to this species if it travels around and over the site.	Unlikely
Scarlet-chested Parrot *Neophema splendida* V	Inhabits arid to semi-arid areas, forageing on or near the ground for seeds of grasses, including spinifex, herbs and acacias (DECC 2005v). Usually nests close to the ground within small trees. Populations are eruptive, building up rapidly during favourable years of abundant rainfall. Several pairs may nest within neighbouring trees.	One record occurs south of Silverton. Turbines may represent a collision risk to this species if it travels over the site. A convergence of this species at the site would increase potential level of impact.	Possible

Species and Status*	Ecology	Presence of habitat	Potential for impact
Flock Bronzewing *Phaps histrionica* E	Likely to occur north of Broken Hill and west of Cobar periodically. Observed in a variety of vegetation types, including grassy plains, saltbush, spinifex and open Mulga. Preferred habitat is tussock grassland, particularly Mitchell grassland. They need to drink daily and may be seen adjacent to water, e.g. at stock tanks, bore drains and pools in water courses. Rest on the ground during the day and nest in a simple scrape on the ground in the cover of a bush, low branch, grass tussock, or in dust on bare ground around bores, often in close proximity to many others of the same species (DECC 2005p).	Known to occur in the region. However, due to the lack of open water, the site is unlikely to provide suitable habitat. It may be present closer to Umberumberka Dam.	Unlikely
Bush Stone-curlew *Burhinus grallarius* E	The Bush Stone-curlew is found throughout Australia excluding the central southern coast and inland, the far south-east corner, and Tasmania. It is rare or extinct throughout most of its former range. Inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber. Largely nocturnal, being especially active on moonlit nights. Feed on insects and small vertebrates, such as frogs, lizards and snakes. Nest on the ground in a scrape or small bare patch (DECC 2005n).	Known to occur in the region with many recordings throughout the Western CMA. The site represents marginal habitat for this species.	Unlikely
Fork-tailed Swift *Apus pacificus* m	Forages over open country and nests in cliffs and tall tress. Occasional mass movements occur and this species may spend nights on the wing (Pizzey and Knight 2003).	Migrant, habitat may occur within the area. It therefore has potential to forage at turbine height as well as be susceptible to collision while migrating in groups at night.	Possible
White-throated Needle-tail *Hirundapus caudacutus* *m*	A summer migrant to Australia, this species is highflying with vertical diving displays undertaken during foraging activities. It feeds on insects. Large flocks are associated with storm fronts.	Not observed onsite. Turbines would represent a collision risk to this species if it travels over the site. Flocking behaviour increases the risk of collision.	Possible
Rainbow Bee-eater *Merops ornatus* *m*	A species of open woodlands and riverbanks. Foraging and breeding in the banks or riparian corridors could occur in the area. This species can form loose colonies when breeding.	Recorded onsite and in nearby Silverton and Umberumberka Dam site. Turbines would represent a collision risk to this species if it travels over the site.	Possible

Species and Status*	Ecology	Presence of habitat	Potential for impact
Redthroat *Pyrrholaemus brunneus* V	In NSW the species has only been recorded in Old Man Saltbush, Bluebush Maireana sp. and Nitrebush shrublands as well as Canegrass and Lignum, particularly on floodplains). This species is solitary and sedentary with no known large-scale seasonal movements (Schodde & Tidemann 1986). On the mainland, the Redthroat mainly inhabits acacia and chenopod shrublands such as those dominated by Mulga in association with chenopods or eremophilas and often along watercourses or drainage lines (Higgins and Peter 2002). Also known to occur in mallee with a diverse heath shrublayer in SA and Victoria and taller semi-arid woodlands in WA. Inhabits lignum, canegrass, spinifex, and heathlands dominated by banksia and tea tree (Victoria). In the Flinders Ranges (SA) Redthroats have been recorded in Cassinia, Daisy Bush and Hop Bush shrublands with a White Cypress Pine overstorey (Higgins and Peter 2002).	Known to occur in region, and detected during surveying. Suitable habitat within the development area includes drainage lines on plains and in shrublands. In these areas, the proposed works would include the development of access tracks, substation and control buildings. Habitat preference and the solitary and sedentary nature of this species suggests that collision impact potential is low.	Unlikely
Thick-billed Grasswren *Amytornis textiles modestus* E, v	Sedentary in dense, low saltbush, cottonbush, bluebush and nitre-bush areas on sandy plains or depressions in gibber, occurring also along watercourses in clumps of Canegrass. Seeks refuge in flood debris and in rabbit burrows. Nests near the ground within low foliage or in debris. Forages on the ground and under or around bushes for a wide variety of seeds, berries and invertebrates (DECC 2005s).	Recorded in a drainage line north (~100km) of Silverton. Suitable habitat, sandy ephemeral streams, is located in the study area. Works may affect a small area of potential habitat, should this species occur onsite.	Possible
Striated fieldwren / Rufous field wren *Calamanthus fuliginosus / Sericonis fuligniosus* V	The Rufous Fieldwren is listed as threatened under the *Calamanthus fuliginosus* listing. While the Striated Fieldwren is associated with coastal swamp heaths, the Rufous Fieldwren is known to occur in semi arid shrublands (DECC 2005ai). This species is an understorey species.	Known from the region. Suitable habitat is located in the study area. Works may affect a small area of potential habitat, should this species occur onsite.	Possible
Pied Honeyeater *Certhionyx variegates* V	Widespread throughout acacia, mallee and spinifex scrubs of arid and semi-arid Australia, movements are affected by periods of drought (DECC 2005t). Highly nomadic, following the erratic flowering of shrubs; can be locally common at times.	Known to occur in region and recorded during surveys in Mulga. It is not likely that resources important to this species would be adversely impacted. Turbines would represent a collision risk to this species if it travels over the site.	Possible
Painted Honeyeater *Grantiella picta* V	Nomadic and occurring at low densities across its range. Nests in the outer canopy of drooping eucalypts and other species. Forages on mistletoe.	Known to occur in region and recorded during surveys. It is not likely that resources important to this species would be adversely impacted. Turbines would represent a collision risk to this species if it travels over the site.	Possible

Species and Status*	Ecology	Presence of habitat	Potential for impact
Hooded Robin *Melanodryas cucullate* V	The species is widespread, occurring in pairs or solitary in lightly timbered country (Schodde & Tidemann 1986). It spends much of its time on the ground in woodland foraging for insects. It frequents places with dead trees and fallen timber (Schodde and Tidemann 1990). This species nests in strong bark cusps of trees.	Known to occur in region with numerous recordings within the Western CMA. However, most of these are far to the east of the study area. This species would represent a low collision risk and only a small amount of potential habitat is likely to be affected (tracks and substation).	Unlikely
MAMMALS			
Dusky hopping-mouse *Notomys fuscus* E	A deep dessert specialist.	No suitable habitat occurs.	Nil
Bolam's Mouse *Pseudomys bolami* E	Inhabits semi-arid environments that contain acacia woodland with scattered low shrubs or sparse mallee communities supported by loamy to clay soils (Watts 1995). A developed chenopod understorey is important (Dickman 1993). Burrows are used as shelters.	Not known from the region.	Unlikely
Long-haired Rat *Rattus villosissimus* V	Requires densely vegetated sites but in plagues can be found in virtually all inland habitats. Eats roots, stems and leaves of grasses and herbs. Shelters during the day in complex burrow systems or in a shallow temporary burrow.	Not known from the region.	Unlikely
Yellow-footed Rock-wallaby *Petrogale xanthopus* *E*	Inhabits rock outcrops in association with Mulga scrub in semi-arid environments. Eats a range of herbaceous forbs and is a competitor with exotic herbivores, particularly during droughts. Lives in colonies of up to one hundred individuals.	Not observed onsite although suitable habitat is present. An anecdotal record exists from Poonamoota Station, north west of the site. Habitat has been degraded by a combination of drought and feral goat grazing. Suitable habitat is unlikely to overlap areas proposed to be developed.	Unlikely
Kultarr *Antechinomys laniger* E	A terrestrial insectivore that inhabits open country, especially claypans among *Acacia* woodlands. Nocturnal, sheltering by day in hollow logs or tree-stumps, beneath saltbush and spinifex tussocks, in deep cracks in the soil and in the burrows of other animals. Widespread across arid and semi-arid NSW but present in very low numbers. Populations appear to fluctuate seasonally in response to environmental stresses, including drought and flooding (DECC 2005x).	Known to occur within the region and predicted to occur in the Barrier Ranges (DECC 2005x), although extensive surveying within the study area did not record this species. All recorded sightings of this species have been to the east and north-east of the study area. Suitable habitat is present within the study area.	Possible

Species and Status*	Ecology	Presence of habitat	Potential for impact
Stripe-faced Dunnart *Sminthopsis macroura* V	Rare on the NSW Central West Slopes and North West Slopes. Preferred habitat includes native dry grasslands and low dry shrublands, often along drainage lines. During periods of hot weather cracks in the soil, grass tussocks, rocks and logs form refuge.	Known to occur in region, however not detected during extensive surveying within the study area. A combination of drought and grazing has reduced habitat quality for this species onsite.	Possible
Forrest's Mouse *Leggadina forresti* V	Preferred habitat includes arid and semi-arid plains, including tussock grassland, chenopod shrubland, Mulga and savannah woodlands, claypans and sandy ridges. Nocturnal and solitary, this animal shelters during the day in shallow burrows, cracks and possibly at the base of spinifex tussocks. They feed on seeds, insects and green leaves & stems obtaining moisture from their food (DECC 2005y).	Known to occur in the Barrier Ranges although not recorded during extensive surveying within the study area. Some areas of marginal habitat occur onsite. In these areas, works would constitute widening of existing tracks nonetheless, this species has a small home range and therefore, even works of small extent may affect this species if present.	Possible
Sandy Inland Mouse *Pseudomys hermannsbuegensis* V	Occurs in a very wide range of open vegetation types including coolibah or *Acacia* woodlands, tall open shrublands (especially Mulga scrub) and hummock grasslands. Mostly on sands (plains and dunes) and sandy loams, but also in areas of cracking earth soils and gibber plains. Refuges are burrows constructed around the base of shrubs or small trees. They congregate into large groups outside the breeding season and in groups of four to five when breeding. Seeds are the dominant food, although grass and other green plant material (including shoots), roots, small tubers and, to a lesser extent, insects are also consumed (DECC 2005z).	No records occur within the study area however it is predicted to occur within the Barrier Ranges (DECC 2005z). Extensive surveying within the wind farm development study area did not detect this species.	Possible
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventrus* V	The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. In most of Victoria, south-western NSW and adjacent South Australia, it is a rare visitor in late summer and autumn. It roosts singly or in groups of up to six, in tree hollows and buildings and in treeless areas are known to utilise mammal burrows. When foraging for insects, it flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees, and appears to defend an aerial territory (DECC 2005aa).	There are numerous records for this species in the north-east of the region. However, no records exist within the study area and this species was not detected during extensive surveying within the study area. Turbines may represent a collision risk to this species if it travels around and over the site.	Possible

Species and Status*	Ecology	Presence of habitat	Potential for impact
Little Pied Bat *Chalinobus picatus* V	The Little-Pied Bat is found in inland NSW (including Western Plains and slopes) in a variety of habitats including dry open forest, open woodland, Mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, Bimbil box. It roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings. It feeds on flying invertebrates and does not require free water although, in arid and semi-arid environments this colonial species may be locally common near permanent or semi-permanent water (Environment Australia 1999).	Records of this species occur to the north of Broken Hill and east of Silverton. This species was also recorded from within the wind farm study area during surveying. Suitable habitat type is present onsite, although it is degraded by a combination of drought and grazing. Umberumberka Dam may be an important resource for this and other microbats in the area. Turbines may represent a collision risk to this species. Its colonial nature increases the significance of this risk.	Possible
Eastern Long-eared Bat *Nyctophilus timoriensis* V v	In NSW this species appears to be confined to the coastal plain and nearby coastal ranges. Lowland subtropical rainforest and wet and swamp eucalypt forest, coastal rainforest and patches of coastal scrub are particularly favoured.	No records exist for this species in the area and no suitable habitat occurs within the study area. It is highly unlikely this species would be present or affected by this proposal.	Nil
Inland Forest Bat *Vespadelus baverstocki* V	Recorded from scattered localities in western NSW, but may be more widespread. Roosts in tree hollows and abandoned buildings. It has been recorded from a variety of woodland formations, including mallee, Mulga and River Red Gum. Colony size ranges from a few individuals to more than fifty. Females congregate to raise young. These bats fly rapidly and cover an extensive foraging area (DECC 2005ab).	No records exist near the study area however it is predicted to occur in the Barrier Ranges (DECC 2005ab). Turbines may represent a collision risk to this species. Its colonial nature increases the significance of this risk.	Possible
REPTILES			
Tawny Rock Dragon *Ctenophorus decresii* E	The Tawny Rock Dragon is highly specialised in its habitat requirements, being restricted to rock outcrops in ranges and gorges. The species is absent from apparently suitable habitat in other parts of its range in NSW. As such, its distribution is highly restricted and fragmented, and NSW populations may be genetically distinct from those in South Australia. This species is potentially threatened via disruption of habitat by introduced herbivores. Grazing of vegetation on and adjacent to rock outcrops by feral goats and rabbits, particularly during periods of drought.	Recorded in several locations within the wind farm development envelope during targeted surveying. Development may constitute a loss of habitat for this highly restricted species.	Yes

Species and Status*	Ecology	Presence of habitat	Potential for impact
Woma *Aspidites ramsayi* V	This terrestrial reptile occurs in north-western NSW. Its range and abundance in south-eastern Australia is considered to be undergoing serious decline. Habitat includes deserts and sandy plains, as well as dunefields and deep cracking black soil plains in semi-arid areas, hummock grasslands, shrublands or woodlands. It shelters in animal burrows, hollow logs or under grass hummocks and feeds on lizards, snakes, birds and small mammals (DECC 2005ac).	Known to occur in the region with one record north of Mount Robe. The potential habitat that would be affected by the proposed works would be marginal at best. Development may constitute a loss of habitat for this species.	Possible
Stimson's Python *Liasis stimsoni* V	This terrestrial semi-arboreal species occurs in north-west NSW, from Bourke and Gundabooka National Park in the east to Broken Hill and Wilcannia in the south, inhabiting a wide range of arid and semi-arid environments including rock outcrops, sandy plains and dunefields. In these habitats it is associated with larger trees and termite mounds. Rocky outcrops provide caves and deep crevices, tree-lined watercourses provide numerous low hollows and fallen trees. They forage nocturnally on small mammals (especially bats), birds, geckoes and other lizards, whilst juveniles take geckoes and skinks (DECC 2005ad).	Known to occur in the region with at least one record to the north of Mount Robe. Upper slope rocky outcrops that would be affected by development were searched extensively during surveys. It is possible that it occurs in the steeper gorges in lower slope landscape positions. These areas would not be affected by the proposed works.	Unlikely
Ringed Brown Snake *Pseudonaja modesta* E	A terrestrial species that inhabits drier areas including rocky outcrops and dry watercourses. Occurs in a variety of vegetation types including woodlands, shrublands, mallee and grasslands. By night it shelters in ground debris or abandoned animal burrows. It is diurnal but may forage during warm nights. Feeds predominantly on small skinks and occasionally small mammals.	This species is known to occur in region with at least one record to the west of Silverton.	Possible
Narrow-banded Burrowing Snake *Simoselaps fasciolatus* V	Inhabitats open woodland or shrubland. Shelters under well embedded fallen timber and stumps, soil cracks, litter, under grass hummocks. Grazing and fox predation are listed threats.	Known from the Barrier Range outwash, fans and plains. Onsite habitat is marginal for this species.	Unlikely

Species and Status*	Ecology	Presence of habitat	Potential for impact
White's Skink *Egernia whitii / Egernia margaretae* Endangered population	A population of skinks formally known as *E. margaretae* have recently undergone taxonomic study and have been found to be a disjunct population of *E. whitii*. The Broken Hill Complex Bioregion population has been reproductively isolated from other populations of *E. whitii* and has been listed as an endangered population.	Found only within a single gorge within Mutawintji National Park. This population is at the limit of its geographic range. Extensive searches in areas of suitable habitat did not identify this species within the study area during this study. Gerry Swan also conducted the extensive surveys across the Barrier Ranges in 1999/2000 for this species which was also not detected during that survey. Further, habitat conducive to the presence of this species (large, rocky gorges) would not be impacted by the proposal.	Unlikely
Interior Blind Snake *Ramphotyphlops endoterus* *E*	Found in red sandy soils in spinifex, Mitchell grassland or shrubland. Shelters in the ground, termite nests or under rocks and logs.	Known from the Barrier Range outwash, fans and plains. Onsite habitat is marginal for this species.	Unlikely
Crowned Gecko *Diplodactylus stenodactylus* V TSC	In NSW, known from four separate locations in the state's far west. These are Sturt National Park, Mutawintji National Park, Loch Lilly, 125km south of Broken Hill, and Thurloo Downs, 145km east of Tibooburra. Habitat preferences largely unknown. In NSW, the species has been reported from red sand habitats and elsewhere from savannah woodland and stony areas with shrubs. The species is nocturnal foraging on small insects (DECC 2005ae).	It is not likely there is suitable habitat for this species within the study area. Essentially a sand hill species.	Unlikely
Fat-tailed Gecko *Diplodactylus conspicillatus* E	In NSW, the species is known from a small number of specimens detected at three locations: Sturt National Park, Nocoleche Nature Reserve and Wanaaring Nature Reserve and a single record from Mutawintji National Park. Habitat constraints are unknown, although the species' rarity suggests that it is highly specialised in its use of habitat. The recent record collected from Sturt National Park was from riverine habitat (R.A. Sadlier, pers. comm.). It is also known to shelter in vertical spider burrows and cracks in the ground (DECC 2005af).	It is not likely there is suitable habitat for this species within the study area. Essentially a sand dwelling species. Extensive surveys on plains within the wind farm development envelope did not detect this species.	Unlikely
Wedgesnout Ctenotus *Ctenotus brooksi* V	In NSW, the species is known from few records, all from Sturt and Paroo-Darling National Park and has only been recorded from large unconsolidated sand dunes. Probably restricted to habitats containing spinifex or other clumping grassland communities. Is diurnal and feeds on a variety of small invertebrates (DECC 2005ag).	Predicted to occur in the Barrier Range and outwash areas (DECC 2005ag). There is not likely to be any suitable habitat within the study area for this species.	Unlikely

Species and Status*	Ecology	Presence of habitat	Potential for impact
Yellow-tailed Plains Slider *Lerista xanthura* V	In NSW, the species is known from two disjunct populations; one between Tarawi Nature Reserve, Ivanhoe and Broken Hill, and the other in the north-west corner of the state. It occurs in a variety of semi-arid and arid habitats; grassed alluvial sands and sand dunes, dry open woodlands and spinifex-dominated red sand plains. The species is fossorial and usually found in loose soil or sand beneath stones, logs and other surface debris. Animals are diurnal and feed on a variety of small invertebrates (DECC 2005ah).	There are no records of this species in the vicinity of the study area. It is not likely there is suitable habitat present for the species to be affected by this proposal.	Unlikely
Western Blue-tongued Lizard *Tiliqua occipitalis* V	Scattered records across central western and western NSW. Diurnally forages for insects, snails, native vegetation and carrion. Inhabits plains, swales, ranges and sometimes dunes of loamy or clayey/sandy soils vegetated by woodlands, especially mallee, shrublands (including chenopods), heaths or hummock grasslands.	No records exist for this species near the study area – the closest being near Ivanhoe. None were detected in areas of suitable habitat during extensive surveying.	Unlikely
Marble-headed Snake-lizard *Delma australis* E	Preferred habitat is known to be spinifex on sand. The closest record is from Coombah, 150km south of the site.	Recorded in spinifex on rocky ridges during the wind farm development envelope assessment. Development may constitute a loss of habitat for this highly restricted species.	Possible
Slender Mallee Blue-tongue Lizard *Cyclodomophus melanops* E	Preferred habitat is spinifex grassland. The closest record to the site is from Coombah, 150km south of the site.	Recorded in several locations in spinifex within rocky areas within the wind farm development envelope. Development may constitute a loss of habitat for this highly restricted species.	Possible
FISH			
Silver Perch *Bidyanus bidyanus* V	The most abundant remaining natural population occurs in the central Murray River downstream of Yarrawonga Weir as well as several of its anabranches and tributaries.	Known to occur in region. No suitable habitat would be affected by the proposal.	Nil
Murray Cod *Maccullochella peelii peelii* v	Occurs naturally in the waterways of the Murray-Darling Basin and is known to live in a wide range of warm water habitats that range from clear, rocky streams to slow flowing turbid rivers and billabongs.	There is no suitable habitat present within the study area for this species.	Nil
MOLLUSCS			

Species and Status*	Ecology	Presence of habitat	Potential for impact
River Snail *Notopala sublineata* E	Virtually extinct throughout its natural range. Populations have been recorded as surviving in artificial habitats (irrigation pipelines) in the Murray and Darling systems. Historic habitat is flowing rivers throughout the Murray-Darling system, attached to logs and rocks or crawling in the mud.	Known to occur in region. No suitable habitat would be affected by the proposal.	Nil

V Listed as Vulnerable on the *NSW Threatened Species Conservation Act, 1995*

E Listed as Endangered on the *NSW Threatened Species Conservation Act, 1995*

v Listed as Vulnerable on the Commonwealth *Environmental Protection Biodiversity Conservation Act, 1999*

e Listed as Endangered on the Commonwealth *Environmental Protection Biodiversity Conservation Act, 1999*

m Listed as Migratory on the Commonwealth *Environmental Protection Biodiversity Conservation Act, 1999*

APPENDIX D: ASSESSMENT OF SIGNIFICANCE

D.1 NSW listed species

The following Assessment of Significance has been completed in accordance with Section 5A of the *Environmental Planning and Assessment Act 1979*. Section 94 of the *TSC Act* lists seven factors ('7 part test') that need to be considered prior to determining if the proposed activity is likely to have a significant effect on the threatened species, populations or ecological communities, or their habitats.

This Act is not applicable for Part 3A Major Projects however, the 7-part test is considered by the authors of this report to provide the most appropriate and transparent characterisation of potential impact.

The following NSW listed threatened species were assessed to have potential for impact as a consequence of site development. They were assigned the impact rating in Appendix C of:

'Possible *Suitable habitat is present and would be affected by the proposal'*

No Endangered Ecological Communities listed under the *TSC Act* were identified as having the potential to be adversely affected by the proposed works.

Flora

Showy Indigo E	Yellow-keeled Swainsona E
Creeping Darling Pea E	

Birds

Thick-billed Grasswren E, v	Rufous Fieldwren V
Pink Cockatoo V	Scarlet-chested Parrot V
Painted Honeyeater V	Pied Honeyeater V
Barking Owl V	Masked Owl V
Grey Falcon V	Black-breasted Buzzard V
Australian Bustard E	Square-tailed Kite V

Mammals

Inland Forest Bat V	Yellow-bellied Sheathtail-bat V
Little Pied Bat V	Stripe-faced Dunnart V
Kultarr E	Forrest's Mouse V
Sandy Inland Mouse V	

Reptiles

Tawny Rock Dragon E	Slender Mallee Blue-tongue Lizard E
Ringed Brown Snake E	Marble-headed Snake-lizard E
Woma V	

V Listed as Vulnerable on the *NSW Threatened Species Conservation Act, 1995*

E Listed as Endangered on the *NSW Threatened Species Conservation Act, 1995*

v Listed as Vulnerable on the Commonwealth *Environmental Protection Biodiversity Conservation Act, 1999*

e Listed as Endangered on the Commonwealth *Environmental Protection Biodiversity Conservation Act, 1999*

m Listed as Migratory on the Commonwealth *Environmental Protection Biodiversity Conservation Act, 1999*

(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,

Flora

Showy Indigo

Showy Indigo is known to grow on rocky hills and along creek beds in limited numbers. Presently it is known to occur in the Waukeroo Hills (east of the study area) and in the Musgrave and Flinders Ranges in W.A. The Bionet mapping tool shows scattered records across the Broken Hill Complex bioregion. This species is generally known to occur only in small cohorts.

Disturbance has been recognised as a threat to this species, contributing to a lack of regeneration and reduced genetic diversity; hence, viable populations are not expected to occur along existing tracks or in other disturbed areas onsite. The combined effects of drought and grazing have reduced the quality of the site such that the majority of areas that constitute potential habitat for this species could be considered poor to marginal.

The development of the wind farm would include excavation for tracks and other infrastructure, as well as upgrading existing roads, in areas of potential habitat. If present, individuals of this species would be lost. Given the quality of potential habitat present and the pattern of works (the location and amount of area that would be disturbed - narrow tracks and discrete development areas) the chances of affecting a viable population of this species such that the population is no longer viable is low.

Yellow-keeled Swainsona

This species is known from deep red sand, recorded from a roadside on a treeless plain, as well as Mulga communities and along creeklines (in central Australia), both of these latter habitat types are present onsite. Specific to the region, habitat preference is noted as arid shrublands and freshwater wetlands. It is not common in NSW and is known from the Barrier Ranges.

Threats to this species include grazing (it is palatable to stock), clearing of Mulga communities, erosion, feral animal disturbance and seed viability in the soil seedbank (DECC 2005g). Similar to the Showy Indigo, discussed above, the combined effects of drought and grazing have reduced the quality of the site such that the majority of areas that constitute potential habitat for this species could be considered poor to marginal. Also, given the quality of potential habitat present and the pattern of works, the chances of affecting a viable population of this species such that the population is no longer viable is low.

Creeping Darling Pea

This species grows in dry, sandy or stony areas on the banks or within creeks. It has been recorded in the Broken Hill area on sandy soils near watercourses and is also known from a roadside sandplain in sandy-loam soil (DECC 2005i). Populations have been recorded as being “large and plentiful” but also infrequent (DECC 2005i). It is generally regarded as a short-lived plant, which makes it particularly susceptible to the impacts of grazing, in particular, feral goats which are suggested to prefer younger plants.

This species was not detected in the study area or the wider area to the south after extensive searches in apparently suitable habitat (along creeklines). In the case of this species, grazing could influence the viability of the seedbank, which may explain their apparent absence.

As discussed for the preceding species, the development of the wind farm would include excavation for tracks and other infrastructure, as well as upgrading existing roads, in areas of potential habitat. If present, individuals of this species would be lost. The disturbance to creek

lines would be limited, restricted to track installation and upgrades, hence the pattern of works suggests the chances of affecting a viable population of this species such that the population is no longer viable is low.

Birds

Thick-billed Grasswren, Rufous Fieldwren

The Thick-billed Grasswren, known from the area, is a sedentary species, associated with dense, low saltbush, cottonbush, bluebush and nitre-bush on sandy plains or depressions in gibber, occurring also along watercourses in clumps of Canegrass. Flood debris and rabbit burrows represent suitable refuges. Nests are constructed low to the ground within low foliage or in debris. It is a ground forager, which seeks out a wide variety of seeds, berries and invertebrates (DECC 2005s). The Rufous Fieldwren is similarly an understorey species in arid and semi-arid shrublands, known from the region.

Works may affect a small area of potential habitat for these species, should they occur onsite. This would be related to clearing for the installation of tracks and infrastructure (substation, control buildings, stock pile areas, concrete batching, etc. as detailed in point **d)** of this 7-part test).Their sedentary nature and habitat preference for low growing vegetation and debris places them at very low turbine collision risk / avoidance behaviour. It is highly unlikely that the amount and location of clearing proposed would adversely affect these species or generate a life cycle impact sufficient to threaten a viable local population.

Pink Cockatoo, Scarlet-chested Parrot, Painted Honeyeater, Pied Honeyeater

The Pink Cockatoo was recorded on site. It is found regularly in a wide range of treed and treeless inland habitats, always within easy reach of water. Nesting, in tree hollows, occurs with no more than one pair every 30 square kilometres (DECC 2005o). The restriction of this resource to large drainage lines and its requirement for permanent water indicates this species would be concentrated at the south-west of the site, near Umberumberka Dam. While it feeds mostly on the ground on the seeds, it is known to flock in small to large groups where food is abundant. It was observed flying within the turbine collision zone in areas where turbines are proposed.

The Scarlet-chested Parrot is known from the area. It inhabits arid to semi-arid areas, foraging on or near the ground, usually nesting close to the ground within small trees. Populations can be large during years of abundant rainfall. Several pairs may nest within neighbouring trees. One record occurs south of Silverton. Turbines may represent a collision risk to this species if it travels over the site. A convergence of this species at the site would increase the potential level of impact.

The Pied and Painted Honeyeaters are nomadic, following the erratic flowering of shrubs. The former can be locally common at times but neither species is known to flock or occur in large congregations. Important resources include nectar and mistletoe, saltbush fruit, berries, seed, flowers and insects. They are both known from the local area, associated with the shrublands.

For these species, it can be seen that foraging resources would be only minimally affected, and considering the pattern of works, loss of habitat and modification of habitat is similarly considered to pose a low risk to the lifecycle of these species, such that a viable population may be placed at risk. For the Pink Cockatoo and Scarlet-chested Parrot however, collision risks exist. Sustained mortalities due to collisions could, potentially, constitute a threat to the viability of a local population. This would require ongoing collisions to occur over time to the extent the local population was reduced to a nonviable level.

Grey Falcon, Masked Owl, Barking Owl, Black-breasted Buzzard, Australian Bustard, Square-tailed Kite

The Grey Falcon is known from the region. It inhabits open woodland but is usually restricted to shrubland, grassland, wooded watercourses and wetlands where surface water attracts prey.

Nests are usually located high in a living eucalypt near water or a watercourse. Habitat and foraging resources in the study area are suitable for this species. It predates primarily on birds, especially parrots and pigeons, using high-speed chases and stoops.

The Masked and Barking Owls have similar habitat requirements. They forage in a range of forest and woodland types, preferring dense vegetation for roosting and large tree hollows for nesting. For the Masked Owl, forested areas adjacent to areas of dense and sparse ground cover within close proximity are required for foraging (Garnett 1993 & Peake *et al.* 1993). Potential nesting and foraging habitat occurs within the study area. Roosting habitat is less abundant and would be expected to be associated with the more dense tree concentrations near drainage lines.

The Black-breasted Buzzard and Australian Bustard are associated with a range of inland habitats, where they hunt over grasslands and sparsely timbered woodlands. The former requires timbered watercourses as breeding habitat while the latter breed in more open areas. While foraging habitat occurs within the development envelope, foraging is unlikely to place these species within the turbine collision zone. Longer distance movements for the Black-breasted Buzzard occurring over the site may however place individuals at risk.

In arid north-western NSW, the Square-tailed Kite, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland (DECC 2005k). It is also known from timbered river courses. It forages in the outer canopy on nestlings and insects and is therefore more likely to be associated with the more dense concentrations of Mulga and the drainage lines onsite.

For these six species, foraging resources and nesting resources are unlikely to be affected by the proposal to the extent that a life cycle impact would result for an individual of any species. Collision risk is present however for all of these species. For species foraging within the potential collision zone, the risk may result in ongoing mortalities such that a local population is affected. This includes the Grey Falcon and potentially the Masked Owl, Barking Owl and Square-tailed Kite, although all three species are more likely to be associated with more dense concentrations of trees in the lower landscape positions and not on the ridges where turbines would be located. A risk is present to all five species when they move across the site, in longer-distance movements (ie dispersing or migrating).

These species occur at low densities within the landscape and ongoing mortalities would be required to constitute a local population scale impact. The significance of mortalities to the local population would depend on other factors, such as the importance of onsite and offsite habitat. For example, if the site harbours a source population, from which individuals regularly disperse to surrounding more marginal areas, the significance of mortalities (and therefore the risk of a local population impact) would be greater. For the Grey Falcon, Masked Owl, Barking Owl, Black-breasted Buzzard and Square-tailed Kite, this may be the case, as the ridge system and associated drainage lines of the Barrier Ranges provide resources which are rare on the surrounding plains (woodland and timbered water courses). If these species are present on site, monitoring of collision impacts would be required to address the risk of a population level impact occurring.

Mammals

Inland Forest Bat, Yellow-bellied Sheathtail-bat, Little Pied Bat

The Inland Forest Bat has been recorded from a variety of woodland formations, including mallee, Mulga and River Red Gum. It roosts in tree hollows and abandoned buildings with colony size ranging from a few individuals to more than fifty. Females congregate to raise young. These bats fly rapidly and cover an extensive foraging area (DECC 2005ab).

The Yellow-bellied Sheathtail-bat was not recorded onsite. This species roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, it flies high and fast over the forest canopy, but lower in more open country. It forages in most habitats across a very wide range.

The Little-Pied Bat was identified to the south-west of the site, at Umberumberka Dam. It occurs in a variety of habitats present onsite including open woodland, Mulga woodlands and chenopod shrublands. It feeds on moths and this colonial species roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings. It does not require free water although, in arid and semi-arid environments this colonial species may be locally common near permanent or semi-permanent water (Environment Australia 1999).

For all three species, it can be seen that foraging resources would be only minimally affected, with foraging more likely located outside of the potential turbine collision zone, in areas containing more dense concentrations of trees. However, all three species are known to be colonial and have fast flying and wide ranging movements. This suggests primarily that the density of the species onsite and therefore the risk that collisions with turbines would occur would be greater than for solitary, sparsely distributed species. Secondly, wide ranging and fast flying species may be considered at greater risk of collision that more sedentary species. A third factor is the proximity of roosts. Species roosting in tree hollows are likely to be outside of the collision zone, as most hollows and refuge are located in the lower slope positions. Only the latter species, the Little-Pied Bat, may seek refuge within rocky outcrops close to potential turbine sites and therefore be at increased risk of collision. Collisions sufficient to place a local population at risk of extinction are a risk for all three species. The risk is considered low to moderate for the Inland Forest Bat and Yellow-bellied Sheathtail-bat but greater for the Little-Pied Bat.

Stripe-faced Dunnart, Kultarr, Forrest's Mouse, Sandy Inland Mouse

The Stripe-faced Dunnart inhabits native dry grasslands and low dry shrublands, often along drainage lines and seeks refuge in the soil, in grass tussocks and under rocks and logs.

The Kultarr inhabits open country, especially claypans among Acacia woodlands, sheltering by day in hollow logs or tree-stumps, beneath saltbush and spinifex tussocks, in deep cracks in the soil and in the burrows of other animals. While it is generally at low density, populations appear to fluctuate seasonally in response to environmental stresses, including drought and flooding (DECC 2005x).

The Forrest's Mouse inhabits arid and semi-arid plains, including tussock grassland, chenopod shrubland, Mulga and savannah woodlands, claypans and sandy ridges, sheltering during the day in shallow burrows, cracks and possibly at the base of spinifex tussocks (DECC 2005y). This species has a small home range.

The Sandy Inland Mouse inhabits a very wide range of open vegetation types including coolibah or Acacia woodlands, tall open shrublands (especially Mulga scrub) and hummock grasslands. Mostly on sands (plains and dunes) and sandy loams, but also in areas of cracking earth soils and gibber plains. Refuges are burrows constructed around the base of shrubs or small trees. They congregate into large groups outside the breeding season and in groups of four to five when breeding.

All but the Sandy Inland Mouse are known from the region. Suitable habitat for all four species is present onsite, predominantly in the lower landscape positions where infrastructure such as tracks, substation, control buildings, stock pile areas, concrete batching, etc. (detailed in point **d)**) would be located. These areas appear in general to be quite degraded, being heavily grazed over most of the site. The Day Dream Mine access provides better quality habitat, having a greater density of ground cover and shrub vegetation. Spinifex covered ridges onsite may also provide good habitat. Cracking soils preferred for sheltering are not present and ground refuge is sparse. It has been noted previously in this report that no small mammal species were captured in Elliot, funnel or pitfall traps or were recorded incidentally and that the study area provides poor refuge and connectivity for small mammals. If present, they are likely to be in very low density. Loss of habitat and direct mortalities through crushing of burrows could potentially generate lifecycle impacts to these species if present. However, given the quality of habitat and the pattern and extent of the proposed works, the potential for local population level impacts is considered remote.

Reptiles

Tawny Rock Dragon, Ringed Brown Snake

The Tawny Rock Dragon is highly specialised in its habitat requirements, being restricted to rock outcrops in ranges and gorges. Grazing of vegetation on and adjacent to rock outcrops by feral goats and rabbits, particularly during periods of drought, has been recognised as a process which alters the environment surrounding its habitat and may impede the movement of individuals between patches. This species was identified in several upper slope rock outcrops during surveying onsite. They were not observed in other seemingly suitable outcrops, in the south of the site which were more degraded by goat grazing.

These rock outcrops and the connectivity between them constitute resources critical to this species. If turbines, roads or hardstand areas were placed within these rock outcrops, it would constitute a loss of habitat. This may affect the size of the local population, as this species appears to be limited in distribution by this resource. Considering the restriction of this species, it would be considered a severe threat to remove habitat for this species as it may affect the viability of the local population. This impact is underscored as within NSW, this species was only previously known from two locations, and only one of these considered as a viable population (Mutawinjii National Park).

In a study in western NSW, Olsson (2001) determined that the home range of Mallee Dragons was around 1400 square metres in size, roughly equating to a 38m x 38m area. This species is smaller than the Tawny Rock Dragon (19cm in total length, compared with 26cm). The Painted Dragon is around the same size as the Mallee Dragon. The home range of this species has been estimated at around 2500 square metres, or 50m x 50m (Mats Olsson, Professor Evolutionary Ecology, University of Wollongong, pers.com. Dec 2007). Therefore, it is likely that the Tawny Rock Dragon has a slightly larger home range considering it is slightly larger in size (an important factor in determining reptile home ranges; Turner *et al.* 1969).

Considering these factors, it is important to define a buffer distance around each record of the Tawny Rock Dragon to maintain extant cohorts and therefore, the viability of the local population present. Based on what is known about home range of slightly smaller species within the same genus, the home range requirements of the Tawny Rock Dragon is estimated to be up to 4,500 square metres, or around 67m X 67m. This equates to a suitable buffer around each point where the species was identified of approximately 33m. However, reptile species are known to use resources differently; both spatially and temporally (Cogger 1969), so it recommended that this buffer should be increased as a precautionary measure.

The Tawny Rock Dragon is a short lived animal. Individuals are known to live only a short period of time compared with other dragons, living around two years from birth (Gerry Swan, pers.com. Dec 2007). Adults generally inhabit the higher quality habitat with rock outcrops for territorial and mating display, while juveniles are forced to occupy the outer fringes of these areas (Gerry Swan, pers. com Dec 2007). An increased buffer would contribute to the ability of these juvenile lizards to continue habitation and aid in providing the Tawny Rock Dragon with long-term security in its already limited distribution across the study area. Based on the scientific literature on dragons in the same genus, discussions with herpetologists who have undertaken extensive research on the *Ctenophorus* dragons, what little is known of the ecology of Tawny Rock Dragons, and reptile dispersal and home ranges, it is recommended that a buffer distance be applied to sites were Tawny Rock Dragon have been recorded.

Feral animal grazing, particularly by goats, is likely to threaten the long-term viability of Tawny Rock Dragons in the study area. Feral goats have already been attributed to the degradation of rocky habitats for other rock-crevice specialists such as the Broad-headed snake *Hoplocephalus bungaroides,* (Murphy 1996) and the Centralian Ranges Rock-skink *Egernia margaretae* (NSW NPWS 2000). Seemingly suitable habitat for this species was present across the site. However, in most cases, rock crevices were filled with goat scats. The apparent absence of this species in the southern portion of the study area may be linked to the seemingly higher abundance of goat numbers in this area and the lower abundance of ground

vegetation (resulting in lower numbers of invertebrates). As previously identified, the presence of Umberumberka dam (in the southern portion of the study area) is likely to be contributing to the level of goat impacts in the southern end of the study area. It is considered that the current level of grazing by feral goats is likely to be an important limiting factor on the distribution and long-term viability of Tawny Rock Dragon in the study area. The control and ongoing management of feral goats would have significant benefit in maintaining the long-term viability of Tawny Rock Dragon in the study area. The management of feral goats may also lead to increases in distribution of this species should suitable areas of habitat become free of this threatening process. Therefore, with the management of feral grazing, the retention of habitat that is known to host populations of this species, and the retention of significant rock outcrops as identified on Map 5-2, the proposed activity is likely to not only avoid having a negative impact on the life cycle and subsequent decline of a viable local population of Tawny Rock Dragon but have the potential to improve population numbers.

The Ringed Brown Snake inhabits rocky outcrops and dry watercourses in a variety of vegetation types including woodlands, shrublands, mallee and grasslands, such as occur onsite. Ground debris or abandoned animal burrows form nocturnal shelters. It feeds predominantly on small skinks and occasionally small mammals, the former being abundant onsite. It was not detected during extensive surveying onsite in rock outcrops and in dry watercourses. Similarly, if turbines, roads or hardstand areas were placed within rock outcrops, it may constitute a loss of habitat. Dry watercourses would be minimally affected and in protecting habitat for the Tawny Rock Dragon, this species is likely also to benefit, if present, avoiding the potential for a life cycle impact and subsequent decline of a viable local population.

Slender Mallee Blue-tongue Lizard, Marble-headed Snake-lizard, Woma

For the Slender Mallee Blue-tongue Lizard and Marble-headed Snake-lizard, preferred habitat is known to be spinifex on sand. These species were both recorded in spinifex on rocky ridges during the wind farm development envelope assessment. This is considered unusual for the species as no spinifex on sand is present within the development envelope.

The spinifex onsite shows evidence of an extensive die back event several years ago. In many areas large dead spinifex dominate. These dead plants still provide habitat for these and other species. In other areas, clumps are regenerating and small plants are evident, a result of a recent successful germination period. While it appears unusual to find these species on rocky ridges and slopes instead of sand, the spinifex on rocky ridges appears to be a critical resource for the local populations of these species in the area. The poor condition of many areas of spinifex reinforces the importance of retaining areas where it currently occurs. Spinifex grassland is notoriously difficult to regenerate, hence preserving areas where it occurs onsite, is considered paramount to protecting these species onsite in the long-term.

If roads or hardstand areas were placed within spinifex, it would constitute a loss of habitat for these two species. This may affect the size of local populations and constitute a threat to local population viability, as these species appear to be limited in distribution by this resource onsite. This loss is able to be minimised within spinifex.

The Woma occurs in deserts and sandy plains, as well as dunefields and deep cracking black soil plains in semi-arid areas, hummock grasslands, shrublands or woodlands. It shelters in animal burrows, hollow logs or under grass hummocks (DECC 2005ac). Although not recorded onsite, it is known from the Barrier Ranges. The potential habitat that would be affected by the proposed works would be marginal at best however, development may constitute a loss of habitat for this species and therefore may have an effect on the size of a local population and constitute a threat to local population viability.

(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,

No endangered populations are known from the site.

(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,

No endangered ecological communities are known from the site.

(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

Table 4.2 provides an estimate of the type and quantum of native vegetation loss required for the development of the wind farm (illustrated on Map 4-5). Based on these calculations, Stage 1 works would displace approximately 83 hectares of native vegetation. Approximately eight hectares of native vegetation would be disturbed to enable the construction of the turbines; this could be rehabilitated after the construction phase. An additional 60 hectares could be rehabilitated after the life of the project. Approximately 13 hectares of native vegetation would be permanently displaced (footings would remain insitu after the project is decommissioned) even after decommissioning.

The works envelope includes some areas with prior disturbance including many existing tracks that would be upgraded to accommodate vehicles access and turn circles. As well, most areas show extensive degradation from a combination of drought and feral goat grazing; large areas of bare soil, vegetation pruned by grazing and accumulations of goat scat attest to this.

There is the potential to positively address the impact of goats on site biota by instituting exclusion zones or a management program to more intensively harvest goats. Implemented as part of the proposal, this would go some way to offsetting the direct impacts of the proposal.

(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

For the plants and mammals considered in this assessment, the proposed infrastructure is not anticipated to represent a fragmentation of potential habitat.

For birds, while the turbines do not represent an absolute barrier (they do not dissect the range system, but occupy a large area on the western edge of the system), avoidance behaviour may result in some fragmentation of currently available habitat onsite.

This effect is likely to be negligible for most of the birds considered as they are wide ranging species (Pink Cockatoo, Scarlet-chested Parrot, Painted and Pied Honeyeater, Grey Falcon, Black-breasted Buzzard, Australian Bustard, Square-tailed Kite, Barking and Masked Owl). For the smaller-ranging species, it could be speculated that the presence of turbines on ridgetops may hinder dispersal across the range. The applicable species in this case however, the Thick-billed Grasswren and Rufous Fieldwren, inhabit and disperse across low lying plains, as opposed to ridge systems, and so would be unlikely to be affected by the turbines.

For reptiles, the development of tracks may dissect areas of habitat and create a barrier to dispersal. Mapping key habitat areas and excluding tracks from these areas will be required.

(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,

Generally, given the extent and pattern of works proposed, the condition of habitat and representativeness of this habitat, it is not considered that the works would not alter or remove an important area of habitat. There are three exceptions to this statement.

The rocky outcrops harbouring the Tawny Rock Dragon and potentially the Ringed Brown Snake could be considered highly important to the subject species. Tawny Rock Dragons were found to be extensively located onsite and in good numbers however, this species is listed as endangered in NSW and is known from only one additional location in NSW, Mutawinji National Park. It is highly habitat specific and its habitat is restricted.

Secondly, the spinifex grasslands harbouring the Marble-headed Snake-lizard and Slender Mallee Blue-tongue Lizard and potentially the Woma is important habitat. The occurrence of the Marble-headed Snake-lizard and Slender Mallee Blue-tongue Lizard in spinifex on ridges is unusual, these species being more usually associated with spinifex on sands (of which none is present onsite).

Finally, the Barrier Range ridge system, of which the development would occupy a large area of the western edge, provides resources that are generally absent on the surrounding plains. These include timbered watercourses and areas of dense woodland, and mature hollow-bearing trees able to provide refuge for medium to large fauna. These resources are important for wide ranging raptors including the Grey Falcon, Masked Owl, Barking Owl, Black-breasted Buzzard and Square-tailed Kite, should they occur onsite. The surrounding ridges to the north, east and south are assumed to also contain these resources, however, at the scale of a breeding pair, the habitat within the development envelope could be considered important. Monitoring will be required to establish actual impacts.

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

There is no critical habitat as listed by the *TSC Act 1995*, found within the subject site.

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

Five Recovery Plans and one Threat Abatement Plan are relevant to this assessment.

A Recovery Plan has been prepared for the Forrest's Mouse. Relevant threats to this species are noted to include fox predation (known to be present onsite although currently in low numbers) and grazing (feral goat grazing is heavy in many areas onsite). Features which make

this species susceptible to decline include the reliance on burrowing, use of shrubland habitat, small body weight and omnivorous diet. Relevant recovery actions for this species relate to monitoring existing populations, surveying for new populations and maintaining and reviewing feral animal management programs. The proposed works are not inconsistent with any of these actions.

A Recovery Plan has been prepared for the Kultarr. Habitat degradation through overgrazing, predation by feral cats and foxes, severe local flooding, fire, as well as insecticide and pesticide use are listed threats to this species, linked to its decline. Recovery objectives relate to increasing what is known of habitat requirements, threats and distribution and increasing community awareness.

A Recovery Plan has been prepared for the Thick-billed Grasswren. The decline of this species is thought to be associated with the degradation of understorey vegetation caused by over stocking, goat and rabbits herbivory. Introduced predators, including feral cats, are also considered a threat to this species and are responsible for a number of local extinctions. Relevant recovery objectives for this species relate to surveying in areas likely to contain extant populations, establishing community awareness and monitoring the results of future fauna surveys. The proposed works are not inconsistent with any of these actions.

A Recovery Plan has been prepared for the Barking Owl and for Large Forests Owls (incorporating the Masked Owl). Habitat loss, degradation and fragmentation are major threats to forest owls. Wildfires, grazing, pest control, drought and predation are also listed. Relevant Key Threatening Processes are Clearing of native vegetation, Loss of native hollow bearing trees, Removal of dead wood, dead trees and logs, Competition from feral honeybees and possibly, Predation by the fox and the feral cat.

A common theme for the species considered is the combined effects of drought and overgrazing on habitat resources. There area likely to be benefits for multiple species in controlling heavy grazing by feral goats onsite.

A Threat Abatement Plan has been prepared for the Red fox. This species is known to occur onsite. While tracks can often be seen to facilitate the movement of this species, the existing openness of the site could already be considered to allow unrestricted access of this species over the site. The proposed works would not benefit this species or be in contravention of the aims 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.

Several listed Key Threatening Processes (KTPs) are relevant to the proposal: bushrock removal, clearing of native vegetation, competition and grazing by the feral European rabbit, competition and habitat degradation by feral goats, predation by the red fox, human-caused climate change and removal of dead wood and dead trees.

Bushrock removal can remove or disturb the habitat of many native species, which may find shelter in or under rocks, use rocks for basking, or which grow in rocky areas (NSW Scientific Committee 1999). Many species listed as threatened in NSW, including the Tawny Rock Dragon and Ringed Brown Snake, are reliant on the habitat that bush rock provides. The creation of roads and hardstand areas may redistribute but would not remove rocks from the site.

Clearing of native vegetation constitutes destruction of flora and fauna habitat and is the major cause of loss of biological diversity (NSW Scientific Committee 2001). For species of restricted distribution, clearing of native vegetation may result in total extinction, for more widespread

species there may be loss of local genotypes (NSW Scientific Committee 2001). The proposed works would result in approximately 83 hectares of native vegetation loss. Most of the tracks would be developed over existing tracks. Further more, the area is sparsely vegetated. Combined heavy goat grazing and drought are likely to have been responsible for extensive die back of a large proportion of all vegetation strata onsite; trees, shrubs and ground cover. As stated in point **d)** of this assessment, important habitats occur onsite (including rocky outcrops and spinifex areas) and are considered important resources to retain.

Competition and grazing by the feral European rabbit and Competition and habitat degradation by feral goats are both listed as Key Threatening Processes. Both species are present onsite and evidence of the degradation caused by these species includes warrens (rabbits only), heavy grazing (both species) and associated erosion and die back. Landforms are steep and unstable in places and vegetation to bind soils is sparse. The proposed works may exacerbate the associated erosion onsite. Erosion and sediment controls will be required to address this impact. Control of goat numbers onsite however, if implemented as part of this proposal, would have substantial benefits.

Predation by the red fox has been implicated in limiting habitat choice and population size of a number of medium-sized marsupials. Even at low densities foxes can eliminate remnant populations and instigate localised declines. Foxes are also one of several factors which have been implicated in the disappearance of many medium-sized, ground-dwelling mammals from the arid and semi-arid regions of New South Wales. As discussed, this species is known to occur onsite. While tracks can often be seen to facilitate the movement of this species, the existing openness of the site could already be considered to allow unrestricted access of this species over the site.

Human-caused climate change is recognised as likely to generate a different response from organisms than the climate change that has occurred through geologic history. Modelling suggests that many species will be adversely affected including those with long generations, poor mobility, narrow ranges, specific host relationships, isolate and specialised species and those with large home ranges (Hughes and Westoby 1994). Pest species may also be advantaged by climate change. The proposal to develop a wind farm would not have immediate or local effects in this regard, it constitutes a significant part of NSW's strategy to address climate change.

The accelerated and ongoing Removal of standing dead trees and woody debris on the ground caused by human activity has been recognised as a factor contributing to loss of biological diversity (ANZECC 2001). Removal of dead wood and dead trees can cause the broad scale change of woodlands into paddocks with isolated standing trees, with little natural understorey and no woody debris on the ground (Landsberg 2000). The proposed works would result in minimal clearing given the sparsity of native vegetation in many areas. Combined heavy goat grazing and drought are likely to have been responsible for extensive die back of all vegetation strata in many areas onsite; including trees, shrubs and ground cover. Where trees, standing dead trees and woody debris must be moved to allow for the tracks and hardstand areas, it is recommended that it be placed adjacent to the impact areas, to retain this refugia in the immediate area.

D.2 Commonwealth listed species

The *Environmental Protection and Biodiversity Conservation Act* 1999 specifies factors to be taken into account in deciding whether a development is likely to significantly affect Endangered Ecological Communities, threatened species and migratory species, listed at the Commonwealth level.

The following Commonwealth listed threatened species were assessed to have potential for impact as a consequence of site development. They were assigned the impact rating in Appendix C of:

'Possible *Suitable habitat is present and would be affected by the proposal'*

No Endangered Ecological Communities listed under the *EPBC Act* were identified as having the potential to be adversely affected by the proposed works.

Birds:

Thick-billed Grasswren E, v

Rainbow Bee-eater m

Fork-tailed Swift m

White-throated Needle-tail m

E Listed as Endangered on the *NSW Threatened Species Conservation Act, 1995*

v Listed as Vulnerable on the Commonwealth *Environmental Protection Biodiversity Conservation Act, 1999*

m Listed as Migratory on the Commonwealth *Environmental Protection Biodiversity Conservation Act, 1999*

D2.1 Vulnerable species

Thick-billed Grasswren

This assessment relies on information already stated in Section D.1 of this report, to avoid duplication of information.

a) Will the action lead to a long-term decrease in the size of a population of a species?

Their sedentary nature and habitat preference for low growing vegetation and debris places them at very low turbine collision risk / avoidance behaviour. It is highly unlikely that the amount and location of clearing proposed would lead to a long-term decrease in the size of a local population.

b) Will the action reduce the area of occupancy of the species?

Works may affect a small area of potential habitat for this species, should the species occur onsite. This would be related to clearing for the installation of tracks and infrastructure. Refer to *Table 4-2 Estimated extent of vegetation loss.*

c) Will the action fragment an existing population into two or more populations?

It could be speculated that the presence of turbines on ridgetops may hinder dispersal of this species across the range, effectively constituting a fragmentation of available habitat. However, this species inhabits and disperses across low lying plains, as opposed to ridge systems, and so would be unlikely to be affected by the turbines.

d) Will the action adversely affect habitat critical to the survival of a species?

Critical habitat for this species is assumed to consist of dense, low saltbush, cottonbush, bluebush and nitre-bush on sandy plains or depressions and watercourses. The impact in this

habitat would largely be confined to the upgrade of access tracks as well as the development of the substation, stockpile areas and control rooms. The areas of impact proposed and local distribution of habitat resources suggest this effect would not be significant.

e) Will the action disrupt the breeding cycle of a population?

The works proposed would be unlikely to disrupt a breeding population, should one occur within the works envelope. Fox predation and grazing by goats represent a larger threat to this species. These effects would not be exacerbated by the proposal.

f) Will the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

As discussed, the areas of impact proposed and local distribution of habitat resources suggest this effect would not be significant.

g) Will the action result in invasive species that are harmful to a critically endangered or endangered/vulnerable species becoming established in the endangered or critically endangered species/vulnerable habitat?

It is expected that an Environmental Management Plan would specify weed controls (and soil conservation measures) to be employed during construction, hence the site would not be substantially modified with respect to potential habitat for these species.

h) Will the action interfere with the recovery of the species?

A NSW Recovery Plan has been prepared for this species. Relevant recovery objectives for this species relate to surveying in areas likely to contain extant populations, establishing community awareness and monitoring the results of future fauna surveys. The proposed works are not inconsistent with any of these actions and considering the threats posed by the proposal to habitat, this effect is not anticipated.

D2.2 Migratory species

Rainbow Bee-eater, Fork-tailed Swift, White-throated Needle-tail

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

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

This effect is unlikely. The vegetation onsite will remain much as before the development over most of the site. It is anticipated that the grazing of the site will continue (although this report makes recommendations to reduce the level of grazing). It is expected that an Environmental Management Plan would specify soil and water controls, weed controls and hazardous spill controls to be employed during construction, hence the site would not be substantially modified with respect to potential habitat for these species.

The installation of the turbines may act as a barrier to movement on a very local level, however, considering the range and manoeuvrability of these species, and the distances over which they range, the turbines are not be anticipated to impact the accessibility of important habitats. Breeding habitat would not be affected for either species.

b) result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species,

The development would not have this effect; vegetation will remain much as before the development over most of the site. Sediment erosion and weed controls would be implemented to ensure that weed species are not encouraged further by the development.

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

There is potential to impact the life cycle of these species via collision mortalities during migration. There is also potential to affect foraging and movements around the site. The White-throated Needletail and Fork-tailed Swift can occur in large numbers, increasing the risk of the impact disrupting a significant proportion of a population of these species. The risk is lessened by limited time they could be expected to spend at the site and the capacity to habituate to humanised landscapes.

The Rainbow Bee-eater is known to breed in drainage lines in the local area and congregate in small groups at this time. This habitat would not be affected by the proposal to the extent that a significant proportion of the local population would be affected.

Local migration routes are not known. Monitoring will be required to ensure that mortality levels do not reach unacceptable levels without action being taken. With rigorous monitoring in place, this uncertainty can be addressed.

D.3 Conclusion of assessments of significance

These assessments have shown that, without the adoption of mitigation measures, there is potential for the proposed works to generate lifecycle impacts sufficient to affect local viable populations (if present onsite) for 16 of the 29 species considered. The risk relates to:

- Loss or modification of important habitat - four species

  (Tawny Rock Dragon, Ringed Brown Snake, Slender Mallee Blue-tongue Lizard, Marble-headed Snake-lizard, Woma)

- Ongoing collisions with turbine infrastructure – 12 species

  (Pink Cockatoo, Scarlet-chested Parrot, Painted Honeyeater, Pied Honeyeater, Masked and Barking Owls, Grey Falcon, Black-breasted Buzzard, Square-tailed Kite, Inland Forest Bat, Yellow-bellied Sheathtail-bat, Little Pied Bat)

The assessment identifies habitat and habitat features important to threatened species onsite as rocky outcrops, spinifex grasslands and the Barrier Range ridge system (for wide ranging raptors). The assessment also identifies a common threat to several species, that being habitat degradation caused by heavy grazing in combination with drought.

Based on the above assessment, **ngh**environmental consider that a significant impact on the subject species can be avoided by the implementation of a number of controls:

- Avoidance of rocky outcrops and spinifex. Particularly, areas where potential or known habitat of the Tawny Rock Dragon, Marble-headed Snake-lizard and Slender Mallee Blue-tongue Lizard have been identified should be avoided. Mapping of habitat for these species is provided in this report. A buffer should be applied to Tawny Rock Dragon habitat in order to ensure that they are not adversely affected

- Design and implementation of specific erosion and sediment controls to ensure that landforms are not destabilised and erosion is not increased onsite. This may rely on site specific physical controls to stabilise slopes. Landforms in many areas are steep and unstable and as revegetation will not be a viable means to stabilise landforms in the short to medium term. Physical methods designed to trap soil and moisture and stabilise slopes will provide the best potential for natural regeneration in the long-term

- Clusters of rocks and boulders should be avoided where possible. Where rocks and boulders cannot be avoided, they should be placed directly adjacent to the works area to preserve the availability of refuge

- Standing dead trees and woody debris should be avoided where possible. Where they must be moved to allow for the tracks and hardstand areas, they should be placed adjacent to the impact areas, to retain these refugia in the immediate area

- There would be benefits for several subject species in controlling heavy grazing by feral goats onsite. Implementation of a feral goat management program as part of the development of the wind farm site would assist in offsetting environmental impacts and halt the degradation that heavy goat grazing is causing across many areas of the site

- An adaptive management monitoring program should be designed to document mortalities, remove carcasses and assess the effectiveness of controls. Timing should be specific to the most at-risk target species. Standardised data should be collected to increase the knowledge base on this subject and it should be made publically available. If mortalities exceed a pre-determined threshold (set out in the monitoring program), additional mitigation measures should be considered, such as further turbine ridge habitat modification and enhancement of off-site habitats

APPENDIX E: BIRD AND BAT RISK ASSESSMENT

E.1 Introduction

This risk assessment examines relevant background information and then evaluates the risk of significant impact posed by the proposed wind farm in terms of:

- Collision with wind turbines, or 'bladestrike'. For these purposes, 'bladestrike' refers to mortality caused by direct collision with turbine blades and by birds being swept down by the wake behind a turbine blade
- Behaviour modification, for example avoidance of foraging areas due to the presence of the turbines and associated infrastructure

The risk assessment is qualitative, combining assessments of likelihood and consequence to produce a final risk assessment of low, moderate or high risk for selected species. Likelihood incorporates biological, behavioural and environmental risk factors. Consequence includes the significance of habitat loss and bladestrike in terms of habitat rarity and importance, population impacts, recovery potential and species conservation status. The assessment draws on the Interim Standards for Risk Assessment relating to birds and wind farms (Brett Lane and Associates 2005) and the Australian Standards for Risk Assessment (AS/NZS 4360).

E.2 Experiences at existing wind farms

Wind farm impacts are usually site-specific and species-specific. Nonetheless, there are a growing number of studies and monitoring programs in Australia and overseas which provide some insight into the nature and scale of potential risks to birds from wind farms.

A review of overseas wind farms showed low mortality rates for most wind farms (Langston and Pullen 2002). On average for all birds, new generation projects in the US (outside California) have recorded three fatalities per megawatt per year (Erikson *et al.* 2001). A review of European and North American wind farms indicates that most wind farms in agricultural settings affect between 2 and 4 birds per turbine per year (Lane and Associates 2004). However, the most commonly recorded bird group to collide with European and North American turbines were night-migrating songbirds, of which there are comparatively few in Australia.

Looking at wind farms in Europe, Winkelman (1994) produced an estimated average of 0.04 to 0.09 mortalities per turbine per day. Forty-three percent of these were killed by being swept down by the wake behind a blade, 36% flew directly into a blade, and for 21% the cause of death was unknown. At Altamont Pass in the United States, 55% of raptors were killed by striking a blade, 8% from electrocution, 11% from wire collision and 26% from unknown causes (Orloff and Flannery 1992, cited in Canada Bird Studies 2001). Winkelman concluded that the number of birds killed per unit of energy produced is low compared to other human-related causes of bird death.

There are relatively few published bird mortality studies at Australian wind farms, and most are of short duration. The studies do however suggest a generally low rate of blade collision, and that species at most risk are locally common birds which are active at the bladeswept height, including some raptors, skylarks, magpies and some seabirds (Meredith 2003, Hydro Tasmania 2004).

Monitoring research at the three operational wind farms in Victoria has recorded no rare, threatened or endangered birds killed by wind turbines to date. Searches conducted by Biosis Research for dead birds around seven turbines at the Codrington Wind farm (Victoria) showed three bird deaths attributable to impact with wind generators. The species concerned were the introduced skylark (1), Richard's pipit (1) and Australian magpie (1). Incidental carcass finds showed a further adult Brown Falcon death. The estimated total number of deaths likely from Codrington's 14 turbines over one year is 18 to 38 birds, or 1.2 to 2.7 birds per turbine per year (Brett Lane and Associates 2005).

At the Toora Wind Farm in Victoria, no bird carcasses were found during a year of monitoring or during informal inspections. Wedge-tailed eagles were regularly observed before and after operations began at this site. Eagles were observed to avoid the turbines by flying around or between them, not into them (Brett Lane and Associates 2005). A study at Codrington also found that all birds approaching the turbines were observed to take avoidance action, by flying over, around or under the rotating turbine blades (Biosis Research Pty Ltd 2002).

The rate of bird collisions at Woolnorth Wind Farm stage 1 in north-west Tasmania is estimated at 14 native birds per year or 2.3 birds/turbine/year (Hydro Tasmania 2004). Monitoring at Woolnorth recorded 18 bird collisions in 2003, 7 of which were the introduced Skylark. One of these collisions was a Wedge-tailed Eagle, which is threatened in Tasmania. Eagles have been observed living near the turbines for more than 12 months and the collision occurred during a period of limited visibility (Hydro Tasmania 2003). Earlier this year an article stated the proposal had killed between 11 and 18 Wedge-tailed Eagles in total (Sydney Morning Herald, 3 Jan 2008). Concern was raised that new eagles moving into the vacant territory may represent an unacceptable level of ongoing collisions, capable of affecting the local population.

E.3 Collision risk factors

A number of factors may operate which affect risk by contributing to either the likelihood of collision with blades or the significance of the consequence of bladestrike. These factors may be related to the ecology of a species, site-specific features or to the design and location of the infrastructure.

Species-specific risks;

The capacity of birds to 'habituate' to turbines may vary between species. Some species groups appear disproportionately vulnerable to bladestrike. Northern hemisphere studies point to three groups which are most vulnerable to bladestrike; gulls, raptors and migrant songbirds (Airiola 1987, cited in Canada Bird Studies 2001). Risk factors include foraging in the bladesweep area, flocking or colonial movements, awkward flight characteristics and migrating at night.

A range of hypotheses have been put forward to explain bat collisions, including echolocation failure, migration along linear corridors, the inability to perceive moving blades ('motion smear'), attraction to lights, attraction to the towers as potential roost sites, attraction to noises emitted by the turbine, curiosity about the blade movement, insect concentrations caused by insect attraction to turbines, and attraction to insect concentrations in rising warm air above ridgetops (Kunz *et al.* in prep. in Arnett 2005) and wing morphology. United States studies show that higher flying 'tree bats' were disproportionately affected by bladestrike (AusWEA 2004).

Vision, as well as manoeuvrability, affects the risk of collision. Erickson *et al.* (2002) suggest that individuals most at risk appear to be migrating bats; migrating bats may navigate without use of echolocation, depending on vision, rather than echolocation. Migratory bats comprise the majority of mortalities in all wind farm studies to date (Erickson *et al.* 2002, Arnett 2005). The functional range of echolocation in North American bats is typically 3-5 metres, giving a bat flying at 5 metres/second less than a second to respond to a wind turbine (Kunz *et al.* in prep. in Arnett 2005).

Species which are rare or declining, or which are naturally distributed at low density (such as top order raptors) may be at greater risk because, while collision rates may be low, each mortality has a higher significance. Similarly, species with low reproductive rates, or poor capacity to disperse and recolonise habitats may be at greater risk of significant impacts from blade collisions at the population level. Microbats are long-lived and have exceptionally low reproductive rates (Kunz 1982 in Arnett 2005). Population growth is slow and the ability to recover from population crashes is limited (Racey and Entwhistle 2003 in Arnett 2005).

Environmental risks;

Many studies have shown that poor weather conditions increase the occurrence of turbine collisions (Canada Bird Studies 2001). Weather conditions which reduce the ability of birds and bats to perceive the turbine blades or avoid collisions (such as fog and strong gusty winds) add to risks for susceptible species. Hence, sites which experience these conditions at higher frequency may be correspondingly riskier for these species. The relative location of key habitat areas (such as updraft zones, prey populations, wetlands and nesting sites) and natural diurnal and seasonal migration routes also affects risks to birds.

US studies show that bats tend to be killed on low wind nights, when blade speeds were at or close to full operational speed (17 rpm) (Arnett 2005). Fatalities tended to increase just before and just after the passage of storm fronts. This study also found that bat activity was greatest during the first two hours after sunset, which may also be a relatively high risk time for collisions. This study showed similar mortality rates at sites lit by aircraft lighting and sites which had no lights.

Seasonal factors;

Many microchiropteran bat species hibernate or aestivate during cold periods to reduce their energy requirements when resources are low. In a compilation of survey results for wind farms in the United States, most bat mortality documented occurred in late summer and autumn (nearly 90% from mid-July through mid- September) with most fatalities attributed to migratory tree bats with no pattern in distribution to suggest the victims were local bats commuting from roosting to foraging areas (Erickson *et al.* 2002). Resource abundance at this time would be expected to be high and bats requiring fat stores for aestivation would need to take advantage of the resource pulse and may migrate in order to do so.

Erickson *et al.* (2002) in a North American study, state that based on available data bat collisions during the breeding season are virtually non-existent. Further, North American research has shown that most bat collisions have occurred with adult bats, hence collisions were not thought to be attributed to dispersing juveniles (ABS 2005).

Structural characteristics of the development;

German studies have shown higher collision rates from turbines located near hedgerows (Australian Bat Society 2005). Many species use linear vegetation or topographic features while commuting (Limpens and Kapteyn 1991, in Erickson *et al.* 2002) and migrating (Humphrey and Cope 1976, Timm 1989, in Erickson *et al.* 2002).

Although the association between man-made structures and bats is not well understood, evidence suggests that most bat collisions with structures occur during migration and that these are normally associated with inclement weather (Erickson *et al.* 2002). A feature of wind turbines is that in high wind speeds they shut down to protect themselves from damage, thereby also mitigating collision risks. Lights on turbines may increase the probability of bat collisions, as insect abundance is higher under lights (Erickson *et al.* 2002). This can also be mitigated by avoiding or reducing the use of lights on or near turbine towers, or by using red flashing lights that would be less likely to attract insects, which are generally not sensitive to the red end of the spectrum.

Features such as guy lines (Erickson *et al.* 2001), aerial cabling and perching opportunities (especially lattice structures) may also be critical factors affecting the frequency of bird and bat collision. Warning lights on towers may attract night migrating birds (Cochran and Graber 1958 in Canada Bird Studies 2001) and insect prey. US studies suggest that red flashing lights on wind turbines do not attract night migrants (Kerlinger and Kerns 2003), and would not attract insects, which are generally not sensitive to the red end of the spectrum.

E.4 Habitat utilisation impacts

The operational phase of wind farm developments has the potential to affect bird and bat habitats and habitat utilisation patterns by degrading off-site habitats (for example, from polluted runoff or weed introductions), alienating and fragmenting breeding or foraging habitat, and altering migration behaviour.

Off-site degradation resulting from the construction and operational phases of the project are readily avoided and controlled using standard best-practice mitigation methods. Risks to local bird populations from off-site habitat degradation are assessed as low.

In Europe, the effects of wind farms on habitat utilisation are considered to have a greater impact on birds than collision mortality (Strickland 2004). Bird abundance data from 19 globally-distributed windfarms found a significant negative impact of windfarms on bird abundance however it was unclear whether this related to a decline in population abundance or a decline owing to avoidance behaviour (Stewart *et al.* 2007). European studies suggest that most habitat displacement involves migrating, resting and foraging birds. Studies have reported displacement effects ranging from 75 metres to as far as 800 metres away from turbines (Strickland 2004). Winkelman (1994) found that resident birds avoided turbines at distances of 250-500 metres. This is likely to reduce the risk of bird mortality, but may affect populations where the alienated habitat is particularly important or limiting.

There does not appear to be evidence that the subject site provides limiting or dependent habitat for microbats. The impacts on habitat or habitat utilisation are not expected to significantly affect local populations of microbats. The topography and concentration of resources within the development is suitable to raptors. This impact may prove more significant.

E.5 Risk assessment

The risk assessment focuses on bird groups which have been shown to be at particular risk in studies at other wind farms (raptors, waterbirds, migratory species), as well as rare, threatened or protected birds and bats with potential to be present in the study area.

Wedge-tailed Eagle *Aquila audax* (non threatened)		
Risk factors Observed at site Utilises updrafts around the range when foraging (at blade height) Large home range Male diving displays Prey source present at turbine sites (goats and rabbits) Low reproductive rate		
Discussion Widely distributed, sedentary. Constructs large stick nests in trees. Utilises updrafts around the range when foraging (at blade height). Observed singly and in a pairs soaring over the range and taking flight from within the turbine envelope. Feeds on birds, rabbits, small mammals. Rabbits and goats are local food sources. Rabbit warrens are present on the plains and goat nurseries on rocky outcrops. Important resources are concentrated within the range and adjacent area. Similar habitat is present in other parts of the range although, the proposal would cover an extensive area of preferred habitat. Mortalities for the related Golden Eagle in US due to presence of prey around turbines (Thelander *et al.* 2003). Turbines with lower blade reaches were most deadly to Golden Eagles. Wedge-tailed Eagles have collided with turbines in Tasmania, South Australia and Victoria. Raptors continue to be present within 1 km of the Crookwell I turbines (URS 2004). At Toora (Vic.), Wedge-tailed eagles were regularly observed before and after operations began at this site. Eagles were observed to avoid the turbines by flying around or between them, but not into them (Brett Lane and Associates 2005). During bird behaviour surveys at Codrington, Wedge-tailed eagles were observed to avoid turbines by flying horizontally around them (twice) and turning and not entering the turbine area (Biosis Research 2002). The species has also been observed flying safely between turbines at the Toora wind farm (Wonthaggi EES Panel 2003). Collisions are not expected to be frequent or in excess of the reproductive and dispersal capacity of the regional population.		
Likelihood of habitat avoidance: possible		*Habitat importance: moderate-high*
Collision likelihood: rare		*Collision consequence: minor-moderate*
Overall risk levels	***Individuals***	***Moderate***
	Population	***Moderate-high***

Australian Kestrel *Falco cenchroides* (non threatened)		
Risk factors Forages in open country at blade height Family parties play in air currents		
Discussion Sedentary or nomadic. Observed foraging on the plains and around the ranges of the proposal. Nests in tree hollows (limited to drainage lines around the ranges). Has been known to collide with aircraft when hunting at airports, but have a relatively rapid reproductive rate (URS 2004). The species is relatively common at the Woolnorth and Codrington wind farm sites and no collisions have been recorded at those sites. Should have the capacity to habituate to turbines over time.		
Likelihood of habitat avoidance: possible		*Habitat importance: low-moderate*
Collision likelihood: rare		*Collision consequence: minor*
Overall risk levels	***Individuals***	***Low-moderate***
	Population	***Low***

Brown Falcon *Falco berigora* (non threatened), Grey Falcon *Falco hypoleucos (threatened)*
Risk factors Performs tumbling and diving flight displays Soars on thermals

Potential to flock		
Discussion The Brown Falcon inhabits open woodland and grassland including arid areas and farmland. Sedentary. Gathers in sometimes large flocks post-breeding, especially at fires and locust and mouse plagues, sometimes with other raptors. Pairs occasionally hunt cooperatively. Makes sloping descent to catch prey on ground (Pizzey 1985). Feeds on carrion but takes mostly live prey: mammals, birds, reptiles (especially snakes), amphibians, and large insects. Nests in nest of crow or hawk, makes own stick nest or uses tree hollows. A Brown Falcon mortality has been reported from the Codrington wind farm (Biosis Research 2002). This species appears able to adapt and habituate to human developments. Observed foraging within the development envelope at turbine height over plains and ranges. Similar habitat is present in other parts of the range although, the proposal would cover an extensive area of preferred habitat. The Grey Falcon is usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions. Preys primarily on birds, especially parrots and pigeons, using high-speed chases and stoops; reptiles and mammals are also taken. It utilises old nests of other birds of prey and ravens, usually high in a living eucalypt near water or a watercourse. Trees, dead or alive, containing stick nests such as those of raptors, crows and ravens are required for breeding. It may be seasonal or irregular visitor to areas.		
Likelihood of habitat avoidance: possible		*Habitat importance: low*
Collision likelihood: possible		*Collision consequence: low-moderate*
Overall risk levels	***Individuals***	***Moderate***
	Population	***Moderate***

Peregrine Falcon *Falco peregrinus* (non-threatened)		
Risk factors Chases prey and dives at high speed within turbine height Forages at dawn and dust (low light conditions)		
Discussion Habitat most commonly gorges and timbered watercourses, generally near rivers and swamps. Nests on rock crevice, bare ledge, tree hollow or old corvid nest, also on spires and tall buildings (Pizzey 1985). This species appears able to adapt and habituate to human developments. Feeds almost exclusively on medium sized birds but will hunt small mammals, including bats. Hunts at dawn and dusk, when prey are most active. Prey is struck and captured in mid-air. Potential habitat occurs in the area although the species is not known from the area. Similar habitat is present in other parts of the range although, the proposal would cover an extensive area of preferred habitat. Several records are present from Mutwintji National Park to the north-east.		
Likelihood of habitat avoidance: possible		*Habitat importance: low*
Collision likelihood: low		*Collision consequence: low*
Overall risk levels	***Individuals***	***Low-moderate***
	Population	***Low***

Australian Hobby *Falco longipennis* (non-threatened)		
Risk factors Forages in open country at blade height Fast pursuit of flying birds and insects		
Discussion Range of open habitats, typically woodland with large trees and timbered watercourses. Builds stick nest in top of tall trees. Hunts small and medium sized birds (including ducks and herons) and flying insects. Appears able to adapt and habituate to developed environments. Known from the Western Division. Preferred habitat features (trees near watercourses and woodland) may attract this species to the development envelope. Similar habitat is present in other parts of the range although, the proposal would cover an extensive area of preferred habitat.		
Likelihood of habitat avoidance: possible		*Habitat importance: low*
Collision likelihood: possible		*Collision consequence: minor*
Overall risk levels	***Individuals***	***Moderate***
	Population	***Low***

Spotted Harrier *Circus assimilis (non-threatened)*		
Risk factors		
Forages in open country at blade height		
Discussion		
Nomadic or migratory. Soars high and very low over open country. Constructs large stick nest in eucalypts. Known from the Western Division. The site represents marginal habitat.		
Likelihood of habitat avoidance: possible		*Habitat importance: minor*
Collision likelihood: possible		*Collision consequence: minor*
Overall risk levels	***Individuals***	***Moderate***
	Population	***Low***

Owls: Barking Owl *Ninox connivens*, Masked Owl *Tyto novaehollandiea*, Grass Owl *Tyto capensis* (threatened); Barn Owl *Tyto alba* (non-threatened)		
Risk factors		
Night-flying Large ranging		
Discussion		
Top order predators at low density in the landscape. Limited by the distribution of refuge including hollow-bearing trees, mature vegetation, dense vegetation and for the Grass Owl, tall understorey vegetation. These species have varied diet and large home range, hunting in grasslands, in open areas and in the tree canopy for mammals and birds (NPWS 2003b). Preferred habitat features may attract this species to the development envelope. Similar habitat is present in other parts of the range although, the proposal would cover an extensive area of preferred habitat. Forest owls are generally confined to areas with tree cover, although dispersing juveniles may fly over open country. Hunting flights are likely to be at ground and canopy level. These species are unlikely to enter the bladeswept zone during hunting flights. Dispersal is likely to be at greater heights however, presenting a risk of bladestrike.		
Likelihood of habitat avoidance: rare		*Habitat importance: low*
Collision likelihood: rare		*Collision consequence: minor*
Overall risk levels	***Individuals***	***Low-moderate***
	Population	***Low-moderate***

Tawny Frogmouth *Podargus strigoides* (non-threatened)		
Risk factors		
Night-flying Occur in small family groups		
Discussion		
Inhabits heavy forests to open woodlands, timber along watercourses in inland areas. Nests in flimsy stick platforms on branches 5-10m high. Sedentary (Pizzey 1985). Active at dusk, takes prey from sitting position from ground surfaces such as roads. Feeding activities are more likely of the site in timbered lowlands, and would generally occur below blade height. Several observed in a water course at the base of the range. Unlikely to fly in the path of blades.		
Likelihood of habitat avoidance: rare		*Habitat importance: minor*
Collision likelihood: rare		*Collision consequence: minor*
Overall risk levels	***Individuals***	***Low***
	Population	***Low***

Diamond Firetail *Emblema guttata* (threatened)
Risk factors
Seasonal flock aggregations Declining
Behaviour and ecology

Sedentary. Restricted largely to woodland remnants of grassy eucalypt woodlands and sometimes lightly wooded farmland. Feeds predominantly on the ground on grass seeds, in groups from 5 to 150 individuals (Schodde & Tidemann 1986), nesting in pairs or communally in shrubs and small trees. May form large flocks during winter and autumn. Research in grazing landscapes in southern NSW suggests that granivores prefer to move along densely vegetated areas (Fischer and Lindenmayer 2002a). Diamond Firetails are considered to have poor dispersal abilities and are likely to be less common away from tree cover.		
Likelihood of habitat avoidance: rare		*Habitat importance: minor*
Collision likelihood: rare		*Collision consequence: moderate*
Overall risk levels	***Individuals***	***Low***
	Population	***Moderate*** *(due to flocking behaviour)*

Parrots: Superb Parrot *Polytelis swainsonii,* Turquoise Parrot *Neophema pulchella,* Scarlet-chested Parrot *Neophema splendida,* Night Parrot *Pezoporus occidentalis* (threatened)
Risk factors Migratory (seasonal) Limited flocking Declining Nocturnal (Night Parrot)
Discussion The Scarlet-chested Parrot inhabits arid to semi-arid areas within mallee Mulga scrublands/open woodlands with spinifex and saltbush ground covers. Forages on or near the ground for seeds of grasses, including spinifex, herbs and acacias. Usually nests close to the ground within small trees. Several pairs may nest within neighbouring trees. These birds band into quite large flocks when not breeding and become highly nomadic (DECC 2007). The Superb Parrot nests in tree hollows in small colonies, often with more than one nest in a single tree. At the micro scale, distribution and abundance is influenced by tree cover and species composition. Nest trees tended to be older, often affected by dieback with little regeneration (Manning 2004). A general dispersal north from Victoria after the breeding season (DNRE 1992) occurs. Local migration routes are not known. Records of flocks of between 20 and 50 birds were made in the Yass region only three times during spring and early summer of 1998; most records were of single birds or pairs (ACT Government 1999). The Superb Parrot avoids open areas on foraging flights, hence simple fragmentation of the habitat can be devastating (DNRE 1992). While Superb Parrots use woodland remnants as corridors, they rarely cross extensive open ground (Webster 1988, Davidson and Chamber 1992, Webster and Ahern 1992, Higgins 1999). The Turquoise Parrot lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals. Prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter. Forages quietly and may be quite tolerant of disturbance. However, if flushed it will fly to a nearby tree and then return to the ground to browse as soon as the danger has passed. Nests in tree hollows. The Night Parrot is thought to have a dependence upon dense spinifex or samphire for daytime roosting spots and for nesting. Although the Night Parrot is capable of flight, it prefers to spend most of its time on the ground. Some reports indicated that it runs between shelter when possible, in preference to flying. When it flies, it usually goes only a short distance, flying close low, before landing and escaping on foot (DECC 2007). These species are unlikely to fly over the ridges into the path of turbines, preferring to forage and disperse using vegetated corridors and / or grassland habitats.

Likelihood of habitat avoidance: rare		*Habitat importance: minor*
Collision likelihood: rare		*Collision consequence: moderate*
Overall risk levels	***Individuals***	***Low***
	Population	***Moderate*** *(due to flocking behaviour)*

Pink Cockatoo *Cacatua leadbeateri* (threatened)
Risk factors

Rapid flight at turbine height Flocking Declining		
Discussion Inhabits a wide range of treed and treeless inland habitats, always within easy reach of water. Feeds mostly on the ground, on the seeds of native and exotic melons, saltbush, wattles and cypress pines. Normally found in pairs or small groups, though flocks of hundreds may be found where food is abundant. Nests in tree hollows (DECC 2007). Observed on site flying with the turbine envelope at blade height. A manoeuvrable flyer. Key habitat is not located within the development envelope.		
Likelihood of habitat avoidance: possible		*Habitat importance: minor*
Collision likelihood: rare		*Collision consequence: minor*
Overall risk levels	***Individuals***	***Low***
	Population	***Moderate***

Painted Snipe (*Rostratula benghalensis*) (threatened)		
Risk factors Migratory Potential habitat adjacent to site Declining		
Discussion Little is known of the behaviour of this cryptic waterbird. Possibly nomadic; has been observed occupying ephemeral wetlands. Seeds and invertebrates are foraged for on the waters edge. Breeding is thought to occur in response to local conditions between September and December (Pringle 1987). A recent assessment of collision risk on 34 bird species present at five operational and planned wind farm sites in Gippsland, Victoria, including migratory wetland species concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006). Habitat is marginal at the site, likely to be limited to infrequent wet years, on surrounding plains. This species does not appear to congregate in large numbers.		
Likelihood of habitat avoidance: rare		*Habitat importance: minor*
Collision likelihood: rare		*Collision consequence: moderate*
Overall risk levels	***Individuals***	***Low***
	Population	***Low***

Latham's Snipe, Japanese Snipe (*Gallinago hardwickii*) (threatened)		
Risk factors Migratory Potential habitat adjacent to site		
Discussion This species nests annually in northern Japan, where it congregates in large numbers on the shores of local lakes (Schodde & Tideman 1995). Favoured habitats during the non-breeding season include wet paddocks or shallow water with good covering of tussocks or other growth, seepage below dams, from sea level to 2000m (Pizzey 1985), where they probe for aquatic invertebrate and seed (Green & Osborne 1994). A recent assessment of collision risk on 34 bird species present at five operational and planned wind farm sites in Gippsland, Victoria, including migratory wetland species such as Lathams Snipe, concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006). Habitat is marginal at the site, likely to be limited to infrequent wet years, on surrounding plains. This species does not appear to congregate in large numbers.		
Likelihood of habitat avoidance: rare		*Habitat importance: minor*
Collision likelihood: rare		*Collision consequence: moderate*
Overall risk levels	***Individuals***	***Low***
	Population	***Low***

Ducks: Blue-billed Duck *Oxyuro australis*, Freckled Duck *Stictonetta naevosa* (threatened)		
Risk factors Flocking Swift flight, possibly with poor manoeuvrability Wide ranging Declining		
Discussion The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. 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. The Freckled Duck similarly prefers permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. Habitat within the development envelope is not suitable although Umberumberka Dam may be periodically utilised. Movement corridors are anticipated to be largely confined to vegetated corridors. While migration routes are not known, periodically, flocks may pass within the turbine envelope. Overseas studies have shown that some waterbird species are able to perceive and avoid turbines, both during the day and at night (Erickson *et al.* 2001). Because of their capacity to avoid turbines, the US National Wind Coordinating Committee (2000) considers waterbirds to be at lower risk from bladestrike than some other groups.		
Likelihood of habitat avoidance: rare		*Habitat importance: minor*
Collision likelihood: rare		*Collision consequence: Moderate*
Overall risk levels	***Individuals***	***Low***
	Population	***Moderate***

Egrets: Cattle Egret *Oxyuro australis*, Great Egret *Stictonetta naevosa* (non-threatened)		
Risk factors Possibly with poor manoeuvrability Wide ranging		
Discussion The Cattle Egret is a wide ranging species, found in dry grassy habitats where it feeds on insects. It is usually found large animals which disturb insects. No Cattle Egrets were observed onsite. The Great Egret is partially migratory. It is found feeding in shallow water or drier habitats on fish, frogs or insects. It breeds in colonies vegetation near permanent water. Overseas studies have shown that some waterbird species are able to perceive and avoid turbines, both during the day and at night (Erickson *et al.* 2001). Because of their capacity to avoid turbines, the US National Wind Coordinating Committee (2000) considers waterbirds to be at lower risk from bladestrike than some other groups.		
Likelihood of habitat avoidance: rare		*Habitat importance: minor*
Collision likelihood: rare		*Collision consequence: minor*
Overall risk levels	***Individuals***	***Low***
	Population	***Low***

White-throated Needle-tail *Hirundapus caudacutus* (non-threatened)
Risk factors Migratory High-flying Vertical flight and diving displays May form large flocks
Discussion Summer migrant to Australia from Asia, mid-October to mid-April. Feed on flying insects. Occurs over cities. Roosting habits not known. Risk is lessened by limited time spent at the site and capacity to habituate to humanised landscapes. Local migration routes are not known. A recent assessment of collision risk on 34 bird species present at five operational and planned wind farm sites in Gippsland, Victoria, including migratory species such as the White-throated Needletail, concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006).

Likelihood of habitat avoidance: rare-possible		*Habitat importance: minor*
Collision likelihood: rare		*Collision consequence: minor-moderate*
Overall risk levels	***Individuals***	***Low-moderate***
	Population	***Low***

Bats: Yellow-bellied Sheathtail-bat *Saccolaimus flaviventrus,* Inland Forest Bat *Vespadelus baverstocki* , Little Pied Bat *Chalinobus picatus* (threatened)		
Risk factors Colonial Forage and disperse within bladesweep area Declining		
Discussion The Yellow-bellied Sheathtail-bat roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. Seasonal movements are unknown; there is speculation about a migration to southern Australia in late summer and autumn. The Inland Forest Bat is recorded from scattered localities in western NSW, but may be more widespread. Roosts in tree hollows and abandoned buildings. It has been recorded from a variety of woodland formations, including mallee, Mulga and River Red Gum. Colony size ranges from a few individuals to more than fifty. Females congregate to raise young. The single young is carried by its mother until its weight affects her flight, and is then left in the roost at night. These bats fly rapidly and cover an extensive foraging area. The Little-Pied Bat was recorded at Umberumberka Dam generally occurring in dry open forest, open woodland, Mulga woodlands, chenopod shrublands, cypress-pine forest, or mallee. It roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings and can tolerate high temperatures and dryness but need access to nearby open water. Potential for collisions exists, although the turbine areas represent marginal foraging habitat. The former two species would roost away from turbines, in tree hollows while the latter has potential to roost in caves or mine shafts occurring closer to the turbine envelope. Dispersing individuals rather than acclimatised resident bats have been found to be at increased risk of collision (Erickson *et al.* 2002).		
Likelihood of habitat avoidance: possible		*Habitat importance: low*
Collision likelihood: rare		*Collision consequence: low-moderate*
Overall risk levels	***Individuals***	***Low***
	Population	***Low-moderate***

Conclusion

The risks of collision with wind farm infrastructure for birds and bats relate to species ecology, environmental conditions and structural characteristics of the infrastructure proposed. Behaviour modification, such as avoiding migration routes or foraging or breeding areas, relates to the how the site is developed (the degree to which indirect and offsite impacts are managed), the distribution of important habitat features (for example, roost sites) and more species specific factors, such as whether species may find perch opportunities or be scared off by turbines.

The risk assessment tables above have rated threatened species and other species considered to be at risk. No species was rated high. The most at risk species were determined to be the Wedge-tail Eagle and Brown Falcon. Both species are present onsite, have preferred resources within with developments envelope, occur at low density in the landscape and would represent excellent species to model the specific impacts of the proposal post construction.

These assessments are provisional, and based on available information. In particular, knowledge is incomplete regarding the migration behaviour and routes of local bird species, the importance of raptor habitat at the turbine sites to breeding success and the short and long term responses to the wind turbines.

APPENDIX F: PHOTOGRAPHS OF THE SITE

Photograph 1. View south-east from southern monitoring tower

Photograph 2. View east from southern monitoring tower

Photograph 3. View from monitoring tower access track towards Umberumberka dam

Photograph 4. View towards Broken Hill from main southern ridge to the east of Umberumberka dam

Photograph 5. Pitfall traps in Bluebush adjacent to Daydream Mine Road

Photograph 6. Main western ridge from lower slopes of eastern ridge

Photograph 7. Large rock outcropping where Eastern Blue tongue lizard was recorded

Photograph 8. River Red Gum lined drainage lines provide numerous hollows suitable for birds and bats

Photograph 9. Slender Mallee-blue tongue (*Cyclodomorphus melanops*) captured in spinifex grass

Photograph 10. Marbled-headed Snake-lizard (*Delma australis*) captured in spinifex grass

Photograph 11. Western brown snake captured during the study

Photograph 12. Northern ridges on the eastern section of the development site

Photograph 13. Lake Knob is a rocky outcrop in the south-eastern section of the study area

Photograph 14. An inactive Wedge-tailed Eagle nest. Located in a drainage line just west of Lakes Knob

Photograph 15. Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland / low sparse woodland in the central section of the western ridge

Photograph 16. View across Mundi Mundi Plain in far northern section of western ridge

Photograph 17. Ephemeral drainage lines are common around the lower parts of the study area

Photograph 18. Main western ridge in southern section near Umberumberka dam. Note the condition of the Mulga which is typical across the study area

Photograph 19. Rocky ridge where at least 25 individual Tawny Rock Dragons were observed in the far north-western section of the study area

Photograph 20. Female Tawny Rock Dragon *(Ctenophorus decressi)* captured at the site depicted in Photo 19

Photograph 21. Male Tawny Rock Dragon *(Ctenophorus decressi)* observed at the site depicted in Photo 19

Photograph 22. View south towards Lords Gorge from western ridgeline

Photograph 23. Central-netted dragon (*Ctenophorus nuchalis*) captured during the study

Photograph 24. Feral goats were widespread across the study area

Photograph 25. Lords Gorge is a prominent feature in the central section of the western ridge

Photograph 26. A family of Tawny frogmouths enjoy a daytime roost camp in River Red Gums

Photograph 27. Rainbow bee-eaters are regular visitors found mainly in drainage lines

Photograph 28. Wedge-tailed eagles are common in the study area

Photograph 29. Mineshafts and natural caves are widespread

Photograph 30. The northern patch of Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland / low sparse woodland on the eastern ridge

Photograph 31. The smaller southern patch of Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland / low sparse woodland on the eastern ridge

Photograph 32. Bluebush shrubland on the proposed powerline route

Photograph 33. River Red Gum community around Umberumberka dam

Photograph 34. Sunset over the study area