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APEM Group

Meering West Wind Farm

BBUS and Collision Risk Assessment

Draft Report

Prepared for Virya Energy Pty Ltd

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Biosis acknowledges the Aboriginal and Torres Strait Islander peoples as Traditional Custodians of the land on which we live and work.

We pay our respects to the Traditional Custodians and Elders past and present and honour their connection to Country and ongoing contribution to society.

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Bird and Bat Utilisation Surveys

A total of 115 bird species were recorded during bird utilisation surveys conducted over eight seasons. Of these, 13 were raptor species, eight were threatened species and one was a migratory species. Bat utilisation surveys, incorporating bat detectors deployed across eight seasons, positively identified 10 microbat species of the 11 species of microbat considered likely to occur within the study area and surrounds in the Flora and Fauna Assessment (Biosis 2026). No threatened bat species were positively identified (probable or almost certain) during the bat utilisation surveys.

Most of the birds recorded during BUS were observed below rotor swept height (RSH) at both the impact and reference survey points. This is generally expected as the tree canopy across the study area is about 10-15 metres high and most species utilise this height to forage and move between vegetation patches. Species that were only observed in the below RSH range were typically smaller birds with strong affiliations to vegetation.

A total of 26 species were observed flying within RSH, including:

- 10 raptor species: Brown Goshawk *Accipiter fasciatus*, Wedge-tailed Eagle *Aquila audax*, Black-shouldered Kite *Elanus axillaris*, Brown Falcon *Falco berigora*, Nankeen Kestrel *Falco cenchroides*, Black Falcon *Falco subniger* (Critically Endangered, FFG Act), Whistling Kite *Haliastur sphenurus,* Spotted Harrier *Circus assimilis*, Little Eagle *Hieraaetus morphnoides* (Vulnerable, FFG Act) and Black Kite *Milvus migrans*.
- 12 woodland species: Sulphur-crested Cockatoo *Catatua galerita*, Long-billed Corella *Cacatua tenuirostris*, Galah *Eolophus roseicapilla*, Australian Raven *Corvus coronoides*, Little Raven *Corvus mellori*, Australian Magpie *Cracticus tibicen*, Welcome Swallow *Hirundo neoxena*, Crested pigeon *Ocyphaps lophotes*, Fairy Martin *Petrochelidon ariel*, Tree Martin *Petrochelidon nigricans*, Magpie-lark *Grallina cyanoleuca* and Dusky Woodswallow *Artamus cyanopterus*.
- Three waterbird species: Australian Pelican *Pelecanus conspicillatus*, Australian White Ibis *Threskiornis molucca*, and Straw-necked Ibis *Threskiornis spinicollis*.
- One exotic species: Common Starling *Sturnus vulgaris*.

Note that only species that have been recorded flying within RSH at impact points (survey points located within the proposed area) are included in the collision risk model analysis.

Qualitative assessment

Collision risk can be assessed using both qualitative and quantitative approaches. The quantitative approach (CRM) provides a numerical estimate of collision risk but is only applicable to species for which BUS data are available, particularly records of individuals flying within RSH at impact points. As species more likely to fly at night such as waterbirds or migratory shorebirds have not meet these data requirements, a qualitative assessment has also been undertaken to ensure that potential risks are considered more broadly across species. This assessment also allows to include bat species, as bats cannot be assessed using CRM. The qualitative approach allows consideration of presence likelihood, behavioural traits, habitat use, and known sensitivities to wind farms, and is therefore applicable to a wider range of species.

Therefore, in order to gain an understanding of potential impacts to bird and bat species identified as occurring or likely to occur within the study area, Biosis has undertaken a bird and bat qualitative risk assessment to inform the overall biodiversity impact assessment for the proposed wind farm. The qualitative risk assessment found 44 species (40 birds and four bats) to be at more than a negligible risk of collision with an operating turbine, which includes:

- Up to 38 bird species with a Low collision risk.
- Three bat species with a Low collision risk.
- Two bird species with a Moderate collision risk, including:
  - Wedge-tailed Eagle.
  - Black Falcon *Falco subniger*.
- One bat species with a High collision risk:
  - White-striped Free-tailed Bat *Austronomus australis.*
- No bird species with a High collision risk.

Up to two bird and two bat species are considered to have a Low risk of impact as a result of barrier effects for the proposed wind farm layout including; Wedge-tailed Eagle, Black Falcon, White-striped Free-tailed Bat and Gould's Wattled Bat *Chalinolobus gouldii*. All other species have no more than a Negligible risk of impact as a result of barrier effect for the proposed wind farm layout.

Collision Risk Modelling

Because the final turbine specifications had not been confirmed at the time of writing this report, two models using different RSH values were used:

- Model 1 with below RSH-1 < 80 metres, RSH-1 = 80-252 metres and above RSH-1 > 252 metres
- Model 2 with below RSH-2 < 104 metres, RSH-2 = 104-280 metres and above RSH-2 > 280 metres

Following the results of the BUS that was undertaken across eight seasons, Biosis CRM was run for all species for which there were any flights recorded at impact points within RSH. A total of 115 species of birds were recorded during BBUS, 88 of which were recorded at impact sites being considered for CRM. While many of them may have capacity to fly at RSH, 18 species were recorded flying at RSH-1 at impact sites, and 12 species at RSH-2.

Collision Risk Models were undertaken for all native species recorded flying at RSH at impact sites. On the assumption that the collision avoidance capacity of these species above is at least 95%, the results can be summarised as follows:

- Model RSH-1:
  - 10 species with up to one flight per annum that would be at some risk of collision across the entire wind farm.
  - Six with one to five flights per annum that would be at some risk of collision across the entire wind farm.
  - One with greater than five flights per annum that would be at some risk of collision across the entire wind farm (Straw-necked Ibis).
- Model RSH-2:
  - nine species with up to one flight per annum that would be at some risk of collision across the entire wind farm.

- two species with greater than one per annum that would be at some risk of collision across the entire wind farm (Nankeen Kestrel and Australian Raven).

Black Falcon activity within the proposed Meering West Wind Farm area has been recorded at low levels, and no breeding has been observed on site or within 2 kilometres of the proposed wind farm at the time of reporting. The qualitative risk assessment identified the project as presenting a Moderate collision risk for this species. However, due to the absence of breeding observations, the lack of information on avoidance capacity and the absence of flights within RSH recorded at impact points, it is not possible to predict (via CRM) the number of blade-strike events per year for this species.

1 Introduction

1.1 Project background

Biosis Pty Ltd was engaged by Meering West Wind Farm Pty Ltd as trustee for the Meering West Wind Farm Trust (the Proponent) to undertake bird and bat utilisation surveys (BBUS) and run a collision risk model (CRM) for the proposed Meering West Wind Farm (Meering West WF).

The Meering West WF is within the Loddon Mallee region of north-west Victoria, within the Gannawarra Shire and the Loddon Shire, approximately 25 kilometres (to the centre of the project) south-west of Kerang.

The proposed Meering West WF is within the proposed North West Renewable Energy Zone, which has been identified by the Victorian Government as suitable to host new renewable energy projects, including wind turbines and battery storage. The wind farm has been designed and located primarily on cropped farmland to avoid impacts to native vegetation and species habitat. Ecological assessments have occurred over several stages and seasons allowing for ongoing modifications to the project design and subsequent impact footprint, with the aim to further reduce the project's ecological impacts.

Up to 164 Wind Turbine Generators are proposed within the Meering West WF. Two terminal station options (located within the project area to the west and south-west of the study area) with a connection into the Victoria to New South Wales Interconnector (VNI) West transmission line have been assessed, however only one of these will be constructed.

Key infrastructure components of the proposed action include:

- The construction and operation of up to 164 wind turbines with adjoining hardstand, to a maximum tip height of 280 metres and a minimum clearance above the ground of 80 metres.
- Installation and operation of a Battery Energy Storage System (BESS) (currently anticipated to be 1,000 MWh / 500 MW capacity, though type of BESS and final capacity will be confirmed during the detailed design phase of the Project).
- An Operations and Maintenance facility, including a car park and an office.
- Internal access tracks to, from and in between wind turbines.
- A terminal station which will connect into the future VNI West transmission line.
- Up to three collector substations.
- One permanent meteorological monitoring mast (at the same location and the existing mast).
- Up to two 220 kilovolt internal above ground power lines.
- 33 kilovolt underground electrical cables.
- Temporary ancillary infrastructure including:
  - A construction office and compounds, including site offices, car parking, storage and amenities.
  - Temporary civil works.
  - Two concrete batching plants.
  - Laydown areas.

The Meering West WF was assessed over several stages and seasons following the below approach:

- Rapid roadside native vegetation and fauna habitat mapping.
- Detailed flora and fauna assessment.
- Targeted surveys for threatened flora species.
- Bird and bat utilisation surveys (eight seasons).
- Brolga *Grus rubicunda* level 1 and level 2 assessments.
- Targeted surveys for threatened bird species (migratory shorebirds, threatened raptors, Latham's Snipe *Gallinago hardwickii* and White-throated Needletail *Hirundapus caudacutus*).

Targeted fauna surveys were undertaken from August 2024 to March 2026. The investigations included:

- Eight bird and bat utilisation surveys (BBUS) conducted in winter 2024, spring 2024, summer 2024-2025, autumn 2025, winter 2025, spring 2025, summer 2025 and autumn 2026. A total of 115 bird species and 10 bat species were recorded during BBUS.
- Brolga Level 1 and Level 2 Assessments conducted in August, October and November 2024 to assess Brolga habitat and record the presence of individuals breeding within the radius of investigation (10 kilometres from the project boundary). During these assessments, no high-quality Brolga breeding habitat was identified within 5 kilometres of the Meering West WF, and no Brolga (foraging or breeding) was recorded with 10 kilometres of the study area.
- Targeted shorebird surveys were initiated in autumn 2025 to provide comprehensive information about an unnamed wetland known as Salt Lake (located toward the north-eastern boundary of the study area) for EPBC Act listed migratory shorebirds. After four opportunistic surveys (while conducting BBUS or Brolga targeted surveys) and eight rounds of targeted shorebird survey, three EPBC Act listed shorebird species were observed.
- Black Falcon, Little Eagle and White-bellied Sea-Eagle *Haliaeetus leucogaster* targeted surveys were conducted in July and September 2025 to collect further information on the presence of these species within the study area and its direct vicinity (2-kilometre buffer) and determine if these species are nesting within this area. No Black Falcon, Little Eagle and White-bellied Sea-Eagle were recorded flying or nesting during these targeted surveys, although three additional incidental observations of Black Falcon were noted during the winter-spring 2025 period.
- Following the incidental observation of one Latham's Snipe, targeted surveys were initiated in spring 2025 to assess suitable habitat and record the presence of individuals within the study area. Habitat was assessed during the first survey in September 2025. Limited potential habitat was recorded along vegetated dams, flooded paddocks and roadside drains. No Latham's Snipe were recorded during the four targeted surveys between September 2025 and March 2026.

Fauna species recorded during these surveys include:

- Up to 25 threatened and/or migratory fauna species recorded within or in direct proximity of the study area:
  - Six species listed under both the EPBC Act (threatened) and FFG Act (threatened): Hooded Robin *Melanodryas cucullata*, Diamond Firetail *Stagonopleura guttata*, Common Greenshank *Tringa nebularia* and White-throated Needletail, Blue-winged Parrot *Neophema chrysostoma*, Caspian Tern *Hydroprogne caspia.*

  - Five species listed as threatened and/or migratory under the EPBC Act only: Sharp-tailed Sandpiper *Calidris acuminata*, Brown Treecreeper *Climacteris picumnus*, Latham's Snipe, Fork-tailed Swift *Apus pacificus* and Red-necked Stint *Calidris ruficollis.*
  - An additional 14 species listed under the FFG Act as threatened.
- An additional 23 threatened fauna species have previously been recorded within 10 kilometres of the study area, but were not recorded within or in direct proximity of the study area during the assessment:
  - Two species listed as threatened under both the EPBC Act and FFG Act: Australian Bittern *Botaurus poiciloptilus* and Curlew Sandpiper *Calidris ferruginea*.
  - Two species listed as threatened under the EPBC Act only: Southern Whiteface *Aphelocephala leucopsis* and Sloane's Froglet *Crinia sloanei.*
- An additional 13 bird species listed as migratory under the EPBC Act and six species listed as threatened under the FFG Act.

1.2 Scope of assessment

The objectives of the Collision Risk Assessment are to:

- Undertake a desktop review of background documents and any previous assessments relating to the project area with a specific focus on birds and bats at risk of wind turbine collision.
- Combine data recorded during BBUS and targeted surveys to conduct a qualitative collision and barrier effects risk assessment for birds and bats.
- Undertake a quantitative collision assessment (Collision Risk Modelling) for diurnal bird species for which suitable data were obtained from the proposed wind farm area.
- Inform the preparation of Bat and Avifauna Management Plan (BAMP).

1.3 Key fauna habitat features

The study area is located within the Murray Basin bioregion of north-west Victoria and is characterised by a low-relief plateau, predominantly situated 10-20 metres above the flat alluvial plain. The landscape has been extensively modified by agricultural development, resulting in the widespread clearing of native vegetation (Figure 1). Remaining vegetation is highly fragmented and discontinuous, occurring primarily as scattered paddock trees, small remnant patches, and linear roadside corridors. These elements represent the principal terrestrial fauna habitat features within the study area and provide limited structural complexity and connectivity for fauna.

The broader landscape context includes a network of wetlands, lakes, and conservation reserves, which are likely supporting comparatively higher-quality habitat. This results in a heterogeneous landscape comprising modified agricultural land interspersed with discrete areas of remnant vegetation and wetland systems. Wetlands in the region exhibit episodic or seasonal inundation, with water levels driven by local rainfall events, or overbank flooding of the Loddon and Avoca River systems. Inundation periods can vary significantly in frequency, duration, and extent, resulting in dynamic habitat conditions. The spatial arrangement and condition of these habitat types are key determinants of fauna distribution, movement patterns, and habitat utilisation.

Woodlands

Woodland habitat within the study area is highly modified and fragmented, reflecting extensive historical clearing for agricultural development (Figure 1). Remnant woodland vegetation is largely restricted to isolated paddock trees, small patches and linear roadside reserves, with limited occurrence of intact canopy–understorey structure. The reduced patch size, simplified understorey, and high edge-to-area ratios constrain habitat quality, limit habitat values to the condition and connectivity of remnant elements, particularly where they occur in proximity to other native vegetation or higher-quality habitat such as wetlands (see following section). The closest significant woodland habitat is Leaghur State Park (1,800 hectares) located approximately 3 kilometres east of the proposed wind farm.

Wetlands

Within the study area, two natural wetlands are recorded in the Victorian Wetland Inventory (Salt Lake and Old Piggery Swamp; see details below), along with 209 farm dams. In addition, some paddocks are occasionally inundated following significant local rainfall events, such as those in December 2023 – January 2024 and March 2026. The extent of inundation and the duration of water retention for the March 2026 event are described below.

Within 5 kilometres of the study area, significant wetlands are primarily located along the north-east boundary (Figure 1), including open freshwater lakes within the Great Spectacle Lakes Complex System, as well as Meran Lake and Lake Murphy (see details below). Other important wetlands include Griffith Lagoon Nature Conservation Reserve (2 kilometres southwest of the study area) and isolated wetlands along Gredgwin East Road (1.5–2 kilometres south of the study area).

Salt Lake

Salt Lake (no official name; VWI wetland 43165) is a 20-hectare temporary saline lake situated in the north-east section of the proposed Meering West Wind Farm area (35.8210°S, 143.7860°E). It is recorded in the VWI as an intermittently inundated freshwater Temporary Lignum Swamp; however, field observations indicate higher salinity, with salt deposits visible during dry periods.

This lake is not permanent and becomes inundated following significant local rainfall events (such as in 2011, 2022, 2024, and 2026), retaining water for up to 24 months and providing temporary foraging habitat for shorebirds and waterbirds. This wetland has been regularly monitored between August 2024 and March 2026 during targeted surveys for Brolga, migratory shorebirds, Latham's Snipe, and White-throated Needletail.

Old Piggery Swamp

Old Piggery Swamp (no official name; VWI wetland 43276) is a 22-hectare temporary lignum swamp situated along the north-western boundary of the study area (35.8210°S, 143.7860°E). It is a semi-closed wetland dominated by Lignum *Duma* sp. or *Muehlenbeckia* sp. and Black Box *Eucalyptus largiflorens*. This wetland is not permanent and becomes inundated following significant local rainfall events (such as in 2011, 2022, 2024, and 2026). This wetland has been regularly monitored between July 2025 and March 2026 during targeted surveys for Black Falcon, Latham's Snipe, and White-throated Needletail.

Temporary inundated paddocks

On rare occasions, significant local rainfall events (>75 millimetres in a single day or over two consecutive days) can result in temporary paddock inundation across the Meering West plateau (independent of

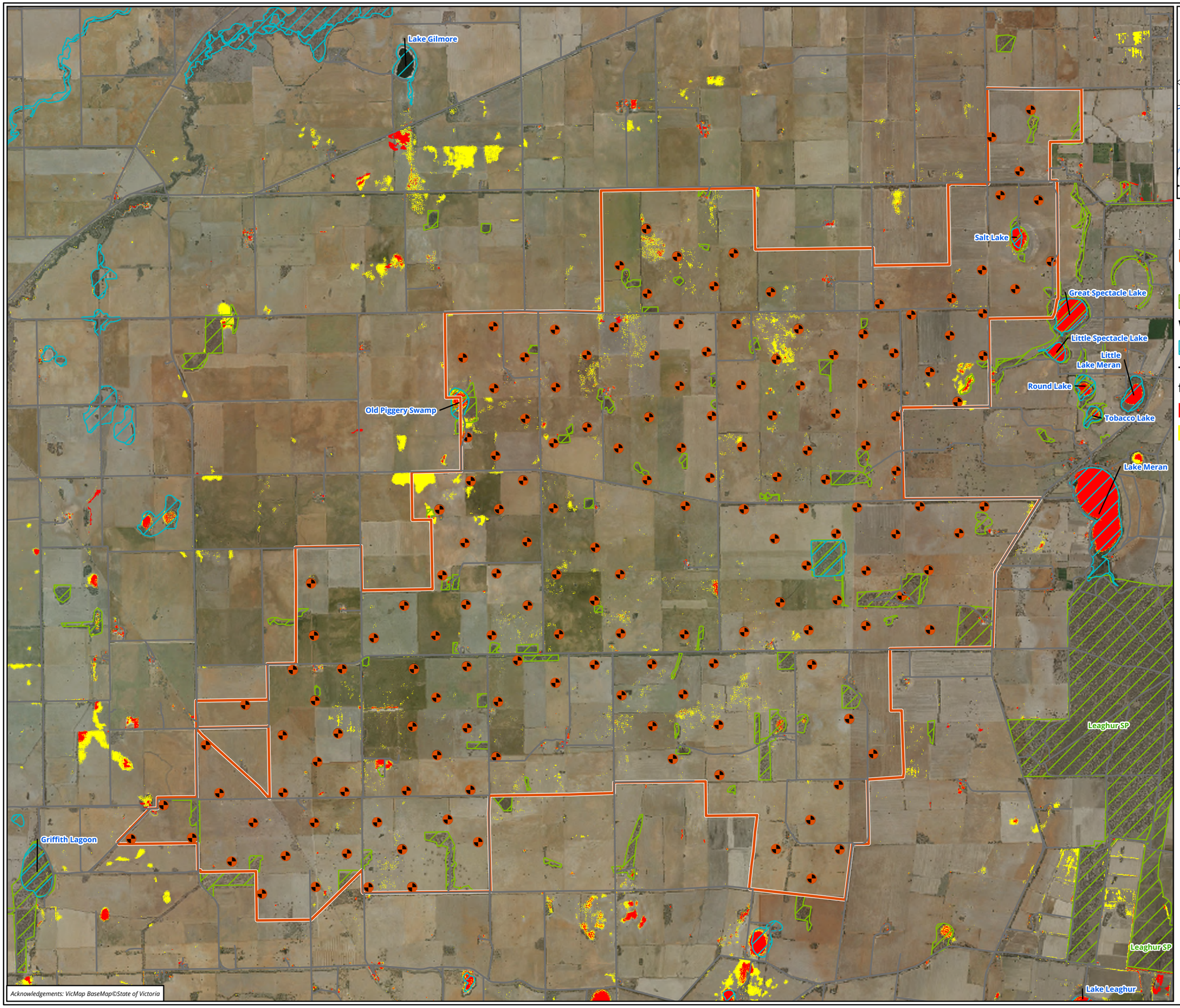
overflows from the Loddon or Avoca Rivers). Such events result in the formation of many small temporary puddles (2–50 metres in diameter, typically holding water for 2–4 weeks), as well as a limited number of larger waterbodies (up to 5 hectares, holding water for up to 2 months).

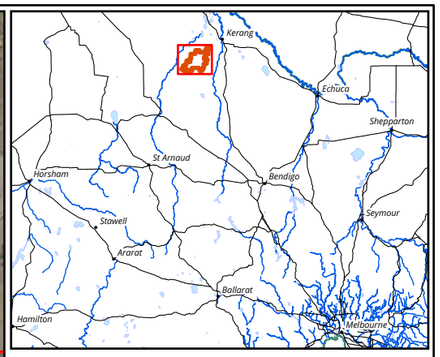
Over the past 15 years, three such events have occurred: in October 2022, December 2023, and March 2026. During the March 2026 event, while conducting planned surveys (BBUS, targeted shorebird surveys, and White-throated Needletail surveys) 1–3 days and 15–19 days after the rainfall event, the Biosis Zoology team recorded the presence, diversity, and distribution of waterbirds throughout the study area.

Great Spectacle Lake Complex, Lake Meran and Lake Murphy

The lakes of the Great Spectacle Lake Complex (Great Spectacle Lake, Little Spectacle Lake, Round Lake, Tobacco Lake, and Little Lake Meran), along with Lake Meran and Lake Murphy, are temporary or semi-permanent freshwater lakes located 1–6 kilometres from the north-eastern boundary of the study area. These lake systems fill following significant local rainfall events and/or when the Loddon River overflows.

These lakes support large populations of waterbirds and provide foraging habitat for shorebirds along their shorelines. These wetlands have been regularly monitored between August 2024 and March 2026 during targeted surveys for Brolga, migratory shorebirds, Latham's Snipe, and White-throated Needletail, and for one round of bat survey (August 2024).





Legend

- Study area
- Turbine layout
- Large woodland patch

Wetlands

- DEECA Wetland

Temporary inundated paddocks following 02/03/2026 rainfall event

- Inundated area (27/03/26)
- Inundated area (10/03/26)

Figure 1 Key fauna habitat

0 0.8 1.6 2.4 3.2 4

Kilometers

Scale: 1:80,000 @ A3

Coordinate System: GDA 1994 VICGRID94

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2 Bird and bat collision risk for onshore wind farms

It is important that threats to native taxa are carefully considered as wind energy technology changes, with bat and bird fatalities as a result of turbine strike representing the principal risk, with recorded instances occurring at international and domestic sites (de Lucas et al. 2012, Smales 2014, Moloney et al. 2019). Despite this, the impacts of wind farms are considered to be relatively low in comparison to other industries, and anthropogenic influences on native taxa (Smales 2014). It is currently estimated that wind farms account for approximately 0.1% of global anthropogenic causes of avian fatalities (Bennett et al. 2022), however the wind industry also being one of the only energy-generating enterprises that must continue systematic monitoring of birds (Smales 2014). While collisions are thought to be the primary cause of mortality, the construction and operation of wind farms can also lead to secondary impacts on bat and bird species including habitat loss or modification, and avoidance response of species (Fox et al. 2006, Masden & Cook 2016, Smales 2014).

Bird and bat collision risk on wind farms is due to a complex number of factors including species-specific elements, such as flight patterns, size and foraging behaviour, environmental factors, and site-specific factors pertaining to the layout of and configuration of turbine infrastructure (de Lucas et al. 2012, Smallwood & Bell 2020). Considering this, not all wind farm sites would contain the same level of collision risk. Quantifying individual collision for bat and bird species presents many challenges. Wind speeds, landscape features and weather events can also contribute to this (Gorman et al. 2021). Understanding collision risk is important to identifying species which may be susceptible and to determining population level impacts, specifically to threatened taxa, with a view to implementing strategies to reduce impacts (Smales 2014, Moloney et al. 2019).

2.1 Birds

Australia is home to considerable avian diversity, with many species inhabiting, utilising, or passing through wind farm sites throughout each year. Studies of bird and bat fatalities across south-eastern Australia have identified 24 species of bird and four species of bat that are most often impacted by direct collision, with larger birds being deemed more likely to collide than smaller birds (Smales 2014, Everaert 2014). Commonly struck species include Australian Magpie *Cracticus tibicen,* Nankeen Kestrel *Falco cenchroides*, and Brown Falcon *Falco berigora* which constitute 24%, 15% and 12% of documented collisions respectively, of all species impacted (Smales 2014). Publicly accessible data from currently operating wind farms in south-east Australia reflects these findings with Australian Magpie being the most commonly found species in post-construction carcass monitoring searches constituting 18% of all bird carcasses found at sites reviewed by Biosis. This is followed by Nankeen Kestrel (17%), Wedge-tailed Eagle (10%), Crimson Rosella *Platycercus elegans* (6.6%), and Sulphur-crested Cockatoo *Cacatua galerita* (4.8%).

A major focus of bird collision research has prioritised large raptors (Smales 2014, de Lucas et al. 2012, Hull et al. 2015, Hull & Cawthen 2013). This may be because there is a large number of threatened species within this group of birds, they have a relatively low reproductive output and are thought to be prone to collision risk and are often of great community interest (Garvin et al. 2011). However other larger bird species including waterbirds, such as ibis, ducks and pelicans, parrots and migratory species are also at risk of collision.

Nesting densities of species may be useful in identifying some likelihood of collision risk (Marques et al. 2014). While important in assessing population and utilisation of a site by different species, abundance alone has been shown to be a poor predictor of collision mortality (Madders & Whitfield 2006, de Lucas et al. 2008). Additionally, there are foraging and feeding behaviours that may make some species more susceptible to collision, such as aerial or shrub searching (Hull et al. 2015). This accounts for observations seen in collision

fatality comparisons between raptor species occupying the same site. Seasonal changes to behaviour have also been seen to affect collision risk for a species (Smith & McWilliams 2016).

Flight height, particularly species flying at rotor height, may expose some species to higher collision risk, but are not the sole factor (Smales 2014). There are some differences in rates of avoidance in eagle species (Hull et al. 2015). Species-dependent avoidance rates are not well known, and more work is needed to understand the ecological differences between species such as the Wedge-tailed Eagle, and White-bellied Sea-Eagle, which have been shown to exhibit differing avoidance rates (Hull et al. 2015). As such, collision risk models are required to make simplistic assumptions about bird behaviour, including uniform avoidance rates for all individuals within a species, which is considered to be unlikely (Masden & Cook 2016). It should be noted that the Biosis collision risk model applies a range of dynamic avoidance rates per species to factor in this potential variation in collision risk (refer Section 5).

2.2 Bats

The primary cause of bat collision with wind turbine infrastructure turbines is still debated (Hein & Schirmacher 2016, de Lucas et al. 2012). A current hypothesis includes turbines acting as a resource attractant, with food sources, including insects, often present. Other sources have attributed their attraction to the consequence of vegetation clearing and landscape modification that sees spaces between turbines mimic flyways (Kunz et al. 2010). There is also insufficient research to determine at what speed blade tips become invisible to echolocation, if any (Wellig et al. 2018, Lawson et al. 2020). Furthermore, we have limited capacity to study and analyse high-altitude bat behaviour (Werber 2024).

Regardless of the cause, bat fatalities have been recorded globally, with a number of high-flying species suspected to be more susceptible, including the White-striped Free-tailed Bat, Gould's Wattled Bat and the Chocolate Wattled Bat *Chalinolobus morio* in south-eastern Australia (Smales 2014, Bennett et al. 2022). White-striped Free-tailed Bat is a common species of bat occurring throughout southern Australia, foraging in open cleared areas often at heights of 50 metres or more. This species was also the first wind farm-related fatality reported globally and is now known to be the most frequently struck species on sites in Victoria and south-east Australia (Smales 2014, Symbolix 2020). This species was found at seven out of the eight wind farms with accessible monitoring data and represented 40.6% of microbat mortalities found. Gould's Wattled Bat was the second most commonly found and represented 20.2% of mortalities, followed by Large Forest Bat *Vespadelus darlingtoni* (7.1%), Chocolate Wattled Bat (6.9%), Little Forest Bat (6.05%) and the Southern Free-tailed Bat *Ozimops planiceps* (5.5%).

To date, there is limited data available in Australia for bat fatalities at large wind farms, with more information and monitoring required to further understand collision risk for the taxa. This is due to a number of factors including challenges involved with detection and movement, due to bats' cryptic nature; difficulties in carcass monitoring and the cost and time-prohibitive nature of searches and methods, including detection dogs (Bennett et al. 2022, Wellig et al. 2018). Furthermore, wind farm monitoring programs have traditionally contained considerable variation, with differences in objectives, design, intensity and duration (Moloney et al. 2019).

Identifying risk for collisions is more attainable for avian species, as their flights can be recorded during bird utilisation surveys. The same cannot be replicated with bat species due to limitations of current survey techniques that prevent understanding key parameters required to estimate collision risk, such as species-specific flight heights, site population size and nocturnal movement patterns and behaviour. Current methods primarily involving ultrasonic recording or trapping must instead be used to identify species presence and use relative activity across a site to predict which areas are most likely to be important to bats, and therefore where bats may be most vulnerable to collisions.

A key limitation to the current use of these detectors is the inability to consistently install them within the rotor-swept area. Current survey methods include the deployment of detectors on meteorological towers, however, as there is usually only one of these installed per site, the sampling area is quite small at these heights, and limited in terms of habitat type sampled (Gration 2011), and ability of direct comparison to the findings of ground-based detectors.

Seasonal patterns in fatalities have been observed with Australian bats, with monitoring finding the majority of bat strikes occurring during January to April in temperate zones (Bennett et al. 2022). Bat activity in the rotor-swept area has also been seen to decrease with higher wind speeds, which can be an important environmental factor in assessing collision risk (Smith & McWilliams 2016, Wellig et al. 2018, Gorman et al. 2021).

It was previously thought that barotrauma was the primary cause of mortality for bats. While conclusive evidence is difficult to attain, it is now generally accepted that it is unlikely that barotrauma is the predominant cause (Guest & Hein 2018, Lawson et al. 2020). Pressure changes necessary to cause barotrauma would be located at such close proximity to the blade itself, it is deemed unlikely that a bat could experience barotrauma without simultaneously being struck by the blade, likely resulting in fatal injury. Furthermore, evidence suggests that visual inspection of bat carcasses may be less effective at identifying injuries related to collision-related mortalities, in contrast to other techniques such as radiography. Additionally, there are similar characteristics that may present as signs of barotrauma, including internal bleeding and fluid buildup in the lung, that may also have been resultant of collision (Guest & Hein 2018). Regardless of the cause, bat interaction with wind turbines causes bat mortality, and a greater understanding is needed of bat activity near wind farm sites.

3 Bird and bat utilisation surveys

In order to describe the baseline for bird and bat fauna and associated movement patterns within the proposed wind farm area, seasonal bird and bat utilisation surveys have been completed between 2024 and 2026. Surveys have been completed in summer, autumn, winter and spring and are considered in this assessment, with empirical flight data from these four seasons also input in the Biosis CRM (see Section 5).

3.1 Bird and bat utilisation survey methods

3.1.1 Bird utilisation survey

A total of two years of seasonal bird utilisation surveys were undertaken to inform CRM and therefore potential prescribed impacts. The methodology employed for the bird utilisation surveys is described below.

The number of survey points were determined based on the number of proposed turbines. At least one impact point site was established for every six planned turbines, and one control point site was established for every four impact sites. Impact count sites were in areas where turbines are proposed to operate. Control sites were in the same general environment but at a sufficient distance that the operational wind farm is not likely to affect bird utilisation, as outlined below. When a body of bird utilisation data is subsequently collected during operation of the wind farm it is theoretically possible to compare the bird utilisation rates of the pre- and post-construction periods to determine whether any change has occurred. Control sites serve as a benchmark to monitor for any effects that are not caused by the wind farm.

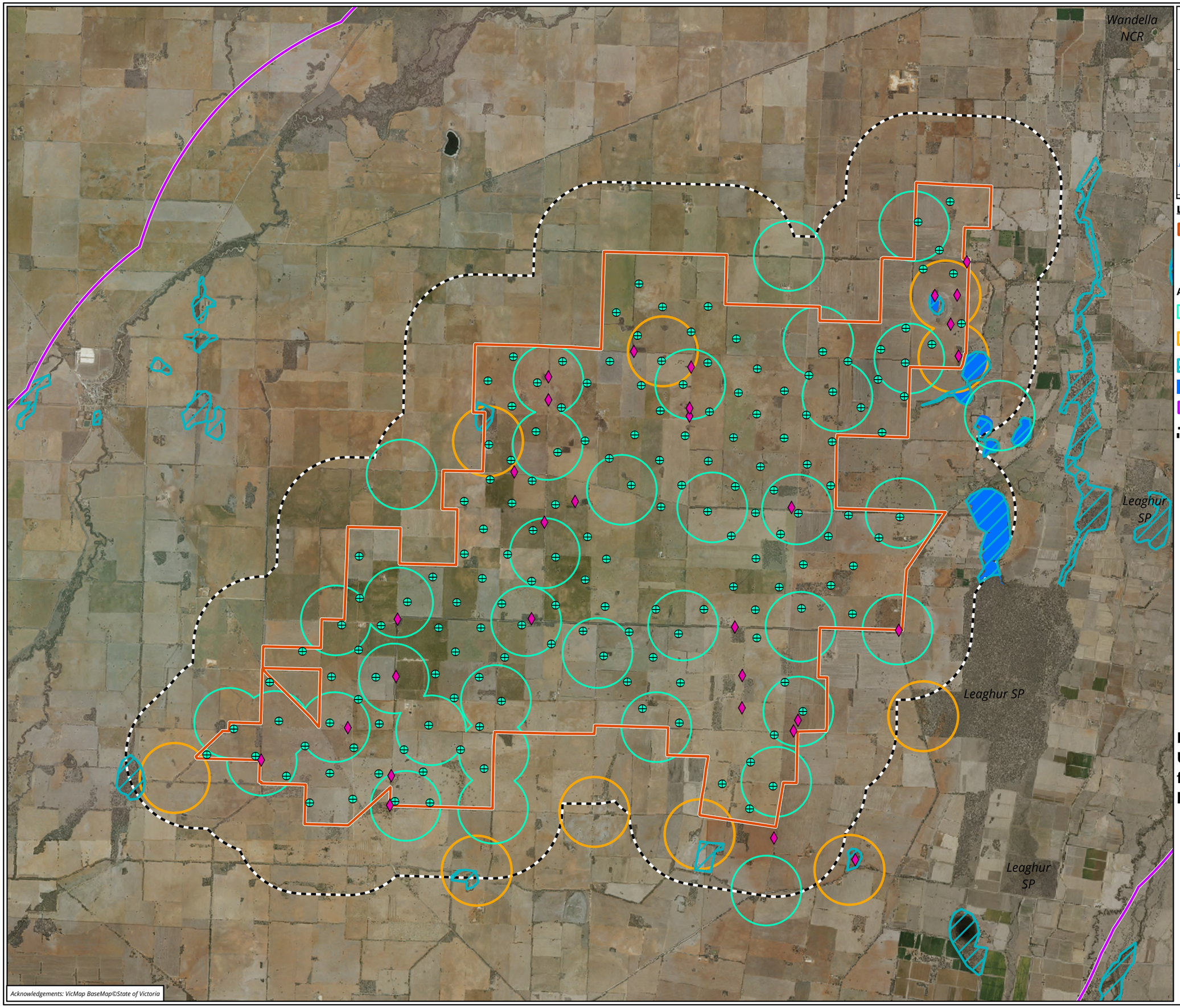
Biosis designed this survey based on the original number of turbines proposed (141 turbines) which resulted in 25 impact sites and six control sites. This design was used for the first two surveys (winter and spring 2024). When the number of proposed turbines increased to 164, four impact and one control point count sites were added to the subsequent surveys, for a total of 29 impact point count sites and seven control point count sites. The bird survey point sites were selected to sample a range of habitat types throughout the study area, including open farmland, scattered trees and woodland (Figure 2, Table 1).

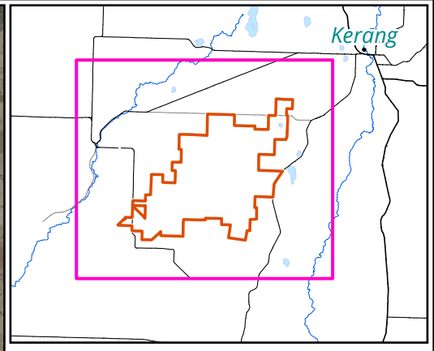
Table 1 Bird utilisation survey sites

Site	Habitat within 500m of the survey site	Distance between survey point and nearest turbine (April 2026)	Notes
Impact sites			
B1	Open paddocks with scattered trees (NE and SE)	190 m	-
B2	Open paddocks, discontinuous roadside treeline (E and W) and small woodland patch (150m NW)	160 m	-
B3	Open paddocks, discontinuous roadside treeline (E and W) and small woodland patch (360m S)	280 m	-
B4	Open paddocks (S) and small woodland patches directly N and SE	180 m	-
B5	Open paddocks and roadside treeline (W)	340 m	-
B6	Open paddocks, roadside treeline (E) and small woodland patch (400m E)	370 m	-

Site	Habitat within 500m of the survey site	Distance between survey point and nearest turbine (April 2026)	Notes
B7	Open paddocks, discontinuous roadside treeline (E) and small woodland patch directly W	220 m	-
B8	Open paddocks and roadside treeline (N, S and W)	160 m	-
B9	Open paddocks, roadside treeline (W) and small farm dam (150m NW)	340 m	-
B10	Open paddocks and roadside treeline (N, E and S)	180 m	-
B11	Open paddocks with scattered trees (NW, NE and S) and roadside treeline (S)	170 m	-
B12	Open paddocks, roadside treeline (N and S) and small farm dam (90m NE)	200 m	-
B13	Open paddocks and roadside treeline (N and S)	310 m	-
B14	Open paddocks with scattered trees (NW and NE)	140 m	-
B15	Open paddocks and discontinuous roadside treeline (E and S)	320 m	-
B16	Open paddocks and discontinuous roadside treeline (N and S)	550 m	-
B17	Open paddocks and discontinuous roadside treeline (E and SW)	140 m	Pig farm 950m NW with two 0.3-0.4 hectares farm dam
B18	Open paddocks, roadside treeline (N and S) and small woodland patch directly E	530 m	Pig farm 850m SE with two 0.3-0.4 hectares farm dam (same farm than B17)
B19	Open paddocks, discontinuous roadside treeline (N and S), small woodland patch (50m SE) and small farm dam (320m S)	225 m	-
B20	Open paddocks, roadside treeline (E and W) and small woodland patch (250m E)	220 m	-
B21	Open paddocks, discontinuous roadside treeline (N and S) and small woodland patch directly W	330 m	-
B22	Open paddocks, roadside treeline (N and S) and small woodland patch (400m NW)	190 m	-
B23	Open paddocks, discontinuous roadside treeline (E and W) and woodland patch (450m N)	130 m	-
B24	Open paddocks and roadside treeline (E and W)	540 m	-
B25	Open paddocks, discontinuous roadside treeline (E and W) and small woodland patch (350m N)	300 m	-
B26	Open paddocks with scattered trees (E and SE) and discontinuous roadside treeline (400 W)	170 m	-
B27	Open paddocks and discontinuous roadside treeline (N and S)	205 m	-

Site	Habitat within 500m of the survey site	Distance between survey point and nearest turbine (April 2026)	Notes
B28	Open paddocks with scattered trees (E and SE), discontinuous roadside treeline (N and S) and small woodland patch (420m NE)	540 m	-
B29	Open paddocks with scattered trees (N), discontinuous roadside treeline (E and W), small woodland patch (420m W) and small farm dam (320m SW)	340 m	-
Control sites			
R1	Open paddocks and roadside treeline (N, E, S and W)	1170 m	-
R2	Open paddocks with scattered trees (S and W), discontinuous roadside treeline (NW and NE) and small farm dam (50m NE)	2000 m	-
R3	Open paddocks with scattered trees (S), roadside treeline (N, E and W) and Round Lake 400m SW	2800 m	Site in between Little Lake Meran (730m SE), Tobacco Lake (800m S), Round Lake (400m SW), Little Spectacle Lake (950m NW) and Great Spectacle Lake (1200m NW)
R4	Open paddocks, discontinuous roadside treeline (N, and E) and small woodland patches (100m S and 220m SW)	2400 m	-
R5	Open paddocks with scattered trees (N), discontinuous roadside treeline (W and E) and small farm dam (60m SE)	1400 m	-
R6	Open paddocks and roadside treeline (W, S and E)	2700 m	-
R7	Open paddocks, roadside treeline (E), native grassland (W) and treed wetland (Quambatook Bushland Reserve; 180m W)	160 m	-





Legend

- Study area
- Proposed turbine location
- Bat survey

Assessment area

- Bird utilisation survey (General)
- Bird utilisation survey (White-throated Needletail targeted survey)
- Wetland survey
- Migratory shorebirds survey
- Brolga breeding habitat survey
- Black Falcon, Little Eagle and Latham's Snipe surveys

Figure 2 Bird and Bat Utilisation Survey (BBUS) and fauna targeted surveys locations

0 1,000 2,000 3,000 4,000 5,000

Metres

N

Scale: 1:100,000 @ A3

Coordinate System: GDA2020 MGA Zone 54

biosis
APEM Group

Matter: 40787,
Date: 15 April 2026 ,
Prepared for: SH, Prepared by MK, Last edited by: mknudsen
Layout: 40787_F2_SurveyCoverage
Project: P:\41100s\41107\Mapping\41107_MeeringWF_Brolga.aprx

Bird utilisation surveys have been undertaken over two years within the study area in the seasons and dates outlined in Table 2 below, to support the CRM. In the assessment of the data, seasons were defined by three-month intervals as summer (December–February), autumn (March–May), winter (June–August) and spring (September–November).

Table 2 Diurnal bird survey effort

Year	Autumn	Winter	Spring	Summer
2024	-	12-16 August (125 count replicates)	07-11 October (124 count replicates)	16-20 December (135 count replicates)
2025	07-11 and 15-17 April (144 count replicates)	07-11 and 14-18 July (145 count replicates)	08-12 and 15-19 September (141 count replicates)	01-05 and 08-12 December (149 count replicates)
2026	02-06 and 16-19 March (142 count replicates)	-	-	-

Surveys comprised fixed-point surveys, which included one observer stationed at each point for 20 minutes. Survey details including the date, start and end times, site location, weather conditions, and habitat features of interest were recorded during each survey. During surveys, all observations within 360 degrees and up to 3 kilometres of the observer were recorded, including:

- Species observed taking flights.
- Count of individuals.
- Height of bird above ground when first detected.
- Distance of bird from observer when first detected.
- Flight direction.
- Species behaviour, if relevant.
- Incidental bird observations were also recorded, especially for raptors and threatened species.

Each fixed point was surveyed up to four times per seasonal survey, with a minimum of once each at three different times of day:

- Morning (6:00 AM to 10:59 AM).
- Midday (11:00 PM to 13:59 PM).
- Afternoon (2:00 PM to 6:00 PM).

This methodology aimed to capture seasonal and temporal changes, including migration and species behaviour.

The 29 fixed survey impact points (25 for the winter and spring 2024 surveys, and 29 for the following surveys) obtaining a total of 890 replicates and 17,800 minutes (or a total of 296.7 hours) of targeted diurnal bird surveys (Table 2). In addition, seven fixed survey experimental control points (6 for the winter and spring 2024 surveys, and 7 for the following surveys) obtaining a total of 215 replicates and 4,300 minutes (71.7 hours) of reference surveys (Table 2). This provides a total (impact and control) of 1105 replicates across the 36 fixed survey points.

At the time of writing this report, the turbine model had not been confirmed. Therefore, BBUS results were analysed using a conservative Rotor Swept Height (RSH). The following draft height matrix was defined to classify bird flight heights; however, it remains subject to revision pending final turbine specifications, particularly the lower and upper blade tip heights:

- Below RSH: <80 metres.
- Within RSH: 80-300.
- Above RSH: >300 metres.

The following bird guilds were used to categorise species:

- Raptors
- Grassland, shrubland and ground-dwelling birds
- Waterbirds, seabirds and other aquatic foragers
- Woodland birds (including parrots and songbirds)
- Exotic birds (introduced species)

The above guilds were applied to the BUS results to identify birds of concern for future collision risk modelling.

3.1.2 White-throated Needletail and Fork-tailed Swift targeted surveys

In addition to seasonal BUS effort, targeted surveys for White-throated Needletail and Fork-tailed Swift were conducted between December 2025 and March 2026. This additional survey effort was implemented for one season following incidental observations of both species in summer 2024 and autumn 2025.

Five surveys were conducted, in late mid-December 2025, mid-January 2026, mid-February 2026, late-February 2026 and mid-March 2026. The aim was to increase the survey effort of general BUS during the peak of presence of these two migratory species. These surveys consisted of conducting 20-minute fixed-point counts from 10 new points located near ecological features where the two target species are more likely to be observed (above woodlands or in proximity to wetlands) (Figure 2). For each survey, each point was surveyed up to four times with at least one replicate in the morning, mid-day and late afternoon. This provides an additional 193 replicates across the 10 fixed survey points (64.3 hours).

3.1.3 Bat utilisation survey

For each survey, nine to 11 ultrasonic bat detectors were deployed in habitat types likely to be relevant to bats using desktop analysis to allocate survey points across the site in representative habitats (Figure 2). Stratification was associated with vegetation structure and diversity, with modified land assumed to provide little structural or floristic (and insect) diversity and woodland habitats likely to contain the highest structural and floristic diversity and therefore be more highly utilised by bats. Scattered trees were also sampled as they are known to be attractive to bats in the landscape. Waterbodies are known to be focal points in the landscape for bat activity and were sampled to ensure species richness in the area was sufficiently captured. The four habitat types selected therefore included:

- Modified land (crop).
- Scattered trees (isolated trees with no vegetation within >50 metres of the tree).

- Woodland (locations with >1 hectare of woodland noting that the site does not contain large woodland patches).
- Wetland / farm dam.

Different sample sites were selected within each habitat type in each of winter 2024, spring 2024 and summer 2024 to increase spatial coverage at the site. From autumn 2025, sites were resampled, resulting in each site having at least one sample in a period of high bat activity (spring/summer) and a period of low bat activity (autumn/winter). Only Crop7 had a single seasonal sample (due to equipment failure), with all the remaining sites having 2-4 surveys.

Data was also collected at height during each seasonal deployment (70 and 110 metres above ground level) by using an ultrasonic detector mounted on a meteorological mast (met mast) located south of Meran Road (35.8735°S 143.6730°E). A unit was also placed at ground level at the met mast, resulting in paired detectors sampling call data at ground level and at height simultaneously.

Effort has been separated to show effort for seasonal deployments versus effort of detector deployments at the met mast. Effort per deployment is shown in Table 3 for ground level detectors and Table 4 for met mast detectors. Note that data from the ground-based met mast detector was included in seasonal data comparisons where dates overlapped with other ground-based detectors deployed across the site. Nights with only one detector have been removed to prevent outliers arising from a lack of replication. Similarly, activity comparisons between sites used nights where there was appropriate replication achieved.

Table 3 Bat survey effort for seasonal data collection

Season	Deployment start	Deployment end	No. of detectors deployed	Detector nights
Winter 2024	16/08/2024	28/08/2024	11	116
Spring 2024	11/10/2024	23/10/2024	11	102
Summer 2024-25	20/12/2024	06/01/2025	11	159
Autumn 2025	07/04/2025	17/04/2025	9	85
Winter 2025	07/07/2025	18/07/2025	11	94
Spring 2025	08/09/2025	19/08/2025	11	121
Summer 2025-26	01/12/2025	11/12/2025	11	92
Autumn 2026	03/03/2026	19/03/2026	11	140
TOTAL				909

Table 4 Number of detector nights sampled for each of the met mast detectors

Season	Ground	Height (70 m)	Height (110 m)
Winter 2024	12	12	0
Spring 2024	12	12	12
Summer 2024-25	0	17	11
Autumn 2025	14	14	13
Winter 2025	10	10	3

Season	Ground	Height (70 m)	Height (110 m)
Spring 2025	11	11	10
Summer 2025-26	5	16	0
Autumn 2026	14	14	0
TOTAL	77	106	42

Calls were recorded from dusk until dawn using Anabat Swift (Titley Scientific) ultrasonic bat detectors. The device at 110 metres was an Anabat Ranger (Titley Scientific). Default settings for trigger, sensitivity, sampling rate and minimum / maximum frequency were used. Each time a bat flies past the detector, its call is recorded as a digital file (defined here as a 'pass') that is saved directly onto a memory card in the detector unit. Units were set on trigger mode to record at night. Files were recorded in full spectrum format (.wav).

Units were located to allow space in front of and around the microphone to minimise echoes from hard surfaces, call attenuation from surrounding vegetation, and ensure adequate flight space around the microphone. Representative images of detector deployments are shown Plate 1. All units were deployed at ground level (between 1–3 metres above the ground) except the units attached to the met mast. Ground-level units were preferentially mounted on star pickets and/or stakes, unless stock were present that necessitated mounting on trees to prevent disturbance/damage to equipment.

Measures of temperature were recorded by the detector units themselves. Average temperature was calculated per night from all units. Maximum and minimum temperature was the highest or lowest recorded by any unit on a given night (excluding unit located at height on the met mast).

3.2 Bird and bat utilisation survey results

3.2.1 Bird utilisation survey

A total of 115 bird species were recorded during the eight BUS seasons and five White-throated Needletail targeted surveys (see detailed list in Table A 1 and Table A 2 of Appendix 1). A total of 95 bird species were recorded at the 29 impact survey points, 78 species were recorded at the seven reference points, and 82 species were recorded at the 10 White-throated Needletail targeted survey points.

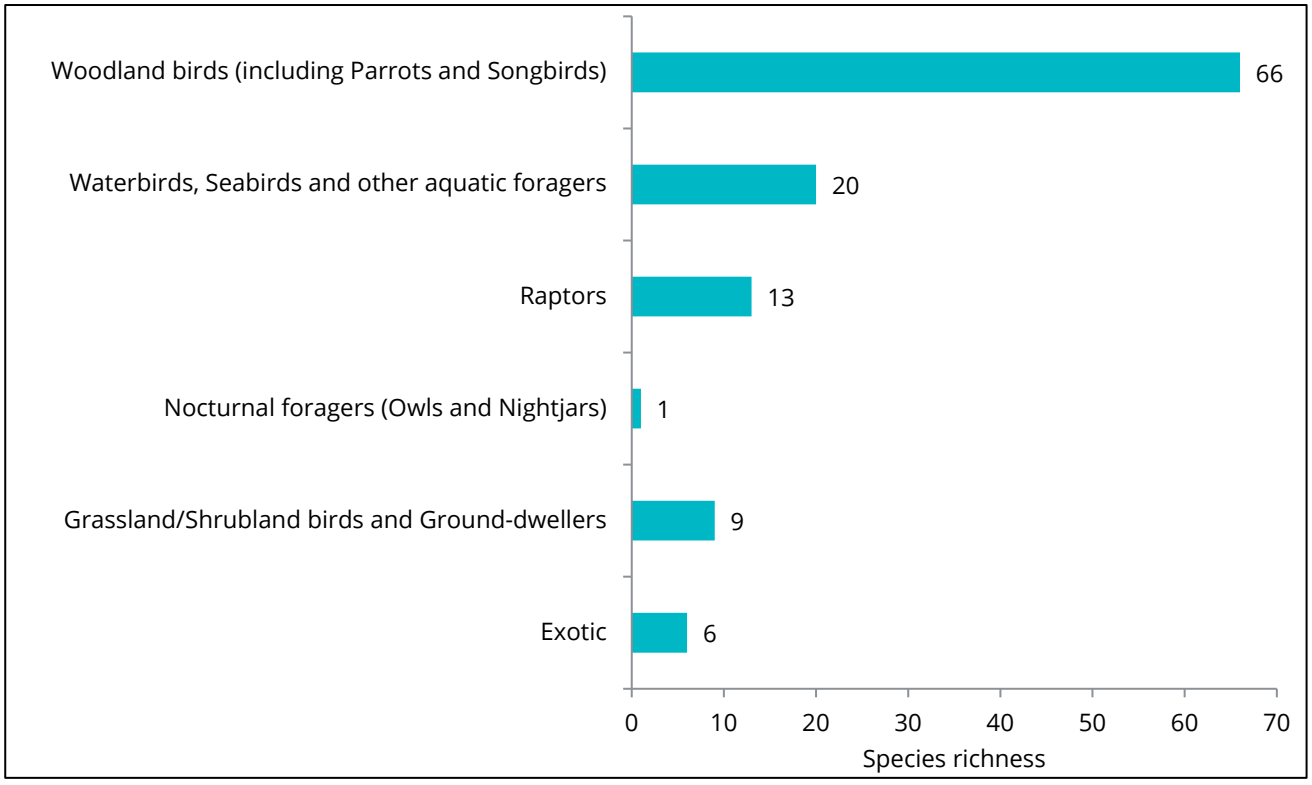
Of the 115 species recorded during BUS, 13 were raptor species, eight were threatened species and one was a migratory species. Threatened and migratory species consisted of:

- Black Falcon (Critically Endangered, FFG Act).
- Brown Treecreeper (Vulnerable, EPBC Act and FFG Act).
- Fork-tailed Swift (Migratory, EPBC Act).
- Grey-crowned Babbler *Pomatostomus temporalis* (Vulnerable, FFG Act).
- Hardhead *Aythya australis* (Vulnerable, FFG Act).
- Hooded Robin (Endangered, EPBC Act; Vulnerable, FFG Act).
- Little Eagle (Vulnerable, FFG Act).
- White-bellied Sea-Eagle (Endangered, FFG Act).
- White-throated Needletail (Vulnerable, EPBC Act and FFG Act).

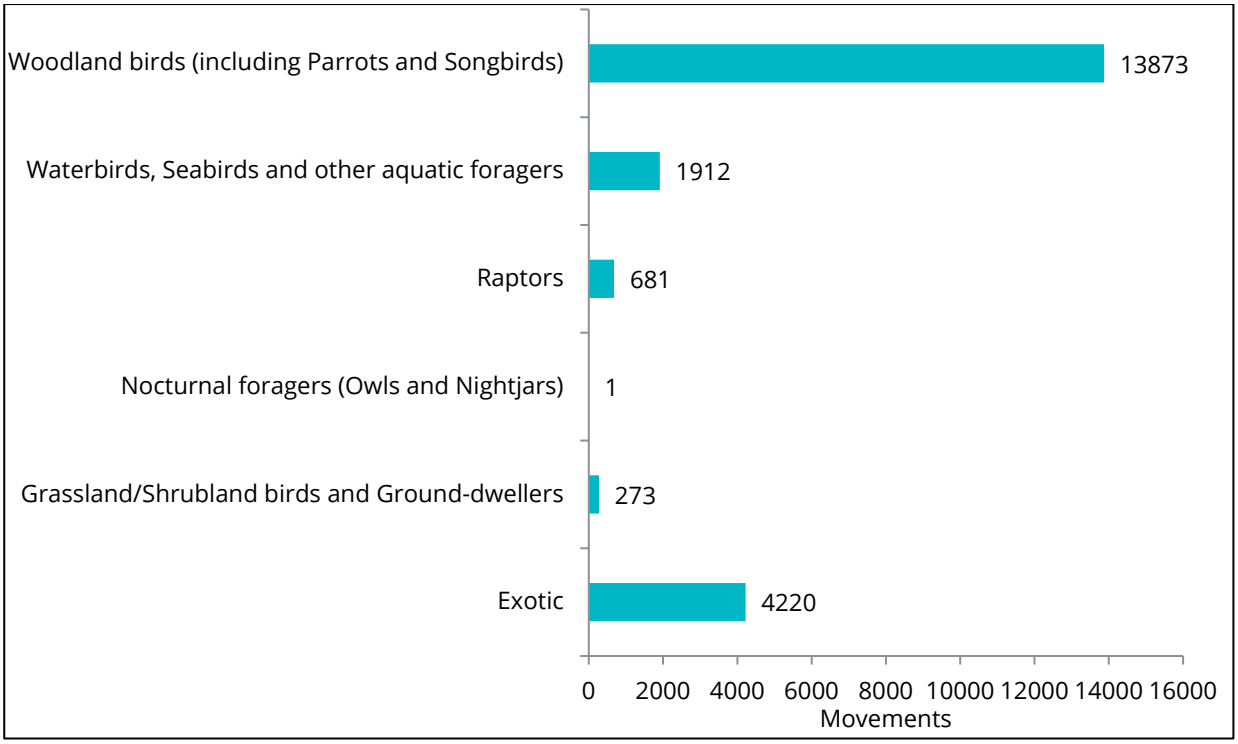
Of the 115 bird species recorded during BUS, nine species were never recorded flying, 13 species were only recorded once, and 28 additional species were recorded 10 times or less. The most common species recorded in the study area were Common Starling *Sturnus vulgaris* (4,062 observations), Raven sp. (which includes Australian Raven *Corvus coronoides* and Little Raven *C. mellori;* 3,154 observations), Eastern Rosella *Platycercus eximius* (2,072 observations), Galah *Eolophus roseicapilla* (1,731 observations), Miner sp. (which includes Noisy Miner *Manorina melanocephala* and Yellow-throated Miner *M. flavigula*; 1,416 observations), and Australian Magpie (1,408 observations). These seven bird species make up 53% of all bird movement observations.

A total of 31 bird species were also observed outside of BBUS (when conducting other surveys or recorded incidentally), bringing the total of species observed on site to 146. Most of these species are waterbirds and shorebirds, and although they were not recorded flying during BBUS, they are still considered at risk of colliding with turbines due to their flying behaviour (mostly flying at night).

The most diverse guild of birds recorded during BBUS were the woodland birds (including Parrots and Songbirds) which made up about 57% of all species observed (66 species) followed by waterbird (17% of all species observed; 20 species) and raptor species (11% of all species observed; 13 species). A summary of bird guild diversity and abundance is shown in Graph 1. The summary of movements recorded per guild (Graph 2) illustrates that woodland birds far exceed the numbers of movements recorded for the other guilds.



Graph 1 Bird species richness across guilds



Graph 2 Number of bird movements across guilds

Resident raptor species

The following resident raptor species were identified as being present within the study area during bird utilisation surveys:

- Australian Hobby *Falco longipennis*
- Black Falcon (Critically Endangered, FFG Act)
- Black Kite
- Black-shouldered Kite
- Brown Falcon
- Brown Goshawk
- Little Eagle (Vulnerable, FFG Act)
- Nankeen Kestrel
- Spotted Harrier
- Swamp Harrier *Circus approximans*
- Wedge-tailed Eagle
- Whistling Kite
- White-bellied Sea-Eagle (Endangered, FFG Act)

All of these species are common/widespread and likely to occur as resident raptor species within 10 kilometres of the proposed wind farm. The threatened Black Falcon and Little Eagle were observed from impact points at nine and two occasions, respectively. White-bellied Sea-Eagle was recorded during White-throated Needletail targeted surveys or incidentally and not recorded at impact points.

Other aerial bird species

Aerial bird species (foraging in flight at height) recorded flying during BUS include the following species:

- Black-faced Woodswallow *Artamus cinereus*
- Dusky Woodswallow
- Fairy Martin
- Rainbow Bee-eater *Merops ornatus*
- Tree Martin
- Welcome Swallow
- White-breasted Woodswallow *Artamus leucorynchus*
- White-browed Woodswallow *Artamus superciliosus*

White-throated Needletail (Vulnerable, EPBC Act and FFG Act) and Fork-tailed Swift (Migratory, EPBC Act) were recorded incidentally (one observation each). For these two species, no further individuals were observed despite additional survey in summer 2025–2026 during targeted surveys.

Resident waterbird/shorebird species

Waterbird/shorebird species recorded flying during BUS include the following species:

- Australian Pelican
- Australian Shelduck *Radjah radjah rufitergum*
- Australian White Ibis
- Australian Wood Duck *Chenonetta jubata*
- Great Cormorant *Phalacrocorax carbo*
- Grey Teal *Anas gracilis*
- Pacific Black Duck *Anas superciliosa*
- Straw-necked Ibis
- White-faced Heron *Egretta novaehollandiae*
- White-necked Heron *Ardea pacifica*

Other waterbird species observed flying during White-throated Needletail surveys include the following species:

- Black Swan *Cygnus atratus*
- Black-fronted Dotterel *Elseyornis melanops*
- Chestnut Teal *Anas castanea*
- Hardhead (Vulnerable, FFG Act)
- Little Pied Cormorant *Microcarbo melanoleucos*
- Masked Lapwing *Vanellus miles*
- Pink-eared Duck *Malacorhynchus membranaceus*

Additional waterbird species were observed but not flying, including the following:

- Australasian Darter *Anhinga novaehollandiae*
- Australasian Grebe *Tachybaptus novaehollandiae*
- Australasian Shoveler *Spatula rhynchotis* (Vulnerable, FFG Act)
- Australasian Swamphen *Porphyrio melanotus*
- Baillon's Crake *Porzana pusilla*
- Banded Lapwing *Vanellus tricolor*
- Black-tailed Native-hen *Tribonyx ventralis*
- Blue-billed Duck *Oxyura australis* (Vulnerable, FFG Act)
- Dusky Moorhen *Gallinula tenebrosa*
- Eastern Great Egret *Ardea alba modesta* (Vulnerable, FFG Act)
- Eurasian Coot *Fulica atra*
- Freckled Duck *Strictonetta naevosa* (Endangered, FFG Act)
- Great Crested Grebe *Podiceps cristatus*
- Hoary-headed Grebe *Poliocephalus poliocephalus*
- Little Black Cormorant *Phalacrocorax sulcirostris*
- Little Egret *Egretta garzetta* (Vulnerable, FFG Act)
- Musk Duck *Biziura lobata* (Vulnerable, FFG Act)
- Pied Stilt *Himantopus leucocephalus*
- Red-capped Plover *Charadrius ruficapillus*
- Red-kneed Dotterel *Erythrogonys cinctus*
- Red-necked Avocet *Recurvirostra novaehollandiae*
- Silver Gull *Chroicocephalus novaehollandiae*
- Whiskered Tern *Chlidonias hybrida*
- Yellow-billed Spoonbill *Platalea flavipes*

Most of these species were recorded along the north-eastern boundary of the proposed wind farm area, within the Great Spectacle Lake Complex System.

Migratory species

No migratory species were observed during BUS. However, the following species were recorded incidentally:

- Caspian Tern (Migratory, EPBC Act)
- Common Greenshank (Endangered and Migratory, EPBC Act and Endangered FFG Act)
- Fork-tailed Swift (Migratory, EPBC Act)
- Latham's Snipe (Vulnerable and Migratory, EPBC Act)
- Red-necked Stint (Migratory, EPBC Act)
- Sharp-tailed Sandpiper (Vulnerable and Migratory, EPBC Act)

- White-throated Needletail (Vulnerable and Migratory, EPBC Act and Vulnerable, FFG Act)

Flyways and nomadic movements

Flyways and movements of aerial taxa likely to occur, or recorded within the study area, are described below in the following species groups: raptors, waterbirds, woodland and shrubland birds and ground dwelling birds and microbats.

Raptors

Raptor presence varied between seasons, however the raptor species recorded are considered resident within the study area. Raptor species utilise woodland and scattered trees for roosting and nesting. Foraging was observed over woodland, scattered trees and grassland. Raptor species move throughout the day between nesting, roosting and foraging locations. These species can cover large areas of habitat while foraging, especially Wedge-tailed Eagle.

Waterbirds

Common waterbird species such as ducks, cormorants and herons were identified primarily within farm dams, or flying between dams. Movements of common and local waterbird species are likely to occur throughout the year within the study area due to the presence of permanent water and ephemeral water from farm dams and earthen channels. In general, minimal areas within the study area were identified as containing water outside of dams, however, important rainfall events such as March 2026 (which may occur every 2–5 years) can provide temporary foraging habitat throughout the proposed wind farm area.

Movements of waterbird species are likely to occur as a mixture of resident day or night movement, nomadic movements subject to climatic conditions and for some species, seasonal migration movements during warm and/or cold months. Flight paths are likely to occur through the study area and across into the broader landscape. Key riparian and wetland movement corridors are located outside the study area along the Avoca and Loddon Rivers.

Woodland and grassland birds

A total of 66 woodland and grassland birds were recorded within the study area during the BUS, targeted and incidental survey. The collective sum of these species utilise almost all the habitat within the study area for foraging, roosting or nesting. Resident species such as ravens, cockatoos or parrots complete daily movements, moving from roosting habitat across foraging areas. Movements of many species are centred on abundance and availability of food, or occur seasonally with temperature changes and seasonal conditions. Breeding is likely to occur year-round across the species identified. Species subject to nomadic movements are likely to use woodland patches to connect with large corridor outside the study area. Movement of grassland species is subject to fragmentation and structural changes from grazing and cropping. Common grassland species such as ground foraging parrots are likely to use woodland patches and roadside reserves to connect to patches of grassland for foraging.

Movements within rotor swept height (RSH)

Most of the birds recorded during BUS were observed below RSH at both the impact and reference survey points. This is generally expected as the tree canopy across the study area is about 10-15 metres high and most species utilise this height to forage and move between vegetation patches. Species that were only observed in the below RSH range were typically smaller birds with strong affiliations to vegetation.

A total of 26 species were observed flying within RSH (Graph 3; Table 5), including:

- 10 raptor species: Brown Goshawk, Wedge-tailed Eagle, Black-shouldered Kite, Brown Falcon, Nankeen Kestrel, Black Falcon (Critically Endangered, FFG Act), Whistling Kite, Spotted Harrier, Little Eagle (Vulnerable, FFG Act) and Black Kite.
- 12 woodland species: Sulphur-crested Cockatoo, Long-billed Corella, Galah, Australian Raven, Little Raven, Australian Magpie, Welcome Swallow, Crested pigeon, Fairy Martin, Tree Martin, Magpie-lark and Dusky Woodswallow.
- Three waterbird species: Australian Pelican, Australian White Ibis, and Straw-necked Ibis.
- One exotic species: Common Starling.

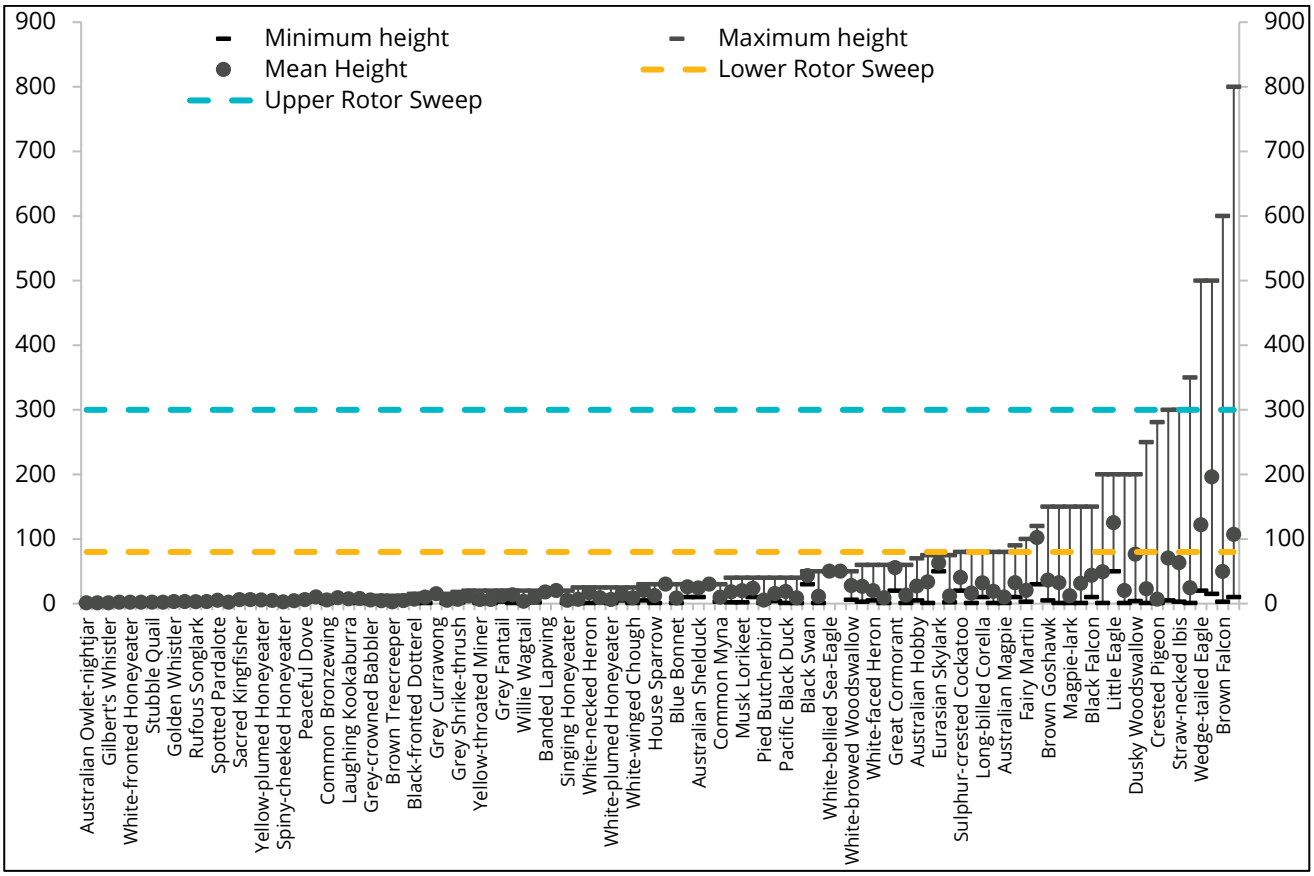
Note that only species that have been recorded flying within RSH at impact points are included in the CRM analysis (Table 5; see Section 5 for more details).

Out of 24,086 movements recorded, 952 (3.95%) were recorded at RSH, and 58 (0.24%) were recorded above RSH. The number of movements observed within RSH varied seasonally, with a peak in autumn 2025 for raptors (Graph 4), and peaks in winter 2024 and autumn 2026 for waterbirds (Graph 5). For both raptors and waterbirds, these variations were the result of a limited number of observations of a few species, such as Wedge-tailed Eagle, Australian White Ibis or Straw-necked Ibis. For waterbirds, the particular high number of individuals observed at RSH in spring 2025 (306) is explained by the observation of one large flight of Straw-necked Ibis (300 individuals). It illustrates that the observed seasonal variations for waterbirds can be strongly influenced by a few observations. Note that observations recorded during White-throated Needletail targeted surveys are excluded from this analysis because these surveys were conducted in summer only.

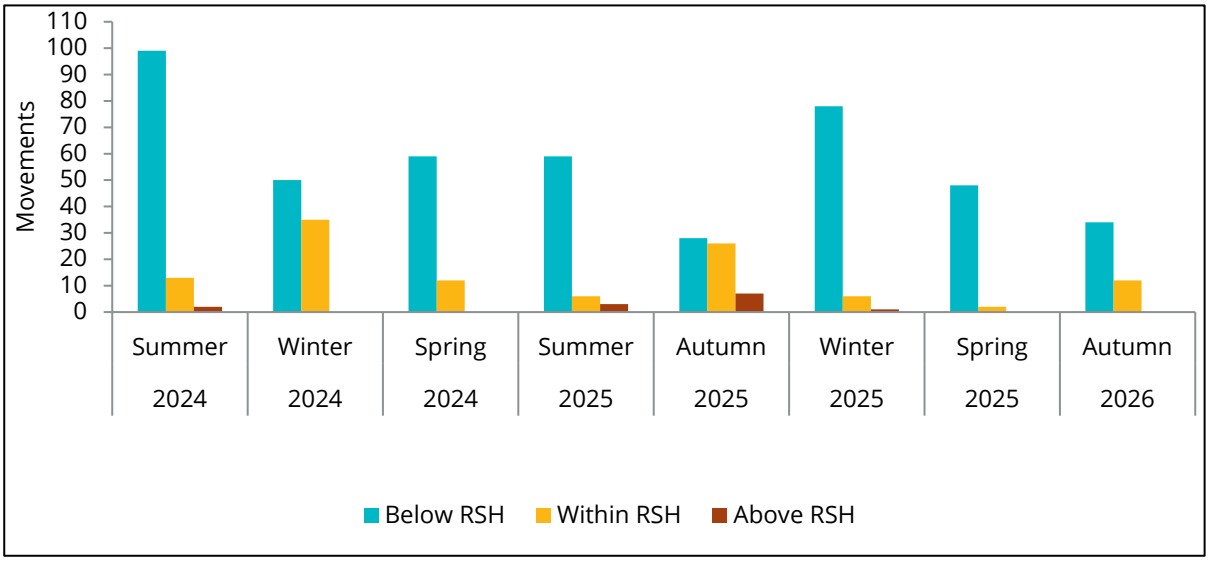
Table 5 Number of movements at RSH (80-300 metres) recorded from impact, control and White-throated Needletail points

Species	Impact point	Control point	White-throated Needle point
Australian Magpie	4	1	-
Australian Pelican	-	7	2
Australian Raven	2	-	1
Australian White Ibis	55	22	-
Black Falcon	-	1	-
Black Kite	11	2	-
Black-shouldered Kite	3	-	-
Brown Falcon	3	4	1
Brown Goshawk	1	-	-
Common Starling	13	2	-
Crested Pigeon	2	-	-
Dusky Woodswallow	-	-	-
Fairy Martin	-	1	15
Galah	-	-	2
Little Eagle	1	-	-
Little Raven	4	1	-
Long-billed Corella	-	1	-

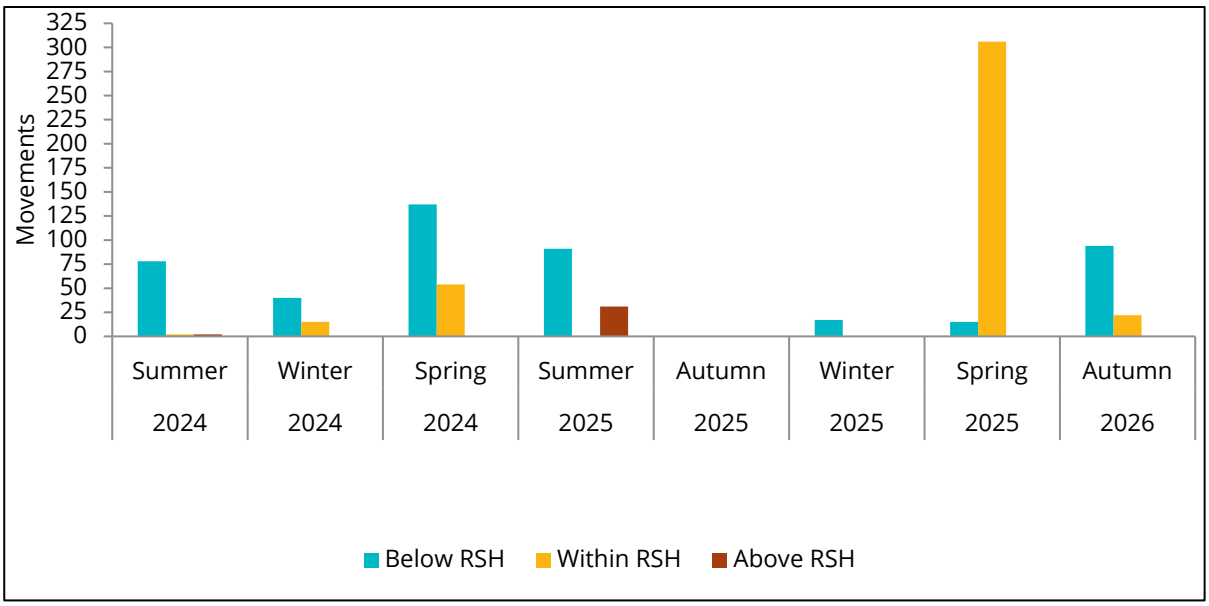
Species	Impact point	Control point	White-throated Needle point
Magpie-lark	2	-	-
Nankeen Kestrel	10	2	1
Spotted Harrier	1	-	-
Straw-necked Ibis	315	-	2
Sulphur-crested Cockatoo	4	-	-
Tree Martin	-	15	-
Wedge-tailed Eagle	43	9	4
Welcome Swallow	5	6	281
Whistling Kite	16	5	2



Graph 3 Bird movements recorded below, within and above RSH (metres)



Graph 4 Seasonal variation of raptor movements recorded below, within and above RSH



Graph 5 Seasonal variation of waterbird movements recorded below, within and above RSH

3.2.2 Bat utilisation survey

A total of 731,744 files were recorded across the bat utilisation survey program. Of these, 301,112 were considered to be valid bat calls, with 32,247 manually reviewed. The remainder were 'trash' files containing unidentified noise (e.g. insects) or false triggers (such as wind, rain, vegetation movement).

Analysis positively identified 10 microbat species (Almost Certain or Probable) of the 11 species of microbat considered likely to occur within the study area and surrounds. Table 6 provides a list of all species known or predicted to occur within the study area, their conservation status, and confirmation of identification following call analysis.

Table 6 Bat species diversity recorded during acoustic microbat surveys

Species name	Common name	EPBC Act	BC Act	Identification
Austronomus australis	White-striped Free-tailed Bat	-	-	Almost certain
Chalinolobus gouldii	Gould's Wattled Bat	-	-	Almost certain
Chalinolobus morio	Chocolate Wattled Bat	-	-	Almost certain
Ozimops planiceps	South-eastern Free-tailed Bat	-	-	Almost certain
Ozimops ridei*	Ride's Free-tailed Bat	-	-	Almost certain
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat	VU	-	Not recorded
Scotorepens balstoni	Inland Broad-nosed Bat	-	-	Almost certain
Vespadelus vulturnus	Little Forest Bat	-	-	Almost certain
Vespadelus regulus	Southern Forest Bat	-	-	Almost certain
Myotis macropus*	Southern Myotis	-	-	Unlikely
Nyctophilus corbeni*	Corben's Long-eared Bat	EN	V	Unlikely
Nyctophilus geoffroyi	Lesser Long-eared Bat	-	-	Almost certain
Vespadelus darlingtoni	Large Forest Bat	-	-	Almost certain

*The study area occurs at the edge of the current accepted distribution range of these species. This is further discussed below.

Threatened and at-risk bat species summary

No threatened bat species were positively identified (probable or almost certain) during the bat utilisation surveys. Calls for the *Nyctophilus* bat genus that were recorded during the survey are most likely to represent the Lesser Long-eared Bat. Although these calls cannot be reliably differentiated from the threatened Corben's Long-eared Bat (Endangered EPBC Act and Vulnerable FFG Act), the likelihood of it being at the site, and the likelihood of it being subject to operational impacts from the project, are both considered to be low.

Yellow-bellied Sheath-tailed Bat (Vulnerable EPBC Act) is a high-flying species however, it is likely to be migratory in southern Australia, appearing as a vagrant in southern NSW and Victoria during summer and autumn (Baker & Gynther 2023). No calls were identified for this species from the data collected. Biosis has also conducted extensive call data collection in south-western NSW in recent years and has not recorded this species in that region since monitoring commenced in 2022. Given the study area occurs at the southern extent of the species' range, if present this species is considered only likely to occur seasonally and in very low numbers.

Turbine strike risk for microbats at wind energy facilities can be inferred from a species' flight characteristics and foraging preferences. Bats with long, narrow wings (such as Free-tailed Bats *Ozimops* spp.) are generally suited to fast, direct flight and therefore forage in open spaces above the canopy capturing prey on the wing. In contrast, bats with broader, shorter wings that are suited to increased manoeuvrability (such as long-eared bats *Nyctophilus* spp.) are generally found to forage in and around vegetation where they glean insects from foliage. In general, bats that fly in open spaces and above the tree canopy are more likely to occur in the vicinity of wind turbines (and turbine blades) and therefore are at a greater risk of blade strike compared to those that forage in and around vegetation. This is reflected in collision data, where a recent review in Victoria found White-striped Free-tailed Bat to be the species most often encountered during carcass searches, followed by Gould's Wattled Bat (Moloney et al. 2019). Species recorded at the study area considered likely to have an increased strike risk include:

- White-striped Free-tailed Bat
- Gould's Wattled Bat
- South-eastern Free-tailed Bat
- Ride's Free-tailed Bat

These species tend to fly in open areas and at height, and are considered most likely to be subject to collisions with turbines. All of these species were recorded throughout the site, reflecting their ability to travel through open spaces, and were also recorded at height (greater than 50 metres above the ground on the met mast detector).

General bat activity

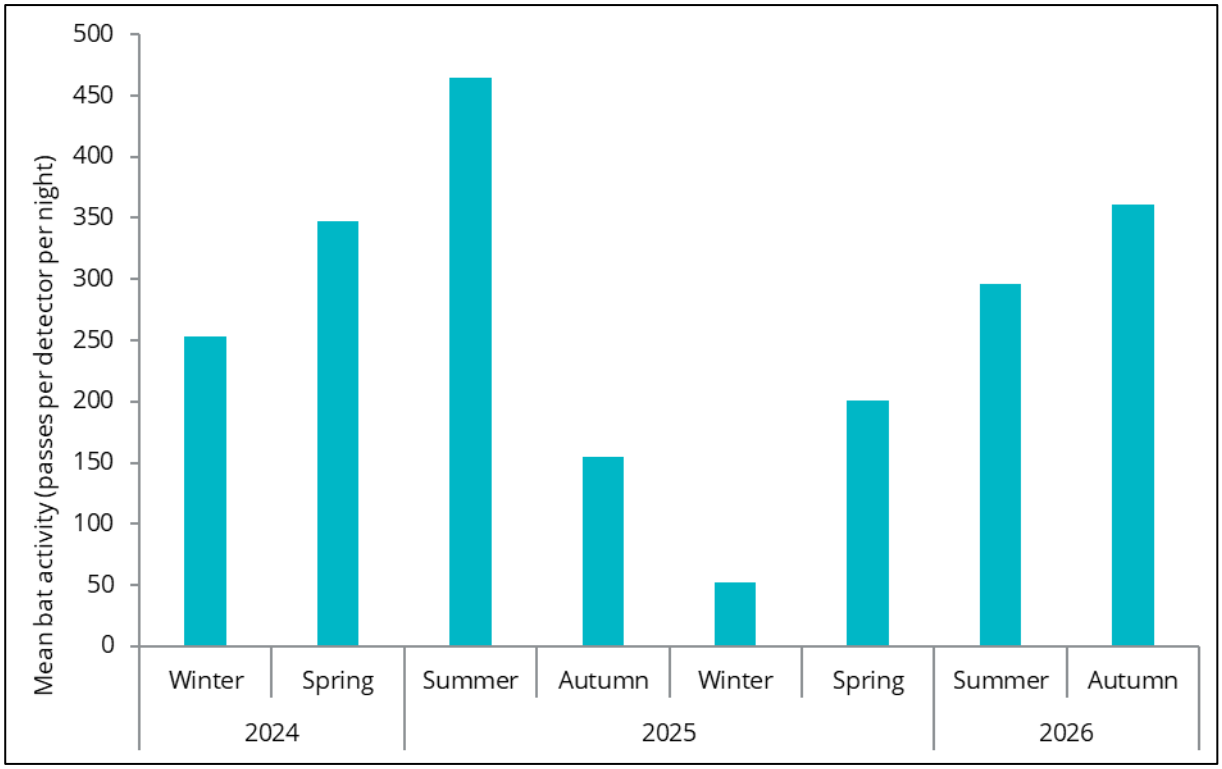
Bat activity at the site appears to be variable between seasons (Graph 6), with summer 2025-2026 having the highest mean nightly activity (464.9 passes per detector per night) and winter 2025 having the lowest (51.9 passes per detector per night).

Activity is also variable within seasons, presumably driven by variations in environmental conditions (such as temperature, wind speed) and/or insect abundance (Graph 7). Spikes in bat activity during winter appeared to relate to temperature increases that presumably provided higher foraging opportunities in otherwise unfavourable weather conditions.

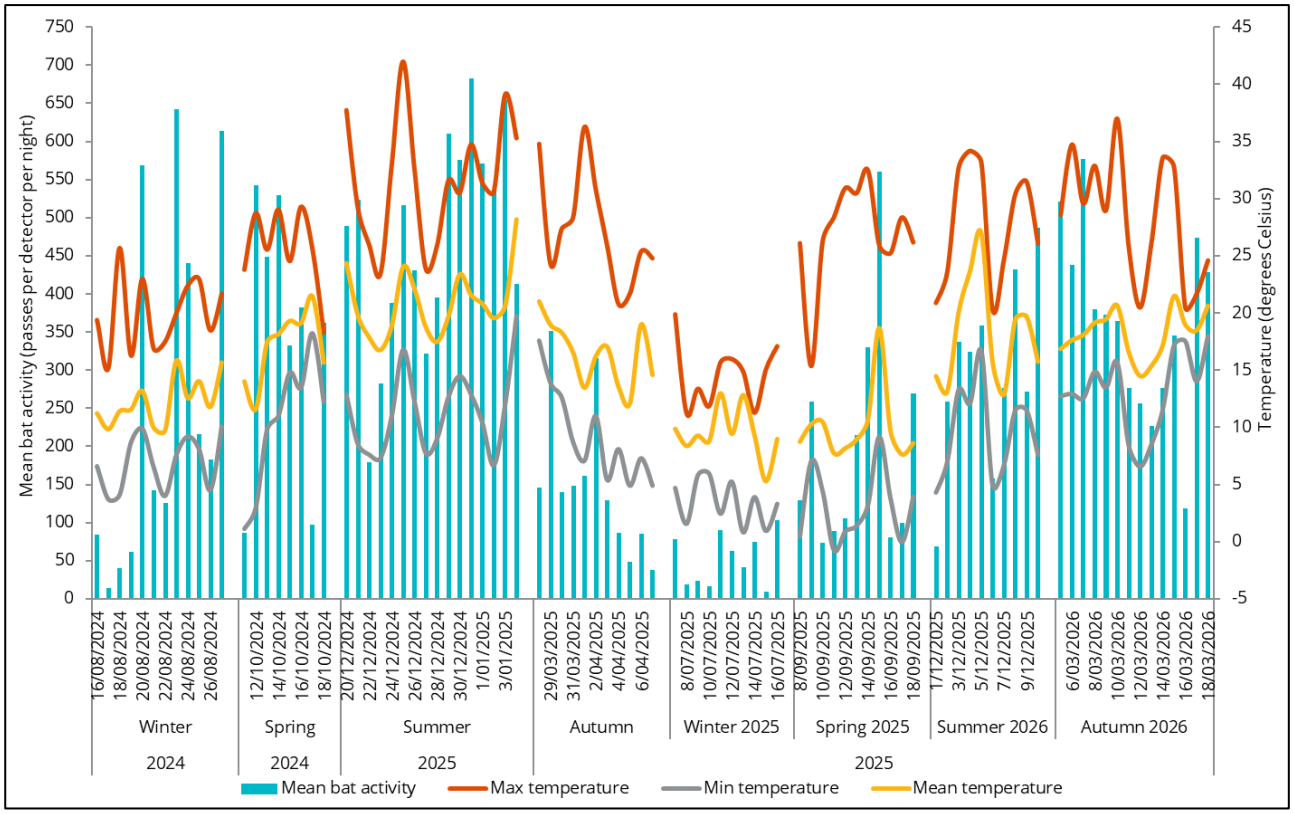
Sampling in summer 2025-26 did not include farm dams, which may account for the higher mean bat activity recorded the previous summer (2024-25). The difference in autumn bat activity between the two years may be due to timing, with autumn 2025 sampling occurring late March to early April compared to autumn 2026 occurring in early March, with comparatively warmer weather. Similarly, winter 2024 had higher daily temperature readings than winter 2025, which may in part account for the differences in bat activity between the two years.

Winter 2024 included sampling effort at wetlands (including Great Spectacle Lake), however, due to the very high bat activity at these sites, they were removed from seasonal comparisons of activity. It was clear from the high activity during the winter sampling period that the wetlands represent a key focal area for bat activity in the landscape. Wetland sites were therefore not included in subsequent sampling periods.

The overall result, however, is consistent with expectations that bat activity is generally higher in warmer seasons and lower in cooler seasons, and that within these periods there is a high degree of variability in response to daily weather conditions including temperature, rainfall and most likely, wind speed.



Graph 6 Mean bat activity per sampling season



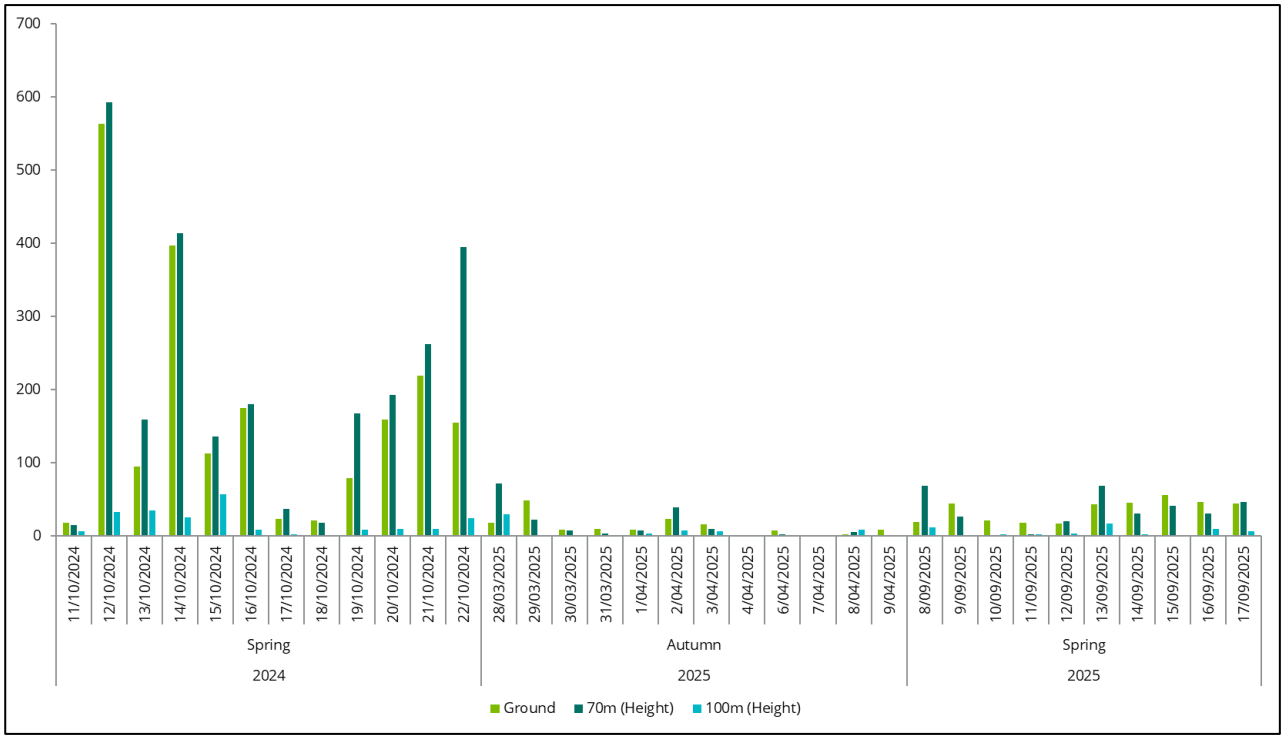
Graph 7 Bat activity compared to temperature for each sampling period

Activity at height

Activity at the met mast was highly variable between nights (Graph 8). Unexpected equipment issues (malfunctions) resulted in a limited number of nights where all three units (ground, 70 metres, 110 metres) recorded simultaneously, concentrated in spring 2024 and 2025, and autumn 2025. Activity recorded at 110 metres was consistently lower than either the 70 metres detector or the ground-based detector (Graph 8).

The highest number of passes recorded at 110 metres was 57 (15 October 2024). The highest activity on the 70-metre microphone was 593 the night of 12 October 2024. On this night, the ground unit recorded similarly high activity (563 passes) while the 110 metres height unit recorded only 33.

These results suggest that bat activity is likely to be concentrated between 0–70 metres, with reduced activity above 70 metres as reflected by the lower number of calls recorded on the 110-metre microphone consistently throughout the sampling period.



Graph 8 Bat activity at ground level, 70 metres and 110 metres

4 Qualitative collision and barrier effect risk assessments

Collision risk can be assessed using both qualitative and quantitative approaches. The quantitative approach (CRM) provides a numerical estimate of collision risk but is only applicable to species for which BUS data are available, particularly records of individuals flying within RSH at impact points. As species more likely to fly at night such as waterbirds or migratory shorebirds have not meet these data requirements, a qualitative assessment has also been undertaken to ensure that potential risks are considered more broadly across species. This assessment also allows to include bat species, as bats cannot be assessed using CRM. The qualitative approach allows consideration of presence likelihood, behavioural traits, habitat use, and known sensitivities to wind farms, and is therefore applicable to a wider range of species.

Therefore, in order to gain an understanding of potential impacts to all bird and bat species occurring within the study area, Biosis has undertaken a bird and bat qualitative risk assessment to inform the overall biodiversity impact assessment for the proposed wind farm. This assessment identified species or groups of birds and bats considered at potential risk of collision with turbines, as well as potential impacts associated with disturbance and/or barrier effects posed by operational wind turbines. The outcomes of these assessments are presented below. These assessments have enabled targeted evaluation of key species to be considered in the preparation of the overall impact assessment for the wind farm.

4.1 Risk matrix methodology

Assessment of potential impacts to birds and bats as a result of turbine strike has been undertaken by way of a qualitative risk assessment used to determine the likelihood of impact. This risk assessment has been applied to all bird and bat species recorded by Biosis during the field assessments (excluding exotic species), and EPBC or FFG Act listed species recorded or predicted to occur within 10 kilometres of the study area, based on database searches, including:

- Species listed as threatened under both EPBC Act and/or FFG Act.
- DEECA's Victorian Biodiversity Atlas (VBA), including the 'VBA_FAUNA25, FAUNA100 & FAUNA Restricted' datasets (DSE 2009a,b).
- DCCEEW's Protected Matters Search Tool for matters protected by the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Birdlife Australia https://birdata.birdlife.org.au/.
- eBird https://ebird.org/home.
- Australasian Bat Society Bat map https://www.ausbats.org.au/batmap.html.
- Species known to have documented collisions with turbines based on collision data from operating wind farms in southeastern Australia.
- Species that may exhibit risk behaviour and potentially interact with the operation of wind turbines.

The criteria used to establish the likelihood of impact and potential consequences of turbine strike and barrier effect are provided Table 7 and Table 8 bellow.

Table 7 Qualitative risk assessment criteria for likelihood and consequences of the impacts of turbine strike and barrier effect for birds and bats

Likelihood	Criteria	Consequence	Criteria
Rare	An event may occur only in unusual circumstances (less than 5%). The risk event is only theoretically possible, or would require exceptional circumstances to occur.	**Negligible**	Occasional individuals lost but no reduction in population viability.
Unlikely	It is less probable than not that the risk event could occur in any year (< 50%).	**Minimal**	Repeated loss of small number of individuals but no reduction in population viability.
Likely	It is equally probable that the risk event could or could not occur in any year (50%).	**Moderate**	Moderate loss in numbers of individuals, leading to minor reduction in population viability for between one and five years.
Possible	It is more probable than not that the risk event could occur in any year (>50%).	**Significant**	Major loss in number of individuals, leading to reduction in population viability for between five to 10 years.
Probable	It is very probable that the risk event could occur in any year (>95%).	**Severe**	Extreme loss in number of individuals, leading to reduction in population viability for a period of at least 10 years.

Table 8 Qualitative risk assessment matrix for significance of impacts of potential turbine collisions and barrier effect for birds and microbats

Likelihood	Consequence				
	Negligible	**Minimal**	**Moderate**	**Significant**	**Severe**
Rare	Negligible	Negligible	Negligible	Low	Low
Unlikely	Negligible	Negligible	Low	Moderate	High
Likely	Negligible	Low	Moderate	High	High
Possible	Negligible	Low	Moderate	High	Severe
Probable	Negligible	Low	High	Severe	Severe

4.2 Risk matrix results

The results of the qualitative risk assessment have identified the likely species at risk of collision with operational wind turbines. This then accounts for species that may fly within RSH, but were not recorded during BBUS and accounted for in the CRM, or species that are vagrant, cryptic or migratory. The qualitative risk assessment found 44 species (40 birds and four bats) to be at more than a negligible risk of collision with an operating turbine as shown in Table A 3 and Table A 4 of Appendix 2.

The qualitative risk assessment identified:

- Up to 38 bird species with a Low collision risk.
- Three bat species with a Low collision risk.
- Two bird species with a Moderate collision risk, including:

  - Wedge-tailed Eagle.
  - Black Falcon.
- One bat species with a High collision risk:
  - White-striped Free-tailed Bat.
- No bird species with a High collision risk.

Up to two bird and two bat species are considered to have a Low risk of impact as a result of barrier effects for the proposed wind farm layout including; Wedge-tailed Eagle, Black Falcon, White-striped Free-tailed Bat and Gould's Wattled Bat. All other species have no more than a Negligible risk of impact as a result of barrier effect for the proposed wind farm layout.

An assessment of the impacts on birds and bats from onshore wind farms in Australia has been undertaken by Reid & Baker (2025), where spatial distribution, productivity (based on generation time and population status) and susceptibility (based on flight height, flight manoeuvrability / morphology, flight time for birds and habitat specialisation) were used to determine an overall risk score and rating (low, moderate, high). Reid & Baker's (2025) risk value considers both collision risk and barrier effects at the state-wide scale, without site-specific considerations, and thus cannot be applied directly to the qualitative risk assessment approach applied here, which addresses collision and barrier likelihood and consequence as separate measures that are influenced by species abundance in the locality and flight / movement data collected at the site-specific scale. However, where a species considered herein has been assessed by Reid & Baker (2025), the risk applied by the latter has been considered in the assessment. Some species have had a lower risk applied herein than that proposed by Reid & Baker (2025), generally where there are a low number of records in the locality, where the species has not been recorded by Biosis during field investigations, or the species has been recorded but no flights at RSH have been recorded by Biosis or are considered likely to occur based on the species habitat association and site-specific characteristics.

4.3 At-risk species

The following section summarises species considered to be at risk from collision with turbines such that impacts could occur to the species and/or population levels. A full list of species considered in the qualitative risk assessments and potentially at risk by the project is detailed in Table A 3 and Table A 4 of Appendix 2. A total of 40 species of birds and four species of bats are considered to be at more than a negligible risk of impact from turbine collisions, and thus 'at-risk' as a result of the project, summarised in Table 9.

As impacts associated with blade strike are considered somewhat uncertain, an adaptive management is required through the preparation and implementation of an operational Bat and Avifauna Management (BAM) plan.

Table 9 Summary of species considered at risk of collision impacts from the project

Common name	Scientific name	Threat listing		Risk assessed species risk conclusion
		EPBC Act	FFG Act	
Birds				
Anas superciliosa	Pacific Black Duck	-	-	Low
Apus pacificus	Fork-tailed Swift	Mi	-	Low
Aquila audax	Wedge-tailed Eagle	-	-	Moderate
Ardea alba	Great Egret	-	v	Low

Common name	Scientific name	Threat listing		Risk assessed species risk conclusion
		EPBC Act	FFG Act	
Ardea plumifera	Plumed Egret	-	cr	Low
Aythya australis	Hardhead	-	v	Low
Biziura lobata	Musk Duck	-	v	Low
Botaurus poiciloptilus	Australasian Bittern	EN	cr	Low
Calidris acuminata	Sharp-tailed Sandpiper	VU, Mi	-	Low
Calidris ferruginea	Curlew Sandpiper	CR, Mi	cr	Low
Chenonetta jubata	Australian Wood Duck	-	-	Low
Circus approximans	Swamp Harrier	-	-	Low
Circus assimilis	Spotted Harrier	-	-	Low
Corvus coronoides	Australian Raven	-	-	Low
Corvus mellori	Little Raven	-	-	Low
Cygnus atratus	Black Swan	-	-	Low
Egretta garzetta	Little Egret	-	e	Low
Elanus axillaris	Black-shouldered Kite	-	-	Low
Eolophus roseicapilla	Galah	-	-	Low
Falco berigora	Brown Falcon	-	-	Low
Falco cenchroides cenchroides	Australian Nankeen Kestrel	-	-	Low
Falco subniger	Black Falcon	-	cr	Moderate
Gelochelidon nilotica	Gull-billed Tern	Mi	e	Low
Grus rubicunda	Brolga	-	e	Low
Gymnorhina tibicen	Australian Magpie	-	-	Low
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	e	Low
Haliastur sphenurus	Whistling Kite	-	-	Low
Hieraaetus morphnoides	Little Eagle	-	v	Low
Hirundapus caudacutus	White-throated Needletail	VU, Mi	v	Low
Hirundo neoxena	Welcome Swallow	-	-	Low
Milvus migrans	Black Kite	-	-	Low
Nymphicus hollandicus	Cockatiel	-	-	Low
Pelecanus conspicillatus	Australian Pelican	-	-	Low
Petrochelidon ariel	Fairy Martin	-	-	Low
Petrochelidon nigricans	Tree Martin	-	-	Low
Spatula rhynchotis	Australasian Shoveler	-	v	Low
Stictonetta naevosa	Freckled Duck	-	e	Low
Threskiornis molucca	Australian White Ibis	-	-	Low

Common name	Scientific name	Threat listing		Risk assessed species risk conclusion
		EPBC Act	FFG Act	
Threskiornis spinicollis	Straw-necked Ibis	-	-	Low
Tringa nebularia	Common Greenshank	EN, Mi	e	Low
Bats				
Austronomus australis	White-striped Free-tailed Bat	-	-	High
Chalinolobus gouldii	Gould's Wattled Bat	-	-	Low
Ozimops planiceps	South-eastern Free-tailed Bat	-	-	Low
Ozimops ridei	Eastern Free-tailed Bat	-	-	Low

5 Collision risk modelling

5.1 Background

Collisions of birds and bats with wind turbines have been documented to occur at various frequencies around the world. Quantitative modelling to estimate the number of collision mortalities of threatened and non-threatened taxa is widely used as part of environmental impact assessments for proposed wind energy facilities (Masden & Cook 2016). The impact of any collisions on the viability of threatened and non-threatened fauna populations is more important than determination of simple numbers of mortalities, but population modelling would be a separate exercise to the collision risk modelling presented here.

Modelling of collision risk is reliant on empirical data for flights by species at the wind farm site. There is no practicable method to obtain species-specific flight data for bats that are likely to utilise the site and bat-call data does not provide information about the number of flights by bats. Current data collection methods do not include considerations for species that are nocturnal. The modelling presented here is therefore confined to diurnal birds. Mathematical modelling of risk is intended to provide an articulated, transparent and replicable evaluation of what may occur in the real world. The rationale behind projections is explicitly stated in the mathematics of a model, which means that the logical consistency of the predictions can be easily evaluated. The explicit nature of inputs, and rigour entailed in modelling means that the process is replicable and consistent and it is open to analysis, criticism or modification when new information becomes available. Modelling is designed as a mechanism to evaluate uncertainties–if there was no uncertainty there would be no need to use a model. As a consequence of uncertainty in various parameters, some assumptions are required and while it is necessary to include some assumptions and arbitrary choices when deciding on the structure and parameters of a model, these choices are explicit. To the extent feasible, assumptions are informed by the best available information.

Models are also valuable for their heuristic capacities as they focus attention on important processes and parameters entailed in risk (Brook et al. 2002). Their very nature facilitates incorporation of information as it is learnt (Burgman 2005) and refinements should thus be expected of any model.

Most factors related to the layout, dimensions and geometry of turbines are known. The risk modelling detailed here entails the use of informed assumptions related particularly to the flights of birds. The bird utilisation data collected from the site provides an empirical basis for extrapolations required for use in the model. We consider the assumptions and values used are reasonable and they are informed by available information about the ecology of relevant species. As a consequence, we consider the results of modelling detailed here provide a basis for evaluation of probable effects of the proposed Meering West Wind Farm on relevant species of birds. The only alternative to a quantitative modelling approach is one of qualitative subjective judgement (see Section 4). All the benefits of using mathematical modelling outlined above are difficult, if not impossible to achieve with a purely qualitative assessment.

5.2 Turbine Collision Risk Model

The risk of birds colliding with project turbines has been assessed using the Biosis Pty. Ltd. Collision Risk Model (Smales et al. 2013). The model was developed in 2002 and has been refined over time to incorporate new data and knowledge. It has been applied for a wide range of birds at multiple proposed onshore wind farm sites in Australia. Essential functions of the model are similar to those of other turbine CRMs used elsewhere. These functions and substantive differences between various similar models are detailed in

Smales (2017). A description of the Biosis collision risk model can be found in Smales et al. (2013), provided in Appendix 3.

5.3 Overview

The Biosis collision risk model takes account of the proportion of bird flights that occur within and below the height zone that will be occupied by the spinning blades of turbines. Data for the number of flights and their heights was documented by a regime of fixed-time point counts at locations representative of future turbine locations across the site. The model uses the empirical sample of flight data for each species and extrapolates that to determine a potential number of such flights that might occur over an entire 12-month period. This factor takes into account what is known about seasonal presence of particular species that may be migratory or may be present only for part of the year for other reasons.

In the model, the turbine is broken down into its static and dynamic components. The entire turbine (including the tower, nacelle and the rotor when stationary) represents the static component. The dynamic component is the volume swept by the leading edge of the rotor blades in the time it takes the species of interest to pass across the depth of the rotor-swept disk.

Since the turbine tower below rotor swept height is always a static component and poses minimal collision risk, the model takes this into account by dividing flights into those below turbine rotor height, and those within the height zone swept by turbine rotors and allocating different risk rates to these height classes.

The risk assessment accounts for a combination of variables that are specific to the proposed wind farm and to data for birds from the vicinity of the farm. They include the following:

- The numbers of flights of each species below RSH, and for which just the lower portion of turbine towers present a collision risk.
- The numbers of flights at heights within the zone swept by turbine rotors, and for which the upper portion of towers, nacelles and rotors present a collision risk.
- The numbers of bird movements-at-risk, as recorded during timed point counts, extrapolated to determine an estimated number of movements-at-risk the species makes in an entire year. Account is taken of the portion of the year that birds are within proximity of the site and that they may thus be at risk.
- The mean area (m^2 per turbine), of tower, nacelle and stationary rotor blades of a turbine that present a risk to birds. Thus, the mean area presented by a turbine is between the maximum (where the direction of the bird is perpendicular to the plane of the rotor sweep) and the minimum (where the direction of the bird is parallel to the plane of the rotor sweep). The mean presented area is determined from turbine specifications supplied for specific make and model of a turbine. It represents the average area presented to an incoming flight from any direction.
- The additional area (m^2 per turbine) presented by the movement of rotors during the potential flight of a bird through a turbine. This information is determined via a calculation involving species-specific, independent parameters of the flight speed and body length of the bird and supplied specifications for speed and dimensions of the turbine rotor.
- The model assumes that all turbines in the site represent equal risk.
- A calculation of the average number of turbines a bird is likely to encounter in a given flight through the site. This is based on the scattered configuration of turbines in the landscape and the total number of turbines proposed for the project.

5.4 Key assumptions and limitations of CRM

The key assumptions and limitations of CRM include:

- CRM is applicable to diurnal birds but not to bats and nocturnal birds because it can be applied only when the number of flights for a given species can be measured in time and space to provide a *flight flux rate*. That can generally be achieved for diurnal bird species. It cannot routinely or simply be obtained for bats and nocturnal birds. Bat detectors record bat calls but offer no information about the flight rates of bat species. Technologies such as radar and thermal imaging may allow flight rates for bats and nocturnal birds to be measured but, at present, they do not generally permit identification to species. Improvements to these types of techniques may well become applicable soon, but they have not yet been proven for this purpose in Australia.
- Diurnal birds that are highly cryptic or occur rarely at a site are usually poorly represented in BUS data and despite a substantial BUS campaign there may still be insufficient data to provide a robust and defensible CRM result. If that is the case, CRM should either not be used as its results cannot be relied upon, or results should be presented with a clear caveat about their reliability. If CRM is not used, a qualitative assessment for such species will often suggest that their rarity at the site indicates that their collision risk is low (see Section 4).
- Bird utilisation survey data are collected during the pre-approval phase before there are any turbines at the site of a proposed wind farm. Behaviours of birds may change if a wind farm is built and becomes operational at the site, and if that happens it may be in a site-specific manner. There is no way to address that possibility in the pre-approval stage. Almost no Before-After-Control-Impact (BACI) studies of bird utilisation have been undertaken at Australian wind farms and those that have, are quite inconclusive. It is thus necessary for CRM to assume that bird flight behaviours recorded during pre-approval BUS studies are applicable to the operational phase of the wind farm, but that may not be the case.
- Any collision is assumed to result in a bird fatality. It is possible that some collisions result in non-fatal injuries from which birds recover, but at present, that cannot be measured. The assumption that all collisions are fatal is conservative, but appropriate.

5.5 CRM input data

5.5.1 Bird movements at RSH

Because the final turbine specifications had not been confirmed at the time of writing this report, two models using different RSH values were used:

- Model 1 with below RSH-1 < 80 metres, RSH-1 = 80-252 metres and above RSH-1 > 252 metres
- Model 2 with below RSH-2 < 104 metres, RSH-2 = 104-280 metres and above RSH-2 > 280 metres

Following the results of the BUS that was undertaken across eight seasons, the CRM was run for all species for which there were any flights recorded at impact points within rotor swept height. A total of 115 species of birds were recorded during BBUS, 88 of which were recorded at impact sites being considered for CRM. While many of them may have capacity to fly at rotor swept height, 18 species were recorded flying at RSH-1 at impact sites (Table 10), and 12 species at RSH-2 (Table 11).

In both cases, one species was an introduced bird species (Common Starling), which was excluded from the CRM analysis. Species not recorded flying within RSH, but that have potential to fly within RSH on occasion, or

that were not recorded during BUS due to their cryptic nature, have only been considered in the qualitative risk assessments presented in Section 4.

Table 10 Summary of movements for the species observed flying at RSH-1 (80-252 metres) from impact points

Species	Total number of flights recorded at impact sites	Below RSH-1	At RSH-1	Above RSH-1
Australian Magpie	**822**	818	4	-
Australian Raven	**246**	239	2	5
Australian White Ibis	**55**	-	55	-
Black Kite	**26**	12	11	3
Black-shouldered Kite	**29**	26	3	-
Brown Falcon	**37**	33	3	1
Brown Goshawk	**3**	2	1	-
Common Starling	**3086**	3073	13	-
Little Eagle	**2**	1	1	-
Little Raven	**536**	532	4	-
Magpie-lark	**114**	112	2	-
Nankeen Kestrel	**231**	221	10	-
Spotted Harrier	**11**	10	1	-
Straw-necked Ibis	**528**	183	315	30
Sulphur-crested Cockatoo	**6**	2	4	-
Wedge-tailed Eagle	**68**	17	43	8
Welcome Swallow	**64**	59	5	-
Whistling Kite	**31**	15	16	-

Table 11 Summary of movements for the species observed flying at RSH-2 (104-280 metres) from impact points

Species	Total number of flights recorded at impact sites	Below RSH-2	At RSH-2	Above RSH-2
Australian Raven	**246**	240	1	5
Australian White Ibis	**55**	47	8	-
Black Kite	**24**	17	6	3
Brown Falcon	**37**	35	1	1
Brown Goshawk	**3**	2	1	-
Common Starling	**3086**	3085	1	-
Little Eagle	**2**	1	1	-
Magpie-lark	**114**	112	2	-
Nankeen Kestrel	**231**	227	4	-

Species	Total number of flights recorded at impact sites	Below RSH-2	At RSH-2	Above RSH-2
Spotted Harrier	**11**	10	1	-
Wedge-tailed Eagle	**68**	35	25	8
Whistling Kite	**31**	24	7	-

Eight additional species were only recorded flying at RSH at control or White-throated Needletail (WTNT) sites and were not included in CRM, which includes:

- Australian Pelican (eight movements recorded at RSH from control and WTNT sites).
- Black Falcon (one movement recorded at RSH from on control site).
- Dusky Woodswallow (six movements recorded at RSH from one WTNT site).
- Fairy Martin (one movement recorded at RSH from one control site).
- Galah (two movements recorded at RSH from one WTNT site).
- Long-billed Corella (one movement recorded at RSH from one control site).
- Tree Martin (15 movements recorded at RSH from control and WTNT sites).
- Welcome Swallow (36 movements recorded at RSH from WTNT sites).

5.5.2 Bird morphology and flight speed

For each species of bird, the parameter for flight speed uses an average. Each species can fly within a range of speeds and flight speed has not been recorded with precision for many species. Nonetheless, the morphology of birds (in particular wing-loading which is a ratio of the mass of a bird relative to the surface area of its wings) dictates the range of its possible flight speeds (Pennycuick 2008). The literature contains average flight speeds for a variety of taxa, and it is often the case that an average flight speed has been published for a closely related species to the one in question. A bird flying with the wind is likely to fly faster than a bird flying against the wind. We assume that, over multiple flights, for every flight with the wind there will be another against it and that the effect of wind is thus not a factor in determining average flight speed for the purpose of assessing collision risk at Meering West wind farm. So, for the purposes of CRM, we use average ground speed rather than air speed.

It is also assumed that bird flights travel forward so that the length of the bird's body from bill tip to tail tip, or outstretched legs, along with average flight speed, dictates the time taken for the bird to pass through the turbine strike zone.

Table 10 and Table 11 provide details of bird morphology and flight speed for each species included in the CRM.

5.5.3 Flight hours

Flight hours are the number of hours per day that the species is likely to be active undertaking movements. For diurnal species, it is accepted that this is assumed to be 12.

5.5.4 Month on-site

Survey months on-site are the number of months that survey was considered to be effective for each species. Wherever possible, bird utilisation data should be collected regularly throughout the entire annual cycle of the site. Ideally, this should be monthly, but at least quarterly. In the case of seasonal BUS, where each season is represented evenly (two summer, two autumn, two winter, two spring seasonal surveys undertaken), this value should be 12. If a species of interest is present for only a portion of the year and BUS are undertaken only during that period, then it is important not to extrapolate that flight rate to the entire year. In such cases (only) it is necessary to restrict the available flying time to the portion of the year when the species is present. That is done by using the function in the model to nominate the number of months per annum that the species may be present. For example, if one season of BUS data was collected across the site specific to the three months that species A is likely to be present due to its migratory nature, this value would be three, accordingly. Note that if all seasons of the year have been surveyed during BUS, it is important not to reduce this number for seasonally migrating species.

5.5.5 Effective detection radius

Effective detection radius is the distance within which it is assumed that all bird flights are able to be detected, thereby accounting for the fact that detectability declines with increasing distance from the observer. Such a measure is required to extrapolate observed bird activity to the broader wind farm site. As a simplified approach, we halve the maximum distance from the observer within the BUS data collected for the project and use this to reflect the effective detection radius. For example, if species A was recorded up to 1500 metres from the observer, the effective detection radius is assumed to be 750 metres for species A. It is assumed that smaller species would have a lower effective detection radius than larger species.

5.5.6 Population estimates

Generally, the model's results are expressed as the number of flights at risk of collision per annum for each species. This is a relative measure that permits comparison of risk rates associated with various turbines or turbine configurations. It does not necessarily equate to the number of collisions that might occur because we do not know how many individual birds of each species use the site and may thus be at risk. The difference between flights at risk of collision and number of actual collisions can be simply explained by way of an example. If there are just two individuals of a given species occupying the wind farm, they may make multiple flights that could result in collisions, however the maximum number of fatalities that could occur is two. As can be seen from this example, the number of actual fatalities due to collisions can be no greater than the number of individual birds, but it can also be no more than the number of flights at risk, and if the site-population is small but the birds fly actively within the site, the number of collisions will always be considerably lower than the number of flights at risk.

Possible site population estimates were derived for all 17 species recorded at rotor swept height (RSH-1 or RSH-2), using BUS data, as published information may not be applicable to the study area. Accordingly, the site population for each species was estimated using a conservative approach by adding the highest counts of birds per survey points, to which a conservative 50% buffer was added. Population estimates were then rounded up to the upper 10 as an extra level of conservatism given the inherent uncertainties on site populations. It is acknowledged that, because the survey points do not cover the entire proposed site, there is a risk of underestimating the local population of each species. However, all species are highly mobile and are likely to have ranges that overlap one or more survey points.

Table 12 provides details of site population estimate for each species included in the CRM.

Table 12 Species details used in CRM models

Common name	Literature-based metric				Data- and literature-based metric	
	Speed * (Km/hr)	Length (m)	Flight hours	Months on-site	Effective detection radius (m)	Population onsite
Australian Magpie	40	0.40	12	12	500	210
Australian Raven	40	0.50	12	12	500	160
Australian White Ibis	25	0.70	12	12	900	70
Black Kite	40	0.50	12	12	550	40
Black-shouldered Kite	40	0.35	12	12	250	30
Brown Falcon	40	0.45	12	12	500	40
Brown Goshawk	40	0.43	12	12	150	10
Little Eagle	40	0.50	12	12	375	10
Little Raven	40	0.50	12	12	750	270
Magpie-Lark	40	0.27	12	12	750	90
Nankeen Kestrel	45	0.33	12	12	500	90
Spotted Harrier	40	0.56	12	12	250	20
Straw-necked Ibis	25	0.65	12	12	900	660
Sulphur-crested Cockatoo	45	0.52	12	12	500	10
Wedge-tailed Eagle	40	0.95	12	12	1500	70
Welcome Swallow	60	0.15	12	12	100	70
Whistling Kite	40	0.55	12	12	650	30

* Estimate only as no flight speed data available.

5.5.7 Avoidance rates

Results are provided for various avoidance rates. Avoidance rate is the capacity for a bird to avoid a collision, whether that occurs due to a cognitive response on the part of a bird or not. Thus, at the extremes of the rates applied, a 0.90 avoidance rate equates to one flight in 10 in which a bird does not avoid a turbine and a 0.99 avoidance rate equates to one flight in 100 in which it does not avoid a turbine. Based on experience with a wide range of bird species, it is certain that virtually all species have high capacity to avoid collision with the static components of turbines. Avoidance rate for these components is thus consistently considered to be 0.99 in the modelling. Various avoidance rates are modelled for the dynamic turbine components because it is not certain how adept various species may be at evading collision with the moving rotor. For this reason, results are provided for 0.90, 0.95, 0.98 and 0.99 avoidance rates for the dynamic components (moving rotor) of turbines.

It should be noted that internationally there is very little empirical evidence for the actual avoidance rate for any bird species and for this reason it is prudent to provide a range of estimates that are considered to be reasonable. The evidence that is available suggests that avoidance capacity is species-specific and that the great majority of birds have very high avoidance capability that is higher than 0.98. Nonetheless, the avoidance rate Wedge-tailed Eagles appears to differ somewhat between wind farms. For three operational wind farms it has been between 0.95 and 0.97, while for a fourth it has been slightly lower than 0.90 (Smales et al. 2013).

5.5.8 Turbine parameters

The Biosis CRM requires a range of numeric inputs, including the number of turbines and key dimensions of turbines (blade dimensions, geometry and rotor-speed). The CRM for the proposed wind farm used the key parameters outlined in Table 13, as provided by Virya Energy Pty Ltd in February 2026.

Table 13 Turbine data included in the CRM (provided by Virya Energy Pty Ltd)

Turbine statistic	Value for statistic
General data	
Make and model of turbine	Vestas V172
Number of turbines on farm	164
Operational data	
Start-up wind speed (m/s)	3
Shut-down wind speed (m/s)	25
Annual percentage downtime for turbines *This is the annual mean for the entire complement of turbines of time in which rotors will not be rotating (as distinct from not generating, if applicable) due to inappropriate wind speed (too low and too high, as determined from anemometer data), and turbine maintenance.*	10.2 %
Tower	
Height (m)	164 (model RSH-1) 194 (model RSH-2)
Diameter (bottom) (m)	8.5
Diameter (top) (m)	4
Nacelle	
Maximum H (m)	8.4
Maximum W (m) *Usually consistent with hub diameter*	4.2
Maximum L (m)	13
Rotor (Swept)	
Hub height above ground at rotor centreline (m)	166 (model RSH-1) 196 (model RSH-2)
Diameter (m)	172
Rotational speed (rpm)	5-12 (approx. operating range) *12 was used in the CRM*
Tilt (degrees)	6
Number of blades	3 per turbine
Blades + Hub (Stationary)	
Length (m)	84.6
Chord (widest point) (m)	4.5
Chord (tip) (m)	0.7
Thickness (widest point) (m)	1.7

Turbine statistic	Value for statistic
Thickness (tip) (m)	0.14
Angle of attack (deg)	Approx. 6-10 degrees during normal power production *10 was used in the CRM*

In the scattered or 'clustered' array of turbines such as those within the study area, a bird has a high probability of encountering multiple turbines in a given flight. The CRM has a built-in function to account for any difference whereby the turbine array can have any setting from 100% of turbines fully clustered to 0% in which turbines are entirely linearly configured. This parameter was set to 100% of turbines fully clustered.

5.6 CRM model results

CRM results for the all native species recorded flying at RSH at impact sites, with site population estimated, are shown in Table 14 (model RSH-1) and Table 15 (model RSH-2). Results for the species provided are expressed as projected numbers of annual average collisions across the entire wind farm. It is noted that the model is deterministic and therefore cannot forecast the frequency of collisions around the predicted annual average and it is important to recognise that the number of any actual collisions that might occur can be expected to vary from year to year in a distribution around the average.

Table 14 CRM movements at risk and mortality results for species recorded at RSH-1 (80-252 metres)

Common name	Movements at risk			Mortality (Collisions/Year)		
	Dynamic rotor avoidance rate					
	95%	98%	99%	95%	98%	99%
Australian Magpie	3.78	3.71	3.69	3.74	3.67	3.65
Australian Raven	1.13	1.10	1.08	0.13	1.10	1.08
Australian White Ibis	2.02	0.95	0.60	1.99	0.95	0.59
Black Kite	0.44	0.25	0.19	0.44	0.25	0.19
Black-shouldered Kite	0.44	0.34	0.31	0.44	0.34	0.31
Brown Falcon	0.26	0.21	0.19	0.26	0.21	0.19
Brown Goshawk	0.15	0.10	0.08	0.15	0.10	0.08
Little Eagle	0.06	0.03	0.03	0.06	0.03	0.03
Little Raven	1.67	1.62	1.60	1.67	1.62	1.60
Magpie-lark	0.37	0.35	0.35	0.37	0.35	0.35
Nankeen Kestrel	1.29	1.15	1.10	1.28	1.14	1.10
Spotted Harrier	0.17	0.13	0.12	0.17	0.13	0.12
Straw-necked Ibis	11.64	5.75	3.79	11.54	5.73	3.78
Sulphur-crested Cockatoo	0.31	0.17	0.13	0.30	0.17	0.13
Wedge-tailed Eagle	0.76	0.39	0.26	0.75	0.38	0.26
Welcome Swallow	1.86	1.64	1.57	1.84	1.63	1.56

Common name	Movements at risk			Mortality (Collisions/Year)		
	Dynamic rotor avoidance rate					
	95%	98%	99%	95%	98%	99%
Whistling Kite	0.55	0.31	0.23	0.54	0.31	0.23

Table 15 CRM movements at risk and mortality results for species recorded at RSH-2 (104-280 metres)

Common name	Movements at risk			Mortality (Collisions/Year)		
	Dynamic rotor avoidance rate					
	95%	98%	99%	95%	98%	99%
Australian Raven	1.31	1.29	1.29	1.30	1.29	1.28
Australian White Ibis	0.40	0.26	0.22	0.40	0.26	0.22
Black Kite	0.27	0.18	0.15	0.27	0.18	0.15
Brown Falcon	0.22	0.20	0.20	0.22	0.20	0.20
Brown Goshawk	0.15	0.09	0.08	0.14	0.09	0.08
Little Eagle	0.05	0.03	0.02	0.05	0.03	0.02
Magpie-lark	0.43	0.42	0.41	0.43	0.42	0.41
Nankeen Kestrel	1.32	1.27	1.25	1.31	1.26	1.24
Spotted Harrier	0.18	0.14	0.13	0.18	0.14	0.13
Wedge-tailed Eagle	0.44	0.25	0.18	0.44	0.25	0.18
Whistling Kite	0.29	0.20	0.17	0.29	0.20	0.17

On the assumption that the collision avoidance capacity of these species above is at least 95%, the results can be summarised as follows:

- Model RSH-1:
  - 10 species with up to one flight per annum that would be at some risk of collision across the entire wind farm.
  - Six with one to five flights per annum that would be at some risk of collision across the entire wind farm.
  - One with greater than five flights per annum that would be at some risk of collision across the entire wind farm (Straw-necked Ibis).
- Model RSH-2:
  - nine species with up to one flight per annum that would be at some risk of collision across the entire wind farm.
  - two species with greater than one per annum that would be at some risk of collision across the entire wind farm (Nankeen Kestrel and Australian Raven).

Experience with these species at wind energy facilities in south-eastern Australia demonstrates that the following species relevant to the project have been document colliding with wind turbines (Moloney et al. 2019):

- Australian Raven
- Australian White Ibis
- Brown Falcon
- Magpie-lark
- Nankeen Kestrel
- Straw-necked Ibis
- Wedge-tailed Eagle
- Whistling Kite

Wedge-tailed Eagle avoidance rate

For Wedge-tailed Eagles, there is some published empirical data (Smales 2023) where evidence suggests that the model's projections accurately equate to avoidance capacity of between 0.90 and 0.97. On the assumption that the collision avoidance capacity was 0.90, the mortality rates for Wedge-tailed Eagles would be 1.37 (model RSH-1) and 0.76 (model RSH-2). It is noted that these values remain relatively low compared over wind farms (Hull et al. 2010). Although this may reflect an underestimation of the number of collisions, it is primarily due to the limited number of observations recorded during the survey. The proposed project area consists predominantly of cropped paddocks with limited grazing, which provides few scavenging opportunities for Wedge-tailed Eagles (a limited number of sheep or kangaroo carcasses).

Unidentified raptors and ravens

Up to 6 raptors were not identified to species level at impact sites during BUS, usually due to distance from the observer or lighting conditions. These records have not been included in the above CRM, as they could not be allocated to any particular species. This means that the CRM results are likely underestimated for some species. In the case of unidentified raptors, field notes indicate that these observations were likely Nankeen Kestrels, Whistling Kites, or Brown Falcons.

Number of movements limitation

The Biosis CRM generally requires a minimum of 50 movements from pooled surveys in order to obtain suitable data for analysis and confidence in results. The total number of movements recorded that can be utilised in CRM (below and within RSH from impact points) is provided in Table 10 and Table 11. As there are limited movements recorded for Black Kite (24), Brown Falcon (37), Brown Goshawk (3), Little Eagle (2), Spotted Harrier (11) and Whistling Kite (31), the CRM results for these species should be considered to be of a lower accuracy than the results where the minimum 50 movements have been recorded.

6 Cumulative impacts

An assessment of proposed and current wind farm projects sited within 50 kilometres of the proposed Meering West Wind Farm has been carried out to provide a summary of potential cumulative impacts to biodiversity, as provide in Table 16.

Generally, impacts resulting from the project are largely consistent with impacts that are considered to occur at other nearby projects.

The summary of biodiversity impacts from publicly available information was reviewed to gain an understanding of the main biodiversity impacts and how these may contribute to cumulative impacts when considering the development of the project.

Table 16 Cumulative impact summary

project	Distance	Project status	Overview	Potential biodiversity impacts
Normanville Energy Park	2 km north of Meering West Wind Farm	Planning permit application lodged and process underway	• Up to 17 turbines • 26 km of internal access tracks • 7.2 km external transmission (underground)	Impact to the following ecological communities (assessment undertaken by Nature Advisory): • Plains Mallee Box woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions (EPBC Act: Critically Endangered) • Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions (EPBC Act: Critically Endangered) • Natural Grasslands of the Murray Valley Plains (EPBC Act: Critically Endangered) • Plains Mallee Box Woodlands of the Murray Darling Depression and Naracoorte Coastal Plain Bioregions (EPBC Act: Critically Endangered) • Western Basalt Plains Grassland (FFG Act: Threatened) • Semi-arid Northwest Plains Buloke Grassy Woodland Community (FFG Act: Threatened) Listed bird and bat species for which potential impact has been considered are listed below: • Blue-winged Parrot (EPBC Act: Vulnerable): Native vegetation removal has been minimised, and it is considered that this species is unlikely to be impacted during the construction stage. It is considered that the project presents a very low risk to this species, and it is unlikely that the wind farm poses a risk of significant impact to this species during operational stage. • Fork-tailed Swift EPBC Act: Migratory): This species is highly mobile and is not expected to frequent the Project Site regularly. It is unlikely to rely on terrestrial habitats and the proposed removal of native vegetation was assessed as

project	Distance	Project status	Overview	Potential biodiversity impacts
				not significant for the species. It was assessed as unlikely to be impacted during the construction stage. The level of risk to this species during operational stage due to the project was assessed as very low, though it was noted in the assessment documentation that collisions may occur occasionally. • Latham's Snipe (EPBC Act: Migratory, Vulnerable): Native vegetation removal has been minimised including to wet areas potentially used by this species and it is considered that this species is unlikely to be impacted during the construction stage. It is considered that the project presents a very low risk to this species during operational stage, and it is unlikely that the wind farm poses a risk of significant impact to this species. • White-throated Needletail (EPBC Act: Migratory, Vulnerable; FFG Act: Vulnerable): This species is highly mobile and is not expected to frequent the Project Site regularly due to the lack of extensive woodlands. It is unlikely to rely on terrestrial habitats and the proposed removal of native vegetation is not significant for the species. It is considered unlikely to be impacted during the construction stage. The level of risk to this species due to the project is considered to be very low, though collisions may occur on the rare occasion. • Black Falcon (FFG Act: Critically Endangered) Up to two pairs utilised the site, with suspected breeding activity observed by one pair 1.5 km north-east of the site. Black Falcon is unlikely to be significantly impacted by the proposed vegetation removal, or other construction stage activities provided breeding activity is monitored, and nest sites avoided. Any impacts to this species due to turbine collision are considered to be low-medium. • Yellow-bellied Sheath-tailed Bat (FFG Act: Vulnerable) was identified in summer and winter 2024 in relatively low numbers (2.2% and 0.5% of all bat species calls, respectively) but at least once at all survey locations. This species is likely to be infrequent at the Project Site, and any impacts are considered to be low. • Corben's Long-eared Bat (EPBC Act: Vulnerable; FFG Act: Endangered) has potential to occur on site, given Long-eared bat species complexes were recorded. If present, it is unlikely to regularly fly at RSH as it usually forages within vegetation. Any impacts are considered to be

project	Distance	Project status	Overview	Potential biodiversity impacts
				very low, and the project is unlikely to have a significant impact on this species.
Cannie Wind Farm	10 km north-west of Meering West Wind Farm	Referred under Environment Effects Act	• Up to 174 turbines • Access tracks to be confirmed • Transmission lines to be confirmed	To be confirmed (on going assessment)

7 Conclusion

Bird utilisation surveys undertaken across two years and all seasons recorded 115 bird species, of which 13 were raptor species, eight were threatened species and one was a migratory species. Bat analysis positively identified 10 microbat species of the 11 species of microbat considered likely to occur within the study area and surrounds. No threatened bat species were positively identified (probable or almost certain) during the bat utilisation surveys.

The qualitative risk assessment found 44 species (40 birds and four bats) to be at more than a negligible risk of collision with an operating turbine, which includes:

- Up to 38 bird species with a Low collision risk.
- Three bat species with a Low collision risk.
- Two bird species with a Moderate collision risk, including:
  - Wedge-tailed Eagle.
  - Black Falcon.
- One bat species with a High collision risk:
  - White-striped Free-tailed Bat.
- No bird species with a High collision risk.

Up to two bird and two bat species are considered to have a Low risk of impact as a result of barrier effects for the proposed wind farm layout including; Wedge-tailed Eagle, Black Falcon, White-striped Free-tailed Bat and Gould's Wattled Bat. All other species have no more than a Negligible risk of impact as a result of barrier effect for the proposed wind farm layout.

Collision Risk Models were undertaken for all native species recorded flying at RSH at impact sites. On the assumption that the collision avoidance capacity of these species above is at least 95%, the results can be summarised as follows:

- Model RSH-1:
  - 10 species with up to one flight per annum that would be at some risk of collision across the entire wind farm.
  - Six with one to five flights per annum that would be at some risk of collision across the entire wind farm.
  - One with greater than five flights per annum that would be at some risk of collision across the entire wind farm (Straw-necked Ibis).
- Model RSH-2:
  - nine species with up to one flight per annum that would be at some risk of collision across the entire wind farm.
  - two species with greater than one per annum that would be at some risk of collision across the entire wind farm (Nankeen Kestrel and Australian Raven).

Black Falcon activity within the proposed Meering West Wind Farm area has been recorded at low levels, and no breeding has been observed on site or within 2 kilometres at the time of reporting. The qualitative risk assessment identified the project as presenting a Moderate collision risk for this species. However, due to the absence of breeding observations, the lack of information on avoidance capacity and the absence of flights

within RSH recorded at impact points, it is not possible to predict (via CRM) the number of blade-strike events per year for this species.

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Appendices

Appendix 1 BBUS Bird data

Table A 1 Abbreviations and symbols relevant to this Appendix

Code	Meaning	Reference
National listings		
CR	Critically endangered	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
EN	Endangered	
VU	Vulnerable	
State listings		
cr	Critically endangered	Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act)
e	Endangered	
v	Vulnerable	

Table A 2 Bird species recorded from the study area

Status	Scientific name	Common name	Recorded during BBUS
v	*Struthidea cinerea*	Apostlebird	-
-	*Anhinga novaehollandiae*	Australasian Darter	-
-	*Tachybaptus novaehollandiae*	Australasian Grebe	-
-	*Anthus novaeseelandiae*	Australasianan Pipit	Impact, control
v	*Spatula rhynchotis*	Australasian Shoveler	-
-	*Porphyrio melanotus*	Australasian Swamphen	-
-	*Falco longipennis*	Australian Hobby	Impact, control
-	*Cracticus tibicen*	Australian Magpie	Impact, control
-	*Aegotheles cristatus*	Australian Owlet-nightjar	Impact
-	*Pelecanus conspicillatus*	Australian Pelican	Impact, control
-	*Corvus coronoides*	Australian Raven	Impact, control
-	*Tadorna tadornoides*	Australian Shelduck	Impact, control
-	*Threskiornis molucca*	Australian White Ibis	Impact, control
-	*Chenonetta jubata*	Australian Wood Duck	Impact, control
-	*Porzana pusilla*	Baillon's Crake	-
-	*Vanellus tricolor*	Banded Lapwing	Impact
cr	*Falco subniger*	Black Falcon	Impact, control
-	*Sugomel nigrum*	Black Honeyeater	-
-	*Milvus migrans*	Black Kite	Impact, control
-	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	Impact, control

Status	Scientific name	Common name	Recorded during BBUS
-	*Artamus cinereus*	Black-faced Woodswallow	Impact
-	*Elseyornis melanops*	Black-fronted Dotterel	-
-	*Elanus axillaris*	Black-shouldered Kite	Impact, control
-	*Tribonyx ventralis*	Black-tailed Native-hen	-
-	*Cygnus atratus*	Black Swan	-
-	*Northiella haematogaster*	Blue Bonnet	Impact, control
v	*Oxyura australis*	Blue-billed Duck	-
-	*Entomyzon cyanotis*	Blue-faced Honeyeater	Impact, control
VU, v	*Neophema chrysostoma*	Blue-winged Parrot	-
-	*Falco berigora*	Brown Falcon	Impact, control
-	*Accipiter fasciatus*	Brown Goshawk	Impact, control
-	*Synoicus ypsilophorus*	Brown Quail	-
-	*Cincloramphus cruralis*	Brown Songlark	Impact, control
-	*Acanthiza pusilla*	Brown Thornbill	Impact
VU	*Climacteris picumnus*	Brown Treecreeper	Impact, control
-	*Melopsittacus undulatus*	Budgerigar	-
-	*Acanthiza reguloides*	Buff-rumped Thornbill	Impact, control
M, v	*Hydroprogne caspia*	Caspian Tern	-
-	*Anas castanea*	Chestnut Teal	-
-	*Acanthiza uropygialis*	Chestnut-rumped Thornbill	Impact, control
-	*Nymphicus hollandicus*	Cockatiel	Impact, control
-	*Turdus merula*	Common Blackbird*	Control
-	*Phaps chalcoptera*	Common Bronzewing	Impact
EN, M, e	*Tringa nebularia*	Common Greenshank	-
-	*Acridotheres tristis*	Common Myna*	Impact, control
-	*Sturnus vulgaris*	Common Starling*	Impact, control
-	*Ocyphaps lophotes*	Crested Pigeon	Impact, control
VU, v	*Stagonopleura guttata*	Diamond Firetail	-
-	*Gallinula tenebrosa*	Dusky Moorhen	-
-	*Artamus cyanopterus*	Dusky Woodswallow	Impact, control
v	*Ardea alba modesta*	Eastern Great Egret	-
-	*Platycercus eximius*	Eastern Rosella	Impact, control
-	*Fulica atra*	Eurasian Coot	-
-	*Alauda arvensis*	Eurasian Skylark*	Impact

Status	Scientific name	Common name	Recorded during BBUS
-	*Petrochelidon ariel*	Fairy Martin	Impact, control
M	*Apus pacificus*	Fork-tailed Swift	Control
e	*Strictonetta naevosa*	Freckled Duck	-
-	*Eolophus roseicapillus*	Galah	Impact, control
-	*Pachycephala inornata*	Gilbert's Whistler	Impact
-	*Pachycephala pectoralis*	Golden Whistler	Impact
-	*Cisticola exilis*	Golden-headed Cisticola	-
-	*Phalacrocorax carbo*	Great Cormorant	Impact, control
-	*Podiceps cristatus*	Great Crested Grebe	-
-	*Cracticus torquatus*	Grey Butcherbird	Impact, control
-	*Rhipidura albiscapa*	Grey Fantail	Impact
-	*Colluricincla harmonica*	Grey Shrike-thrush	Impact
-	*Anas gracilis*	Grey Teal	Impact, control
v	*Pomatostomus temporalis*	Grey-crowned Babbler	Impact, control
v	*Aythya australis*	Hardhead	-
-	*Poliocephalus poliocephalus*	Hoary-headed Grebe	-
EN, v	*Melanodryas cucullata*	Hooded Robin	Impact
-	*Chrysococcyx basalis*	Horsefield's Bronze-Cuckoo	-
-	*Passer domesticus*	House Sparrow*	Impact, control
-	*Dacelo novaeguineae*	Laughing Kookaburra	-
VU	*Gallinago hardwickii*	Latham's Snipe	-
-	*Phalacrocorax sulcirostris*	Little Black Cormorant	-
-	*Catatua sanguinea*	Little Corella	Impact, control
v	*Hieraaetus morphnoides*	Little Eagle	Impact
v	*Egretta garzetta*	Little Egret	-
-	*Poodytes gramineus*	Little Grassbird	-
-	*Microcarbo melanoleucos*	Little Pied Cormorant	-
-	*Corvus mellori*	Little Raven	Impact, control
-	*Cacatua tenuirostris*	Long-billed Corella	Impact, control
-	*Grallina cyanoleuca*	Magpie-lark	Impact, control
-	*Vanellus miles*	Masked Lapwing	Impact, control
v	*Biziura lobata*	Musk Duck	-
-	*Glossopsitta concinna*	Musk Lorikeet	Impact, control
-	*Falco cenchroides*	Nankeen Kestrel	Impact, control

Status	Scientific name	Common name	Recorded during BBUS
-	*Manorina melanocephala*	Noisy Miner	Impact, control
-	*Anas superciliosa*	Pacific Black Duck	Impact
-	*Cacomantis pallidus*	Pallid Cuckoo	-
-	*Geopelia placida*	Peaceful Dove	Impact
-	*Cracticus nigrogularis*	Pied Butcherbird	Impact, control
-	*Himantopus leucocephalus*	Pied Stilt	-
-	*Malacorhynchus membranaceus*	Pink-eared Duck	-
-	*Malurus assimilis*	Purple-backed Fairywren	-
-	*Parvipsitta porphyrocephala*	Purple-crowned Lorikeet	-
-	*Merops ormatus*	Rainbow Bee-eater	-
-	*Anthochaera carunculata*	Red Wattlebird	Impact, control
-	*Charadrius ruficapillus*	Red-capped Plover	-
-	*Petroica goodenovii*	Red-capped Robin	Impact, control
-	*Erythrogonys cinctus*	Red-kneed Dotterel	-
-	*Recurvirostra novaehollandiae*	Red-necked Avocet	-
M	*Calidris ruficollis*	Red-necked Stint	-
-	*Psephotus haematonotus*	Red-rumped Parrot	Impact, control
-	*Acrocephalus australis*	Reed-Warbler	-
-	*Myiagra inquieta*	Restless Flycatcher	-
-	*Columbia livia*	Rock Dove*	Control
-	*Cincloramphus mathewsi*	Rufous Songlark	Impact, control
-	*Pachycephala rufiventris*	Rufous Whistler	Impact
-	*Todiramphus sanctus*	Sacred Kingfisher	-
VU, M	*Calidris acuminata*	Sharp-tailed Sandpiper	-
-	*Chroicocephalus novaehollandiae*	Silver Gull	-
-	*Gavicalis virescens*	Singing Honeyeater	Impact, control
-	*Acanthagenys furogularis*	Spiny-cheeked Honeyeater	Impact
-	*Circus assimilis*	Spotted Harrier	Impact, control
-	*Pardalotus punctatus*	Spotted Pardalote	Impact
-	*Threskiornis spinicollis*	Straw-necked Ibis	Impact, control
-	*Pardalotus striatus*	Striated Pardalote	Impact, control
-	*Cotumix pectoralis*	Stubble Quail	Impact, control
-	*Cacatua galerita*	Sulphur-crested Cockatoo	Impact, control
-	*Malurus cyaneus*	Superb Fairy-wren	Impact, control

Status	Scientific name	Common name	Recorded during BBUS
-	*Circus approximans*	Swamp Harrier	Impact, control
-	*Podargus strigoides*	Tawny Frogmouth	-
-	*Petrochelidon nigricans*	Tree Martin	Impact, control
-	*Aquila audax*	Wedge-tailed Eagle	Impact, control
-	*Smicrornis brevirostris*	Weebill	Impact, control
-	*Hirundo neoxena*	Welcome Swallow	Impact, control
-	*Chlidonias hybrida*	Whiskered Tern	-
-	*Haliastur sphenurus*	Whistling Kite	Impact, control
e	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	Control
-	*Artamus superciliosus*	White-browed Woodswallow	Impact
-	*Egretta novaehollandiae*	White-faced Heron	Impact, control
-	*Epthianura albifrons*	White-fronted Chat	Impact
-	*Purnella albifrons*	White-fronted Honeyeater	Impact
-	*Melithreptus lunatus*	White-naped Honeyeater	-
-	*Ardea pacifica*	White-necked Heron	Impact
-	*Ptilotula penicillata*	White-plumed Honeyeater	Impact, control
VU, M, v	*Hirundapus caudacutus*	White-throated Needletail	-
-	*Corcorax melanorhamphos*	White-winged Chough	Impact, control
-	*Lalage sueurii*	White-winged Triller	Impact
-	*Rhipidura leucophrys*	Willie Wagtail	Impact, control
-	*Acanthiza nana*	Yellow Thornbill	Impact, control
-	*Platalea flavipes*	Yellow-billed Spoonbill	-
-	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	Impact, control
-	*Manorina flavigula*	Yellow-throated Miner	Impact, control

Appendix 2 Qualitative collision risk and barrier effect risk assessment results

Table A 3 Bird collision risk and barrier risk likelihood assessment

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no known record of collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Acanthiza nana	Yellow Thornbill	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Acanthiza pusilla	Brown Thornbill	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Acanthiza reguloides	Buff-rumped Thornbill	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Acanthiza uropygialis	Chestnut-rumped Thornbill	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Accipiter fasciatus	Brown Goshawk	-	-	Unlikely	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area and was recorded at one occasion flying at RSA height by

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										Biosis during survey. Turbine collisions have been reported for this species in south-eastern Australia. Turbine strikes by commonly occurring raptors are likely, based on experience at other wind farms in south-eastern Australia. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Acrocephalus australis	Australian Reed-Warbler	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Actitis hypoleucos	Common Sandpiper	Mi	-	Rare	Minimal	Negligible	Rare	Minimal	Negligible	There are minimal records within the locality. There is potential for this species to fly at RSA height, however

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a medium risk score by Reid & Baker (2025).
Aegotheles cristatus	Australian Owlet-nightjar	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Anas castanea	Chestnut Teal	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Anas gracilis	Grey Teal	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										This species has been given a high risk score by Reid & Baker (2025).
Anas superciliosa	Pacific Black Duck	-	-	Likely	Minimal	Low	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Anhinga novaehollandiae	Australasian Darter	-	-	Unlikely	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Anseranas semipalmata	Magpie Goose	-	v	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	There are limited records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Anthochaera carunculata	Red Wattlebird	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of this

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Anthus novaeseelandiae	Australian Pipit	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Aphelocephala leucopsis	Southern Whiteface	VU	-	Rare	Minimal	Negligible	Rare	Minimal	Negligible	There are many records within the locality. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act. This species has been given a medium risk

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										score by Reid & Baker (2025).
Apus pacificus	Fork-tailed Swift	Mi	-	Likely	Minimal	Low	Rare	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a high risk score by Reid & Baker (2025).
Aquila audax	Wedge-tailed Eagle	-	-	Likely	Moderate	Moderate	Likely	Minimal	Low	This species has been recorded by Biosis within the study area and has been recorded flying at RSA height within the study area during BBUS undertaken for this project. Turbine collisions have been reported for this species. Turbine strikes by commonly occurring raptors are likely, based on

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										experience at other wind farms in south-eastern Australia. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Ardea alba	Great Egret	-	v	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Ardea pacifica	White-necked Heron	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Ardea plumifera	Plumed Egret	-	cr	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	There are some records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or BC Act. This species has been given a high risk score by Reid & Baker (2025).
Ardeotis australis	Australian Bustard	-	cr	Rare	Moderate	Negligible	Rare	Moderate	Negligible	This species has not been recorded within the locality. This species is

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Artamus cinereus	Black-faced Woodswallow	-	-	Unlikely	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Artamus cyanopterus	Dusky Woodswallow	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area and was

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										recorded at flying at RSA height by Biosis during surveys. There have been no recorded collisions with wind turbines for this species. This species is not listed as threatened under the EPBC or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Artamus superciliosus	White-browed Woodswallow	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Aythya australis	Hardhead	-	v	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Biziura lobata	Musk Duck	-	v	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Botaurus poiciloptilus	Australasian Bittern	EN	cr	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	There are some records within the locality. There is potential for this species to

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Burhinus grallarius	Bush Stone-curlew	-	cr	Rare	Moderate	Negligible	Rare	Moderate	Negligible	There are limited records within the locality. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Cacatua galerita	Sulphur-crested Cockatoo	-	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Cacatua sanguinea	Little Corella	-	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Cacatua tenuirostris	Long-billed Corella	-	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Calidris acuminata	Sharp-tailed Sandpiper	VU, Mi	-	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act. This species is a listed migratory species under the EPBC Act. This species has been given a high risk score by Reid & Baker (2025).
Calidris ferruginea	Curlew Sandpiper	CR, Mi	cr	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	There are some records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a high risk score by Reid & Baker (2025).
Calidris melanotos	Pectoral Sandpiper	Mi	-	Unlikely	Minimal	Negligible	Rare	Minimal	Negligible	There are some records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species in NSW. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or BC Act. This species is a listed migratory species under the EPBC Act. This species has been given a medium risk score by Reid & Baker (2025).

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Calidris pugnax	Ruff	Mi	-	Rare	Minimal	Negligible	Rare	Minimal	Negligible	There are minimal records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species is a listed migratory species under the EPBC Act.
Calidris ruficollis	Red-necked Stint	Mi	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										threatened under the EPBC Act or FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a medium risk score by Reid & Baker (2025).
Calidris subminuta	Long-toed Stint	Mi	-	Rare	Minimal	Negligible	Rare	Minimal	Negligible	There are some records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a medium risk score by Reid & Baker (2025).
Chalcites basalis	Horsfield's Bronze-Cuckoo	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Charadrius bicinctus	Double-banded Plover	Mi	-	Unlikely	Minimal	Negligible	Rare	Minimal	Negligible	There are some records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a medium risk score by Reid & Baker (2025).

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Charadrius ruficapillus	Red-capped Plover	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Chenonetta jubata	Australian Wood Duck	-	-	Likely	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of this species makes population impacts unlikely. This species is not

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Chlidonias hybrida	Whiskered Tern	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Chlidonias leucopterus	White-winged Black Tern	Mi	-	Rare	Minimal	Negligible	Rare	Negligible	Negligible	There are some records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a medium risk score by Reid & Baker (2025).
Chroicocephalus novaehollandiae	Silver Gull	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Cincloramphus cruralis	Brown Songlark	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of this species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Cincloramphus mathewsi	Rufous Songlark	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										given a medium risk score by Reid & Baker (2025).
Circus approximans	Swamp Harrier	-	-	Likely	Minimal	Low	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. Turbine strikes by commonly occurring raptors are likely, based on experience at other wind farms in south-eastern Australia. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Circus assimilis	Spotted Harrier	-	-	Likely	Minimal	Low	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. Turbine strikes by commonly occurring

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										raptors are likely, based on experience at other wind farms in south-eastern Australia. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Cisticola exilis	Golden-headed Cisticola	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Cladorhynchus leucocephalus	Banded Stilt	-	-	Unlikely	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	VU	-	Rare	Minimal	Negligible	Rare	Minimal	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act. This species has been given a high risk score by Reid & Baker (2025).
Colluricincla harmonica	Grey Shrike-thrush	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Coracina novaehollandiae	Black-faced Cuckoo-shrike	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Corcorax melanorhamphos	White-winged Chough	-	-	Rare	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Corvus coronoides	Australian Raven	-	-	Probable	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area and has been recorded flying at RSA height within the study area during BBUS undertaken for this project. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Corvus mellori	Little Raven	-	-	Likely	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Coturnix pectoralis	Stubble Quail	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Cracticus nigrogularis	Pied Butcherbird	-	-	Unlikely	Negligible	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Cracticus torquatus	Grey Butcherbird	-	-	Unlikely	Negligible	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Cygnus atratus	Black Swan	-	-	Likely	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Dacelo novaeguineae	Laughing Kookaburra	-	-	Unlikely	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										This species has been given a medium risk score by Reid & Baker (2025).
Egretta garzetta	Little Egret	-	e	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is listed as threatened under the FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Egretta novaehollandiae	White-faced Heron	-	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Elanus axillaris	Black-shouldered Kite	-	-	Likely	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. Turbine strikes by commonly occurring raptors are likely, based on experience at other wind farms in south-eastern Australia. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Elseyornis melanops	Black-fronted Dotterel	-	-	Rare	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Entomyzon cyanotis	Blue-faced Honeyeater	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Eolophus roseicapilla	Galah	-	-	Probable	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. here is potential for this species to fly at RSA height, however

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Epthianura albifrons	White-fronted Chat	-	-	Unlikely	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Erythrogonys cinctus	Red-kneed Dotterel	-	-	Unlikely	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Falco berigora	Brown Falcon	-	-	Probable	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at height within the study area during BBUS undertaken for this project. Turbine collisions have been reported for this species. Turbine strikes by commonly occurring raptors are likely, based on experience at other wind farms in south-eastern Australia. This species is not listed as threatened

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										under the EPBC Act or FFG Act.
Falco cenchroides cenchroides	Australian Nankeen Kestrel	-	-	Probable	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at height within the study area during BBUS undertaken for this project. There have been no recorded collisions with wind turbines for this species. Turbine strikes by commonly occurring raptors are likely, based on experience at other wind farms in south-eastern Australia. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Falco hypoleucos	Grey Falcon	VU	v	Rare	Moderate	Negligible	Rare	Minimal	Negligible	This species has not been recorded within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										species. Turbine strikes by commonly occurring raptors are likely, based on experience at other wind farms in south-eastern Australia. This species is listed as threatened under the EPBC Act and FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Falco longipennis	Australian Hobby	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. Turbine strikes by commonly occurring raptors are likely, based on experience at other wind farms in south-eastern Australia. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Falco subniger	Black Falcon	-	cr	Unlikely	Significant	Moderate	Unlikely	Moderate	Low	This species has been recorded by Biosis within the study area and was recorded flying at RSA height by Biosis during survey (at one occasion from a BUS control point). Turbine collisions have been reported for this species. Turbine strikes by commonly occurring raptors are likely, based on experience at other wind farms in south-eastern Australia. This species is listed as threatened under the FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Fulica atra	Eurasian Coot	-	-	Unlikely	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										This species has been given a medium risk score by Reid & Baker (2025).
Gallinago hardwickii	Latham's Snipe	VU, Mi		Unlikely	Minimal	Negligible	Rare	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act. This species is a listed migratory species under the EPBC Act. This species has been given a high risk score by Reid & Baker (2025).
Gallinula tenebrosa	Dusky Moorhen	-	-	Unlikely	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Gavicalis virescens	Singing Honeyeater	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Gelochelidon nilotica	Gull-billed Tern	Mi	e	Unlikely	Moderate	Low	Rare	Minimal	Negligible	There are some records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										these species makes population impacts unlikely. This species is listed as threatened under the FFG Act. This species is a listed migratory species under the EPBC Act.
Geopelia cuneata	Diamond Dove	-	v	Rare	Moderate	Negligible	Rare	Negligible	Negligible	There are minimal records within the locality. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is listed as threatened under the FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Geopelia placida	Peaceful Dove	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Grallina cyanoleuca	Magpie-lark	-	-	Unlikely	Negligible	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Grantiella picta	Painted Honeyeater	VU	v	Rare	Minimal	Negligible	Rare	Minimal	Negligible	This species has not been recorded within the locality. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Grus rubicunda	Brolga	-	e	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	Records within 5 km restricted to the north-

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										eastern side of the project area, and <50 records within 10 km of proposed site. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. This species is listed as threatened under the FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Gymnorhina tibicen	Australian Magpie	-	-	Probable	Minimal	Low	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	e	Unlikely	Moderate	Low	Rare	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. Turbine strikes by commonly occurring raptors are likely, based on experience at other wind farms in south-eastern Australia. This species is listed as threatened under the FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Haliastur sphenurus	Whistling Kite	-	-	Possible	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at RSA height within the study area during BBUS undertaken for this project. Turbine collisions have been reported for this species. Turbine strikes by commonly occurring raptors are likely, based on experience at other wind farms in south-eastern

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										Australia. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Heteroscenes pallidus	Pallid Cuckoo	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Hieraaetus morphnoides	Little Eagle	-	v	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. Turbine strikes by commonly occurring

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										raptors are likely, based on experience at other wind farms in south-eastern Australia. This species is listed as threatened under the FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Hirundapus caudacutus	White-throated Needletail	VU, Mi	v	Unlikely	Moderate	Low	Rare	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a high risk score by Reid & Baker (2025).
Hirundo neoxena	Welcome Swallow	-	-	Likely	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at RSA height by Biosis during survey. There have been

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Hydroprogne caspia	Caspian Tern	Mi	v	Rare	Minimal	Negligible	Rare	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a high risk score by Reid & Baker (2025).
Lalage tricolor	White-winged Triller	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Lathamus discolor	Swift Parrot	CR	Cr	Rare	Moderate	Negligible	Rare	Moderate	Negligible	This species has not been recorded within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Leipoa ocellata	Malleefowl	VU	v	Rare	Minimal	Negligible	Rare	Minimal	Negligible	This species has not been recorded within the locality. This species is

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Limosa lapponica baueri	Bar-tailed Godwit	VU, Mi	v	Rare	Moderate	Negligible	Rare	Moderate	Negligible	There are some records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a high risk score by Reid & Baker (2025).
Limosa limosa	Black-tailed Godwit	EN, Mi	cr	Rare	Moderate	Negligible	Rare	Moderate	Negligible	There are some records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a high risk score by Reid & Baker (2025).
Lophochroa leadbeateri leadbeateri	Pink Cockatoo	EN	cr	Rare	Moderate	Negligible	Rare	Moderate	Negligible	There are minimal records within the locality. There is potential for this species to fly at RSA height, however was not recorded by Biosis during BUS survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Malacorhynchus membranaceus	Pink-eared Duck	-	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Malurus assimilis	Purple-backed Fairy-wren	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Malurus cyaneus	Superb Fairy-wren	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Manorina flavigula	Yellow-throated Miner	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Manorina melanocephala	Noisy Miner	-	-	Unlikely	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Melanodryas cucullata cucullata	Hooded Robin	EN	v	Rare	Negligible	Negligible	Rare	Moderate	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Melopsittacus undulatus	Budgerigar	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Merops ornatus	Rainbow Bee-eater	-	-	Unlikely	Negligible	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Microcarbo melanoleucos	Little Pied Cormorant	-	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Milvus migrans	Black Kite	-	-	Likely	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at RSA height within the study area during BBUS undertaken for this project. Turbine strikes by commonly occurring raptors are likely, based on experience at other wind farms in south-eastern Australia. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										given a high risk score by Reid & Baker (2025).
Myiagra inquieta	Restless Flycatcher	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Neophema chrysostoma	Blue-winged Parrot	VU	-	Unlikely	Minimal	Negligible	Rare	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Northiella haematogaster	Blue Bonnet	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Numenius minutus	Little Curlew	Mi	-	Rare	Minimal	Negligible	Rare	Minimal	Negligible	There are minimal records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										This species is a listed migratory species under the EPBC Act. This species has been given a medium risk score by Reid & Baker (2025).
Nymphicus hollandicus	Cockatiel	-	-	Likely	Minimal	Low	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Ocyphaps lophotes	Crested Pigeon	-	-	Unlikely	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Oxyura australis	Blue-billed Duck	-	v	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Pachycephala inornata	Gilbert's Whistler	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is not listed as threatened under the EPBC or FFG Act. This

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										species has been given a medium risk score by Reid & Baker (2025).
Pachycephala pectoralis	Golden Whistler	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is not listed as threatened under the EPBC or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Pachycephala rufiventris	Rufous Whistler	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is not listed as threatened under the EPBC or FFG Act.
Pardalotus punctatus	Spotted Pardalote	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										species. This species is not listed as threatened under the EPBC or FFG Act.
Pardalotus striatus	Striated Pardalote	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is not listed as threatened under the EPBC or FFG Act.
Pedionomus torquatus	Plains-wanderer	CE	cr	Rare	Moderate	Negligible	Rare	Moderate	Negligible	There are minimal records within the locality. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Pelecanus conspicillatus	Australian Pelican	-	-	Probable	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at RSA height within the study area during BBUS undertaken for this project.

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Peltohyas australis	Inland Dotterel	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	There are minimal records within the locality. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Petrochelidon ariel	Fairy Martin	-	-	Likely	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Petrochelidon nigricans	Tree Martin	-	-	Likely	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at RSA height within the study area during BBUS undertaken for this project. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Petroica goodenovii	Red-capped Robin	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Phalacrocorax carbo	Great Cormorant	-	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										given a high risk score by Reid & Baker (2025).
Phalacrocorax sulcirostris	Little Black Cormorant	-	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Phalacrocorax varius	Pied Cormorant	-	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Phaps chalcoptera	Common Bronzewing	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Platalea flavipes	Yellow-billed Spoonbill	-	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Platycercus eximius	Eastern Rosella	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Plegadis falcinellus	Glossy Ibis	Mi	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	There are limited records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a high risk score by Reid & Baker (2025).
Podargus strigoides	Tawny Frogmouth	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Podiceps cristatus	Great Crested Grebe	-	-	Rare	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Poliocephalus poliocephalus	Hoary-headed Grebe	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Polytelis anthopeplus monarchoides	Regent Parrot	VU	v	Rare	Moderate	Negligible	Rare	Moderate	Negligible	This species has not been recorded within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Polytelis swainsonii	Superb Parrot	VU	e	Rare	Moderate	Negligible	Rare	Moderate	Negligible	This species has not been recorded within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	-	v	Rare	Minimal	Negligible	Rare	Minimal	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Poodytes gramineus	Little Grassbird	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										listed as threatened under the EPBC Act or FFG Act.
Porphyrio porphyrio	Purple Swamphen	-	-	Rare	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Psephotus haematonotus	Red-rumped Parrot	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Ptilotula penicillata	White-plumed Honeyeater	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Purnella albifrons	White-fronted Honeyeater	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Radjah radjah refitergum	Australian Shelduck			Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Recurvirostra novaehollandiae	Red-necked Avocet	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Rhipidura albiscapa	Grey Fantail	-	-	Unlikely	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Rhipidura leucophrys	Willie Wagtail	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Rostratula australis	Australian Painted Snipe	EN	cr	Rare	Moderate	Negligible	Rare	Moderate	Negligible	There are minimal records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Smicrornis brevirostris	Weebill	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Spatula rhynchotis	Australasian Shoveler	-	v	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is listed as threatened under the FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Stagonopleura guttata	Diamond Firetail	VU	v	Rare	Minimal	Negligible	Rare	Minimal	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										the EPBC Act and FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Stictonetta naevosa	Freckled Duck	-	e	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is listed as threatened under the FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Struthidea cinerea	Apostlebird	-	v	Rare	Minimal	Negligible	Rare	Minimal	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										these species makes population impacts unlikely. This species is listed as threatened under the FFG Act.
Sugomel nigrum	Black Honeyeater	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.
Synoicus ypsilophorus	Brown Quail	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										This species has been given a medium risk score by Reid & Baker (2025).
Tachybaptus novaehollandiae	Australasian Grebe	-	-	Unlikely	Minimal	Negligible	Unlikely	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Threskiornis molucca	Australian White Ibis	-	-	Likely	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of these species

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Threskiornis spinicollis	Straw-necked Ibis	-	-	Possible	Minimal	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area and was recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a high risk score by Reid & Baker (2025).
Todiramphus sanctus	Sacred Kingfisher	-	-	Rare	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Tribonyx ventralis	Black-tailed Native-hen	-	-	Unlikely	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Trichoglossus concinna	Musk Lorikeet	-	-	Unlikely	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Tringa glareola	Wood Sandpiper	Mi	v	Rare	Minimal	Negligible	Rare	Minimal	Negligible	There are some records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is listed as threatened under the FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a medium risk score by Reid & Baker (2025).
Tringa nebularia	Common Greenshank	EN, Mi	e	Unlikely	Moderate	Low	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. This species is a listed migratory species under the EPBC Act. This species has been given a high risk score by Reid & Baker (2025).
Tringa stagnatilis	Marsh Sandpiper	Mi	e	Rare	Moderate	Negligible	Rare	Minimal	Negligible	There are some records within the locality. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is listed as threatened under the FFG Act. This species is a listed migratory species under the EPBC Act.

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Turnix pyrrhothorax	Red-chested Button-quail	-	e	Rare	Moderate	Negligible	Rare	Negligible	Negligible	There are minimal records within the locality. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is listed as threatened under the FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Vanellus miles	Masked Lapwing	-	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act.

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Vanellus tricolor	Banded Lapwing	-	-	Unlikely	Minimal	Negligible	Unlikely	Minimal	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height, however was not recorded flying at RSA height by Biosis during survey. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been given a medium risk score by Reid & Baker (2025).
Zapornia pusilla	Baillon's Crake	-	-	Rare	Minimal	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. This species has been

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	FFG Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										given a medium risk score by Reid & Baker (2025).

Table A 4 Bat collision risk and barrier risk likelihood assessment

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	BC Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Austronomus australis	White-striped Free-tailed Bat	-	-	Probable	Moderate	High	Possible	Minimal	Low	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. Prefers open foraging areas above canopy. A very common widespread species recorded in high numbers during site surveys. Recognised as an at-risk bat species in relation to wind farm developments due to their foraging and flight behaviour. Due to its poor ability to detect and avoid obstacles, particularly mobile ones, such as turbine blades, White-striped Free-tailed Bats are

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	BC Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										one of the most commonly recorded species in carcass monitoring at Australian windfarms. Highly susceptible to collision mortality regularly, however, populations generally secure and dense to withstand moderate instances of mortality should it occur. This species has been given a high risk score by Reid & Baker (2025).
Chalinolobus gouldii	Gould's Wattled Bat	-	-	Possible	Minimal	Low	Possible	Minimal	Low	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. A common and widespread large microbat that is fast, high flier with restricted manoeuvrability. This species has a poor ability to detect and avoid

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	BC Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										obstacles while pursuing prey, particularly mobile ones such as turbine blades. Highly susceptible to collision mortality regularly, however populations generally secure and dense to withstand moderate instances of mortality should it occur. This species has been given a medium risk score by Reid & Baker (2025).
Chalinolobus morio	Chocolate Wattled Bat	-	-	Unlikely	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. A relatively common and widespread microbat that is fast with increased manoeuvrability than the Gould's Wattled Bat. Generally restricted to

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	BC Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										canopies and fringing vegetation, may be susceptible to collision mortality on occasion, however populations generally secure and dense to withstand low instances of mortality should it occur. This species has been given a low risk score by Reid & Baker (2025).
Nyctophilus corbeni	Corben's Long-eared Bat	VU	e	Rare	Moderate	Negligible	Rare	Minimal	Negligible	This species has not been recorded within the locality. There are no other records within the locality. This species is unlikely to fly at RSA height. There have been no recorded collisions with wind turbines for this species. This species is listed as threatened under the EPBC Act and FFG Act. Generally restricted to foraging within or beneath the canopy however may forage within open areas, in conjunction with White Cypress Pine communities. This species is a slow flying agile bat that roosts in tree hollows, crevices and under loose bark. Unlikely to fly within RSA. Should a

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	BC Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										collision occur, it is likely only a very small number of individuals would be impacted. This species has been given a high risk score by Reid & Baker (2025).
Nyctophilus geoffroyi	Lesser Long-eared Bat	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. A relatively common and widespread microbat that is fast with high manoeuvrability. Generally restricted to foraging within or beneath the canopy however may forage within open areas, especially where lights have attracted large insect numbers. Should a collision occur, it is likely only a very small number

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	BC Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										of individuals would be impacted. This species has been given a low risk score by Reid & Baker (2025).
Ozimops planiceps	South-eastern Free-tailed Bat	-	-	Likely	Minimal	Low	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. Widespread species of varying habitats, but rare within the locality. Fast and direct fliers of unobstructed air-spaces from just above to well above the canopy as well as above grasslands. Should a collision occur, it is likely only a very small number of individuals would be impacted. This species has been given a medium risk score by Reid & Baker (2025).

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	BC Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
Ozimops ridei	Eastern Free-tailed Bat	-	-	Possible	Minimal	Low	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. There is potential for this species to fly at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. Widespread species of varying habitats, but rare within the locality. Fast and direct fliers of unobstructed air-spaces from just above to well above the canopy as well as above grasslands. Should a collision occur, it is likely only a very small number of individuals would be impacted. This species has been given a medium risk score by Reid & Baker (2025).
Scotorepens balstoni	Inland Broad-nosed Bat	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species is unlikely to fly at RSA

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	BC Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. A widespread species that generally fly within riparian areas but may also fly above canopies on occasion. Highly mobile, however, not recorded within RSA and not considered to be at risk of collision due to their favoured foraging and roosting preferences. In the unlikely event a collision occurs, populations generally secure and dense to withstand low instances of mortality should it occur. This species has been given a medium risk score by Reid & Baker (2025).
Vespadelus darlingtoni	Large Forest Bat	-	-	Unlikely	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area to species group. There are minimal

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	BC Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										records within the locality. This species has a low likelihood of flying at RSA height. Turbine collisions have been reported for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. A large widespread bat with restricted manoeuvrability due to its size. Not known to fly within RSA and not considered to be at risk of collision due to their favoured foraging and roosting preferences. In the unlikely event a collision occurs, populations generally secure and dense to withstand low instances of mortality should it occur. This species has been given a low risk score by Reid & Baker (2025).
Vespadelus regulus	Southern Forest Bat	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. There

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	BC Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										have been no recorded collisions with wind turbines for this species. The widespread and common status of these species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. A poorly known species that may cover an extensive foraging area. Like other Vespadelus, is not considered to be at risk of collision due to their favoured foraging and roosting preferences in drier woodland habitats with bias towards riparian areas. This species has been given a medium risk score by Reid & Baker (2025).
Vespadelus vulturnus	Little Forest Bat	-	-	Rare	Negligible	Negligible	Rare	Negligible	Negligible	This species has been recorded by Biosis within the study area. This species has a low likelihood of flying at RSA height. There have been no recorded collisions with wind turbines for this species. The widespread and common status of these

Scientific name	Common name	Threat listing		Collision with operating turbine			Indirect disturbance including barrier effects			Reasoning
		EPBC Act	BC Act	Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating	
										species makes population impacts unlikely. This species is not listed as threatened under the EPBC Act or FFG Act. A poorly known species that may cover an extensive foraging area. Like other Vespadelus, is not considered to be at risk of collision due to their favoured foraging and roosting preferences in drier woodland habitats with bias towards riparian areas. This species has been given a medium risk score by Reid & Baker (2025).

Appendix 3 Biosis collision risk model

Performance of the Biosis wind turbine avian collision risk model evaluated for two species of Australian eagles

Ian Smales

January 2023

Introduction

A number of avian collision risk models are used internationally to provide forecasts of the potential for various species of birds to collide with wind turbines. Their principal application has been to inform impact assessment as a component of regulatory consent processes for proposed wind energy projects.

While it is difficult to determine the frequency of bird collisions at offshore wind farms because it is not possible to search for bird carcasses as is traditionally done at onshore facilities, validation is feasible at terrestrial wind farms. Nonetheless, few pre-consent projections of avian turbine collision risk models used for onshore wind farms have been validated by comparing them with empirical experience of operational wind farms (Masden and Cook 2016). Since validation of that kind is the real test of the performance of models, it is important that the pre-operational projections of models are compared with subsequent experience at operational wind farms. The nature of mathematical models lends them to refinement based on appropriate validation.

The general lack of model validation seems to result from a regulatory context in many jurisdictions whereby collision risk modelling is undertaken as a prerequisite to a consent decision, but once consent has been granted little further consideration is given to its estimates. However, it is also the case that a variety of factors present significant constraints on the capacity to accurately determine the total numbers of collisions that occur at operational wind farms for almost all species (see *Pre-requisites to validation*, below) and this can make it difficult to validate the forecasts of collision risk modelling.

One evaluation exercise undertaken across 46 small wind farms in Germany (Grünkorn et al. 2017) concluded that the Band model (Scottish Natural Heritage 2010a; b) substantially underestimated real numbers of fatalities for various species. In that study bird activity data was collected during operation of the wind farms rather than prior to construction and it is not apparent whether that may have influenced results.

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The Biosis avian collision risk model was developed in the early 2000s when commercial-scale wind energy was in its infancy in Australia. The model has been used to provide quantified assessment of the potential for various species of birds to collide with wind turbines for multiple proposed wind energy facilities since then.

Performance of the model can be evaluated only by comparing its forecasts of bird collision rates (generally prepared prior to wind farm construction) with rates experienced during the operation of wind farms. The latter requires post-construction mortality data of sufficient quality and quantity to permit estimation of annual mortality rate with high precision (see *Pre-requisites to validation*, below).

Background to turbine collision risk modelling

Quantitative modelling to estimate the number of collision mortalities of threatened birds is widely used as part of environmental impact assessments for proposed wind energy facilities (Huppop et al. 2006, Masden & Cook 2016, Smales 2017, Cook & Masden 2019).

Modelling of avian collision risk with wind turbines provides results measured as forecasts of the per annum average number of individual birds that may collide with turbines at a proposed wind energy facility. The forecasts are usually of very low numbers and, by the application of a range of avoidance rates (see below), a range of results is routinely provided. Frequently this range is quite narrow and, as in the examples set out here, is for an impact of within one or two individuals per annum. To the best of our knowledge, no other form of environmental impact assessment for fauna in Australia requires forecasts with this level of precision for the number of individual animals that may be impacted by a proposed action.

A modelling approach to collision risk allows the incorporation of uncertainties. These relate to imperfect knowledge about the behaviours of birds in the presence of a proposed wind farm. All modelling of this type entails the use of assumptions, but the use of a mathematical modelling approach for avian collision risk requires that necessary assumptions are based on available empirical information. Hence, collision risk is best modelled only for species for which empirical data about their flight activity has been obtained from the site of a proposed wind farm, ideally during a period sufficient to encompass a range of seasonal and other environmental conditions.

Mathematical modelling of risk is intended to provide an articulated and replicable evaluation of what may occur in the real world. The rationale behind predictions is explicitly stated in the mathematics of the model, which means that the logical consistency of the predictions can be evaluated. The explicit nature of inputs and rigour entailed in modelling means that the process is replicable, consistent and open to analysis, criticism or modification when new information becomes available. Although it is necessary to include some assumptions and arbitrary choices when deciding on the structure and parameters of a model, these choices are explicit.

Collision risk modelling incorporates multiple variables and uses specifications of the wind farm and of turbines, along with values for size and speed of particular species, and data for flight heights and flight

frequency collected during dedicated investigations at the site. The outputs of the model are numerical estimates of the rates of annual mortalities of relevant species of birds due to turbine collisions.

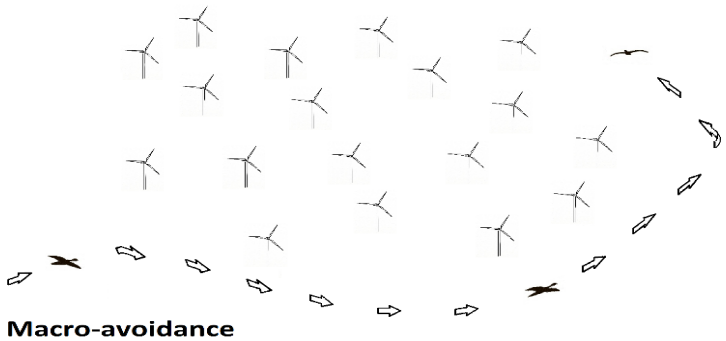
The modelling process uses data specific to particular turbines and relevant species of birds recorded at the wind farm site. Bird flight data represent a sample of the flight activity of particular species measured against time and airspace. In subsequent collision risk modelling, the sample of bird flights obtained from the site are extrapolated to provide per annum rates of flights that might interact with the total number of turbines proposed for the wind farm.

Avoidance rates

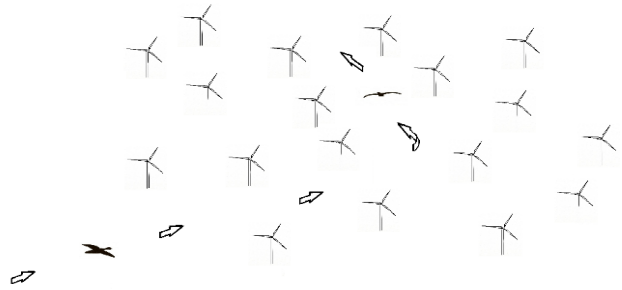
Avoidance rate is the capacity for a bird to avoid a collision (Cook et al. 2014), whether that occurs due to a cognitive response on the part of a bird or by chance (Martin 2011).

Birds are generally adept at avoiding obstacles within their flight space but the capacity of a bird to avoid a collision is clearly an important element in consideration of this risk. 'Avoidance' is recognised at different spatial scales. The best definitions of these are provided by Cook et al. (2014) and are summarised as follows: (1) macro-avoidance occurs when a bird responds to the presence of an entire wind farm by flying around or over it; (2) meso-avoidance refers to the response in which birds fly within the overall wind farm but avoid collisions by choosing to fly only in the airspace between turbines, or in the space below rotor-sweep; and (3) micro-avoidance happens when a bird, flying in close proximity to a turbine and that is otherwise on a collision course, does not in fact collide with the turbine. These were illustrated by Smales (2017) and are reproduced here as Figure 1.

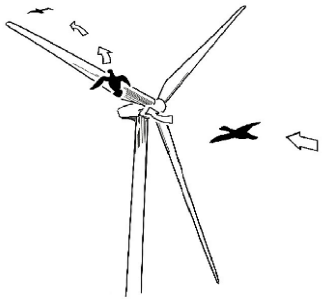
Macro-avoidance is a simple measure of displacement of birds from the area occupied by an operational wind farm. Micro-avoidance may include cognitive behaviour in which a bird becomes aware of danger and takes evasive action, or simple chance resulting in inadvertent safe passage between turbine blades. Data for bird flight activity is collected at the site of a proposed wind farm in the absence of any turbines and thus without any avoidance. For this reason, avoidance rates applied in risk modelling must encompass the potential for avoidance at all three spatial scales.



Macro-avoidance



Meso-avoidance



Micro-avoidance

Figure 1 Three spatial scales at which avoidance of collision may occur (Smales 2017).

An avoidance parameter is incorporated into the collision risk model by scaling the number of movements at risk by (1 – v), where perfect avoidance capacity equates to 1.0, and v is a measure of the rate at which birds avoid turbines. Thus, an avoidance rate of 0.90 equates to one flight in 10 in which a bird does not avoid a turbine; an avoidance rate of 0.98 equates to one flight in 50 in which a bird does not avoid a turbine, and an avoidance rate of 0.99 equates to one flight in 100 in which a bird does not avoid a turbine.

Ideally, empirical data from observational investigations of birds flying within an operating wind farm would provide 'real' rates at which birds avoid turbine collisions at the various spatial scales. However, as discussed by various authors (Chamberlain et al. 2006; Madders & Whitfield 2006; Cook et al. 2012, Smales 2017), it has proven difficult to obtain empirical data for actual turbine avoidance rates from observational

studies. At least in part, this is because, while human observers very rarely document collisions, they experience difficulty in determining the precise flight path of a bird and whether it is actually on a potential collision course, and hence whether avoidance of any kind was involved when no collision occurs.

Owing to the difficulties associated with observational studies of avoidance, avoidance rates have usually been determined not from direct observations of the behaviour of birds within a wind farm, but by an indirect derivation in which an 'avoidance rate' is calculated from the difference between the collision rate projections of a model and the number of fatalities that actually occur (Whitfield 2009; Band 2012; Cook et al. 2012, 2014; Grünkorn et al. 2017; Smales 2017). That is: avoidance rate = 1 – (actual deaths/predicted deaths assuming no avoidance). This approach has a number of problems. Estimation of the total number of deaths at onshore wind farms is based on the number of collision carcasses detected during a search regime, and accounting for carcasses missed by searchers and lost to scavengers. While methods to account for searcher efficiency and carcass persistence have improved (e.g. Huso et al. 2017), the process most often results in mortality estimates with very large confidence intervals. As a consequence, a derived avoidance rate will be imprecise. In addition, the simple difference between the number of fatalities predicted and those experienced may include multiple factors other than avoidance and will also encompass any error in the model (Whitfield 2009; Hull & Muir 2013; Cook et al. 2014; Grünkorn et al. 2017; Smales 2017).

Some advances have been made recently in efforts to obtain empirical data for actual collisions (e.g. Coppack et al. 2015; Cullinan et al. 2015; Larkin 2015; Perrow et al. 2015; Skov et al. 2018). Such studies describe methods using technologies such as fixed pencil-beam radar in combination with an infrared-sensitive camera system, automated thermal imaging, multidimensional radar and Global Positioning System (GPS) boat-based tracking to detect and record collisions and birds' avoidance of collisions at offshore wind farms. While similar technologies have begun to be applied at a few onshore Australian wind farms to achieve targeted curtailment of turbines when a bird is detected in close proximity to a turbine, they have not been applied to ascertain avoidance rates.

In the Biosis model, the turbine is decomposed into its static and dynamic components. The entire turbine (including the tower, nacelle and the rotor when stationary) represents the static component. The dynamic component is the volume swept by the leading edge of the rotor blades in the time it takes a bird of a given length and flight speed to pass across the depth of the rotor-swept disk. Static components (i.e. the stationary turbine) are considered to pose minimal collision risk as they are very likely to be seen and avoided by birds in flight. The dynamic component of the sweeping rotor blades is considered to represent higher risk due to their speed and the likely difficulty of a bird in flight avoiding them. The model takes the two elements into account by allocating different avoidance rates to them.

Model result metrics

Collision risk results are projections extrapolated from the sampled rates of flight activity of a particular species. With the incorporation of a site population estimate, the model's results are expressed as the average number of potential collisions by individual birds that may occur per annum for the various

modelled avoidance rates.

Results are shown to one or more decimal places as per original modelling. This is done for the purposes of indicating differences between results rather than to indicate precision in the results.

The model is necessarily deterministic, but it is important to note that if collisions occur at the operational wind farm their numbers can be expected to vary around a long-term mean for any species.

At present, there are no avoidance rates obtained from empirical studies available for any species of Australian bird. For this reason, results of the Biosis collision risk model are routinely provided for a range of dynamic avoidance rates, often from 0.90 or 0.95 to 0.99.

Model validation

Pre-requisites to validation

Performance of the model can be evaluated only by comparing its forecasts of bird collision rates (generally prepared prior to wind farm construction) with rates experienced during operation of the wind farm. The latter requires post-construction mortality data that is sufficient to permit calculation of a quite precise annual mortality rate. Conditions of regulatory approval for most wind farms that have been built to-date in Australia have varied considerably within and between State jurisdictions and over time. While post-construction monitoring of bird collisions with wind turbines and periodic estimation of total strike rates have been regulatory conditions of approval for many wind energy projects, there has been no standard methodology for these (Moloney et al. 2019) and the consequent variation in reported results has hampered capacity to validate forecasts of the model.

Post-construction monitoring of bird mortalities is a sampling exercise and it is always likely that only a portion of the total number of collision victims will be detected even by well-designed and effective regimes of carcass searches. Factors influencing this include the rate at which carcasses disappear due to scavengers or natural decay; the capacity of searchers to find carcasses; the interval between regular searches and, the portion of the turbine array which is searched. Estimates of total mortality, based on the number of carcasses detected, take account of these additional factors but all of them encompass uncertainty. Worldwide evidence indicates that bird collisions with wind turbines are relatively rare events and for any given species, the number of carcasses detected is most often very low. For each of 56 species of birds, Moloney et al. (2019) document a mode of just 1 fatality detected during monitoring of a combined total 15 wind farms, each of which was monitored for between 2 and 3.5 years. As a consequence, estimates of total collision mortality for birds most often have confidence intervals that may be orders of magnitude greater than the number of carcasses detected. Another consequence of low numbers of collisions is that annual averages of fatalities are prone to significant influence of inter-annual variability (Huso et al. 2017; Moloney et al. 2019).

For these reasons, the ideal species to use in evaluation of the model's performance will be one that has the following characteristics:

- is not favoured by scavengers so that carcasses are likely to persist and be found
- is readily detected by searchers
- has a relatively high collision rate

These characteristics provide data allowing for greater confidence when the number of carcasses detected is used as the basis for calculating an estimate of total collision fatalities.

A recent study of bird carcass persistence at Yaloak South wind farm in southern Victoria (Elmoby Ecology Bennett 2019; 2020; 2021) placed multiple bird carcasses over a period spanning four years and used remote cameras to monitor their persistence. The study included a total of 24 Wedge-tailed Eagle *Aquila audax* carcasses that were monitored until no evidence of the carcasses remained. This was the first substantial investigation using eagle carcasses in Australia.

The study found that Wedge-tailed Eagle carcasses had a mean persistence time of 260 days with a 95% confidence interval of between 119 and 567 days, whereas for all small and medium-sized birds (including some small raptors) mean persistence time was 2.8 days with a 95% confidence interval of between 2 and 4 days.

It was found that the Red Foxes *Vulpes vulpes*, the principal scavenger of bird carcasses at the site, ignored Wedge-tailed Eagle carcasses. The one potential scavenger detected was other Wedge-tailed Eagles, however they did not remove carcasses, which substantially remained in place (E. Bennett pers. comm.). The Elmoby Ecology Bennett reports conclude that there was a high level of confidence that all Wedge-tailed Eagles killed by collision with wind turbines were found and thus that the number of eagles detected were highly likely to reflect the total number of collisions by the species. A similar conclusion was previously drawn for Wedge-tailed Eagle collisions at Bluff Point and Studland Bay wind farms in Tasmania (Hydro Tasmania 2013; Hull et al. 2013) (see below), albeit it without the corroborating evidence from carcass persistence trials using eagles. At those two wind farms scavenger-exclusion fences were in place around a radius of a subset of turbines and they prevented removal of collision carcasses by mammals such as Tasmanian Devils *Sarcophilus harrisii*.

The Wedge-tailed Eagle is one of a very small number of species that experience a relatively high turbine collision rate. Moloney et al (2019) document a total of 58 Wedge-tailed Eagles found during carcass searches at 15 wind farms that were each monitored for between 2 and 3.5 years.

Wedge-tailed Eagles maintain large territories and, by comparison with many other bird species, occur at low densities. These factors along with their flight behaviour and the capacity to readily distinguish adults from younger birds, makes it relatively straightforward to estimate with good precision the number of Wedge-tailed Eagles utilising a wind farm site. The ability to make such an estimate is a key requirement allowing the Biosis model to provide an output in terms of the number of individuals at risk per annum.

No displacement of eagles is apparent at any operational wind farm studied in Australia and it thus appears that macro-avoidance does not have an influence on collision risk for eagles here.

All of these aspects serve to make the Wedge-tailed Eagle a good species for use in validation of the Biosis collision risk model. For the reasons set out above, estimates of total mortalities for the species (by others) are considered to closely equate to the numbers of carcasses detected and to have small 95% confidence intervals. This means that comparisons of model projections and actual mortalities described below, allow avoidance rates to be derived with a high degree of confidence.

Comparing the model's predictions with empirical data – case histories

The Biosis model has been used to provide projections of potential collisions by Wedge-tailed Eagles and/or White-bellied Sea-eagles *Haliaeetus leucogaster* as part of environmental impact assessments for the following projects:

- Codrington Wind Farm, Victoria
- Bluff Point Wind Farm, Tasmania
- Studland Bay Wind Farm, Tasmania
- Yaloak Wind Farm, Victoria
- Yaloak South Wind Farm, Victoria
- Musselroe Wind Farm, Tasmania
- Cattle Hill Wind Farm, Tasmania
- Low Head Wind Farm, Tasmania
- Kentbruck Wind Farm, Victoria

Codrington, Bluff Point, Studland Bay, Yaloak South, Musselore and Cattle Hill wind farms have all been operational for a number of years. Codrington was the first commercial scale wind farm built in Australia. Carcass searches were undertaken there under seven turbines for just seven months. No eagle carcasses were found. Yaloak Wind Farm did not proceed as proposed but was replaced by the smaller Yaloak South Wind Farm. Collision risk modelling for Cattle Hill Wind Farm was undertaken for a proposal with more than twice the number of turbines that were subsequently installed. Cattle Hill also operates a successful automated system to detect either species of eagle and curtail turbines whilst an eagle is within a predetermined proximity of a turbine (Goldwind 2022). This system facility was not envisaged at the time of the modelling. As a consequence of the differences between the proposed and actual wind farm, the model results were for a greater number of eagle mortalities than have been reported from the operational wind farm. Low Head Wind Farm is not yet operational and planning processes for Kentbruck are in process at the time of writing.

The Biosis model was used to provide projections of potential collisions by Wedge-tailed Eagles for four of these wind farms where intensive carcass searching was subsequently undertaken and for which results are publicly available. They are Bluff Point, Studland Bay, Musselroe and Yaloak South wind farms. At the first three of these, White-bellied Sea-eagles were also resident and modelling was also provided for that species and mortality results for it are also published. We consider it is likely that the factors that make the

Wedge-tailed Eagle particularly suitable for use in validation of the model apply equally to the White-bellied Sea-eagle and the following case examples provide details for both species.

Eagle flight activity data was collected by Biosis prior to wind farm construction at Bluff Point, Studland Bay and Musselroe wind farms. At Yaloak South Wind Farm, eagle flight activity data was collected by others during 2006. Biosis collected additional data in 2009 and 2010. In all cases Biosis prepared the collision risk modelling. Carcass searches during the operation of the wind farms were undertaken by other parties in all cases.

Data for the results of carcass searches for eagles were provided by wind farm operators and/or consultant reports prepared by those parties.

Bluff Point and Studland Bay wind farms

Substantial investigations of the Tasmanian subspecies of Wedge-tailed Eagle *Aquila audax fleayi* and White-bellied Sea-eagle have been undertaken at Bluff Point and Studland Bay Wind Farms operated by Woolnorth Renewables in north-western Tasmania. These included utilisation surveys designed to measure eagle activity before and after development of the wind farm; collision carcass monitoring; eagle breeding success; and eagle behaviours and movements relative to turbines. Details of design and outcomes of these are provided in annual environmental performance reports prepared by Woolnorth Renewables and its predecessors. Hull et al. (2013) detail a specific study of eagle behaviour during early years of the operation of the two wind farms. Commissioning of turbines began at Bluff Point Wind Farm in 2002 and at Studland Bay Wind Farm in 2007. Bluff Point Wind Farm consists of 37 Vestas V66 turbines in a scattered array on an area of 1,524 ha. Studland Bay Wind Farm is situated 3 km south of Bluff Point and comprises 25 Vesta V90 turbines in a scattered array over an area of 1,410 ha. Both wind farms are close to the coast and both species are resident at both sites.

Monitoring eagle flights

Flight activity data for both species were collected during 20-minute point counts at Bluff Point Wind Farm site during three years prior to construction of turbines and in four years after they commenced operating. At Studland Bay, they were collected in six years prior to turbine construction and in three years after turbines commenced operation. As prescribed by regulatory authorities, point counts were undertaken in autumn and spring. Ten replicate point counts were made in each season at each of 18 locations within each wind farm. There were 545 point counts undertaken at Bluff Point between 1999 and 2007 and 854 point counts at Studland Bay between 1999 and 2009.

Collision risk model results

The model was used to estimate risk for populations of six Wedge-tailed Eagles and four White-bellied Sea-eagles at each of the two wind farms.

State regulatory authorities required that the collision risk model be re-run with the accumulated sum of eagle movement data obtained during the entire period of both pre-construction and operation of the two of the two wind farms spanning the period from 1999 to 2009 (Table 1). As the numbers of eagles using the sites were not apparently affected, it was reasonable to pool the data from both periods. Static avoidance was modelled at a rate of 0.99 in all cases and dynamic avoidance at 0.90; 0.95; 0.98 and 0.99 (Biosis Research 2008, 2010; Smales et al. 2013). The model results are shown in Table 1.

Table 1. Modelled mean annual turbine collision estimates for White-bellied Sea-eagle and Wedge-tailed Eagle at Bluff Point and Studland Bay Wind Farms for four avoidance rates.

	White-bellied Sea-eagle		Wedge-tailed Eagle	
Avoidance rate	Bluff Point	Studland Bay	Bluff Point	Studland Bay
0.90	0.9	0.8	2.7	1.9
0.95	0.5	0.4	1.5	1.1
0.98	0.2	0.2	0.7	0.5
0.99	0.1	0.1	0.4	0.3

Documented eagle collisions

Carcass monitoring surveys were conducted at Bluff Point and Studland Bay wind farms from when they commenced operating. Fences to exclude mammalian scavengers were maintained at 27% of turbines across the two sites. All turbines, both fenced and unfenced, were searched routinely within a 100 m radius of the tower base. Red Fox does not occur in Tasmania but native mammals with capacity to scavenge eagle carcasses include the Tasmanian Devil *Sarcophilus harrisi* and Spot-tailed Quoll *Dasyurus maculatus*. The region of the wind farms is an area where facial tumour disease has had little impact on the Tasmanian Devil population.

The frequency of carcass searches was informed by trials to determine rates of loss to scavengers and of observers' capacity to detect carcasses. From 2007, searches were carried out twice weekly during periods that may have represented higher risk to the species (i.e. eagle courtship display period June – August, inclusive, and eagle fledging period mid December – February, inclusive) and fortnightly outside these periods (Hull et al. 2013). Carcass searches were undertaken by human observers. Searches were carried out at Bluff Point in eleven years (2003 – 2013, inclusive) and at Studland Bay they were carried out in seven years (2007 - 2013, inclusive).

Assessment of the extent of undetected eagle collisions (Woolnorth Wind Farm Holding 2013) concluded that it is unlikely that significant numbers of eagle carcasses were missed because they are conspicuous; the search zone around turbines was adequate to detect eagle carcasses where they fell after colliding with turbines (Hull and Muir 2010); personnel on site had capacity to detect carcasses that may have been moved from formal search zones; eagle carcasses in vegetation were found not to decompose readily and,

even when scavenged, remains were identifiable; and, while mammalian scavengers could remove carcasses this was controlled at the subset of fenced turbines; survey intensity was informed by predetermined scavenger removal rates; and, while a small number of eagles survived collision with a turbine, in all documented cases such birds were unable to fly and are likely to have been detected as both scavenger exclusion or farm fences prevented them from leaving the immediate area. The empirical results of eagle carcass persistence trials recently provided by Elmoby Ecology Bennett (2021) corroborate the conclusions of Hydro Tasmania (2013) and Hull et al. (2013).

Table 2 shows the numbers of carcasses of the two species detected at the two sites for each year of monitoring.

Table 2. Numbers of collision mortalities of two species of eagle detected during targeted searches at Bluff Point and Studland Bay Wind Farms.

	Bluff Point		Studland Bay	
Year	White-bellied Sea-eagle	Wedge-tailed Eagle	White-bellied Sea-eagle	Wedge-tailed Eagle
2003	0	1		
2004	0	0		
2005	0	0		
2006	0	6		
2007	0	1	0	3
2008	1	3	0	1
2009	1	1	0	0
2010	0	1	0	1
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
total	2	13	0	5

Mean annual mortality rates and associated 95% confidence intervals for both species at the two wind farms are shown in Table 3.

Table 3. Mean annual mortality rates and variance for eagle species based on carcasses detected at Bluff Point and Studland Bay wind farms.

	White-bellied Sea-eagle		Wedge-tailed Eagle	
Year	Bluff Point	Studland Bay	Bluff Point	Studland Bay
mean annual mortalities	0.18	0.00	1.18	0.71
annual variance (95% C.I.)	0.01-0.41	-	0.15-2.22	0.00-1.48

Comparison of collision risk model estimates with actual mortality rates

Estimates of annual collisions modelled for avoidance rates between 0.90 and 0.99 correctly encompassed the long-term average of real collisions for both species at the two wind farms. The 95% confidence intervals associated with the average real collision rates were entirely encompassed by the model's estimates.

Comparison of the model's projections (Table 1) with the annual average documented collision rates (Table 3) indicate the following:

- For White-bellied Sea-eagle at Bluff Point the annual average of actual mortalities (0.18) is slightly lower than the model's projections for an avoidance rate of 0.98 (0.2 collisions p.a.)
- No White-bellied Sea-eagle collisions were recorded during five years of monitoring at Studland Bay so the model's estimates are higher than actual experience for that species there.
- For Wedge-tailed Eagle at Bluff Point the annual average of actual mortalities (1.18) is between the model's projections for an avoidance rate of 0.95 and 0.98 (1.5 – 0.7 collisions p.a.) and most closely approximates an avoidance rate of 0.96.
- For Wedge-tailed Eagle at Studland Bay the annual average of actual mortalities (0.71) is between the model's projections for an avoidance rate of 0.95 and 0.98 (1.1 – 0.5 collisions p.a.) and most closely approximates an avoidance rate of 0.97.

Hull and Muir (2013) documented turbine avoidance from observations of eagle activity at these two wind farms. They found that White-bellied Sea-eagles showed empirical avoidance rates of 0.89 and 0.97 at Studland Bay and Bluff Point, respectively, and that Wedge-tailed Eagles had empirical avoidance rates of 0.81 and 0.90, at Studland Bay and Bluff Point, respectively. These values are as expected because they indicate that the principal avoidance they documented was meso-avoidance (the rate at which the birds flew within the wind farm but avoided close proximity to turbines). However, as a small number of collisions occurred at the wind farms, it is evident that some eagles did, in fact fly within the rotor-swept zone of turbines. This indicates that in addition to meso-avoidance, a level of micro-avoidance occurs. This additional level of avoidance serves to increase the overall avoidance rate of eagles at the wind farms. It is therefore reasonable to assume that the overall avoidance rates for the two species would be higher than the meso-avoidance rates documented by Hull and Muir (2013).

Musselroe Wind Farm

Substantial investigations have been undertaken at Musselroe Wind Farm operated by Woolnorth Renewables at Cape Portland in north- eastern Tasmania. These have included utilisation surveys designed to measure eagle activity before and after development of the wind farm; collision carcass monitoring; eagle breeding success; eagle behaviours and movements relative to turbines and investigations and trails aimed at reduction of collisions. Details of design and outcomes of these are provided in annual

environmental performance reports prepared by Woolnorth Renewables and its predecessors. Commissioning of turbines began at Musselroe Wind Farm in 2013. The wind farm consists of 56 Vesta V90 turbines in a scattered array. The wind farms is close to the coast and both species are resident at the site.

Monitoring eagle flights

Flight activity data for both species were collected during timed point counts at Musselroe Wind Farm site during three years prior to construction of the wind farm. Data were recorded from nine point count locations during 2002 and then at 19 fixed point count locations, including the original nine sites, during 2005 and 2006.

Collision risk model results

The model was used to estimate risk based on movement data for populations of eight Wedge-tailed Eagles and eight White-bellied Sea-eagles at the wind farm.

Collision risk modelling was undertaken for a number of turbine configurations under consideration in 2011 (Biosis Research 2011). That included the design that was subsequently built and has been operational since 2013. Static avoidance was modelled at a rate of 0.99 in all cases and dynamic avoidance at 0.90; 0.95; 0.98 and 0.99. The model results are shown in Table 4.

Table 4. Modelled mean annual turbine collision estimates for White-bellied Sea-eagle and Wedge-tailed Eagle at Musselroe Wind Farms for four avoidance rates.

Avoidance rate	White-bellied Sea-eagle	Wedge-tailed Eagle
0.90	0.53	2.05
0.95	0.31	1.23
0.98	0.17	0.69
0.99	0.13	0.50

Documented eagle collisions

Carcass monitoring surveys were conducted at Musselroe Wind Farm since it commenced operating. All turbines were searched routinely within a 100 m radius of the tower base. Native mammals with capacity to scavenge eagle carcasses include the Tasmanian Devil and Spot-tailed Quoll. Tasmanian Devils have remained quite prevalent at Musselroe Wind Farm (Driessen et al. 2018).

As required by the State and Commonwealth regulators, the monitoring regime for detecting bird collisions at wind turbines during the period from 2013 to 2017 differed in intensity across the site in line with perceived risk. Six turbines in the north-west of the array were monitored twice weekly during periods that were regarded as high risk for migratory waders (during the portion of the year in which those species are present in Australia and utilised nearby wetlands). Outside these periods and across the rest of the wind

farm, each turbine was searched once every eight weeks, using a regime in which a quarter of the turbines were searched every two weeks (Woolnorth Wind Farm Holding 2014). After it became evident that migratory waders were not materially at risk of turbine collisions, from November 2017 a change to the search regime was approved and from then all turbines have been searched once every eight weeks, using a regime in which a quarter of the turbines were searched every two weeks (Woolnorth Wind Farm Holding 2019). Carcass searches were undertaken by human observers. Searches have been carried out at Musselroe in 10 years (2013 – 2022, inclusive (Woolnorth Renewables 2022).

Assessment of the extent of undetected eagle collisions at Musselroe is outlined in Woolnorth Wind Farm Holding (2016). Searcher efficiency trials and carcass persistence trials were undertaken and results for eagles is reported to have been similar to that at Bluff Point and Studland Bay wind farms where searcher efficiency for large birds was 98%. Carcass persistence trials at Musselroe demonstrate there was an average time to complete disappearance of 80 days with a 95% confidence interval of between 74 and 86 days. As each turbine was surveyed every 8 weeks, these trials indicate that the majority of eagle collision fatality carcasses would have been detectable during at least one or more surveys. Results of the trials indicate there is a high probability that the great majority, if not all, eagle carcasses have been detected.

Table 5 shows the numbers of carcasses of the two species detected at the two sites for each year of monitoring.

Table 5. Numbers of collision mortalities of two species of eagle detected during targeted searches at Musselroe Wind Farm.

Year	White-bellied Sea-eagle	Wedge-tailed Eagle
2013	1	2
2014	0	0
2015	0	4
2016	0	1
2017	0	2
2018	0	2
2019	0	8
2020	0	7
2021	1	0
2022	0	3
total	2	29

Mean annual mortality rates and associated 95% confidence intervals for both species at the two wind farms are shown in Table 6.

Table 6. Mean annual mortality rates and variance for eagle species based on carcasses detected at Musselroe Wind Farm.

Year	White-bellied Sea-eagle	Wedge-tailed Eagle
mean annual mortalities	0.20	2.90
annual variance (95% C.I.)	0.00-0.45	1.30-4.50

Comparison of collision risk model estimates with actual mortality rates

Estimates of annual collisions modelled for avoidance rates between 0.90 and 0.99 correctly encompassed the long-term average of real collisions for White-bellied Sea-eagle at the wind farm. The 95% confidence intervals associated with the average real collision rates were entirely encompassed by the model's estimates for that species.

Comparison of the model's projections (Table 4) with the annual average documented collision rates for White-bellied Sea-eagle (Table 6) indicate that:

- For White-bellied Sea-eagle at Musselroe the model's projections for an avoidance rate of slightly less than 0.98 (0.17 collisions p.a.) closely approximates the annual average of actual mortalities (0.20).

The model's estimates of annual collisions for Wedge-tailed Eagle at avoidance rates between 0.90 and 0.99 were a little lower than the mean annual number of collisions that occurred.

Comparison of the model's projections (Table 1) with the annual average documented collision rates for Wedge-tailed Eagle (Table 3) indicate that:

- At Musselroe the model's projections for an avoidance rate of 0.90 (2.05 collisions p.a.) was lower than the annual average of actual mortalities (2.90).

While the model's forecasts are lower than the annual average of actual mortalities known to have occurred, they are still close to that value. As noted above, annual averages of fatalities are prone to significant influence of inter-annual variability. In the case of Wedge-tailed Eagles at Musselroe, there were eight years in which mortalities detected were between 0 and 4 and two years in which there were 7 and 8 known mortalities. It is not known whether this degree of variation may continue over the life of the wind farm, but it remains plausible that the model's projections will encompass the annual average of actual mortalities over that timespan.

Yaloak South Wind Farm

Yaloak South Wind Farm is operated by Pacific Hydro Pty Ltd near Ballan in western Victoria. The wind farm consists of 14 Senvion MM92 turbines in a scattered array. The wind farm property and immediate vicinity have a high degree of topographic variability including a significant escarpment associated with the Parwan

Valley. The wind farm is situated on the plateau above the escarpment. The local area is attractive to Wedge-tailed Eagles as its topography creates thermal uplift for soaring and local land uses provide substantial food resources. Studies of the species there have included utilisation surveys designed to measure eagle activity before and after development of the wind farm; collision carcass monitoring; eagle breeding success; eagle behaviours and the most comprehensive and long-term investigations of eagle carcass persistence and searcher efficiency undertaken in Australia. Details of design and outcomes of these are provided in reports prepared by consultants for Pacific Hydro (Biosis 2019; Elmoby Ecology Bennett 2019, 2020, 2021). The wind farm reached practical completion in 2018 and a three-year post-construction program of monitoring of eagles commenced in July 2018.

Monitoring eagle flights

Flight activity data for Wedge-tailed Eagles were obtained during point counts undertaken during 2006 and between July 2009 and March 2010. Ten point count locations were used for a total of 543 x 20-minute counts.

Collision risk model results

The model was used to estimate risk based on movement data for a Wedge-tailed Eagle population in which an average of six birds using the site for 90% of the year and fifteen birds using the site for 10% of the year. These values were agreed to by State regulators prior to final modelling undertaken as part of environmental assessment of the proposed wind farm.

Static avoidance was modelled at a rate of 0.99 in all cases and dynamic avoidance at 0.90; 0.95; 0.98, 0.99 and 0.998. The model results are shown in Table 7.

Table 7. Modelled mean annual turbine collision estimates for Wedge-tailed Eagle at Yaloak South Wind Farms for five avoidance rates.

Avoidance rate	6 Wedge-tailed Eagles (90% of year)	15 Wedge-tailed Eagles (10% of year)	Combined annual total collisions
0.90	4.4	0.9	5.3
0.95	3.2	0.5	3.7
0.98	2.0	0.3	2.3
0.99	1.5	0.2	1.7
0.998	0.3	0.0	0.3

Documented eagle collisions

Carcass monitoring surveys were conducted at Yaloak South Wind Farm since it commenced operating. All turbines were searched routinely to cover a horizontal radius of 60 metres centered on the base of the

turbine tower. On the basis of analyses of Huso and Dalthorp (2014) this search zone was selected to encompass more than 95% of collision carcasses for the dimensions of turbines at the wind farm.

As required by State regulators, the monitoring regime for detecting bird collisions at wind turbines differed in frequency over time in response to the findings of preceding search periods. Carcass surveys were conducted by trained detection dogs and their handlers weekly between July 2018 and June 2019, fortnightly between June 2019 and December 2019 and monthly from January 2019 to June 2021, inclusive, at all 14 turbines. Additional 'pulse' surveys were conducted between November and May in each of the three years of the program for the detection of bats, but also documented all birds found. A total of 1355 surveys were undertaken at the 14 turbines over the three-year period.

Overall, searches were carried out at Yaloak South in three years (from July 2018 – June 2021, inclusive (Elmoby Ecology Bennet 2021).

As discussed previously, investigations at Yaloak South included study of bird carcass persistence and searcher efficiency (Elmoby Ecology Bennett 2019; 2020; 2021), with a specific focus on Wedge-tailed Eagles and was the first substantial investigation using eagle carcasses in Australia. The study found that Wedge-tailed Eagle carcasses had a mean persistence time of 260 days with a 95% confidence interval of between 119 and 567 days, whereas for all small and medium-sized birds (including some small raptors) mean persistence time was 2.8 days with a 95% confidence interval of between 2 and 4 days. The Elmoby Ecology Bennett reports conclude that there was a high level of confidence that all Wedge-tailed Eagles killed by collision with wind turbines were found and thus that the number of eagles detected was highly likely to reflect the total of collisions by the species.

Table 8 shows the numbers of Wedge-tailed Eagle carcasses detected at the site for each year of monitoring.

Table 8. Numbers of collision mortalities of Wedge-tailed Eagles detected during targeted searches at Yaloak South Wind Farm.

Year	Wedge-tailed Eagle
2018/19	4
2019/20	3
2020/21	4
total	11

The mean annual mortality rate and associated 95% confidence intervals for the species at Yaloak South Wind Farm is shown in Table 9.

Table 9. Mean annual mortality rate and variance for Wedge-tailed Eagle based on carcasses detected at Yaloak South Wind Farm.

Year	Wedge-tailed Eagle
mean annual mortalities	3.62
annual variance (95% C.I.)	0.04-7.29

Comparison of collision risk model estimates with actual mortality rates

Estimates of annual collisions modelled for avoidance rates between 0.90 and 0.998 correctly encompassed the long-term average of real collisions for Wedge-tailed Eagle at the wind farm. The 95% confidence intervals associated with the average real collision rates were largely encompassed by the model's estimates for the species.

Comparison of the model's projections (Table 7) with the annual average documented collision rates for Wedge-tailed Eagle (Table 9) indicate that:

- The model's projections for an avoidance rate of 0.95 (3.7 collisions p.a.) closely approximates the annual average of actual mortalities (3.62).

Conclusion

The Biosis collision risk model has provided forecasts of the annual average numbers of turbine collisions by Wedge-tailed Eagle and White-bellied Sea-eagle. Comparison of the forecasts with data for known and estimated total collisions from targeted carcass searches at four operational wind farms indicate that results of the model for the range of avoidance rates reported were accurate and in every case the forecasts were precise to within less than one Wedge-tailed Eagle collision per annum and were more accurate for White-bellied Sea-eagles.

It is not feasible to make similar comparisons for the great majority of bird species that may interact with wind turbines in Australia due to a high degree of uncertainty about the true numbers of collisions that occur. The factors influencing uncertainty are outlined in *Pre-requisites to validation*, above. Careful and refined design of carcass search regimes, such as standard use of pulse searches, and the application of appropriate, specific mathematical methods to the estimation of total collisions (e.g. Huso et al. 2017) should be used in efforts to reduce such uncertainties.

In 2006 the then Australian Government Department of the Environment and Heritage published reports by Biosis Research (2006) that provided methodologies for assessment of cumulative impacts due to turbine collisions of multiple wind energy facilities. Four species of birds, including the Tasmanian Wedge-tailed Eagle were used as examples of how this could work. That work was not prepared for, and was not used for, environmental impact assessment of any project. The exercise was undertaken for many wind

farms, including a significant number that were then mooted but have not since been carried to fruition and are no longer proposed. Some of the wind farms that have since been built differ from the designs that were then proposed. The reports noted the heuristic value of mathematical modelling. At the time of preparation of that work there was almost no empirical information about actual collisions by Wedge-tailed Eagles. The report said that it was likely that avoidance rates for Tasmanian Wedge-tailed Eagle would generally be in the range of 0.95 to 1.00 in most conditions. Then available information for the closely related Golden Eagle *Aquila chrysaetos* was cited that suggested an avoidance rate of greater than 0.99. At the request of the Department of the Environment and Heritage, the report provided modelling for avoidance rates of 0.95, 0.98 and 0.99, but also noted, "we recommend that [avoidance rate] is a key area requiring further soundly based investigation within operational wind farms." The case studies detailed above have used collision risk modelling that was prepared specifically for wind farms as designed and subsequently approved and now in operation. The comparisons with documented eagle collisions have achieved the recommendation of the 2006 Biosis Research report.

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